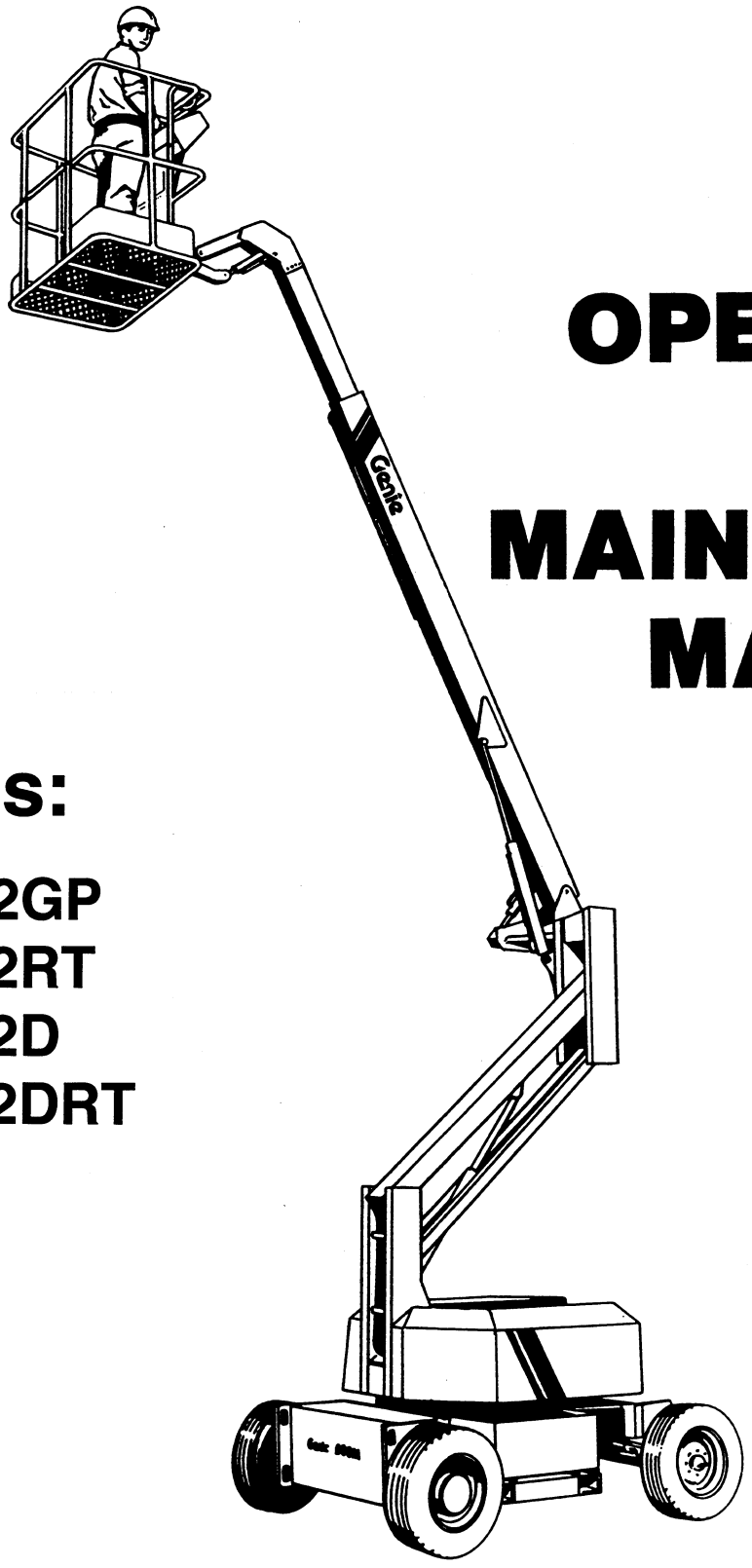
Genie BOOM
Z-45/22



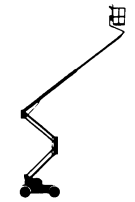
OPERATING AND MAINTENANCE MANUAL

Models:

- Z-45/22GP
- Z-45/22RT
- Z-45/22D
- Z-45/22DRT

Part No. 22417

Genie Industries



Self-propelled Booms



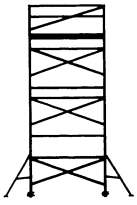
Self-propelled Vertical Lifts



Portable Aerial Work Platforms



Material Lifts



Scaffolds

CONGRATULATIONS!

You now own one of the most versatile self-propelled aerial work access tools on the market today--a Genie BOOM. Genie takes pride in designing products that stand for quality, value and service. You can be assured that your new Genie BOOM will offer all of these.

This manual has been prepared to assist you with the initial unpacking and operation of your Gas/Liquid Propane or Diesel model Genie BOOM Z-45/22. In addition, this manual will illustrate how to transport and troubleshoot the machine, as well as how to perform periodic maintenance.

We have tried to answer all possible questions and project any service situation that you might encounter. But, as with any publication of this type, we cannot guarantee that it is all inclusive. If you have a question or situation that has not been addressed in this manual, please contact us. WE RELY ON YOUR FEEDBACK!

Write: GENIE INDUSTRIES
Attention: Service Manager
18340 North East 76th Street
P.O. Box 69
Redmond, WA 98073-0069

Call: Toll free, 800-426-8089
In Washington state (206) 881-1800

Once again, congratulations on the purchase of your new Genie BOOM. We are confident it will provide you with quality, value and years of service.

Sincerely,

GENIE INDUSTRIES

Steve Gooding
Genie Service Manager

18340 NE 76th Street, P.O. Box 69, Redmond, Washington, U.S.A. 98073-0069 • (206) 881-1800 • FAX (206) 885-4638 • Telex 152351
Canadian Office: 340 Brooksbank Avenue, P.O. Box 86754, North Vancouver, B.C., Canada V7L4L3 • (604) 984-4242 • Fax (604) 988-2662
European Office: Market Place, Southwell, Nottinghamshire, England NG25 OHE • 0636-813943 • Fax 0636-815270

WE NEED YOUR INPUT

Your comments will help us improve future editions of this manual. Would you use this manual for a month or so, then answer the questions below, fold, drop in the mail and send them to us? We have included a postage paid envelope for your convenience. Thank you for your help, we appreciate it.

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2. What do you like most about this manual? Explain.

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4. How would you improve this manual?

5. Additional comments:

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INTRODUCTION

1.1 PURPOSE

This manual provides instructions for the operation and maintenance of the Genie BOOM Z-45/22GP, Z-45/22RT, Z-45/22D and Z-45/22DRT. Each section of this manual refers to all of these machines unless otherwise noted.

After reading this manual be sure to keep it as a ready reference. If you require further information:

Write: GENIE INDUSTRIES
Attn: Service Department
18340 North East 76th Street
P.O. Box 69
Redmond, WA 98073-0069

Call: Toll free, 800-426-8089
In Washington state (206) 881-1800

Telex: 152351

Fax: (206) 883-3475

We are happy to help you and answer any questions you may have about your Genie BOOM.

All information, illustrations and product descriptions contained in this manual are valid at the time of publication.

Genie Industries reserves the right to make changes in design, additions to, or improvements on any Genie products without imposing any obligation upon itself to retrofit previously manufactured products.

1.2 PRODUCT SPECIFICATIONS

The Genie BOOM is a two person self-propelled, integral frame, boom supported elevating work platform. All models of the Z-45/22 articulate, rotate and telescope above and beyond the base dimension to position personnel, along with their tools and materials, at the work location. A maximum platform height of 45 ft. (13.7 m) and horizontal reach of 22 ft. (6.7 m) are additional Z-45/22 features. Boom travel is from -22^{o} to $+73^{o}$ horizontally unrestricted.

Refer to specification chart on following page for addititional product specifics.

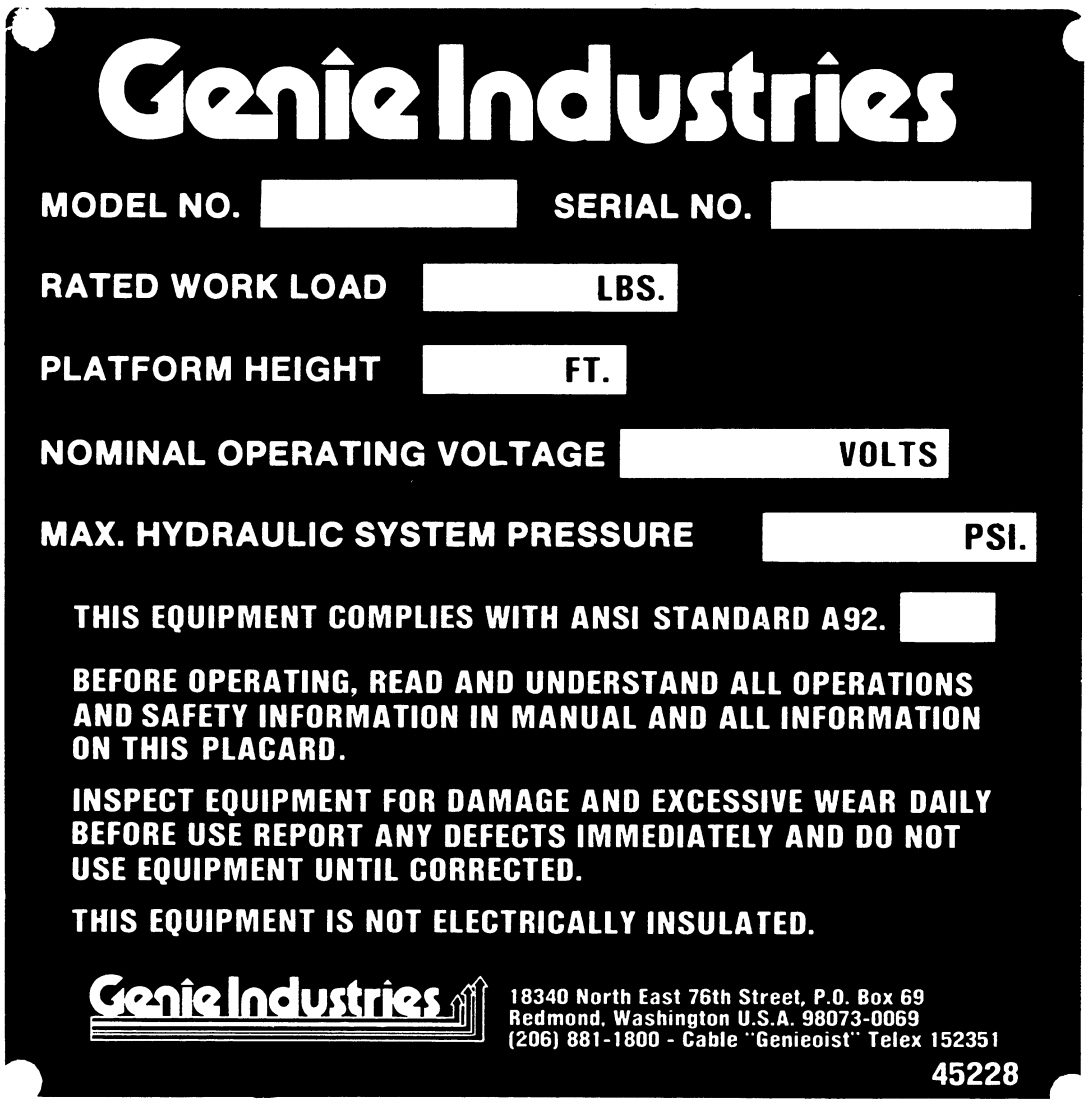
Section 1.2 **Product Specifications** Continued

Genie BOOM Z-45/22GP, Z-45/22RT, Z-45/22D & Z-45/22DRT Specifications

MODEL		Z-45/22GP	Z-45/22RT	Z-45/22D	Z-45/22DRT
Height-working max.	U.S.-ft.	52	52	52	52
	Metric-m	15.84	15.84	15.84	15.84
Height-platform max.	U.S.-ft.	45	45	45	45
	Metric-m	13.72	13.72	13.72	13.72
Height-stowed	U.S.-ft.	6'7"	6'8.5"	6'7"	6'8.5"
	Metric-m	2.01	2.04	2.01	2.04
Horizontal reach max.	U.S.-ft.	22	22	22	22
	Metric-m	6.70	6.70	6.70	6.70
Width	U.S.-ft.	5'10"	6'9"	5'10"	6'9"
	Metric-m	1.80	2.06	1.80	2.06
Length-stowed	U.S.-ft.	16'2"	16'2"	16'9"	16'9"
	Metric-m	4.93	4.93	5.11	5.11
Lift capacity (evenly distributed) +	U.S.-lbs.	500	500	500	500
	Metric-kg	226	226	226	226
Wheelbase	U.S.-ft.	6	6	6	6
	Metric-m	1.83	1.83	1.83	1.83
Turning radius (outside)	U.S.-ft.	14	14	14	14
	Metric-m	4.27	4.27	4.26	4.26
Turning radius (inside)	U.S.-ft.	7	7	7	7
	Metric-m	2.13	2.13	2.13	2.13
Turret rotation	Degrees	360°	360°	360°	360°
Turret tailswing		Zero	Zero	Zero	Zero
Power Source		24 Hp Engine	24 Hp Engine	20 Hp Diesel Engine	20 Hp Diesel Engine
		Gasoline/Liquid Propane	Gasoline/Liquid Propane	Diesel Fuel No. 2-D	Diesel Fuel No. 2-D
Travel speed-stowed +	U.S.-mph	0-4	0-4	0-4	0-4
	Metric-km/h	0-6.4	0-6.4	0-6.4	0-6.4
Travel speed-raised +	U.S.-mph	0-.8	0-.8	0-.8	0-.8
	Metric-km/h	0-1.3	0-1.3	0-1.3	0-1.3
Controls		12VDC Proportional	12VDC Proportional	12VDC Proportional	12VDC Proportional
Platform dimensions (length × width)	U.S.-in.	30 × 48	30 × 72	30 × 48	30 × 72
	Metric-m	.76 × 1.22	.76 × 1.83	.76 × 1.22	.76 × 1.83
Platform leveling		Self-Leveling	Self-Leveling	Self-Leveling	Self-Leveling
Platform rotation	Degrees	130°	130°	130°	130°
AC outlet in platform		Standard	Standard	Standard	Standard
Hydraulic pressure max. (drive functions)	U.S.-PSI	3650	3650	3650	3650
	Metric-kPa	25148	25148	25148	25148
Hydraulic pressure max. (boom functions)	U.S.-PSI	2000	2000	2000	2000
	Metric-kPa	13800	13800	13800	13800
Tires Front	U.S.-in.	9×14.5, 12 ply	31×15.5×13	9×14.5, 12 ply	31×15.5×13
	Metric-mm	229×368, 12 ply	787×394×330	229×368, 12 ply	787×394×330
Rear	U.S.-in.	9×14.5, 12 ply	31×15.5×15	9×14.5, 12 ply	31×15.5×15
	Metric-mm	229×368, 12 ply	787×394×381	229×368, 12 ply	787×394×381
Gradeability +		30%	30%	30%	30%
Ground clearance obstacle/high center	U.S.-in.	7.0/9.5	8.2/10	7.0/9.5	8.2/10
	Metric-mm	178/241	208/254	178/241	208/254
Hydraulic reservoir capacity	U.S.-gal.	12	12	12	12
	Metric-liter	45.4	45.4	45.4	45.4
Weight	U.S.-lbs.	13,000	13,000	13,000	13,000
	Metric-kg	5896	5896	5896	5896

+ In lift mode (platform elevated), the machine is designed for operation on firm level surfaces only.

1.3 IDENTIFICATION



The identification plate (above) is attached to the primary riser (at the time of manufacture) of every Genie. Refer to the following page for a complete description of each item listed on the plate.

Model No. Z - 45 / 22

Refers to lifting mechanism configuration

Maximum platform height (feet)

Maximum outreach (feet)

NOTE: *The "GP" (Gas/Propane), "RT" (Rough Terrain), "D" (Diesel) and "DRT" (Diesel/Rough Terrain) designations on the Genie BOOM Z-45/22 do not appear on the identification plate.*

Serial No.

This number identifies a particular machine with reference to the original owner. This number should always be referred to when requesting information or ordering service parts for the machine.

Rated Work Load

This is the maximum distributed platform capacity. It designates the maximum safe load which can be evenly distributed on the platform at any elevation.

Platform Height

This is the maximum attainable platform height and is measured from level ground surface to the floor of the platform.

Nominal Operating Voltage

The number stamped into this box designates the voltage at which the machine operates.

Maximum Hydraulic System Pressure

This is the maximum achievable operating hydraulic pressure.

ANSI

This is the standard of the **A**MERICAN **N**ATIONAL **S**TANDARD **I**NSTITUTE (ANSI) the machine complies to.

SAFETY

2.1 MANDATORY PRECAUTIONS

YOUR SAFETY IS GENIE'S UTMOST CONCERN. PLEASE MAKE CERTAIN EACH PERSON OPERATING OR SERVICING THE MACHINE READS AND UNDERSTANDS ALL OF THE FOLLOWING PRECAUTIONS. PLEASE DO NOT HESITATE TO CALL OUR SERVICE DEPARTMENT TOLL FREE AT 800-426-8089 IF YOU HAVE ANY QUESTIONS REGARDING THE PROPER USE OR MAINTENANCE OF THIS EQUIPMENT.

ON A DAILY BASIS, BEFORE USING THE GENIE BOOM, CONDUCT A VISUAL INSPECTION AND FUNCTIONAL TEST AS DETAILED IN SECTION 3.2.

⚠ **WARNING:** FAILURE TO UNDERSTAND AND FOLLOW ALL SAFETY RULES AND OPERATING INSTRUCTIONS COULD RESULT IN PROPERTY DAMAGE, SERIOUS INJURY OR DEATH.

- ONLY TRAINED, AUTHORIZED PERSONS SHALL BE PERMITTED TO OPERATE THE GENIE BOOM.
- **DO NOT** OPERATE A POTENTIALLY DEFECTIVE MACHINE.
- **DO NOT** OPERATE THE GENIE BOOM IF **DANGER, WARNING, CAUTION** OR **OPERATING** PLACARDS OR DECALS ARE MISSING OR ILLEGIBLE.
- **DO NOT** OPERATE THE GENIE BOOM IF SAFETY DEVICES OR INTERLOCKS HAVE BEEN ALTERED, MODIFIED OR DISABLED.
- **DO NOT** OPERATE THE GENIE BOOM FOR ANY OTHER PURPOSE THAN POSITIONING PERSONNEL, THEIR TOOLS AND EQUIPMENT.
- BEFORE OPERATING THE GENIE BOOM FAMILIARIZE YOURSELF WITH THE LOCATION AND OPERATION OF THE GROUND CONTROL STATION, BOOM FUNCTION AUXILIARY CONTROLS AND HAND PUMP.

- PRIOR TO USE, CHECK THE AREA IN WHICH THE GENIE BOOM IS TO BE USED FOR DROP-OFFS, HOLES, BUMPS, DEBRIS, FLOOR AND/OR OVERHEAD OBSTRUCTIONS, ENERGIZED HIGH VOLTAGE CONDUCTORS OR OTHER POSSIBLE HAZARDOUS CONDITIONS.

- **DO NOT** POSITION ANY PART OF THE GENIE BOOM WITHIN 10 FEET
(3 M) OF ANY ENERGIZED HIGH VOLTAGE CONDUCTOR.

⚠ **THIS MACHINE IS NOT ELECTRICALLY INSULATED.**

- NEVER START THE GENIE BOOM IF YOU SMELL GASOLINE, LIQUID PROPANE OR DIESEL FUEL.

⚠ **GASOLINE, LIQUID PROPANE AND DIESEL FUELS ARE FLAMMABLE.**

- **DO NOT** ELEVATE THE PLATFORM OR DRIVE WHILE ELEVATED UNLESS THE MACHINE IS ON A FIRM, LEVEL SURFACE.

- THE OPERATOR IS RESPONSIBLE FOR AVOIDING GROUND PERSONNEL AND WARNING THEM NOT TO WORK OR WALK UNDER AN ELEVATED BOOM EXTENSION OR PLATFORM.

- BEFORE DRIVING ON FLOORS, BRIDGES, TRUCKS AND OTHER SURFACES, CHECK ALLOWABLE WEIGHT CAPACITY.

- ALWAYS POST A LOOK-OUT AND SOUND THE HORN WHEN DRIVING IN AREAS WHERE VISION IS OBSTRUCTED.

- **DO NOT** ACTIVATE THE **DRIVE** JOYSTICK THROUGH NEUTRAL TO THE OPPOSITE DIRECTION. INSTEAD, RETURN THE LEVER TO NEUTRAL, STOP, THEN PROCEED IN OPPOSITE DIRECTION.

- LIMIT TRAVEL SPEED ACCORDING TO CONDITIONS OF GROUND SURFACE, CONGESTION, SLOPE, LOCATION OF PERSONNEL, AND OTHER FACTORS CAUSING HAZARD OF COLLISION OR INJURY TO PERSONNEL.

- WORKING LOADS MUST NOT EXCEED THE 500 LB. (226 KG) PLATFORM LOAD CAPACITY (TWO PERSONS) AND MUST BE SECURELY PLACED ON PLATFORM FLOOR.

- CLOSE PLATFORM ACCESS OPENINGS BEFORE OPERATING THE GENIE BOOM.
- OCCUPANTS MUST WEAR AND PROPERLY ATTACH A SAFETY HARNESS AND LANYARD.
- OCCUPANTS MUST MAINTAIN A FIRM FOOTING ON THE PLATFORM FLOOR. **DO NOT** SIT, STAND, OR CLIMB ON GUARD RAIL, MID-RAIL OR BOOM LINKAGE.
- **DO NOT** PLACE LADDERS OR SCAFFOLDS AGAINST THE PLATFORM OR SUBJECT THE PLATFORM TO A HORIZONTAL OR SIDE FORCE BY PUSHING OR PULLING THE PLATFORM.
- **DO NOT** POSITION LADDERS, STEPS OR SIMILAR ITEMS ON THE MACHINE TO PROVIDE ADDITIONAL HEIGHT OR REACH FOR ANY PURPOSE.
- **DO NOT** ATTACH OVERHANGING LOADS OR INCREASE PLATFORM SIZE.
- NEVER ATTEMPT USING THE MACHINE AS A CRANE. THIS MAY RESULT IN STRUCTURAL DAMAGE OR TIPPING.
- NEVER PUSH OR PULL THE MACHINE OR OTHER OBJECTS BY USING THE **REACH** EXTEND/RETRACT FUNCTION.
- USE THE TELESCOPE AND SWING FUNCTIONS WITH THE **BOOM** PROPORTIONAL CONTROL ROTARY SWITCH SET AT THE MINIMUM SETTING TO CAREFULLY POSITION THE PLATFORM CLOSE TO THE DESIRED WORKSITE.
- **DO NOT** LOWER THE PLATFORM UNLESS THE AREA BELOW THE PLATFORM AND BOOM EXTENSION IS CLEAR OF PERSONNEL AND OBSTRUCTIONS.
- **DO NOT** TOW THE MACHINE UNLESS IT IS IN FREE-WHEEL CONFIGURATION AND EQUIPPED WITH PROVISIONS FOR TOWING.

- STOW THE MACHINE, SHUT OFF THE KEY SWITCH, SHUT OFF POWER BUTTONS, AND CLOSE EACH FUEL TANK SHUT-OFF VALVE BEFORE LEAVING THE MACHINE.
- MACHINE MUST BE REFUELED IN AN OPEN, WELL-VENTILATED AREA FREE OF FLAME, SMOKE, SPARKS AND FIRE.
- NEVER REFUEL THE MACHINE WITH THE ENGINE RUNNING.

⚠ **GASOLINE, LIQUID PROPANE AND DIESEL FUELS ARE FLAMMABLE.**

- BATTERY ACID IS CORROSIVE. WEAR PROTECTIVE CLOTHING, GLOVES AND SAFETY GLASSES WHEN SERVICING.
- **DO NOT** RECHARGE BATTERY NEAR SPARKS OR OPEN FLAME. BATTERIES BEING CHARGED EMIT HIGHLY EXPLOSIVE HYDROGEN GAS.

⚠ **BATTERIES EMIT AN EXPLOSIVE GAS DURING CHARGING.**

OPERATION

3.1 UNPACKING

Upon delivery, it is important to promptly and correctly, unpack and inspect your new Genie BOOM. Follow the steps listed below to unpack the machine. Prior to use, refer to section 3.2 and complete the preoperation inspection.

1. Remove all restraints used to secure the machine to the transport vehicle. In many cases, the platform has been removed to prevent damage during shipment. The platform must be reinstalled and the foot switch reconnected prior to operating the machine.

2. Ensure that the ramp upon which the machine will be driven is capable of withstanding the full machine weight: 13,000 lbs. (5896 kg)

3. Close the manual lowering valve located at the base of the Reach lift cylinder.

4. Before driving the machine off the transport vehicle, ensure that you understand the functions of the controls (refer to section 3.3, Operating Instructions). Turn the key switch on the ground control station to the GROUND position and pull up on the ground control station POWER ON/OFF button.

   For GP & RT machines move the FUEL SELECT toggle switch to the GAS position and operate the START and CHOKE toggle switches.

   For D & DRT machines move the START/PREHEAT toggle switch to the PREHEAT position for 30 seconds then to START.

5. The machine should now be fully operational. Use the ground control station to lower the platform to the fully lowered position and rotate the swing chassis so that the platform is parallel to the direction of the chassis.

6. Before you enter the platform to drive the machine off the transport vehicle, turn the key switch on the ground control station to the PLATFORM position. Enter the platform and familiarize yourself with the platform control station. Pull up on the platform control station POWER ON/OFF button then operate the START function (refer to section 3.3, Operating Instructions).

7. Make sure that all personnel and obstructions are out of the way. Step on the foot switch and operate the REACH Retract function switch to ensure that the platform is fully retracted.

   NOTE: *Before reaching the bottom of the ramp, stop the machine and operate the REACH Up function switch until the platform has been elevated approximately 18 inches (46 cm). This will prevent the tip of the machine from contacting with the ground. It will also ensure a smooth transition from the slope to level ground.*

8. Now operate the DRIVE joystick slowly in the desired direction of travel. To slow down the machine, move the DRIVE joystick toward the Neutral position. To stop, allow the DRIVE joystick to return to the Neutral position.

3.2 PREOPERATION INSPECTION

⚠ **WARNING:** READ AND UNDERSTAND THE INFORMATION CONTAINED IN THIS SECTION BEFORE ANY ATTEMPT IS MADE TO OPERATE THE GENIE BOOM.

⚠ **WARNING:** NEVER OPERATE A POTENTIALLY DEFECTIVE MACHINE. ANY DEFECT OR DAMAGE NOTED DURING THIS INSPECTION MUST BE CORRECTED BEFORE THE MACHINE IS USED.

Initial Inspection

Before a new Genie BOOM is put into operation, it must be carefully inspected for any evidence of damage resulting from shipment. Use the following check list to detect defective, damaged or improperly installed parts.

Inspection Prior To Use

Before operating the machine each day, the following inspection should be performed to ensure maximum safety for the machine operator and others using the Genie BOOM. It is recommended that each user inspect the machine before operation even if the machine has already been put into service by another user. The most efficient method for inspecting your machine is by conducting a brief, but thorough, walk-around inspection.

BEGIN THE PREOPERATION INSPECTION WITH THE MACHINE IN THE STOWED POSITION ON A FIRM LEVEL SURFACE.

1. **Overall cleanliness** - Check machine for hydraulic oil residue and foreign objects. Inspect the surface upon which the machine is resting for any indication of leaks.

2. **Front Tire and Wheel Assemblies** - Check for damaged, loose or missing parts. Make sure the lug nuts are tight. Torque to 140-150 ft. lbs. (190-203 Nm). Look for worn spindles; defective components and hardware; and worn, damaged or improperly inflated tires.

3. **Steering Assembly** - Check for damaged, loose or missing parts. Check for loose or bent tie rods. Inspect steering cylinders and hydraulic lines for leaks and proper installation.

4. **Swing Chassis Covers And Drive Chassis Rear Hood** - Check for damaged, loose or missing parts. Ensure proper operation of cover fasteners.

5. **Fuel Tanks** - Check for damaged, loose or missing parts. Make sure that the tanks are secure, leak free and properly installed.

6. **Hydraulic Oil Reservoir** - When the machine is in the stowed position, then check for damaged, loose or missing parts. Ensure the hydraulic oil level is at approximately the 180°F mark on the oil level/temperature indicator. Inspect the reservoir, oil filters, breather cap and hydraulic lines for leaks.

7. **Battery** - Check battery for state of charge. Ensure battery posts and connecting terminals are secure and free of corrosion. Ensure that hold-down brackets are tight.

8. **Ground Control Station** - Check for damaged, loose or missing parts. Confirm that all electrical connections are secure and corrosion free. Inspect wiring for insulation damage. Ensure all switches operate properly.

9. **Swing Chassis** - Check for damaged, loose or missing parts. Check the swing bearing for damage, wear, proper lubrication, and loose or missing bearing bolts [bearing bolts should be torqued to 110 ft. lbs. (149 Nm)]. Check the swing torque hub, hydraulic motor and brake for damage, loose or missing parts. Inspect hydraulic lines and component housings for evidence of leaks. Also check the oil level in the swing torque hub by removing the pipe plug on the side and feeling for the oil level.

   The swing torque hub should be approximately one-half full of 90 weight oil.

10. **Internal Combustion Engine** - Check for damaged, loose or missing parts. Ensure that engine oil is at the proper level. Ensure that coolant is at proper level (if applicable).

11. **Hydraulic Pumps** - Check for damaged, loose or missing parts. Inspect pumps and hydraulic lines for leaks.

13. **Drive Motor and Rear Wheel Assembly** - Check for damaged, loose or missing parts. Make sure the lug nuts are tight. Torque to 140-150 ft. lbs. (190-203 Nm). Inspect drive torque hubs, hydraulic drive motors, drive brakes, and brake lines for damage and leaks. Check the oil level in the drive torque hub by removing the pipe plug on the side and feeling for the oil level.

    The drive torque hubs should be approximately one-half full of 90 weight oil.

14. **Boom Assembly** - Check for damaged, loose or missing parts. Make certain that all pivot pins and retaining clips for securing pivot pins are in place. Check the wear on the slide pads and cable track. Check electrical lines for damage. Inspect the boom assembly cylinders and hydraulic lines for leaks.

15. **Platform Assembly** - Check for damaged, loose or missing parts. Ensure that foot switch, manual platform rotator, sliding mid-rail, guard rails, and the safety belts/lanyards that you plan to use are in good working condition.

16. **Platform Control Station** - Check for damaged, loose or missing parts. Confirm electrical connections are secure and corrosion free. Inspect wiring for insulation damage. Ensure all switches operate properly.

17. **Placards and Decals** - Ensure that all placard and decals are clean, unobstructed, legible, and in the proper location. Make sure the operating instructions are included at the platform.

⚠ **WARNING:** PERFORM ALL INSPECTION TESTS WHERE THE PLATFORM IS ELEVATED AND/OR EXTENDED, WITH THE MACHINE POSITIONED ON A FIRM LEVEL SURFACE.

18. **Boom Functions Test** - A test of all boom functions must be performed to ensure proper operation. The test should be executed first from the ground control station. Function tests should be performed in the order listed below:
    A. PLATFORM LEVEL Up/Down
    B. BOOM ELEVATE Up/Down
    C. BOOM REACH Up/Down (observe the platform automatic self-leveling system)
    D. BOOM REACH Extend/Retract
    E. SWING Left/Right

    Repair any defects. Now complete the Auxiliary Controls Test below, then repeat the Boom Functions Test from the platform.

19. **Auxiliary Controls Test** - With the engine off and the platform at maximum elevation/extension operate BOOM ELEVATE Down and BOOM REACH Retract functions from the auxiliary controls. With platform fully lowered operate SWING Left/Right functions from the auxiliary controls. Repair any defects.

20. **Tilt Level Sensor and Platform Boom Function Test.** Activate the tilt level sensor located on the swing chassis by depressing it off center. After a moment, the tilt alarm should sound a loud oscillating tone at the platform. Repair any defects. Now, repeat the Boom Functions Test, this time from the platform. Repair any defects then proceed to the Drive System Test.

21. **Drive System Test** - Perform test of all drive functions. With the platform lowered, DRIVE Forward/Reverse speed should vary proportionally from zero to approximately 4 mph (6.4 km/h). With the platform elevated, DRIVE Forward/Reverse speed should vary proportionally from zero to 0.8 mph (1.3 km/h).

⚠ **WARNING:** DO NOT OPERATE THE MACHINE IF IT IS CAPABLE OF DRIVING FASTER THAN 0.8 mph (1.3 km/h) WITH THE PLATFORM ELEVATED (refer to section 4.4, Troubleshooting).

Operate the STEER Left/Right function to ensure proper operation in either direction. Check that the drive brakes hold when the machine is driven up a grade and stopped. Do not operate the machine if the brakes do not hold. Repair any defects.

3.3 OPERATING INSTRUCTIONS

Refer to the following inserts for Genie BOOM Z-45/22GP & Z-45/22RT Operating Instructions and Genie BOOM Z-45/22D & Z-45/22DRT Operating Instructions.

GENIE BOOM
Z-45/22GP & Z-45/22RT
OPERATING INSTRUCTIONS



Part No. 21934

CAUTION

UNDERSTANDING THE SAFETY RULES AND OPERATING INSTRUCTIONS IS CRITICAL TO SAFE OPERATION OF THE GENIE BOOM. MAKE SURE ALL OPERATORS READ AND UNDERSTAND THE INFORMATION CONTAINED IN THIS DOCUMENT AND ARE INSTRUCTED BY A QUALIFIED INDIVIDUAL ON PROPER, SAFE MACHINE OPERATION.

If there is anything you do not understand, or if you have questions regarding the operation of the Genie Boom, call Genie Industries:

U.S.A
800-426-8089 or (206) 881-1800
Telex 152351 • FAX (206) 885-4638

Canada
800-663-4475 or (604) 984-4242
FAX (604) 988-2662

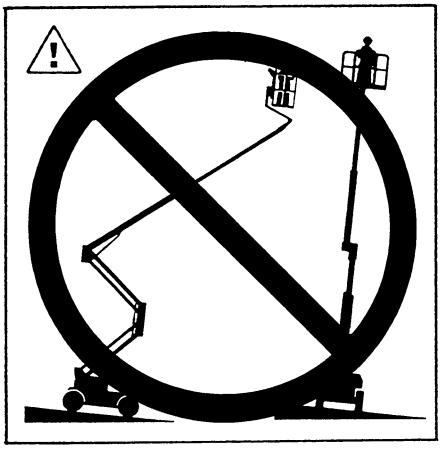
Europe
0636-813943
FAX 0636-815270

Genie Industries

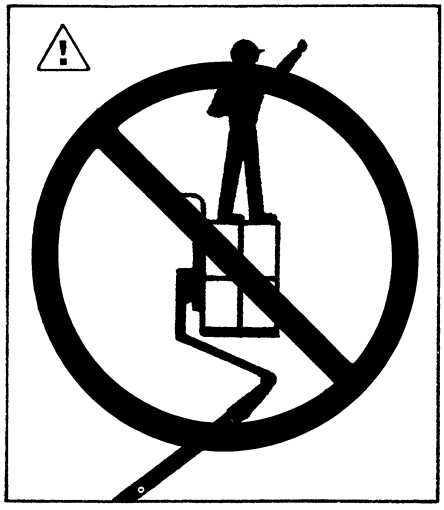
SAFETY RULES

⚠ WARNING: FAILURE TO UNDERSTAND AND FOLLOW ALL SAFETY RULES AND OPERATING INSTRUCTIONS COULD RESULT IN PROPERTY DAMAGE, SERIOUS INJURY OR DEATH.

- ONLY TRAINED AUTHORIZED PERSONS SHALL BE PERMITTED TO OPERATE THE GENIE BOOM.
- DO NOT OPERATE THE GENIE BOOM FOR ANY OTHER PURPOSE THAN POSITIONING PERSONNEL, THEIR TOOLS AND EQUIPMENT.
- DO NOT OPERATE A POTENTIALLY DEFECTIVE MACHINE.
- ON A DAILY BASIS, BEFORE USING THE GENIE BOOM, CONDUCT A VISUAL INSPECTION AND FUNCTIONAL TEST AS DETAILED IN THESE OPERATING INSTRUCTIONS.
- DO NOT OPERATE THE GENIE BOOM IF SAFETY DEVICES OR INTERLOCKS HAVE BEEN ALTERED, MODIFIED OR DISABLED.

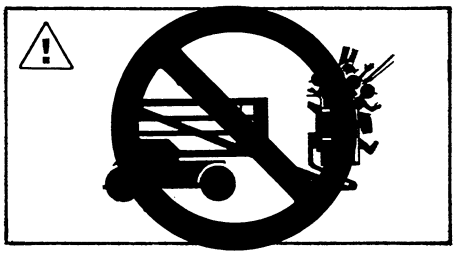


- DO NOT ELEVATE THE PLATFORM OR DRIVE WHILE ELEVATED UNLESS THE MACHINE IS ON A FIRM LEVEL SURFACE.
- PRIOR TO USE, CHECK THE AREA IN WHICH THE GENIE BOOM IS TO BE USED FOR DROP-OFFS, HOLES, BUMPS, DEBRIS, FLOOR AND/OR OVERHEAD OBSTRUCTIONS, ENERGIZED HIGH VOLTAGE CONDUCTORS OR OTHER POSSIBLE HAZARDOUS CONDITIONS.

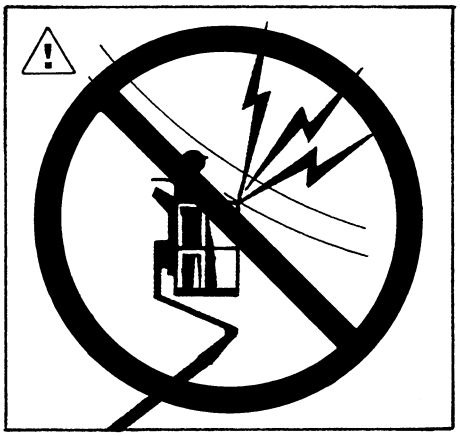


- OCCUPANTS MUST MAINTAIN A FIRM FOOTING ON THE PLATFORM FLOOR. DO NOT SIT, STAND OR CLIMB ON GUARD RAIL, MID-RAIL OR BOOM LINKAGE.
- OCCUPANTS MUST WEAR AND PROPERLY ATTACH A SAFETY HARNESS AND LANYARD.
- CLOSE PLATFORM ACCESS OPENINGS BEFORE OPERATING THE GENIE BOOM.

SAFETY RULES
---CONTINUED---

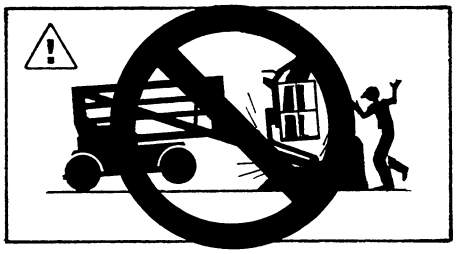


- WORKING LOADS MUST NOT EXCEED THE 500 lb. (226 kg) PLATFORM LOAD CAPACITY (TWO PERSONS) AND MUST BE SECURELY PLACED ON PLATFORM FLOOR.
- DO NOT ATTACH OVERHANGING LOADS.
- DO NOT PLACE LADDERS OR SCAFFOLDS ON OR AGAINST THE PLATFORM.

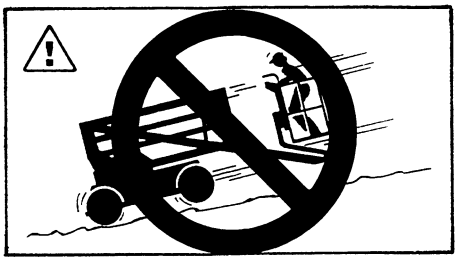


- DO NOT POSITION ANY PART OF THE GENIE BOOM WITHIN 10 FEET (3 m) OF ANY ENERGIZED HIGH VOLTAGE CONDUCTOR.

⚠ **THIS MACHINE IS NOT ELECTRICALLY INSULATED.**



- NEVER LOWER THE PLATFORM UNLESS THE AREA BELOW THE PLATFORM AND EXTENSION IS CLEAR OF PERSONNEL AND OBSTRUCTIONS.



- LIMIT TRAVEL SPEED ACCORDING TO CONDITIONS OF GROUND SURFACE, CONGESTION, SLOPE, LOCATION OF PERSONNEL, AND OTHER FACTORS CAUSING HAZARD OF COLLISION OR INJURY TO PERSONNEL.

- MACHINE MUST BE REFUELED AND BATTERIES CHARGED IN AN OPEN WELL-VENTILATED AREA FREE OF FLAME, SMOKE, SPARKS AND FIRE.
- NEVER REFUEL THE GENIE BOOM WITH THE ENGINE RUNNING.
- NEVER START THE GENIE BOOM IF YOU SMELL LIQUID PROPANE OR GASOLINE.

⚠ **LIQUID PROPANE AND GASOLINE ARE EXTREMELY FLAMMABLE.**

⚠ **BATTERIES EMIT AN EXPLOSIVE GAS DURING CHARGING.**

OPERATING INSTRUCTIONS
GROUND CONTROLS

⚠ WARNING: FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO PROPERTY, SERIOUS INJURY OR DEATH.

⚠ WARNING: DO NOT OPERATE A POTENTIALLY DEFECTIVE MACHINE. REPAIR ANY DEFECTS BEFORE OPERATING THE GENIE BOOM.

PRE-START INSPECTION AND FUNCTIONS TEST

- **Before operating, conduct a thorough walk around inspection of the machine.**
- Inspect for damaged electrical cables, wiring, hydraulic hoses and fittings; missing or loose fasteners and wheel lug nuts; proper tire pressure; weld or structural cracks; and any defective, improperly installed or missing parts.
- Check engine for leaks and correct oil level.
- Check hydraulic reservoir for leaks and correct oil level. (Photo 1, detail A)
- Check gasoline (GAS) tank for leaks and correct fuel level. (Photo 1, detail B)
- Check liquid propane (LP) tank for leaks and correct fuel level. (Photo 1, detail C)
- **Perform a test of all machine functions.**
- Test START, FUEL SELECT and BOOM functions as detailed in this section.
- Test DRIVE and STEER functions as detailed in the Platform Controls section on page 10.
- Operate functions through their entire range of motion.
- Lift lid on grey swing chassis cover to access ground control station. (Photo 2, detail A)
- Insert key in key switch and turn to GROUND position. (Photo 3, detail A)
- Pull out red POWER button to turn on power. (Photo 3, detail B)
- **To cut off power and stop all functions, push in red POWER button.** (Photo 3, detail B)

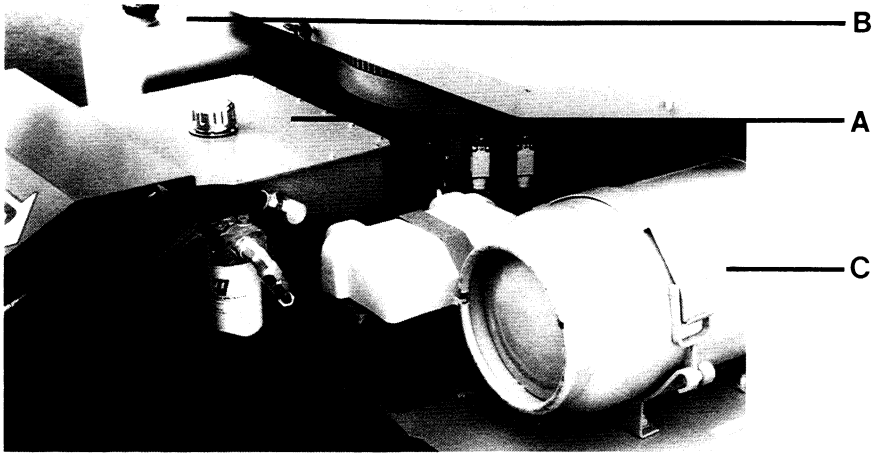
⚠ WARNING: NEVER START THE GENIE BOOM IF YOU SMELL LP OR GAS. A FIRE OR EXPLOSION COULD RESULT.

STARTING THE ENGINE

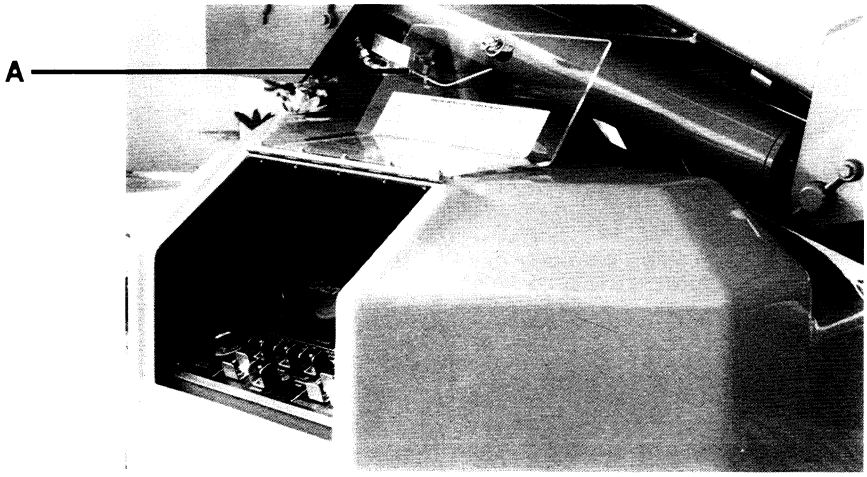
- Move the FUEL SELECT toggle switch to the desired LP or GAS position. (Photo 3, detail C)
- To start the engine when it is warm or hot, move only the START toggle switch. (Photo 3, detail D)
- To start the engine when it is cold, move the START and CHOKE toggle switches. (Photo 3, details D and E)
- When cold it may be necessary to move the engine RPM toggle switch to the HIGH position while operating the START and CHOKE functions. (Photo 3, detail F)
- To keep engine running after it has started it may be necessary to hold the CHOKE toggle switch until the engine reaches operating temperature. (Photo 3, detail E)
- When it is very cold, always start engine on GAS and then switch to LP (if desired).
- If the engine fails to start after 30 seconds of cranking, determine the cause and wait one minute before re-cranking.

- To switch fuels with engine running:
    - GAS to LP: Move the FUEL SELECT toggle switch to the OFF position. When the engine hesitates, move the switch to the LP position. (Photo 3, detail C)
    - LP to GAS (engine running): Move the FUEL SELECT toggle switch back and forth from the LP position to the GAS position until the engine continues to run on GAS. (Photo 3, detail C)

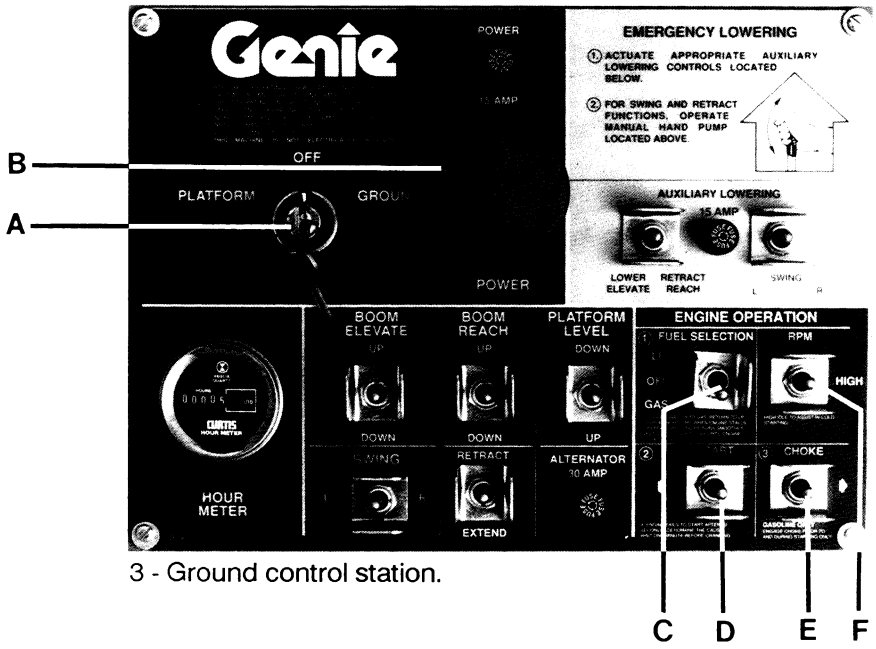
CAREFULLY STUDY INSTRUCTIONS ON THE PREVIOUS PAGE



1 - Hydraulic reservoir, gasoline and liquid propane tanks.



2 - Swing chassis cover lid.



3 - Ground control station.

OPERATING INSTRUCTIONS

GROUND CONTROLS ---CONTINUED

FUEL REQUIREMENTS

- Gasoline (GAS): Unleaded Regular Gasoline is preferred. Leaded Regular gasoline can be used, but its use may result in shorter maintenance intervals due to spark plug fouling.
- Liquid propane (LP) gas: Clean, dry liquid propane gas from a bulk storage tank is preferred. Observe correct tank filling instructions (as indicated on tank).

NOTE: Install the LP tank so that the mounting pin engages the hole in the tank handle and both tank latches close properly. Improper installation may result in reduced engine performance. (Photo 4)

⚠ WARNING: DO NOT ELEVATE PLATFORM UNLESS MACHINE IS ON A FIRM LEVEL SURFACE.

BOOM FUNCTIONS

- **Do not operate if platform load exceeds 500 lb. (226 kg) or two persons.**
- **Check overhead for personnel, electrical cables, lights and other obstructions which may interfere with boom function operation or endanger operator.**
- To operate boom functions (BOOM ELEVATE Up/Down [A], BOOM REACH Up/Down [B], REACH Extend/Retract [C], PLATFORM LEVEL Up/Down [D] and SWING Left/Right [E]) move the appropriate toggle switch in the desired direction as indicated on the control panel. (Photo 6)

EMERGENCY STOP - PUSH IN RED POWER BUTTON.

- To stop engine and boom/drive functions, push in red POWER button. (Photo 6, detail F)
- Operate all functions to test for proper shut down.
- **Repair any function that operates with red POWER button pushed in.**
- With the engine running and the key switch in the PLATFORM position, move the tilt sensor, located left of the ground control station, off angle to test sensor function. Repair the tilt sensor system if the tilt alarm does not sound. (Photo 5)

⚠ WARNING: IF THE PLATFORM FAILS TO RETRACT OR LOWER, DO NOT ALLOW OCCUPANTS TO CLIMB DOWN -- USE AUXILIARY CONTROLS OR EMERGENCY HAND PUMP TO LOWER PLATFORM.

EMERGENCY CONTROLS

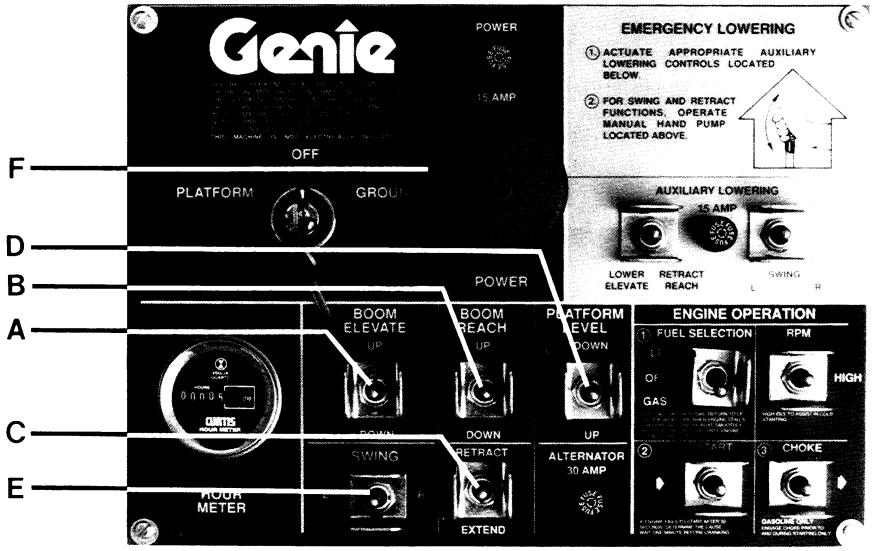
- To retract, lower, or rotate the platform operate the appropriate auxiliary control toggle switch, as indicated on the yellow section of the ground control station. (Photo 7, detail A)
- A manual hand pump (located just behind the ground control station) is provided to allow for the operation of Boom functions if there is a hydraulic system failure. (Photo 7, detail B)
- A manual lowering valve (located at the base of the reach lift cylinder) is provided to lower the platform if there is an electrical system failure. (Photo 8, detail A)



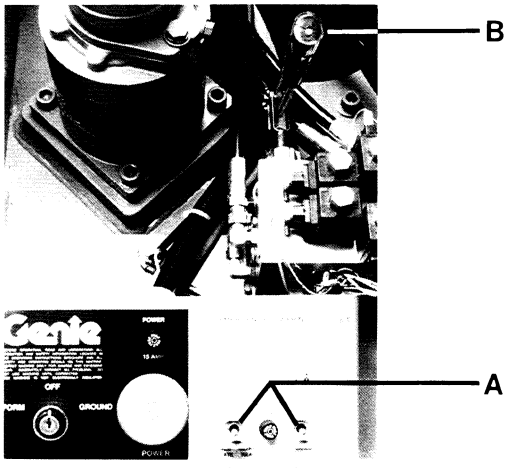
4 - Liquid propane tank installation.



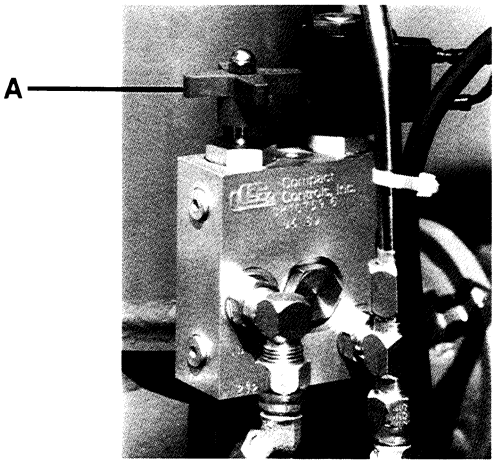
5 - Tilt sensor.



6 - Ground control station.



7 - Auxiliary controls and emergency hand pump.



8 - Manual lowering valve.

OPERATING INSTRUCTIONS
PLATFORM CONTROLS

⚠ WARNING: FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO PROPERTY, SERIOUS INJURY OR DEATH.

⚠ WARNING: DO NOT OPERATE A POTENTIALLY DEFECTIVE MACHINE. REPAIR ANY DEFECTS BEFORE OPERATING THE GENIE BOOM.

PRE-START

- Before operating any functions at the platform control station, complete the walk around inspection and machine functions test, detailed on page 4.
- Insert key in key switch at ground control station, turn to PLATFORM position and pull out red POWER button.
- Operator may now enter the platform.
- Make sure platform access mid-rail bar is down.
- Occupants must wear and properly attach a safety harness and lanyard. (Photo 9)
- Pull out red POWER button to turn on power. (Photo 11, detail A)
- **To cut off power and stop all functions, push in red POWER button.** (Photo 11, detail A)

⚠ WARNING: NEVER START THE GENIE BOOM IF YOU SMELL LP OR GAS. A FIRE OR EXPLOSION COULD RESULT.

STARTING THE ENGINE

- Ensure foot switch is **NOT** depressed or engine will not start.
- To start the engine when it is warm or hot, move only the START toggle switch. (Photo 11, detail B)
- To start the engine when it is cold, move the START and CHOKE toggle switches. (Photo 11, details B and C)
- When cold it may be necessary to move the engine RPM toggle switch to the HIGH position while operating the START and CHOKE functions. (Photo 11, detail D)
- To keep engine running after it has started it may be necessary to move the CHOKE toggle switch until the engine reaches operating temperature. (Photo 11, detail C)
- When it is very cold, always start engine on GAS and then switch to LP (if desired).
- If the engine fails to start after 30 seconds of cranking, determine the cause and wait one minute before re-cranking.

⚠ WARNING: DO NOT ELEVATE PLATFORM UNLESS MACHINE IS ON A FIRM LEVEL SURFACE.

BOOM FUNCTIONS

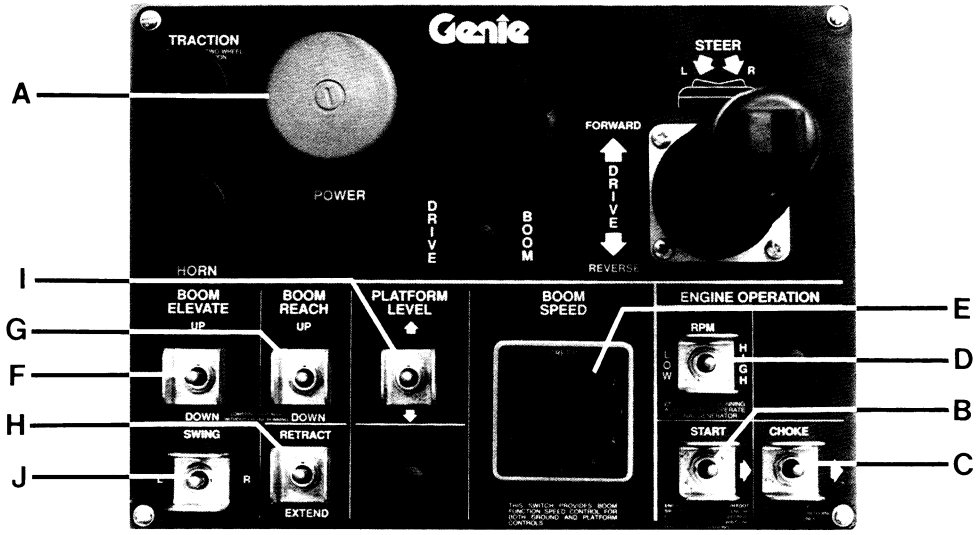
- **Do not operate if platform load exceeds 500 lb. (226 kg) or two persons..**
- **Check overhead for personnel, electrical cables, lights and other obstructions which may interfere with boom function operation or endanger operator.**
- Use the BOOM SPEED rotational switch to adjust the rate of boom functions. CREEP indicates slowest speed and 9 indicates fastest speed. (Photo 11, detail E)
- If your machine is equipped with the DRIVE/BOOM toggle switch, place it in the BOOM position.
- Press down on the foot switch. (Photo 10)
- To operate boom functions (BOOM ELEVATE Up/Down [F], BOOM REACH Up/Down [G], REACH Extend/Retract [H], PLATFORM LEVEL Up/Down [I] and SWING Left/Right [J]) move the appropriate toggle switch in the desired direction as indicated on control panel. (Photo 11)
- The platform may be rotated by turning the manual hand crank in either a clockwise or counterclockwise direction. (Photo 12)



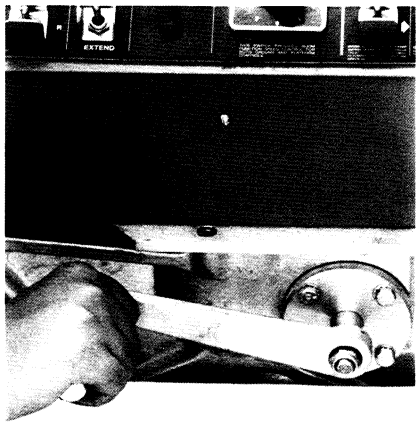
9 - Fasten lanyard.



10 - Foot switch.



11 - Platform control station.



12 - Platform rotator.

OPERATING INSTRUCTIONS

PLATFORM CONTROLS---CONTINUED

⚠ WARNING: DO NOT DRIVE MACHINE WHILE ELEVATED UNLESS ON FIRM LEVEL SURFACE.

DRIVE & STEER FUNCTIONS

- **Check surface area for possible hazards such as drop-offs, holes, bumps, floor obstructions and personnel before driving or steering.**
- If machine is equipped with DRIVE/BOOM toggle switch, move to the DRIVE position.
- Press down on the foot switch. (Photo 14)
- Operate the STEER rocker switch, located on the drive lever, to the L (left) and R (right) position to ensure the proper operation of each. STEERING IS NOT SELF-CENTERING. You must move the STEER rocker switch to return wheels to straight ahead position. (Photo 13, detail A)
- Maximum travel speed is obtainable only when platform is fully lowered.
- With platform up, machine travel speed is restricted to .8 mph (1.3 km/h) and must never be exceeded.
- Move drive lever just off center in both the FORWARD and REVERSE directions as a test to ensure proper operation of both. (Photo 13, detail B)
- To increase speed, move DRIVE lever slowly in desired direction of travel. (Photo 13, detail B)
- To properly slow down or stop, move DRIVE lever slowly to center position. (Photo 13, detail B)
- You may also remove your foot from the foot switch or push in the red POWER button to stop abruptly.
- If single wheel spin occurs due to poor traction or uneven surface conditions, push in the TRACTION button. (Photo 13, detail C)

EMERGENCY STOP - PUSH IN RED POWER BUTTON.

- To stop engine and boom/drive functions, push in red POWER button. (Photo 13, detail D)
- Operate all functions to test for proper shut down.
- **Repair any function that operates with red POWER button pushed in.**

⚠ WARNING: IF THE PLATFORM FAILS TO RETRACT OR LOWER, DO NOT CLIMB DOWN -- USE AUXILIARY CONTROLS OR EMERGENCY HAND PUMP TO LOWER PLATFORM.

EMERGENCY CONTROLS

- To retract, lower, or rotate the platform have ground personnel operate the appropriate auxiliary control toggle switch, as indicated on the yellow section of the ground control station. (Photo 15, detail A)
- A manual hand pump (located behind the ground control station) is provided to allow for the operation of boom functions in the event of a hydraulic system failure. (Photo 15, detail B)
- A manual lowering valve (located at the base of the reach lift cylinder) is provided to lower the platform in the event of an electrical system failure. (Photo 16, detail A)

CAREFULLY STUDY INSTRUCTIONS ON THE PREVIOUS PAGE



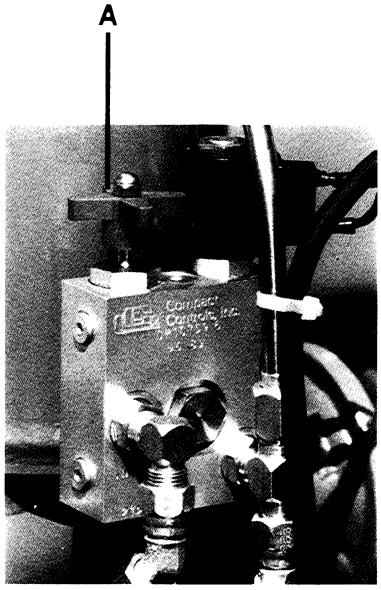
13 - Platform control station.



14 - Foot switch.



15 - Auxiliary controls and emergency hand pump.



16 - Manual lowering valve.

MAINTENANCE & ROUTINE SERVICE

DAILY SERVICE INSPECTION

- Thoroughly inspect the entire machine for damaged, loose or missing parts. Repair any potential defects before operating the machine.
- Inspect all hydraulic hoses, fittings and components for leaks and damage.
- Inspect all electrical wires, cables and components for abrasions, improper connection and damage.
- Inspect Gasoline tank for improper installation, leaks and proper fuel level. (Photo 17, detail A)
- Inspect Liquid Propane tank for improper installation, leaks and proper fuel level. (Photo 17, detail B)
- Inspect elevate assembly for signs of wear and structural damage.
- Inspect steering assembly and front end for signs of wear and structural damage.
- Inspect drive assembly for signs of wear and structural damage.
- Check battery cleanliness and connection. (Photo 17, detail C)
- Check hydraulic oil level. (Photo 17, detail D)
- Check engine oil level. (Photo 18, detail A)+
- Maintain proper tire pressure. GP model-100 psi (689 kPa), RT model-45 psi (310 kPa). (Photo 19)
- Check wheel lug nuts for proper tightness. Torque to 140-150 ft. lbs. (190-203 Nm). (Photo 19)
- Check the tilt level sensor and alarm for proper operation. (Photo 20)
- Check auxiliary controls for proper operation. (Photo 21, detail A)
- Check emergency hand pump for proper operation. (Photo 21, detail B)
- Check drive brake operation. (Photo 18, detail B)
- Check elevate/drive speed limit switch operation. (Photo 22)

FIRST TWO WEEKS (OR FIRST 25 HOURS)

- Change engine oil filter. (Photo 18, detail A)+*
- Change engine crankcase oil. (Photo 18, detail A)+*
- Service engine air filter every 25 hours. (Photo 18, detail A)+*

FIRST MONTH (OR FIRST 50 HOURS)

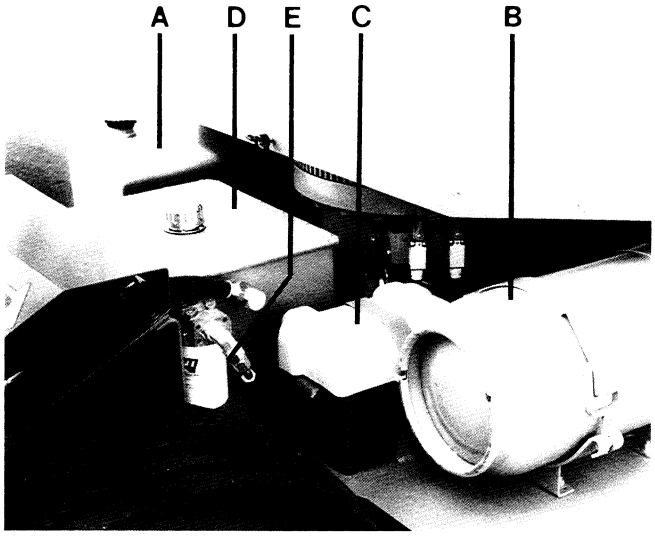
- Check oil level in drive and swing chassis torque hubs (EP-90 weight).
- Change the hydraulic oil filter located at the hydraulic oil reservoir. (Photo 17, detail E)
- Change the hydraulic oil filter located at the engine compartment. (Photo 18, detail B)
- Check engine low and high idle RPM. Set low idle at 1200 RPM and high idle at 3000-3100 RPM. (Photo 18, detail A)+
- Check engine valve clearance. (Photo 18, detail A)+

MONTHLY OR EVERY 50 HOURS

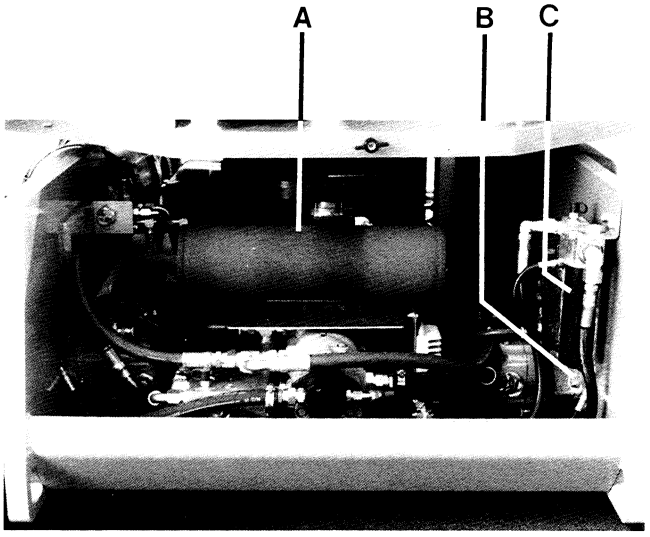
- Check battery electrolyte level and specific gravity (between 1.20 and 1.25 when fully charged). (Photo 17, detail C)
- Change engine crankcase oil. (Photo 18, detail A)+*
- Change engine oil filters. (Photo 18, detail A)+*
- Clean engine cooling fins. (Photo 18, detail A)+*

\+ For complete engine maintenance information consult your machine's Operating & Maintenance Manual.

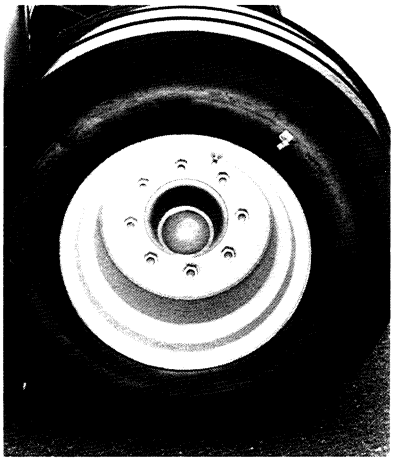
* Extreme dust or temperature conditions will create a need for more frequent servicing.



17 - Hydraulic reservoir, gasoline and liquid propane tanks.



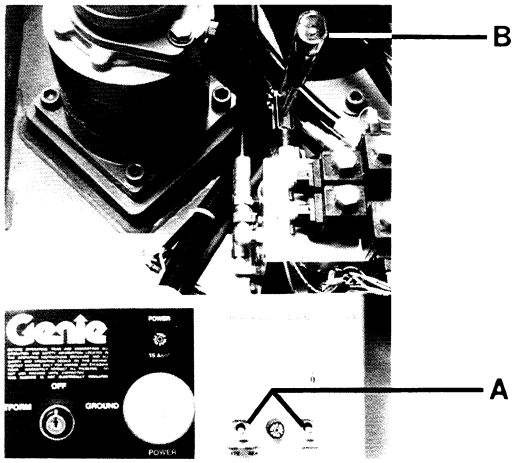
18 - Engine and drive assembly.



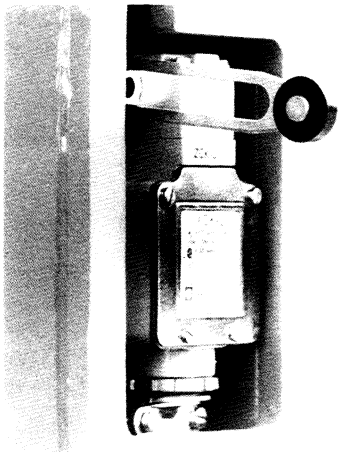
19 - Tire pressure and wheel lug nuts.



20 - Tilt sensor.



21 - Auxiliary controls and emergency hand pump.



22 - Elevate/drive speed limit switch.

MAINTENANCE & ROUTINE SERVICE

---CONTINUED---

SIX MONTHS OR 200 HOURS

- Lubricate swing chassis turntable bearing.*
- Check the one inch flexnut (located inside the platform rotation mechanism) for tightness. Torque to 190 ft. lbs. (258 Nm).
- Check wear pad clearance in EXTEND/RETRACT boom.
- Change oil in the drive and swing torque hubs (EP-90 weight).
- Change hydraulic oil filter located at the hydraulic oil reservoir. (Photo 23, detail A)
- Change hydraulic oil filter located at the engine compartment. (Photo 24, detail A)*
- Service the hydraulic oil reservoir, replace the suction screens and filler breather. (Photo 23, detail B)*
- Check engine valve clearance. (Photo 24, detail B)+
- Check engine spark plugs. (Photo 24, detail B)+
- Clean engine crankcase breather valve. (Photo 24, detail B)+*
- Replace engine air cleaner element. (Photo 24, detail B)+*
- Replace engine fuel filter. (Photo 24, detail B)+*
- Check engine low and high idle RPM. Set low idle at 1200 RPM and high idle at 3000-3100 RPM. (Photo 24, detail B)+

EVERY TWO YEARS (OR EVERY 1000 HOURS)

- Change hydraulic oil. Use Shell Tellus T68 or equivalent when operating the Boom in temperatures above 32°F (0°C). In colder climates substitute with Shell Tellus T32 or equivalent. (Photo 23, detail B)*
- Re-pack front axle bearings (use Texaco Marfax or an equivalent multipurpose lithium grease).

\+ For complete engine maintenance information consult your machine's Operating & Maintenance Manual.

* Extreme dust or temperature conditions will create a need for more frequent servicing.

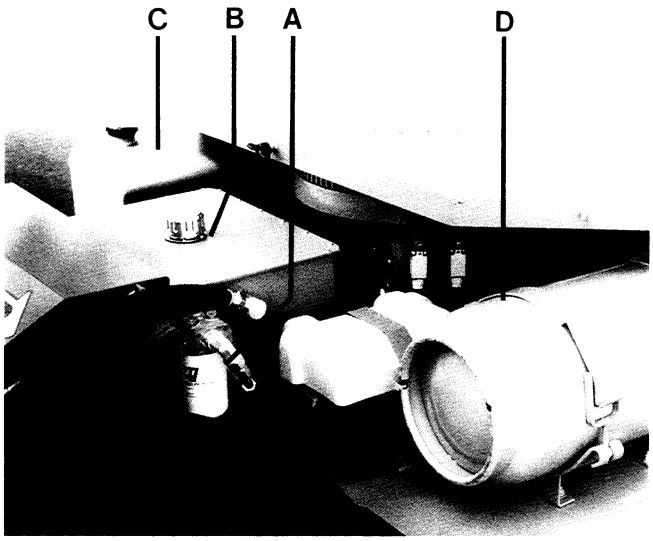
TRANSPORT

SECURING TO TRUCK OR TRAILER FOR ROAD TRANSIT

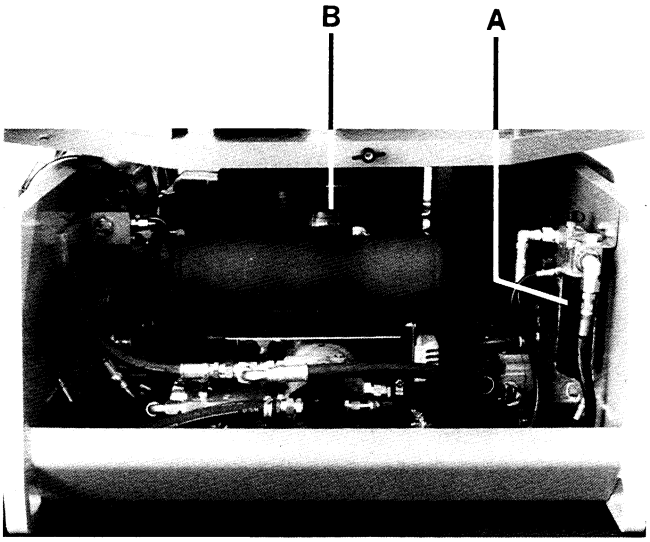
- The Genie Boom weighs 13,000 lbs. (5897 kg).
- Use chains or straps of ample load capacity.
- Always chock wheels on truck or trailer bed.
- Use tie points (on chassis) and binder chains (secured to transport vehicle) to anchor machine. (Photo 25, detail A)
- Secure the primary boom assembly to its resting pad.
- Open the manual lowering valve located at the base of the Reach lift cylinder. (Photo 26, detail A)
- Turn key switch to the OFF position, push in red POWER buttons and remove key before transporting.
- Ensure the Gasoline and Liquid Propane fuel tanks are secure and their manual shut off valves are closed. (Photo 23, details C and D)
- Inspect the entire machine for loose or unsecured items.

FOR MORE INFORMATION ON MACHINE SAFETY, OPERATION, TRANSPORT, MAINTENANCE, REPAIR OR SPECIFICATIONS REFER TO YOUR MACHINE'S OPERATING & MAINTENANCE MANUAL.

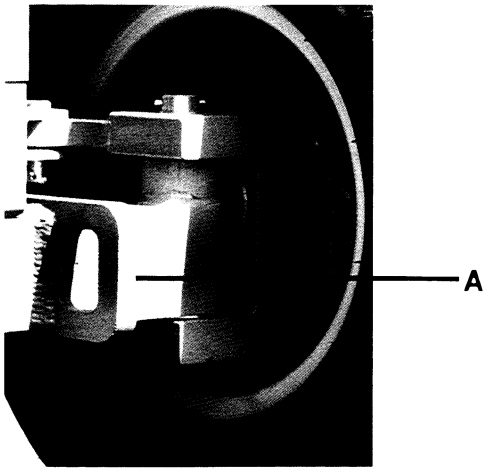
FOR MORE INFORMATION ON MACHINE REPLACEMENT PARTS REFER TO THE GENIE BOOM Z-45/22GP & Z-45/22RT PARTS REFERENCE GUIDE.



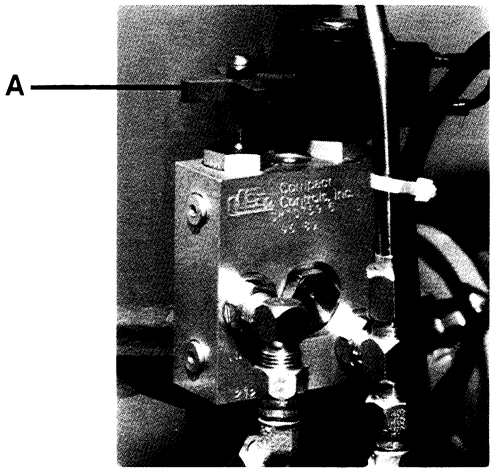
23 - Hydraulic reservoir, gasoline and liquid propane tanks.



24 - Engine and drive assembly.



25 - Tie points.



26 - Manual lowering valve.

LIMITED WARRANTY

Genie Booms Z-45 / 22GP and Z-45 / 22RT

GENIE INDUSTRIES, INC. standard warranty for your Genie Booms covers repairs or adjustment of manufactured and installed parts and equipment which prove defective in material or workmanship for a specified period from the effective date of warranty, but only such defects as results from normal use. Coverage periods are as follows:

- Structural steel components and bushings.....5 years
- Hydraulic componentry.....3 years
- Internal combustion engine.....2 years
- Electric componentry.....1 year
- Batteries.....90 days

(100% replacement warranty from date unit ships from manufacturer)

Items specifically not covered under warranty and / or exceptions to warranty include:

- Tires
- Belts
- Filters
- Covers

Repairs required as a result of the following are not covered under warranty:

- Damage from environment:
  - airborne fallout
  - chemicals
  - salt
  - sandblasting
  - job-site hazards
  - lightning
  - floods
  - other acts of God
- Damage due to alterations, misuse or accidents:
  - fire
  - accidents
  - abuse
  - negligence
  - objects striking the machine
  - misuse of machine
  - adjustments to components not complying to Genie specifications
- Damage resulting from improper maintenance or failure to follow established maintenance schedule.
- Damage to the finished appearance from normal deterioration due to use and exposure.

Seller's liability shall be limited to the repair or replacement of the defective material or workmanship at its factory or authorized service center. Buyer shall be responsible for all freight charges required for the repair.

SELLER MAKES NO OTHER WARRANTY, EXPRESS OR IMPLIED, AND SPECIFICALLY MAKES NO WARRANTY AS TO MERCHANTABILITY AND FITNESS FOR ANY PARTICULAR PURPOSE.

Qualification for warranty coverage is conditioned upon completion and filing of a "Product Warranty Registration" form within 30 days of original invoice, or from the date the equipment is first put into service, whichever comes first, and upon prompt notice of the claimed defect within. Receipt of the "Product Warranty Registration" form by Genie Industries establishes the effective date of warranty. Seller must be given an opportunity to examine any defect before any alteration is made.

Seller reserves the right to make any changes in design or add any improvements on its basic product or any accessories thereto at any time without incurring any obligation to install such improvements on any Genie Booms or accessory previously purchased.

This warranty supersedes all other warranties, stated or published, on Genie Booms released on or after July, 1, 1989.

For more information regarding this warranty, please contact the Genie Customer Service Department toll free at 800-426-8089.

All other manufacturers' warranties in excess of Genie warranty will be assigned to purchaser.

DISTRIBUTED BY

Genie Industries

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7008-0290

GENIE BOOM Z-45/22D & Z-45/22DRT OPERATING INSTRUCTIONS



Part No. 22659

CAUTION

UNDERSTANDING THE SAFETY RULES AND OPERATING INSTRUCTIONS IS CRITICAL TO SAFE OPERATION OF THE GENIE BOOM. MAKE SURE ALL OPERATORS READ AND UNDERSTAND THE INFORMATION CONTAINED IN THIS DOCUMENT AND ARE INSTRUCTED BY A QUALIFIED INDIVIDUAL ON PROPER, SAFE MACHINE OPERATION.

If there is anything you do not understand, or if you have questions regarding the operation of the Genie Boom, call Genie Industries:

U.S.A
800-426-8089 or (206) 881-1800
Telex 152351 • FAX (206) 885-4638

Canada
800-663-4475 or (604) 984-4242
FAX (604) 988-2662

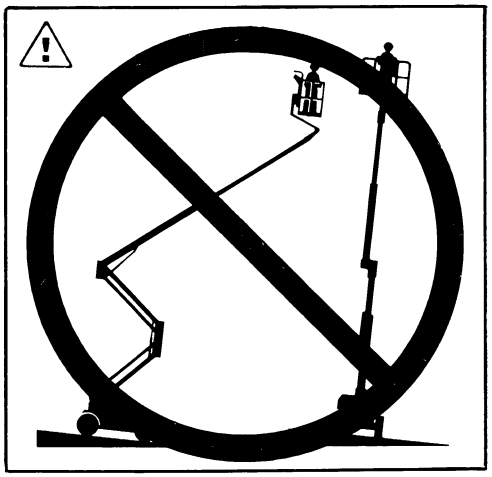
Europe
0636-813943
FAX 0636-815270

Genie Industries

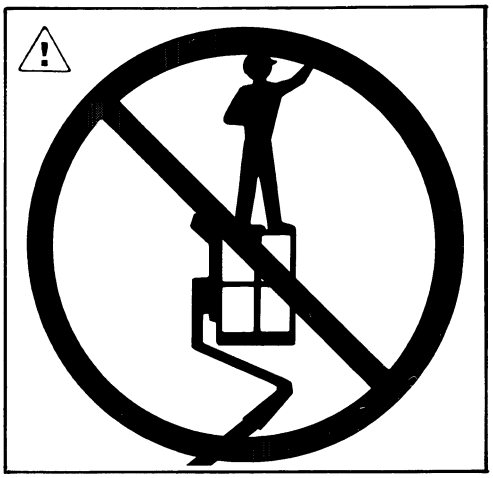
SAFETY RULES

⚠ WARNING: FAILURE TO UNDERSTAND AND FOLLOW ALL SAFETY RULES AND OPERATING INSTRUCTIONS COULD RESULT IN PROPERTY DAMAGE, SERIOUS INJURY OR DEATH.

- ONLY TRAINED AUTHORIZED PERSONS SHALL BE PERMITTED TO OPERATE THE GENIE BOOM.
- DO NOT OPERATE THE GENIE BOOM FOR ANY OTHER PURPOSE THAN POSITIONING PERSONNEL, THEIR TOOLS AND EQUIPMENT.
- DO NOT OPERATE A POTENTIALLY DEFECTIVE MACHINE.
- ON A DAILY BASIS, BEFORE USING THE GENIE BOOM, CONDUCT A VISUAL INSPECTION AND FUNCTIONAL TEST AS DETAILED IN THESE OPERATING INSTRUCTIONS.
- DO NOT OPERATE THE GENIE BOOM IF SAFETY DEVICES OR INTERLOCKS HAVE BEEN ALTERED, MODIFIED OR DISABLED.



- DO NOT ELEVATE THE PLATFORM OR DRIVE WHILE ELEVATED UNLESS THE MACHINE IS ON A FIRM LEVEL SURFACE.
- PRIOR TO USE, CHECK THE AREA IN WHICH THE GENIE BOOM IS TO BE USED FOR DROP-OFFS, HOLES, BUMPS, DEBRIS, FLOOR AND/OR OVERHEAD OBSTRUCTIONS, ENERGIZED HIGH VOLTAGE CONDUCTORS OR OTHER POSSIBLE HAZARDOUS CONDITIONS.

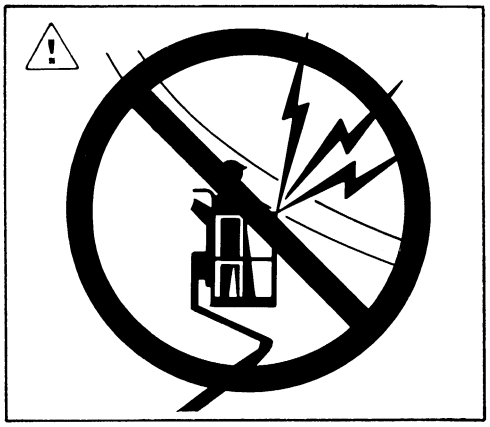


- OCCUPANTS MUST MAINTAIN A FIRM FOOTING ON THE PLATFORM FLOOR. DO NOT SIT, STAND OR CLIMB ON GUARD RAIL, MID-RAIL OR BOOM LINKAGE.
- OCCUPANTS MUST WEAR AND PROPERLY ATTACH A SAFETY HARNESS AND LANYARD.
- CLOSE PLATFORM ACCESS OPENINGS BEFORE OPERATING THE GENIE BOOM.

SAFETY RULES
---CONTINUED---

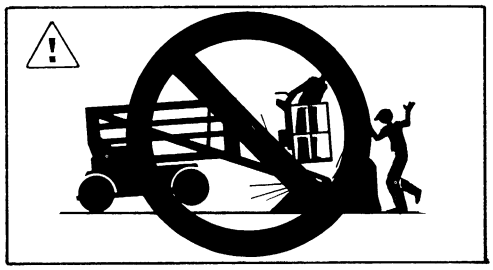


- WORKING LOADS MUST NOT EXCEED THE 500 lb. (226 kg) PLATFORM LOAD CAPACITY OR TWO PERSONS AND MUST BE SECURELY PLACED ON PLATFORM FLOOR.
- DO NOT ATTACH OVERHANGING LOADS.
- DO NOT PLACE LADDERS OR SCAFFOLDS ON OR AGAINST THE PLATFORM.

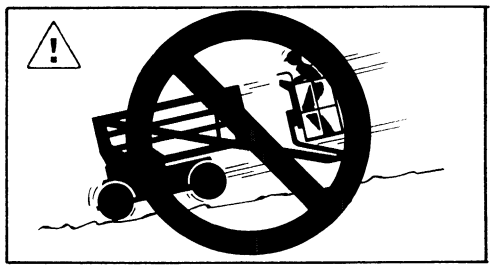


- DO NOT POSITION ANY PART OF THE GENIE BOOM WITHIN 10 FEET (3 m) OF ANY HIGH VOLTAGE CONDUCTOR.

⚠ **THIS MACHINE IS NOT ELECTRICALLY INSULATED.**



- NEVER LOWER THE PLATFORM UNLESS THE AREA BELOW THE PLATFORM AND EXTENSION IS CLEAR OF PERSONNEL AND OBSTRUCTIONS.



- LIMIT TRAVEL SPEED ACCORDING TO CONDITIONS OF GROUND SURFACE, CONGESTION, SLOPE, LOCATION OF PERSONNEL, AND OTHER FACTORS CAUSING HAZARD OF COLLISION OR INJURY TO PERSONNEL.

- MACHINE MUST BE REFUELED AND BATTERY CHARGED IN AN OPEN WELL-VENTILATED AREA FREE OF FLAME, SMOKE, SPARKS AND FIRE.
- NEVER REFUEL THE GENIE BOOM WITH THE ENGINE RUNNING.
- NEVER START THE GENIE BOOM IF YOU SMELL DIESEL FUEL.

⚠ **DIESEL FUEL IS FLAMMABLE.**

⚠ **BATTERIES EMIT AN EXPLOSIVE GAS DURING CHARGING.**

OPERATING INSTRUCTIONS
GROUND CONTROLS

⚠WARNING: FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO PROPERTY, SERIOUS INJURY OR DEATH.

⚠WARNING: DO NOT OPERATE A POTENTIALLY DEFECTIVE MACHINE. REPAIR ANY DEFECTS BEFORE OPERATING THE GENIE BOOM.

PRE-START INSPECTION AND FUNCTIONS TEST

- **Before operating, conduct a thorough walk around inspection of the machine.**
- Inspect for damaged electrical cables, wiring, hydraulic hoses and fittings; missing or loose fasteners and wheel lug nuts; proper tire pressure; weld or structural cracks; and any defective, improperly installed or missing parts.
- Check engine for leaks and correct oil level.
- Check radiator overflow for correct coolant level.
- Check diesel tank for leaks and correct fuel level. (Photo 1, detail A)
- Check hydraulic reservoir for leaks and correct oil level. (Photo 1, detail B)
- **Perform a test of all machine functions.**
- Test START and BOOM functions as detailed in this section.
- Test DRIVE and STEER functions as detailed in the Platform Controls section on page 10.
- Operate functions through their entire range of motion.
- Lift lid on grey swing chassis cover to access ground control station. (Photo 2)
- Insert key in key switch and turn to GROUND position. (Photo 3, detail A)
- Pull out red POWER button to turn on power. (Photo 3, detail B)
- **To cut off power and stop all functions, push in red POWER button.** (Photo 3, detail B)

⚠WARNING: NEVER START THE GENIE BOOM IF YOU SMELL DIESEL FUEL. A FIRE OR EXPLOSION COULD RESULT.

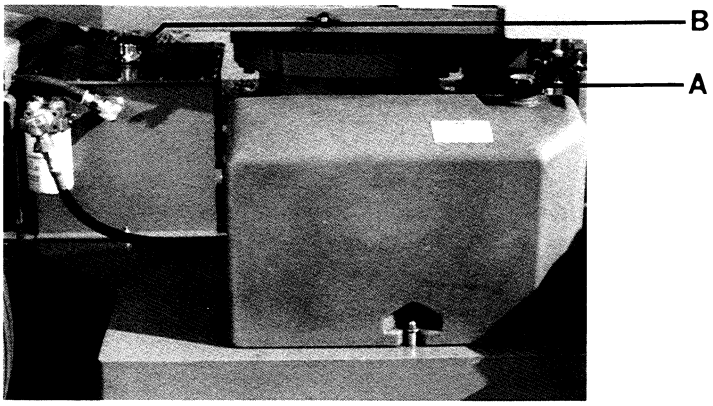
STARTING THE ENGINE

- To start the engine when it is warm or hot, move the START toggle switch to the START position. (Photo 3, detail C)
- To start the engine when it is cold, move the START toggle switch to the PREHEAT position for 15 seconds (30 seconds when below 0^{O}c - 32^{O}F) then to START. (Photo 3, detail C)
- When cold it may be necessary to move the engine RPM toggle switch to the HIGH position while operating the START function. (Photo 3, detail D)
- To keep engine running after it has started it may be necessary to use the HIGH RPM toggle switch until the engine reaches operating temperature. (Photo 3, detail D)
- If the engine fails to start after 30 seconds of cranking, determine the cause and wait one minute before re-cranking.

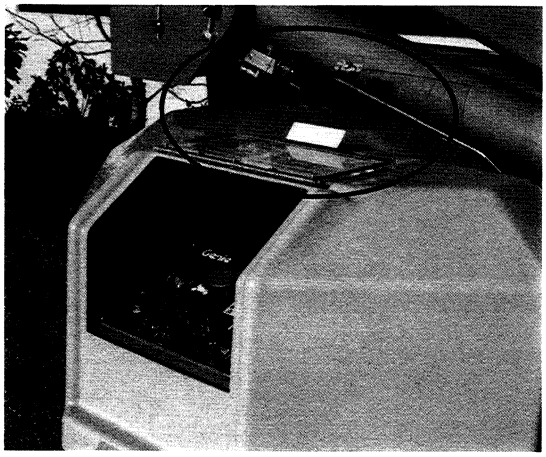
FUEL REQUIREMENTS

- Use DIESEL fuel No. 2-D **ONLY**.
- Allowing the fuel tank to empty may allow air in the fuel system, requiring bleeding before operation.

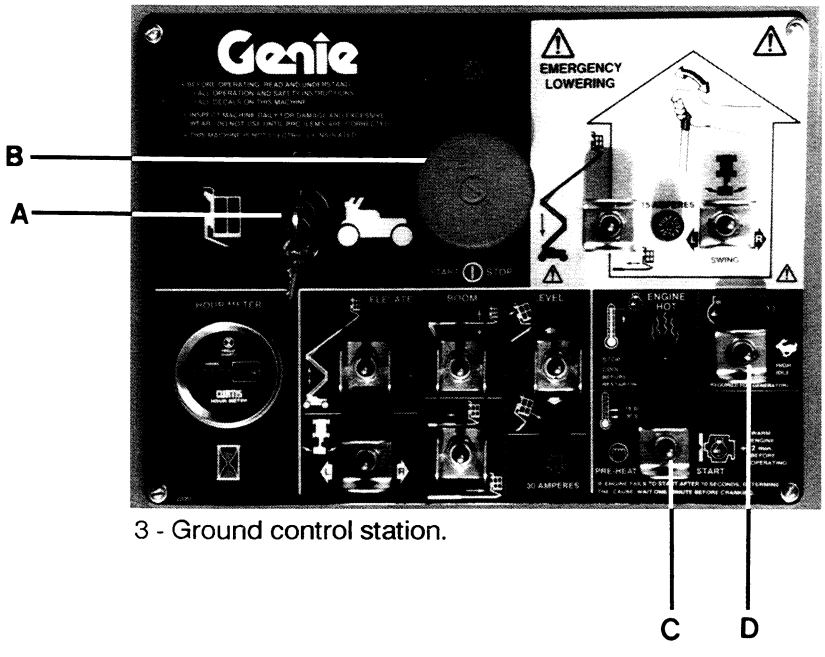
CAREFULLY STUDY INSTRUCTIONS ON THE PREVIOUS PAGE



1 - Diesel tank and hydraulic oil reservoir.



2 - Swing chassis cover lid.



3 - Ground control station.

OPERATING INSTRUCTIONS
GROUND CONTROLS ---CONTINUED

⚠ WARNING: DO NOT ELEVATE PLATFORM UNLESS MACHINE IS ON A FIRM LEVEL SURFACE.

BOOM FUNCTIONS

- **Do not operate if platform load exceeds 500 lb. (226 kg) or two persons.**
- **Check overhead for personnel, electrical cables, lights and other obstructions which may interfere with boom function operation or endanger operator.**
- To operate boom functions (BOOM ELEVATE Up/Down [A], BOOM REACH Up/Down [B], REACH Extend/Retract [C], PLATFORM LEVEL Up/Down [D] and SWING Left/Right [E]) move the appropriate toggle switch in the desired direction as indicated on the ground control station. (Photo 4)

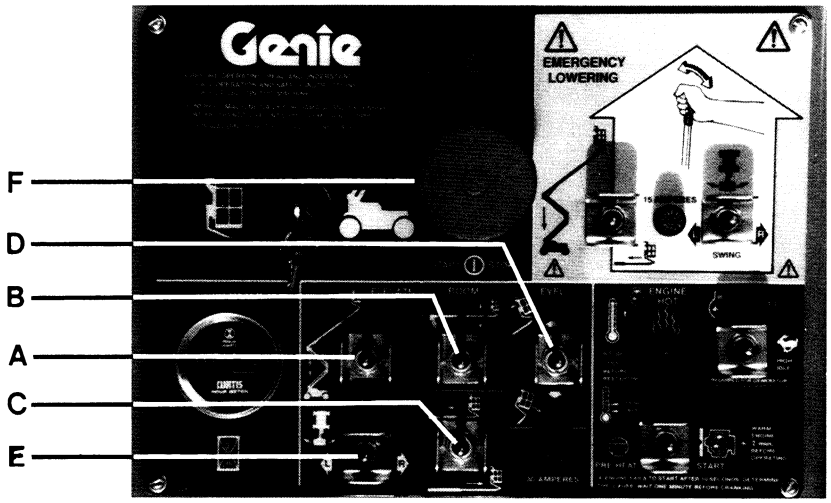
EMERGENCY STOP - PUSH IN RED POWER BUTTON.

- To stop engine and boom/drive functions, push in red POWER button. (Photo 4, detail F)
- Operate all functions to test for proper shut down.
- **Repair any function that operates with red POWER button pushed in and do not operate machine until repaired.**
- With the engine running and the key switch in the PLATFORM position, move the tilt sensor, located left of the ground control station, off angle to test sensor function. Repair the tilt sensor system if the tilt alarm does not sound. (Photo 5)

⚠ WARNING: IF THE PLATFORM FAILS TO RETRACT OR LOWER, DO NOT ALLOW OCCUPANTS TO CLIMB DOWN--USE AUXILIARY CONTROLS OR EMERGENCY HAND PUMP TO LOWER PLATFORM.

EMERGENCY CONTROLS

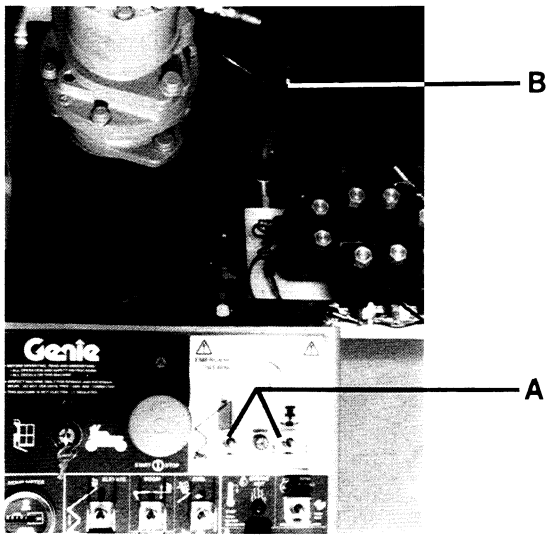
- To retract, lower, or rotate the platform operate the appropriate auxiliary control toggle switch, as indicated on the yellow section of the ground control station. (Photo 6, detail A)
- A manual hand pump (located just behind the ground control station) is provided to allow for the operation of Boom functions if there is a hydraulic system failure. (Photo 6, detail B)
- A manual lowering valve (located at the base of the reach lift cylinder) is provided to lower the platform if there is an electrical system failure. (Photo 7)



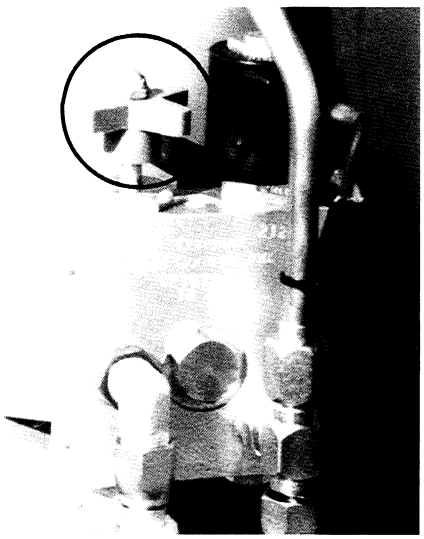
4 - Ground control station.



5 - Tilt sensor.



6 - Auxiliary controls and emergency hand pump.



7 - Manual lowering valve.

OPERATING INSTRUCTIONS
PLATFORM CONTROLS

⚠ WARNING: FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO PROPERTY, SERIOUS INJURY OR DEATH.

⚠ WARNING: DO NOT OPERATE A POTENTIALLY DEFECTIVE MACHINE. REPAIR ANY DEFECTS BEFORE OPERATING THE GENIE BOOM.

PRE-START

- Before operating any functions at the platform control station, complete the walk around inspection and machine functions test, detailed on page 4.
- Insert key in key switch at ground control station, turn to PLATFORM position and pull out red POWER button.
- Operator may now enter the platform.
- Make sure platform access mid-rail bar is down.
- Occupants must wear and properly attach a safety harness and lanyard. (Photo 8)
- Pull out red POWER button to turn on power. (Photo 9, detail A)
- **To cut off power and stop all functions, push in red POWER button**. (Photo 9, detail A)

⚠ WARNING: NEVER START THE GENIE BOOM IF YOU SMELL DIESEL FUEL. A FIRE OR EXPLOSION COULD RESULT.

STARTING THE ENGINE

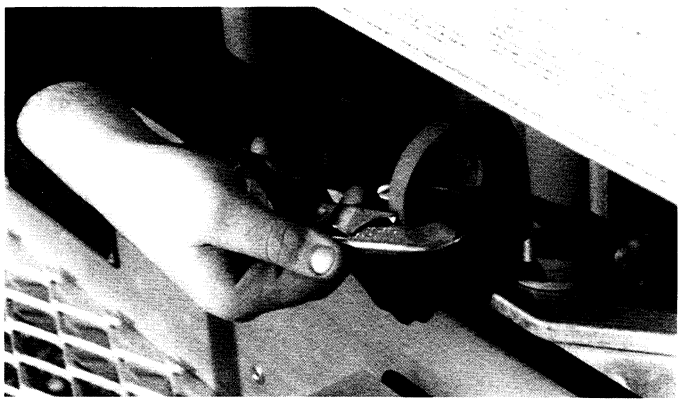
- Ensure foot switch is **NOT** depressed or engine will not start.
- To start the engine when it is warm or hot, move the START toggle switch to the start position. (Photo 9, detail B)
- To start the engine when it is cold, move the START toggle switches to the PREHEAT position for 15 seconds (30 seconds below 0^{o}c - 32^{o}F) then to START. (Photo 9, detail B)
- When cold it may be necessary to move the engine RPM toggle switch to the HIGH position while operating the START function. (Photo 9, detail C)
- To keep engine running after it has started it may be necessary to use the HIGH RPM toggle switch until the engine reaches operating temperature. (Photo 9, detail C)
- If the engine fails to start after 30 seconds of cranking, determine the cause and wait one minute before re-cranking.

⚠ WARNING: DO NOT ELEVATE PLATFORM UNLESS MACHINE IS ON A FIRM LEVEL SURFACE.

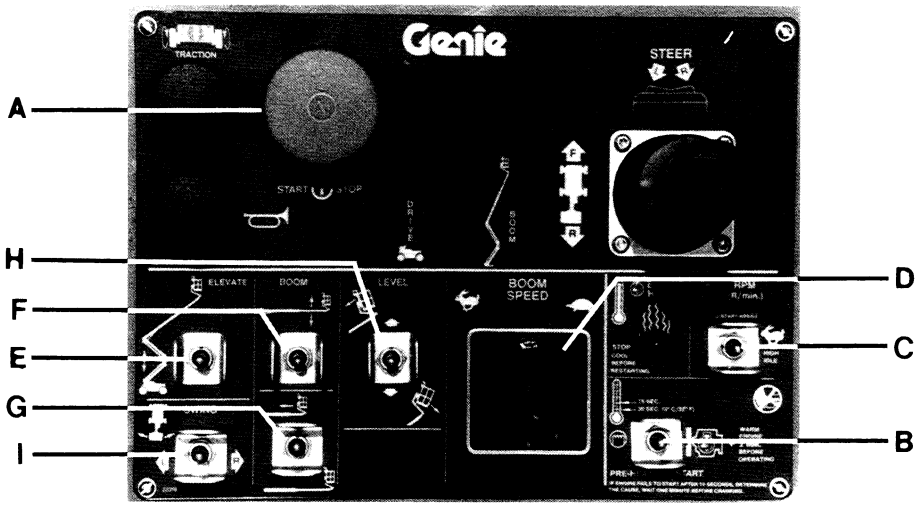
BOOM FUNCTIONS

- **Do not operate if platform load exceeds 500 lb. (226 kg) or two persons.**
- **Check overhead for personnel, electrical cables, lights and other obstructions which may interfere with boom function operation or endanger operator.**
- Use the BOOM SPEED rotational switch to adjust the rate of boom functions. CREEP indicates slowest speed and 9 indicates fastest speed. (Photo 9, detail D)
- If your machine is equipped with the DRIVE/BOOM toggle switch, place it in the BOOM position.
- Press down on the foot switch. (Photo 10)
- To operate boom functions (BOOM ELEVATE Up/Down [E], BOOM REACH Up/Down [F], REACH Extend/Retract [G], PLATFORM LEVEL Up/Down [H] and SWING Left/Right [I]) move the appropriate toggle switch in the desired direction as indicated on control panel. (Photo 9)
- The platform may be rotated by turning the manual hand crank in either a clockwise or counterclockwise direction. (Photo 11)

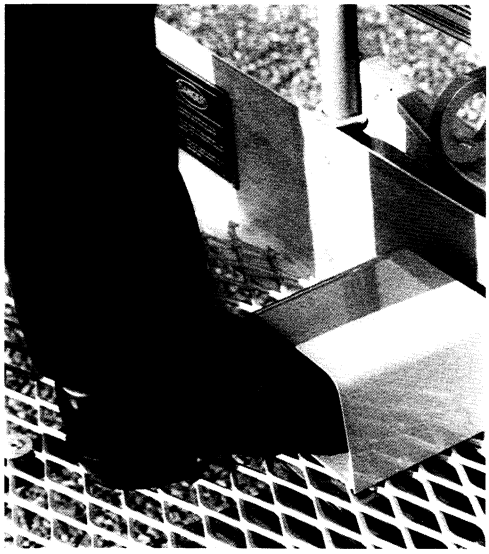
CAREFULLY STUDY INSTRUCTIONS ON THE PREVIOUS PAGE



8 - Fasten lanyard.



9 - Platform control station.



10 - Foot switch.



11 - Platform rotator.

OPERATING INSTRUCTIONS

PLATFORM CONTROLS---CONTINUED

⚠ WARNING: DO NOT DRIVE MACHINE WHILE ELEVATED UNLESS ON FIRM LEVEL SURFACE.

DRIVE & STEER FUNCTIONS

- **Check surface area for possible hazards such as drop-offs, holes, bumps, floor obstructions and personnel before driving or steering.**
- If machine is equipped with DRIVE/BOOM toggle switch option, move to the DRIVE position.
- Press down on the foot switch. (Photo 12)
- Operate the STEER rocker switch, located on the drive lever, to the L (left) and R (right) position to ensure the proper operation of each. STEERING IS NOT SELF-CENTERING. You must move the STEER rocker switch to return wheels to straight ahead position. (Photo 13, detail A)
- Maximum travel speed is obtainable only when platform is fully lowered.
- With platform up, machine travel speed is restricted to .8 mph (1.3 km/h) and must never be exceeded.
- Move drive lever just off center in both the FORWARD and REVERSE direction as a test to ensure proper operation of both. (Photo 13, detail B)
- To increase speed, move DRIVE lever slowly in desired direction of travel. (Photo 13, detail B)
- To properly slow down or stop, move DRIVE lever slowly to center position. (Photo 13, detail B)
- You may also remove your foot from the foot switch or push in the red POWER button to stop abruptly.
- If single wheel spin occurs due to poor traction or uneven surface conditions, push in the TRACTION button. (Photo 13, detail C)

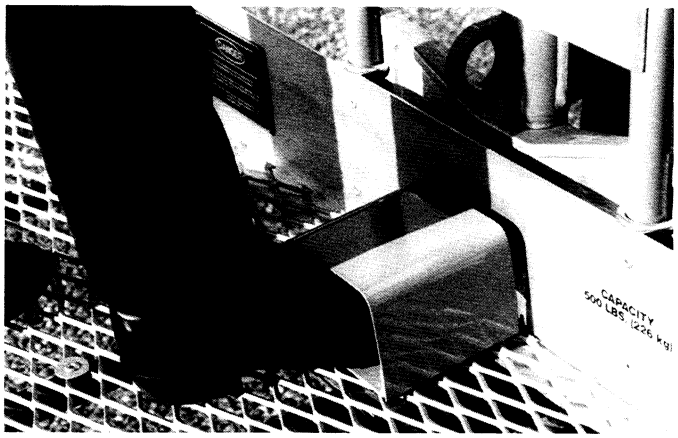
EMERGENCY STOP - PUSH IN RED POWER BUTTON.

- To stop engine and boom/drive functions, push in red POWER button. (Photo 13, detail D)
- Operate all functions to test for proper shut down.
- **Repair any function that operates with red POWER button pushed in and do not operate machine until repaired.**

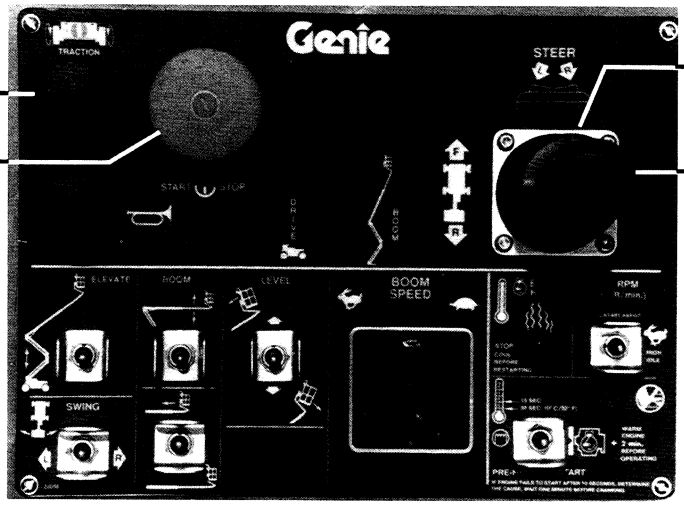
⚠ WARNING: IF THE PLATFORM FAILS TO RETRACT OR LOWER, DO NOT CLIMB DOWN--USE AUXILIARY CONTROLS OR EMERGENCY HAND PUMP TO LOWER PLATFORM.

EMERGENCY CONTROLS

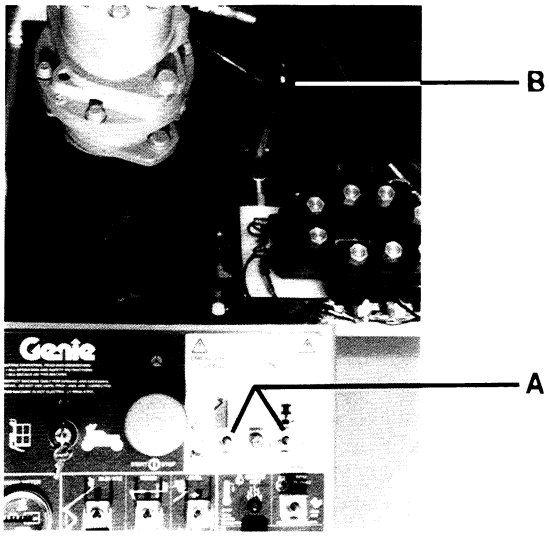
- To retract, lower, or rotate the platform have ground personnel operate the appropriate auxiliary control toggle switch, as indicated on the yellow section of the ground control station. (Photo 14, detail A)
- A manual hand pump (located behind the ground control station) is provided to allow for the operation of boom functions in the event of a hydraulic system failure. (Photo 14, detail B)
- A manual lowering valve (located at the base of the reach lift cylinder) is provided to lower the platform in the event of an electrical system failure. (Photo 15)



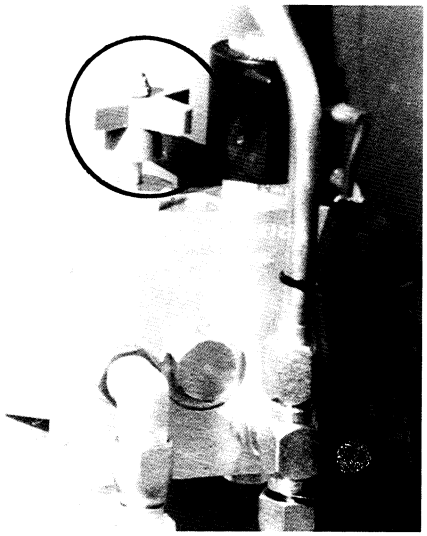
12 - Foot switch.



13 - Platform control station.



14 - Auxiliary controls and emergency hand pump.



15 - Manual lowering valve.

MAINTENANCE & ROUTINE SERVICE

⚠ WARNING: FAILURE TO FOLLOW THIS MAINTENANCE AND SREVICE PROGRAM MAY RESULT IN PROPERTY DAMAGE, SERIOUS INJURY OR DEATH.

DAILY SERVICE INSPECTION

- Thoroughly inspect the entire machine for damaged, loose or missing parts. Repair any potential defects before operating the machine.
- Inspect all hydraulic hoses, fittings and components for leaks and damage.
- Inspect all electrical wires, cables and components for abrasions, improper connection and damage.
- Inspect diesel tank for proper installation, leaks and correct fuel level. (Photo 16, detail A)
- Inspect elevate assembly for signs of wear and structural damage.
- Inspect steering assembly and front end for signs of wear and structural damage.
- Inspect drive assembly for signs of wear and structural damage.
- Check battery cleanliness and connection. (Photo 17, detail A)
- Check hydraulic oil level. (Photo 16, detail B)
- Check engine oil level. (Photo 17, detail B)+
- Check engine coolant level. (Photo 17, detail C)+
- Maintain proper tire pressure. Z-45/22D-100 psi (689 kPa), Z-45/22DRT-45 psi (310 kPa). (Photo 18)
- Check wheel lug nuts for proper tightness. Torque to 140-150 ft. lbs. (190-203 Nm). (Photo 18)
- Check the tilt level sensor and alarm for proper operation. (Photo 19)
- Check auxiliary controls for proper operation. (Photo 20, detail A)
- Check emergency hand pump for proper operation. (Photo 20, detail B)
- Check drive brake operation. (Photo 17, detail D)
- Check elevate/drive speed limit switch operation. (Photo 21)

FIRST TWO WEEKS (OR FIRST 25 HOURS)

- Change engine oil filter. (Photo 17, detail B)+*
- Change engine crankcase oil. (Photo 17, detail B)+*

FIRST MONTH (OR FIRST 50 HOURS)

- Check oil level in drive and swing chassis torque hubs (EP-90 weight).
- Change the hydraulic oil filter located at the hydraulic oil reservoir. (Photo 16, detail C)*
- Change the hydraulic oil filter located at the engine compartment. (Photo 17, detail E)*
- Check engine low and high idle RPM. Set low idle at 800 RPM and high idle at 3200 RPM. (Photo 17, detail B)+
- Check engine valve clearance. (Photo 17, detail B)+

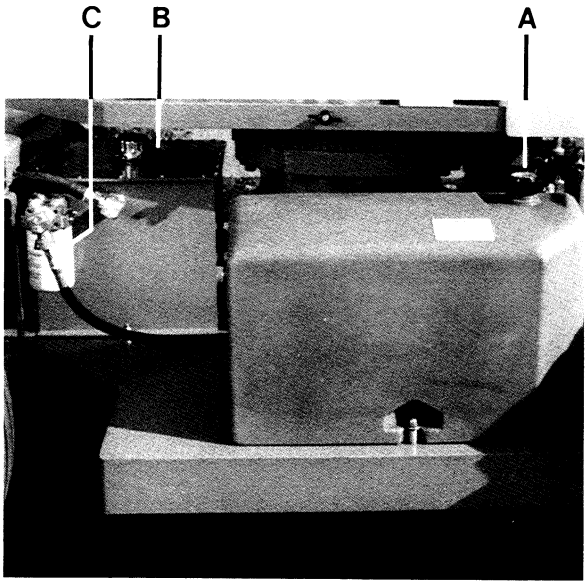
MONTHLY OR EVERY 50 HOURS

- Check battery state of charge. (Photo 17, detail A)
- Check fuel lines and clamps. (Photo 17, detail B)+
- Check coolant hoses and clamps.(Photo 17, detail F)+*
- Check fan and pulley belts. (Photo 17, detail G)+
- Drain fuel filter/water seperator. (Photo 17, detail H)+*
- Change engine crankcase oil. (Photo 17, detail B)+*
- Change engine oil filter. (Photo 17, detail B)+*
- Service engine air filter. (Photo 17, detail I)+*

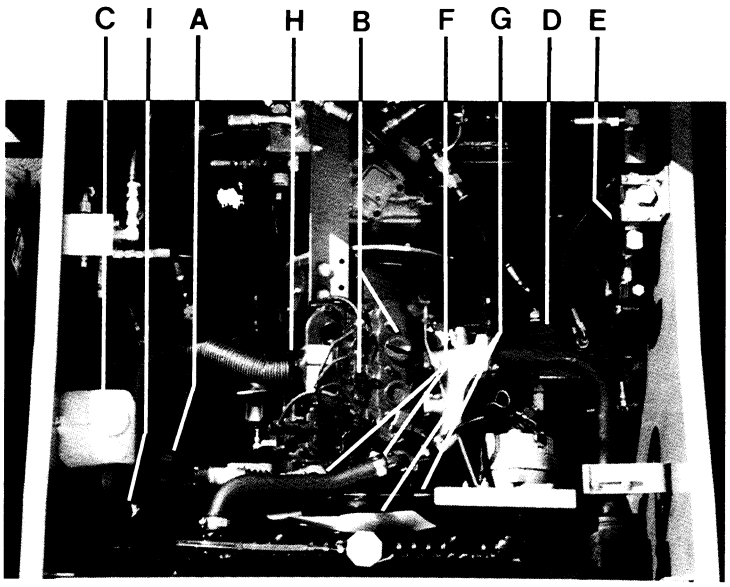
\+ For complete engine maintenance information refer to your machine's operating and maintenance manual.

* Extreme dust or temperature conditions will create a need for more frequent servicing.

CAREFULLY STUDY INSTRUCTIONS ON THE PREVIOUS PAGE



16 - Diesel tank and hydraulic oil reservoir.



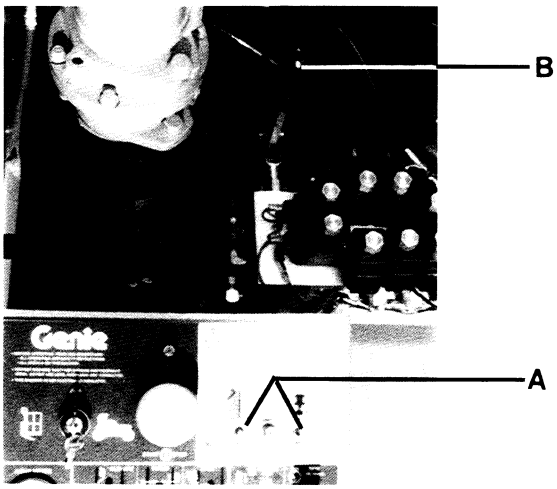
17 - Engine, battery and drive assembly.



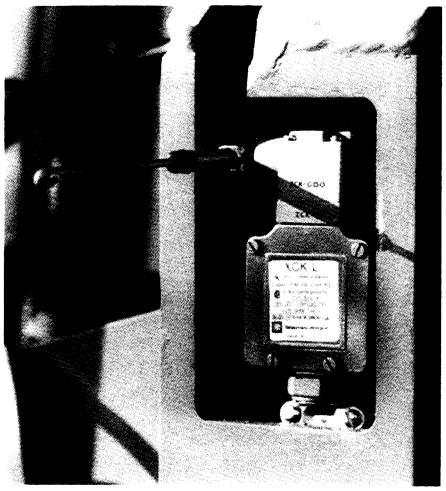
18 - Tire pressure and wheel lug nuts.



19 - Tilt sensor.



20 - Auxiliary controls and emergency hand pump.



21 - Elevate/drive speed limit switch.

MAINTENANCE & ROUTINE SERVICE

---CONTINUED---

SIX MONTHS OR 200 HOURS

- Lubricate swing chassis turntable bearing.*
- Check the one inch flexnut (located inside the platform rotation mechanism) for tightness. Torque to 190 ft. lbs. (258 Nm).
- Check wear pad clearance in boom EXTEND/RETRACT arm.
- Change oil in the drive and swing torque hubs (EP-90 weight).*
- Change hydraulic oil filter located at the hydraulic oil reservoir. (Photo 22, detail A)*
- Change hydraulic oil filter located at the engine compartment. (Photo 23, detail A)*
- Service the hydraulic oil reservoir, replace the suction screens and filler breather. (Photo 22, detail B)*
- Service engine radiator. (Photo 23, detail B)+*
- Check engine valve clearance. (Photo 23, detail C)+
- Replace engine air cleaner element. (Photo 23, detail D)+*
- Replace engine fuel filter element. (Photo 23, detail E)+*
- Check engine low and high idle RPM. Set low idle at 800 RPM and high idle at 3200 RPM. (Photo 23, detail C)+

EVERY TWO YEARS (OR EVERY 1000 HOURS)

- Check engine nozzel injection pressure.+
- Change engine coolant hoses and clamps. (Photo 23, detail F)+
- Change engine glow plugs.+
- Change engine fuel lines and clamps.+
- Change hydraulic oil. Use Shell Donex TG (Dextron II ATF) or equivelent (Photo 22, detail B).*
- Re-pack front axle bearings (use Texaco Marfax or an equivalent multipurpose lithium grease).

\+ For complete engine maintenance information refer to your machine's operating and maintenance manual.

* Extreme dust or temperature conditions will create a need for more frequent servicing.

TRANSPORT

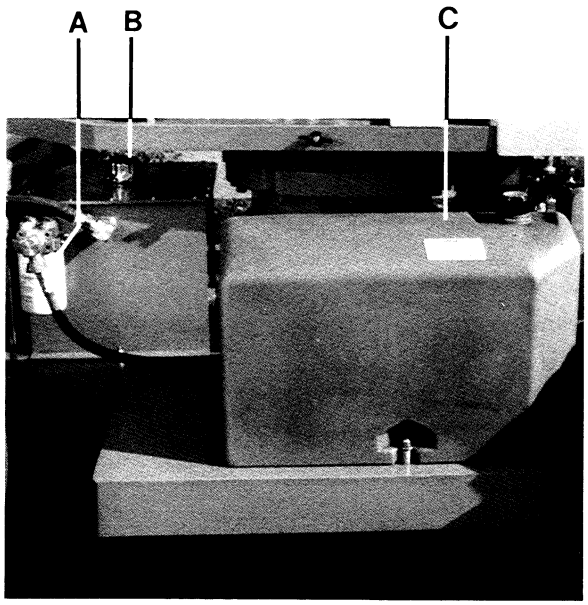
SECURING TO TRUCK OR TRAILER FOR ROAD TRANSIT

- The Genie Boom weighs 13,400 lbs. (6078 kg).
- Use chains or straps of ample load capacity.
- Always chock wheels on truck or trailer bed.
- Use tie points (on chassis) and binder chains (secured to transport vehicle) to anchor machine. (Photo 24)
- Secure the primary boom assembly to its resting pad.
- Open the manual lowering valve located at the base of the Reach lift cylinder. (Photo 25)
- Turn key switch to the OFF position, push in red POWER buttons and remove key before transporting.
- Ensure the diesel fuel tank is secure and its manual shut off valve is closed. (Photo 22, details C)
- Inspect the entire machine for loose or unsecured items.

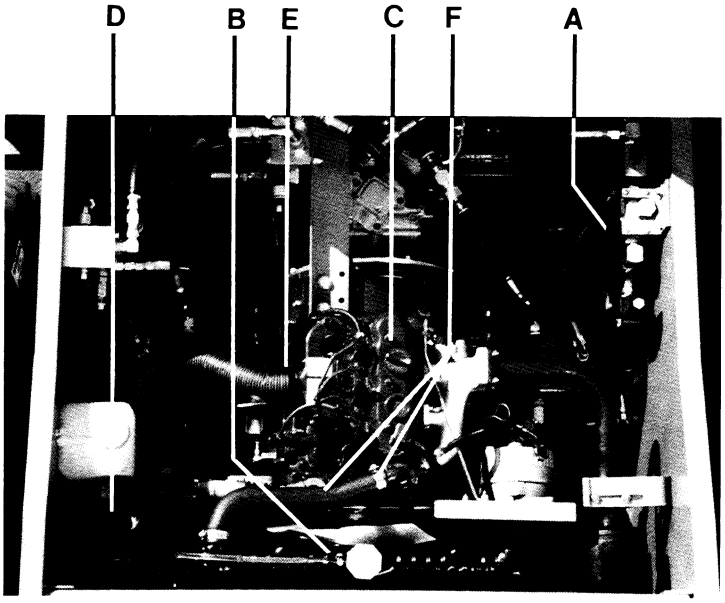
FOR MORE INFORMATION ON MACHINE SAFETY, OPERATION, TRANSPORT, MAINTENANCE, REPAIR OR SPECIFICATIONS REFER TO YOUR MACHINE'S OPERATING AND MAINTENANCE MANUAL.

FOR MORE INFORMATION ON MACHINE REPLACEMENT PARTS REFER TO YOUR MACHINE'S PARTS REFERENCE GUIDE.

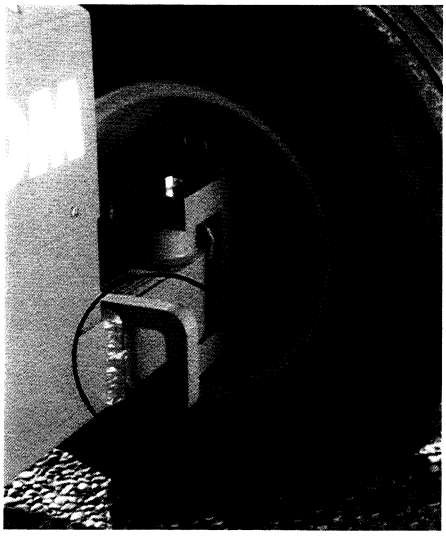
CAREFULLY STUDY INSTRUCTIONS ON THE PREVIOUS PAGE



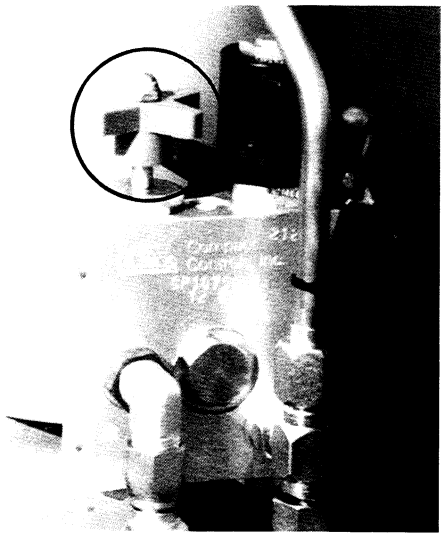
22 - Diesel tank and hydraulic oil reservoir.



23 - Engine and drive assembly.



24 - Tie points.



25 - Manual lowering valve.

LIMITED WARRANTY

Genie Booms Z-45/22 Gas / Liquid Propane and Diesel Models

GENIE INDUSTRIES, INC. standard warranty for your Genie Booms covers repairs or adjustment of manufactured and installed parts and equipment which prove defective in material or workmanship for a specified period from the effective date of warranty, but only such defects as results from normal use. Coverage periods are as follows:

- Structural steel components and bushings.....5 years
- Hydraulic componentry.....3 years
- Internal combustion engine .....2 years
- Electric componentry.....1 year
- Batteries.....90 days

(100% replacement warranty from date unit ships from manufacturer)

Items specifically not covered under warranty and / or exceptions to warranty include:

• Tires • Belts • Filters • Covers

Repairs required as a result of the following are not covered under warranty:

- Damage from environment:
  - airborne fallout
  - chemicals
  - salt
  - sandblasting
  - job-site hazards
  - lightning
  - floods
  - other acts of God
- Damage due to alterations, misuse or accidents:
  - fire
  - accidents
  - abuse
  - negligence
  - objects striking the machine
  - misuse of machine
  - adjustments to components not complying to Genie specifications
- Damage resulting from improper maintenance or failure to follow established maintenance schedule.
- Damage to the finished appearance from normal deterioration due to use and exposure.

Seller's liability shall be limited to the repair or replacement of the defective material or workmanship at its factory or authorized service center. Buyer shall be responsible for all freight charges required for the repair.

SELLER MAKES NO OTHER WARRANTY, EXPRESS OR IMPLIED, AND SPECIFICALLY MAKES NO WARRANTY AS TO MERCHANTABILITY AND FITNESS FOR ANY PARTICULAR PURPOSE.

Qualification for warranty coverage is conditioned upon completion and filing of a "Product Warranty Registration" form within 30 days of original invoice, or from the date the equipment is first put into service, whichever comes first, and upon prompt notice of the claimed defect within. Receipt of the "Product Warranty Registration" form by Genie Industries establishes the effective date of warranty. Seller must be given an opportunity to examine any defect before any alteration is made.

Seller reserves the right to make any changes in design or add any improvements on its basic product or any accessories thereto at any time without incurring any obligation to install such improvements on any Genie Booms or accessory previously purchased.

This warranty supersedes all other warranties, stated or published, on Genie Booms released on or after July, 1, 1989.

For more information regarding this warranty, please contact the Genie Customer Service Department toll free at 800-426-8089.

All other manufacturers' warranties in excess of Genie warranty will be assigned to purchaser.

DISTRIBUTED BY

Genie Industries

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Canadian Office: 340 Brooksbank Avenue • P.O. Box 86754, North Vancouver, B.C., Canada V7L4L3 • (604) 984-4242 • Toll Free 800-663-4475
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PATENTED AND PATENTS PENDING

7009-0490

3.4 TRANSPORT

The Genie Boom may be transported by truck, ship or airplane. It is not recommended to ship by train due to possible shock or vibration damage. We recommend driving the machine on to the truck bed or shipping vessel. If driving is impractical, the machine has free-wheeling capabilities to allow towing or winching into the shipping position.

The instructions listed below are designed to prevent any undue stress on the mechanical and hydraulic systems during transport. All transport loads should be carried through the tie down points on the chassis weldment and the tire blocking points.

1. Park the machine with the platform fully lowered and retracted. Ensure that the steering wheels are straight, and remove any material from the platform.

2. The machine may now be driven or winched on to the transport vehicle.

⚠ **WARNING**: DO NOT OPERATE THE MACHINE ON AN UNLEVEL SURFACE UNLESS THE PLATFORM IS FULLY LOWERED.

A. Driving: The machine is capable of driving onto the transport vehicle as long as the ramp* does not exceed the gradeability of the machine. Gradeability for all Gas/Liquid Propane or Diesel models is 30%.

Maximum drive speed is available only when the platform is fully lowered and the drive speed control limit switch is in the held position.

B. Winching: Before winching* the machine must be placed in the free-wheel configuration (see instructions on the next page).

⚠ **WARNING:** WHEN THE MACHINE IS IN THE FREE-WHEEL CONFIGURATION IT HAS NO BRAKING CAPABILITIES. SECURE THE MACHINE TO PREVENT ROLLING BEFORE PLACING IN THE FREE-WHEEL CONFIGURATION.

Secure the winch cable to the tie down points on the machine chassis.

3. The wheels should be blocked from rolling by wood pieces nailed to the transport vehicle and binder chains used to prevent sideways and fore/aft movement.

4. If the machine was placed in the free-wheel configuration, re-engage the drive torque hubs once the machine is secured for shipment. To re-engage the drive torque hubs, simply perform the steps listed below in reverse order.

5. Secure the primary boom assembly to its resting pad and open the manual lowering valve located at the base of the Reach lift cylinder to prevent bouncing during transport.

6. Shut off the key switch and all POWER switches, and close fuel tank manual shut off valve(s).

7. Inspect the machine thoroughly before shipping for loose or unsecured items.

How To Place The Machine In Free-Wheel Configuration **

⚠ **WARNING:** WHEN THE MACHINE IS IN THE FREE-WHEEL CONFIGURATION IT HAS NO BRAKING CAPABILITIES. SECURE THE MACHINE TO PREVENT ROLLING BEFORE PLACING IN THE FREE-WHEEL CONFIGURATION.

1. Chock the wheels to prevent the machine from rolling.

2. The drive torque hubs must be disconnected (released). Remove the two 1/4 - 20 x 3/4 in. bolts that secure disconnect caps to drive torque hub covers.

3. Turn the disconnect cap over and re-install. Make sure the cap's nipple will contact the disconnect rod. Secure each disconnect cap to the cover with the two 1/4 - 20 x 3/4 in. bolts. The machine is now in the free-wheel configuration.

* Ensure that the transport vehicle ramp, winch (if a winch is to be used) and winch cable are of sufficient strength to support the machine. Machine weight: 13,000 lbs. (5896 kg)

** Refer to the Fairfield Section of the Manufacturers Appendices.

3.5 THEORY OF OPERATION

Energy Source

The Genie BOOM Z-45/22GP and Z-45/22RT are powered by a dual fuel 24 horsepower, air cooled, internal combustion engine. An integral flywheel mounted 12 volt, 35 amp alternator is included to charge the battery.

The Genie BOOM Z-45/22D and Z-45/22DRT are powered by a diesel fueled 20 horsepower, water cooled internal combustion engine. An external mounted 12 volt, 37 amp belt driven alternator is included to charge the battery.

Hydraulic System

The hydraulic system can be divided into two groups: BOOM/STEER functions and DRIVE functions.

The **BOOM/STEER** functions consist of BOOM REACH Up/Down, BOOM REACH Extend/Retract, BOOM ELEVATE Up/Down, PLATFORM LEVEL Up/Down, SWING Left/Right and STEER Left/Right. BOOM/STEER function components include a .39 cu. in./rev (6.4 cm^3) fixed displacement 5 gpm (19 lpm) gear pump and a function control manifold. When the engine is running it turns the pump supplying hydraulic oil to the directional control valves located on the function control manifold. When actuated, the directional control valves direct hydraulic oil to the corresponding boom/steer function actuators (reach lift cylinder, reach extend/retract cylinder, elevate cylinders, platform level cylinders, swing hydraulic motor and steering cylinders). The function control manifold incorporates a priority flow divider which ensures that the steering systems hydraulic oil requirement is met prior to supplying hydraulic oil to boom function control valves. A 2000 psi (13800 kPa) boom/steer hydraulic system relief valve (located on the function control manifold) is used to prevent the system from being over pressurized. A system bypass valve (located on the function control manifold) is used to direct hydraulic oil to the hydraulic oil reservoir when no function is actuated. A variable voltage boom proportional control valve (located on the manifold) is used to control the speed of all powered boom functions. The valve regulates hydraulic oil flow in direct relation to an input voltage provided by the boom proportional rotary switch.

An emergency hand pump (located on the function control manifold) is provided to allow operation of all boom functions in the event of a hydraulic system failure. In order to operate any of the powered boom functions, with the hand pump, the appropriate directional control valve must be electrically actuated while pumping the emergency hand pump.

The BOOM REACH Up/Down functions use one lifting cylinder. The BOOM REACH Up function is accomplished by actuating the reach up directional control valve (located on the function control manifold), thereby directing hydraulic oil to the cylinder. Attached to the barrel end port of the cylinder is a manifold. The manifold incorporates a check valve, a down directional valve, flow control valve, and a manual lowering valve. The check valve is used to maintain cylinder pressure and prevent free descent in the event of a hydraulic line failure. The BOOM REACH Down function is accomplished by actuating the down directional control valve which creates a flow path for the hydraulic oil to exit the cylinder allowing it to retract. The flow control valve controls the rate of cylinder retraction by regulating the rate at which hydraulic oil exits the cylinder. In the event the down directional control valve cannot be actuated, the manual lowering valve can be opened to provide a flow path for hydraulic oil to exit the cylinder.

The BOOM REACH Extend/Retract functions use one dual acting cylinder. The functions are accomplished by actuating the appropriate extend or retract directional control valve (located on the function control manifold), thereby directing hydraulic oil to the cylinder. Attached to the port at both ends of the cylinder is a manifold containing a counter balance valve. The counter balance valve is used to prevent hydraulic oil from exiting the cylinder unless pilot pressure is supplied to the valve causing it to open. When pilot pressure is not applied to the counter balance valve, the valve remains closed maintaining cylinder pressure and preventing free descent in the event of hydraulic line failure.

The BOOM ELEVATE Up/Down functions use two lifting cylinders connected in parallel. The BOOM ELEVATE Up function is accomplished by actuating the elevate up directional control valve (located on the function control manifold) thereby directing hydraulic oil to the elevate cylinders. Attached to the barrel end port of each cylinder is a manifold. These manifolds each incorporate a 1500 psi (10342 kPa) relief valve, check valve, down directional control valve and a flow control valve. The 1500 psi (10342 kPa) relief valves ensure that neither of the parallel cylinders experience over pressurization. In the event that one cylinder is unable to maintain operating pressure, the relief valve ensures that the other parallel cylinder is not used to support the platform load and exceed its rated safe operating pressure. The check valve is used to maintain cylinder pressure and prevent free descent in the event of a hydraulic line failure.

The BOOM ELEVATE Down function is accomplished by actuating the down directional control valves. This creates a flow path for hydraulic oil to exit the cylinders allowing them to retract. The flow control valve controls the rate that the cylinders retract by regulating the exiting hydraulic oil flow.

The PLATFORM LEVEL functions utilize a master cylinder (attached to the boom reach arm) and a slave cylinder (attached to the platform). Both cylinders are dual acting and connected in parallel. The platform self-leveling function incorporates a closed loop hydraulic system. Located on the function control manifold are two counter balance valves which are used to prevent over pressurization of the closed loop hydraulic system. The machine features an automatic platform self leveling system. When the boom reach arm lifts, it causes the level master cylinder to retract. Hydraulic oil is then forced from the level master cylinder to the platform slave cylinder, causing the slave cylinder to extend. This automatically keeps the platform in a level position.

The powered PLATFORM LEVEL Up/Down functions are accomplished by actuating the platform level up or down directional control valves (located on the function control manifold), thereby directing hydraulic oil to the level slave cylinder. Attached to the ports at each end of the level slave cylinder are counter balance valves. The counter balance valves are used to prevent hydraulic oil from exiting the cylinder unless the valve is supplied with pilot pressure causing it to open. When pilot pressure is not applied, the counter balance valve will remain closed, maintaining cylinder pressure and preventing free descent in the event of a hydraulic line failure.

The SWING Left/Right functions use a 16.4 cubic in. (269 cm^3) rotary drive motor, a 4.1:1 single planetary torque hub, and a spring applied hydraulically released brake. The functions are accomplished by actuating the swing left/right directional control valve (located on the function control manifold) which directs hydraulic oil to both the swing brake shuttle valve (located in the function control manifold) and to the swing hydraulic motor. The shuttle valve directs hydraulic oil to the swing brake releasing the brake and allowing the swing hydraulic motor to rotate the swing chassis assembly. Incorporated in the swing flow path is an orifice (located in the function control manifold) which limits the rate of swing chassis rotation.

The STEERING Left/Right functions use two, dual acting cylinders connected in parallel. The steering functions are accomplished by actuating the steering left and right, 3-position, 4-way, directional control valve (located on the function control manifold), thereby directing hydraulic oil to the steering cylinders.

The **DRIVE** functions consist of DRIVE Forward/Reverse. The major system components include: a 2.8 cu. in./rev (46 cm^3) bi-directional, variable displacement 0-37 gpm (140 lpm) piston pump with an external mounted .85 cu. in./rev (14 cm^3) fixed displacement, 11 gpm (42 lpm) gerotor charge pump, a electrohydraulic displacement control (EDC), a hot oil shuttle valve assembly, two (2) 2.3 cu. in./rev (36 cm^3) fixed displacement piston drive motors, two (2) 35:1 double planetary torque hubs and two (2) spring applied, hydraulically released brakes. Two (2) 3500 psi (24131 kPa) relief valves are used to prevent the closed loop drive system from being over pressurized.

With the engine running the charge pump supplies: cool, clean de-aerated hydraulic oil to the low pressure side of the closed loop system. At the same time the hot oil shuttle valve provides a flow path for hot hydraulic oil to exit the system back to the tank. Charge pump hydraulic oil is also supplied to pilot the EDC, and provide oil for the brake control valve.

When activated, the drive joystick controller determines the speed and direction of machine travel by signaling the EDC to hydraulically stroke the piston pump swashplate. The swashplate controls the rate and direction of hydraulic oil flow to the drive motors in direct relation to drive joystick controller position. Drive joystick controller activation also signals the brake control valve to open providing charge pump oil to the drive brakes releasing the brakes and thereby allowing the drive motors to turn.

Electrical System

The Genie Boom uses stored electrical energy to control all machine functions. The electrical system can be divided into two categories; the Control Circuit and the Power Circuit.

The **control circuit** incorporates the components and circuitry required to turn the machine on and off or control other electrical devices. Components include the key switch, foot switch, toggle switches, limit switches, POWER On/Off buttons, relays, diodes and solenoids. Since the control circuit typically conducts very low current, small diameter (12-18 AWG) wire and multi-wire control cables are used to connect the control circuit components.

The **power circuit** incorporates the components which convert stored electrical energy into a mechanical force to provide movement. Components include the battery, starter motor and contacts. Since the power circuit must be able to conduct full operating current, heavy #2 or #4 welding cable is used to connect the power circuit components.

Before any BOOM, STEER or DRIVE functions can be operated, the key switch (located on the ground control station) must be turned to the appropriate PLATFORM or GROUND position and the POWER On/Off buttons (located on the ground and platform control stations) must be pulled up. At this point a circuit is completed to the START, CHOKE (GP & RT) and PRE-HEAT (D & DRT) functions. Without the engine running powered machine functions are not operational. Only the auxiliary controls, BOOM REACH Down, BOOM ELEVATE Down and SWING Left/Right functions at the ground control station are operational. This eliminates current draw if the key switch and POWER On/Off buttons are accidently left on and also provides lowering and swing functions when the engine is not running. With the engine running, an oil pressure switch mounted on the engine will close completing a circuit to the powered machine functions at both control stations.

The BOOM functions (BOOM REACH Up/Down, BOOM REACH Extend/Retract, BOOM ELEVATE Up/Down, PLATFORM LEVEL Up/Down and SWING Left/Right) can be operated from either the platform or ground control station by actuating the proper function control toggle switch. When the toggle switch is actuated, a circuit is completed from the toggle switch to the boom hydraulic system bypass valve solenoid and to the appropriate directional control valve solenoid. (BOOM REACH Down and BOOM ELEVATE Down functions are not powered functions and do not supply current to the boom hydraulic system bypass valve solenoid). When energized, the bypass valve and directional control valve solenoids will actuate their related valve spools. The speed of all powered boom functions is controlled by actuating the boom proportional control rotary switch. When a powered boom function is actuated, a circuit is completed supplying variable current from the rotary switch to the boom proportional control valve solenoid. When energized, the proportional control valve solenoid will actuate its related valve spool. Whenever the above mentioned actions are accomplished, the appropriate boom function will operate.

The STEER Left/Right functions are operated from the platform control station. Actuating the rocker switch (located on the end of the drive proportional control joystick) to the Left or Right position completes a circuit to the steer Left or Right directional control valve solenoid. When energized the directional control valve solenoid will actuate its related valve spool. Whenever the above mentioned actions are accomplished, the appropriate steer function will operate.

The DRIVE functions (DRIVE Forward/Reverse) are operated from the platform control station. The direction and speed of the DRIVE functions are accomplished by actuating the drive proportional control joystick in either the Forward or Reverse position. When actuated, the drive joystick completes a circuit from the joystick to the electrohydraulic displacement control (EDC). The EDC regulates pump displacement in direct relation to the joystick controller position.

A Load (horsepower) limiter (mounted inside the platform control box) is provided to maintain engine RPM when drive system load becomes too great. This is done by sensing engine RPM and limiting the amount of current supplied to the EDC, which de-strokes the pump reducing pump displacement. Whenever the above mentioned actions are accomplished, the appropriate drive function will operate.

MAINTENANCE

4.1 Maintenance Schedule

To gain optimum performance from your Genie BOOM, simply follow these routine maintenance and service procedures.

DAILY SERVICE INSPECTION

- Thoroughly inspect the entire machine for physical damage and wear. Complete the preoperation inspection detailed in section 3.2. Repair any defects before operating the machine.
- Inspect all hydraulic hoses, fittings and components for leaks and damage.
- Inspect all electrical wires, cables and components for abrasions, improper connection and damage.
- Inspect fuel tank(s) for proper installation, leaks and correct fuel level.
- Inspect elevate assembly for signs of wear and structural damage.
- Inspect steering assembly and front end for signs of wear and structural damage.
- Inspect drive assembly for signs of wear and structural damage.
- Check battery condition, cleanliness and connection.
- Check hydraulic oil level.
- Check engine oil level. +
- Check engine coolant level (D & DRT models only). +
- Maintain proper tire pressure. GP & D models-100 psi (689 kPa), RT & DRT models-45 psi (310 kPa).
- Check wheel lug nuts for proper tightness. Torque to 140-150 ft. lbs. (190-203 Nm).
- Check the tilt level sensor and alarm for proper operation.
- Check auxiliary controls for proper operation.
- Check emergency hand pump for proper operation.
- Check drive brake operation.
- Check elevate/drive speed limit switch operation.

+ Refer to section 6.2, the manufacturers appendices, for complete engine service and maintenance information.

FIRST TWO WEEKS (OR FIRST 25 HOURS)

- Change engine oil filter. +*
- Change engine crankcase oil. +*
- Service engine air filter **EVERY 25 HOURS** (GP & RT models only). +*

FIRST MONTH (OR FIRST 50 HOURS)

- Check oil level in drive and swing torque hubs (EP-90 weight).
- Change the hydraulic oil filter located at the hydraulic oil reservoir. *
- Change the hydraulic oil filter located at the engine compartment. *
- Check engine low and high idle RPM. Set low idle at 1800 RPM (GP & RT models) 800 RPM (D & DRT models) and high idle at 3000-3100 RPM (GP & RT models 3200) 3200 RPM (D & DRT models). +
- Check engine valve clearance. +

MONTHLY OR EVERY 50 HOURS

- Inspect elevate assembly piviot points for signs of wear.
- Check battery state of charge.
- Check fuel lines and clamps. +
- Check coolant hoses and clamps (D & DRT models only). +*
- Check fan and pulley belt (D & DRT models only). +
- Drain fuel filter/water seperator (D & DRT models only). +*
- Change engine crankcase oil. +*
- Change engine oil filter. +*
- Service engine air filter (D & DRT models only). +*
- Clean engine cooling fins (GP & RT models only). +*

SIX MONTHS OR 200 HOURS

- Lubricate swing chassis bearing.*

\+ Refer to the manufacturers appendices section 6.2, for complete engine service and maintenance information.
* Extreme dust or temperature conditions will create a need for more frequent servicing.

SIX MONTHS OR 200 HOURS

- Check the one inch flexnut (located inside the platform rotation mechanism) for tightness. Torque to 190 ft. lbs. (258 Nm).
- Check wear pad clearance in EXTEND/RETRACT boom.
- Change oil in the drive and swing torque hubs (EP-90 weight). *
- Change hydraulic oil filter located at the hydraulic oil reservoir. *
- Change hydraulic oil filter located at the engine compartment. *
- Service the hydraulic oil reservoir, replace the suction screens and filler breather. *
- Clean engine crankcase filter (GP & RT models only). +*
- Service engine radiator (D & DRT models only). +*
- Check engine valve clearance. +
- Check engine spark plugs (GP & RT models only). +
- Replace engine air cleaner element. +*
- Replace engine fuel filter. +*
- Check engine low and high idle RPM. Set low idle at 1200 RPM (GP & RT models) 800 RPM (D & DRT models) and high idle at 3000-3100 RPM (GP & RT models) 3200 RPM (D & DRT models). +

EVERY TWO YEARS (OR EVERY 1000 HOURS)

- Check engine nozzel injection pressure (D & DRT models only). +
- Change engine coolant hoses and clamps (D & DRT models only).
- Change engine glow plugs (D & DRT models only). +
- Change engine fuel lines and clamps. +
- Change hydraulic oil. Use Shell Donex TG (Dextron II ATF) or equivalent. *
- Re-pack front axle bearings (use Texaco Marfax or an equivalent multipurpose lithium grease).

+ Refer to the manufacturers appendices section 6.2, for complete engine service and maintenance information.
* Extreme dust or temperature conditions will create a need for more frequent servicing.

4.2 CONSUMABLE MATERIALS

MATERIAL	DESCRIPTION	LOCATION
Hydraulic Oil	Shell Donex TG (Dextron II ATF) or equivalent	Hydraulic Oil Reservoir
Gear Oil	SAE 90 multipurpose Gear Lubricant, API service classification GL-5	Drive & Swing Torque Hubs
Thread Adhesive	Loctite Removable Thread Locker 242	Fasteners
Paint	Rudd 91-869, Blue Rudd 91-841, Grey	Painted Surfaces
Wheel Bearing Grease	Texaco Marfax (or equivalent multi-purpose lithium grease)	Front Wheel Hubs
Motor Oil	API service classification SF or SF/CC Oil*	Engine Crankcase
Gasoline	Unleaded regular gasoline preferred*	Gasoline Tank
Liquid Propane	Clean, dry liquid propane gas*	Propane Tank
Diesel Fuel	Diesel fuel 2-D only*	Diesel Tank
Diesel Engine Coolant	50/50 mix water and Ethylene Glycol (Premix before adding)*	Radiator

* Refer to section 6.2, Manufacturer's Appendices for specific oil and fuel requirements.

4.3 TORQUE REQUIREMENTS

The purpose of this section is to allow the user to take prompt, effective action in the event an unacceptable condition is discovered during the inspection procedure. The table on the following page lists the standard torque values based on bolt diameters, grades and lubricated or dry conditions.

Torque Requirement Table

Size	Threads Per Inch	Bolt Diameter D (In.)	Tensile Stress Area (Sq. In.)	SAE Grade 5 Bolts			SAE Grade 8 Bolts		
				Clamp Load P (lb.)	Torque Dry K = 0.20	Torque Lub. K = 0.15	Clamp Load P (lb.)	Torque Dry K = 0.20	Torque Lub. K = 0.15
					In. Lb.	In. Lb.		In. Lb.	In. Lb.
4	40	0.1120	0.00604	380	8	6	540	12	9
	48	0.1120	0.00661	420	9	7	600	13	10
6	32	0.1380	0.00909	580	16	12	820	23	17
	40	0.1380	0.01015	610	18	13	920	25	19
8	32	0.1640	0.01400	900	30	22	1260	41	31
	36	0.1640	0.01474	940	31	23	1320	43	32
10	24	0.1900	0.01750	1120	43	32	1580	60	45
	32	0.1900	0.02000	1285	49	36	1800	68	51
1/4	20	0.2500	0.0318	2020	96	75	2860	144	108
	28	0.2500	0.0364	2320	120	86	3280	168	120
					Ft. Lb.	Ft. Lb.		Ft. Lb.	Ft. Lb.
5/16	18	0.3125	0.0524	3340	17	13	4720	25	18
	24	0.3125	0.0580	3700	19	14	5220	25	20
3/8	16	0.3750	0.0775	4940	30	23	7000	45	35
	24	0.3750	0.0878	5600	35	25	7900	50	35
7/16	14	0.4375	0.1063	6800	50	35	9550	70	55
	20	0.4375	0.1187	7550	55	40	10700	80	60
1/2	13	0.5000	0.1419	9050	75	55	12750	110	80
	20	0.5000	0.1599	10700	90	65	14400	120	90
9/16	12	0.5625	0.1820	11600	110	80	16400	150	110
	18	0.5625	0.2030	12950	120	90	18250	170	130
5/8	11	0.6250	0.2260	14400	150	110	20350	220	170
	18	0.6250	0.2560	16300	170	130	23000	240	180
3/4	10	0.7500	0.3340	21300	260	200	30100	380	280
	16	0.7500	0.3730	23800	300	220	33600	420	320
7/8	9	0.8750	0.4620	29400	430	320	41600	600	460
	14	0.8750	0.5090	32400	470	350	45800	660	500
1	8	1.0000	0.6060	38600	640	480	51500	900	680
	12	1.0000	0.6630	42200	700	530	59700	1000	740
1 1/8	7	1.1250	0.7630	42300	800	600	68700	1280	960
	12	1.1250	0.8560	47500	880	660	77000	1440	1080
1 1/4	7	1.2500	0.9690	53800	1120	840	87200	1820	1360
	12	1.2500	1.0730	59600	1240	920	96600	2000	1500
1 3/8	6	1.3750	1.1550	64100	1460	1100	104000	2380	1780
	12	1.3750	1.3150	73000	1680	1260	118100	2720	2040
1 1/2	6	1.5000	1.4050	78000	1940	1460	126500	3160	2360
	12	1.5000	1.5800	87700	2200	1640	142200	3560	2660



Grade 5 **Grade 8**

4.4 TROUBLESHOOTING

Page

Troubleshooting Introduction 4.08

1. Engine will not crank over.* 4.10
2. Engine cranks over but will not start (GP & RT models) 4.13
3. Engine cranks over but will not start (Platform controls only GP & RT models) 4.16
4. Engine cranks over but will not start (D & DRT models) 4.17
5. Engine cranks over but will not start (Platform controls only D & DRT models) 4.21
6. Engine starts on gasoline, but not on liquid propane. (GP & RT models) 4.22
7. Engine starts on liquid propane, but not on gasoline. (GP & RT models) 4.24
8. Machine will not lift, lower, extend, retract, swing, drive or steer. All powered functions lost. Engine starts and runs.* 4.26
9. Machine will not lift, lower, extend, retract, swing or steer. DRIVE functions operational.* 4.27
10. Machine will not lift, lower, extend, retract swing. DRIVE and STEER functions operational.* 4.28

* **IMPORTANT**: WHEN CONDUCTING A TEST WHILE OPERATING ANY OF THE PLATFORM CONTROL TOGGLE SWITCHES OR THE DRIVE AND STEER JOYSTICK CONTROLLER, THE PLATFORM FOOTSWITCH (FS-1) MUST BE DEPRESSED.

11. BOOM ELEVATE Up function inoperative.* 4.30

12. BOOM ELEVATE Down function inoperative.* 4.33

13. PLATFORM LEVEL Up function inoperative.* 4.35

14. PLATFORM LEVEL Down function inoperative.* 4.38

15. BOOM REACH Up function inoperative.* 4.41

16. BOOM REACH Down function inoperative.* 4.43

17. BOOM REACH Extend function inoperative.* 4.45

18. BOOM REACH Retract function inoperative.* 4.48

19. SWING Left function inoperative.* 4.50

20. SWING Right function inoperative.* 4.53

21. SWING functions operate at wrong rate 4.57

22. STEER Left function inoperative.* 4.58

23. STEER Right function inoperative.* 4.59

24. All STEER functions lost (hydraulic section).* 4.60

25. Machine will not DRIVE or STEER.
BOOM functions are operational.* 4.61

26. Machine will not DRIVE.
STEER and BOOM functions are operational.* 4.62

27. Machine only drives one direction.* 4.66

28. Machine traction function inoperative.* 4.67

29. Machine drives at full speed with platform elevated.* 4.68

Troubleshooting Introduction

The following section is designed to aid in the diagnosis of problems which may occur on a Genie BOOM. A system of troubleshooting flow charts is used to diagnose problems ranging from defective solenoids to the need for pump replacement. To use this section, a technician should have basic hand tools and the following test equipment: a voltmeter, ohmmeter, pressure gauges, and flow meters.

Included in this section are twenty-nine (29) troubleshooting flow charts which cover various machine defective conditions. These flow charts include several numbered tests, and test results (shaded boxes), which are used to direct the technician to the recommended machine repair. Bold framed boxes indicate that the flow chart continues on another page.

Before performing any machine tests the following safety precautions should be observed:

- Read and understand section 3.5, Theory of Operation.
- Read and follow all safety instructions as recommended in section 2.1, Mandatory Precautions and as indicated by decals on the machine.
- When troubleshooting, make certain the machine is resting on a firm, smooth, level surface.
- When testing drive system defective conditions, make certain the machine is secured from rolling by chocking the tires and by jacking the machine chassis and drive assembly off the ground before conducting any tests.
- Two persons will be needed to safely conduct some drive system defective condition tests.
- When inspecting or replacing any hydraulic valve used for BOOM functions, always support Boom, Reach, Swing and Elevate structures from movement.

This Troubleshooting section deals primarily with malfunctions or defective components. Therefore, make certain all correct operating procedures are performed prior to conducting any of the recommended tests.

NOTE: It should be noted that various degrees of a particular function loss may occur. For example: "BOOM ELEVATE Up function inoperative". This should mean "Elevate cylinder will not operate with the same speed or power of a properly functioning machine."

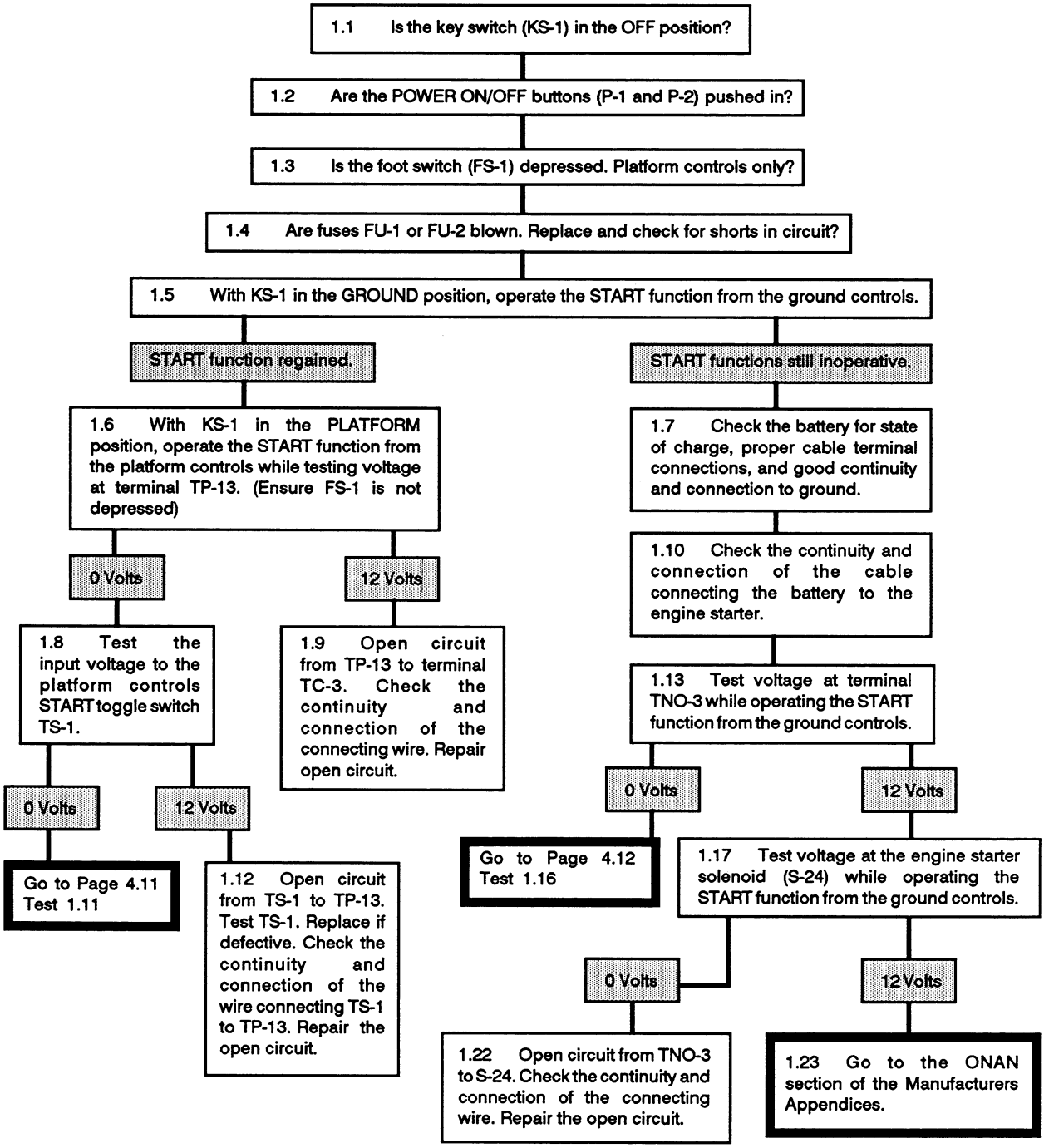
Before commencing diagnosis of a problem, make sure that the battery is fully charged and the engine is running (if possible).

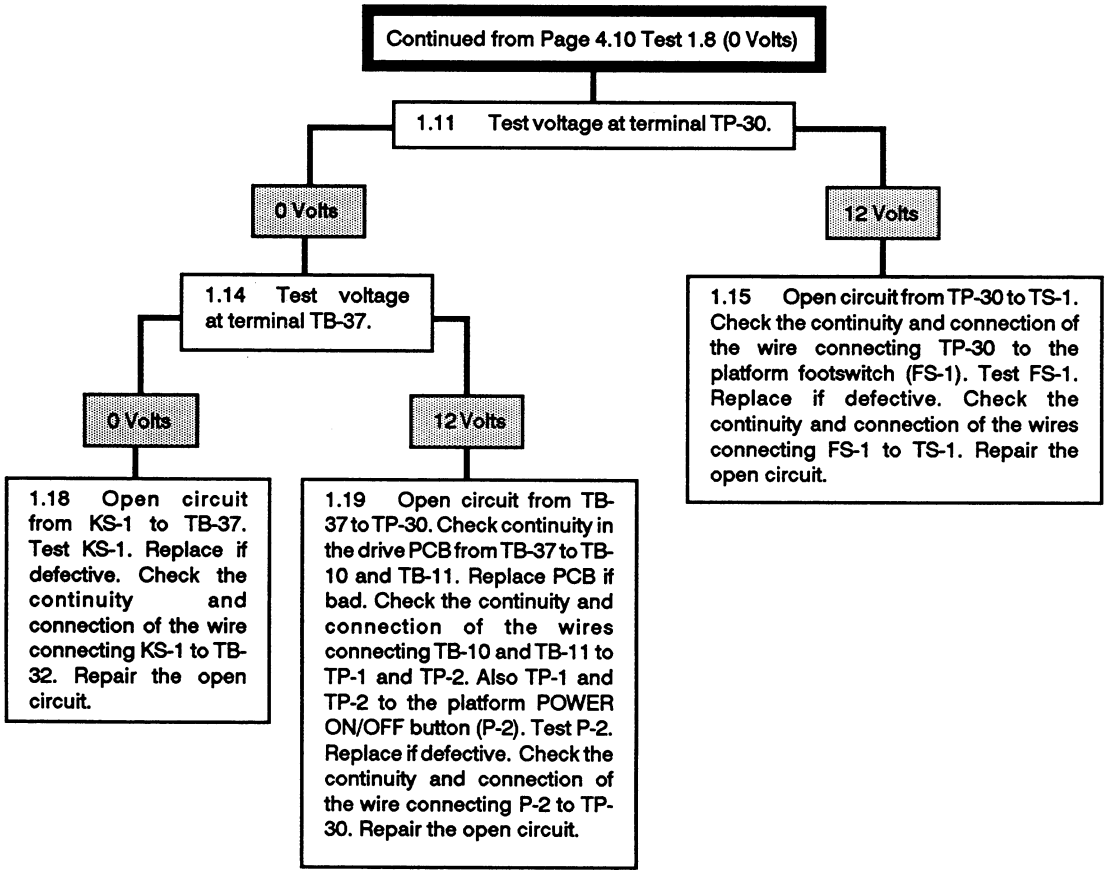
Throughout the Troubleshooting Section, references are made to terminal numbers. For the exact location of these terminal points, refer to the electrical schematic and accompanying legend in Section 5.1, Schematics and Diagrams.

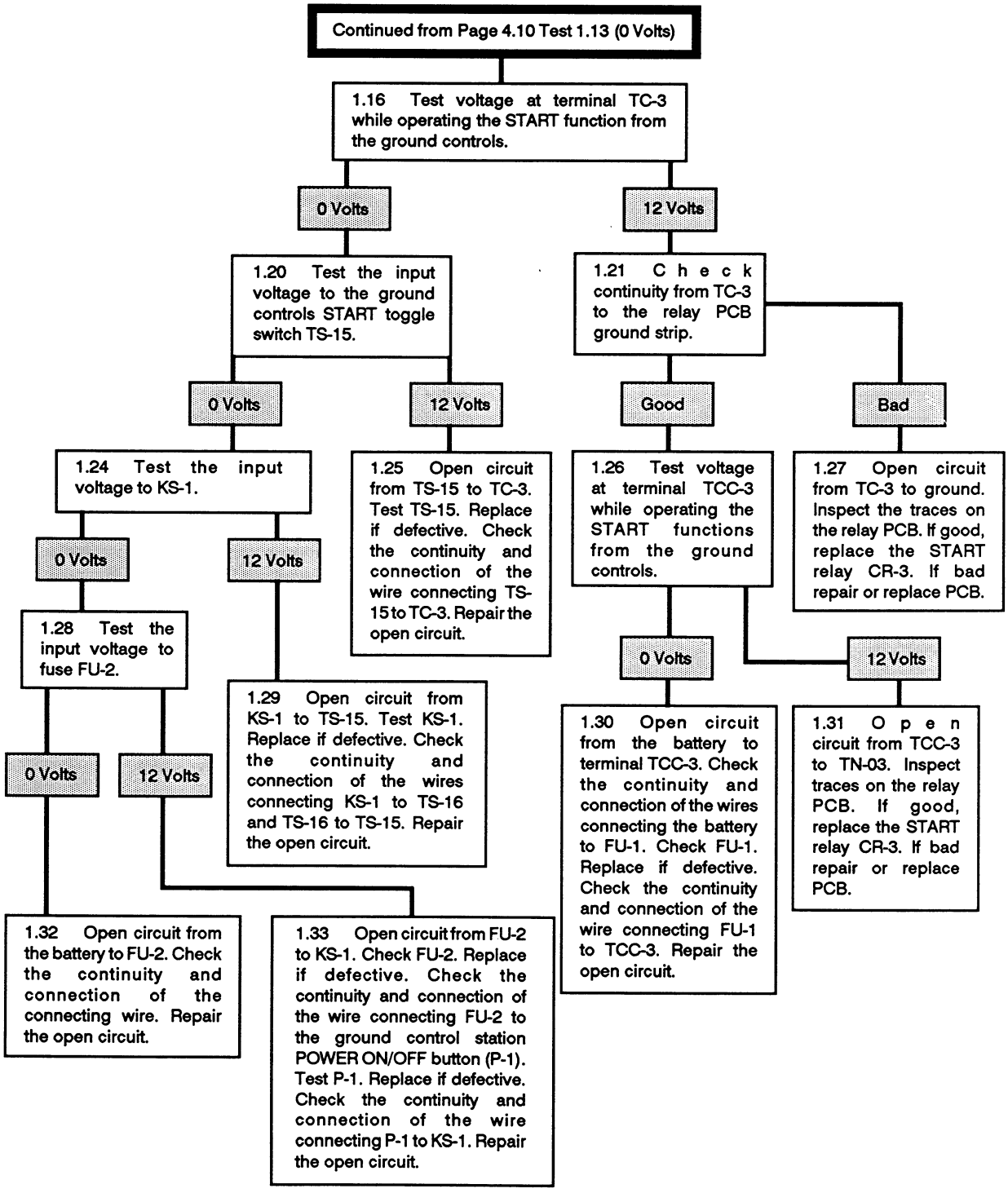
Pages 4.06 and 4.07 list problems which may occur due to component malfunctions. Refer to the flow chart which most accurately describes your problem. In muliple-problem cases, solve one problem at a time beginning with the lowest number.

If you have any questions concerning this Troubleshooting Section, you will be best served by referring to the defective condition flow chart number and machine test number when calling the Genie Service department toll free at 800-426-8089.

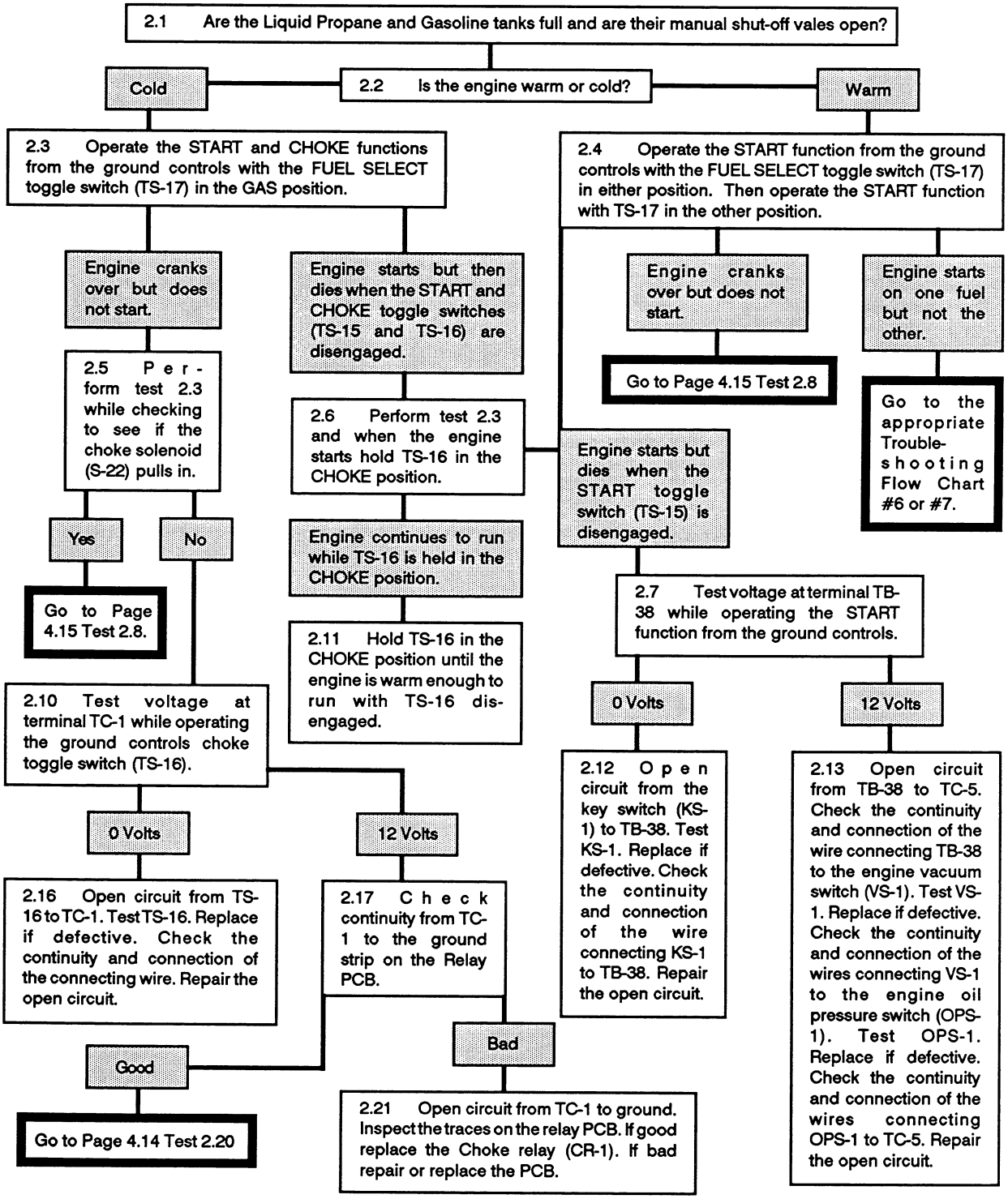
1. Engine will not crank over.

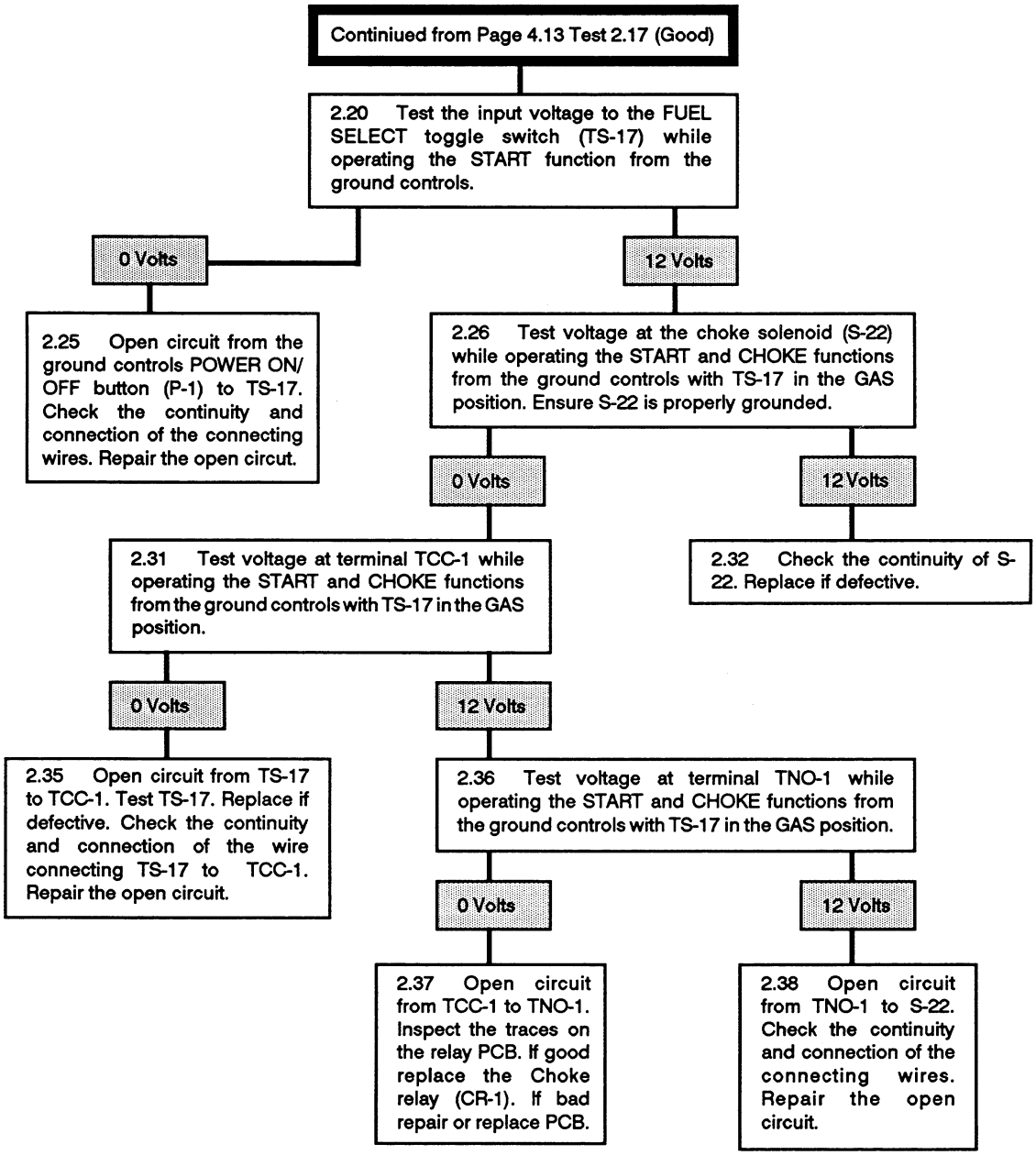


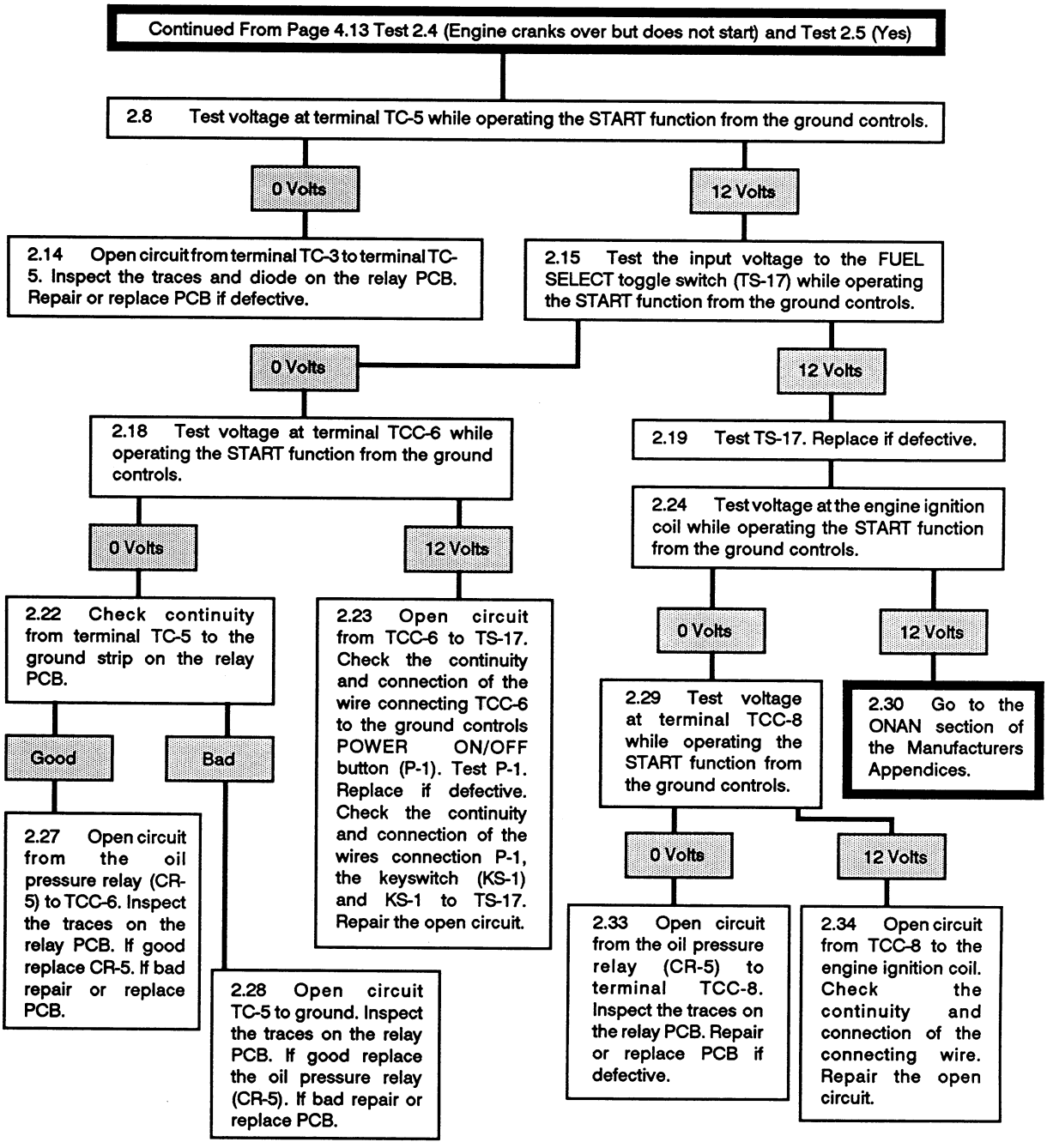

Continued from Page 4.10 Test 1.8 (0 Volts)
1.11 Test voltage at terminal TP-30.
0 Volts
12 Volts
1.14 Test voltage at terminal TB-37.
1.15 Open circuit from TP-30 to TS-1. Check the continuity and connection of the wire connecting TP-30 to the platform footswitch (FS-1). Test FS-1. Replace if defective. Check the continuity and connection of the wires connecting FS-1 to TS-1. Repair the open circuit.
0 Volts
12 Volts
1.18 Open circuit from KS-1 to TB-37. Test KS-1. Replace if defective. Check the continuity and connection of the wire connecting KS-1 to TB-32. Repair the open circuit.
1.19 Open circuit from TB-37 to TP-30. Check continuity in the drive PCB from TB-37 to TB-10 and TB-11. Replace PCB if bad. Check the continuity and connection of the wires connecting TB-10 and TB-11 to TP-1 and TP-2. Also TP-1 and TP-2 to the platform POWER ON/OFF button (P-2). Test P-2. Replace if defective. Check the continuity and connection of the wire connecting P-2 to TP-30. Repair the open circuit.


Continued from Page 4.10 Test 1.13 (0 Volts)
1.16 Test voltage at terminal TC-3 while operating the START function from the ground controls.
0 Volts
12 Volts
1.20 Test the input voltage to the ground controls START toggle switch TS-15.
1.21 Check continuity from TC-3 to the relay PCB ground strip.
0 Volts
12 Volts
Good
Bad
1.24 Test the input voltage to KS-1.
1.25 Open circuit from TS-15 to TC-3. Test TS-15. Replace if defective. Check the continuity and connection of the wire connecting TS-15 to TC-3. Repair the open circuit.
1.26 Test voltage at terminal TCC-3 while operating the START functions from the ground controls.
1.27 Open circuit from TC-3 to ground. Inspect the traces on the relay PCB. If good, replace the START relay CR-3. If bad repair or replace PCB.
0 Volts
12 Volts
1.28 Test the input voltage to fuse FU-2.
1.29 Open circuit from KS-1 to TS-15. Test KS-1. Replace if defective. Check the continuity and connection of the wires connecting KS-1 to TS-16 and TS-16 to TS-15. Repair the open circuit.
0 Volts
12 Volts
1.30 Open circuit from the battery to terminal TCC-3. Check the continuity and connection of the wires connecting the battery to FU-1. Check FU-1. Replace if defective. Check the continuity and connection of the wire connecting FU-1 to TCC-3. Repair the open circuit.
1.31 Open circuit from TCC-3 to TN-03. Inspect traces on the relay PCB. If good, replace the START relay CR-3. If bad repair or replace PCB.
1.32 Open circuit from the battery to FU-2. Check the continuity and connection of the connecting wire. Repair the open circuit.
1.33 Open circuit from FU-2 to KS-1. Check FU-2. Replace if defective. Check the continuity and connection of the wire connecting FU-2 to the ground control station POWER ON/OFF button (P-1). Test P-1. Replace if defective. Check the continuity and connection of the wire connecting P-1 to KS-1. Repair the open circuit.

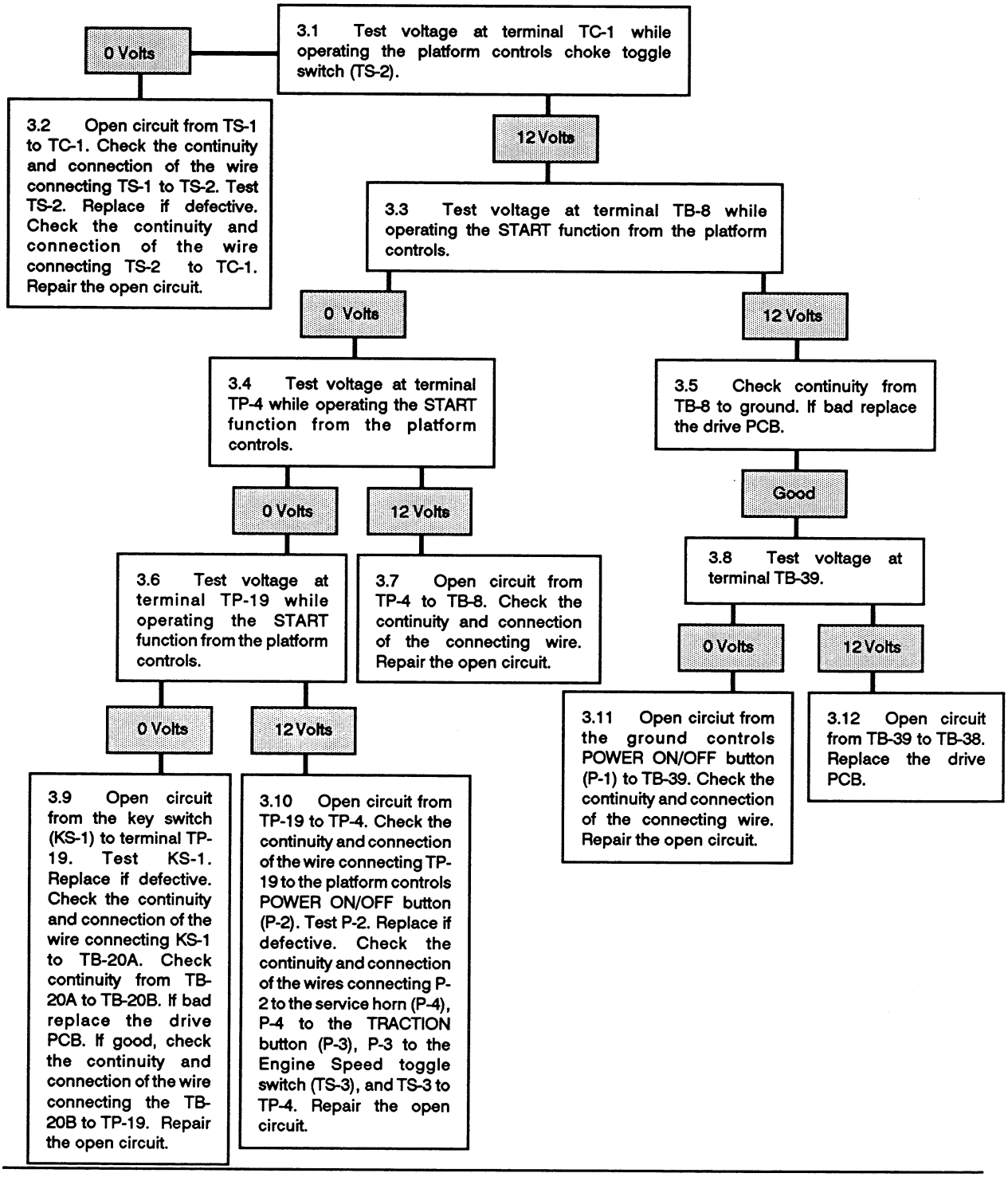
2. Engine cranks over but will not start (GP & RT models).



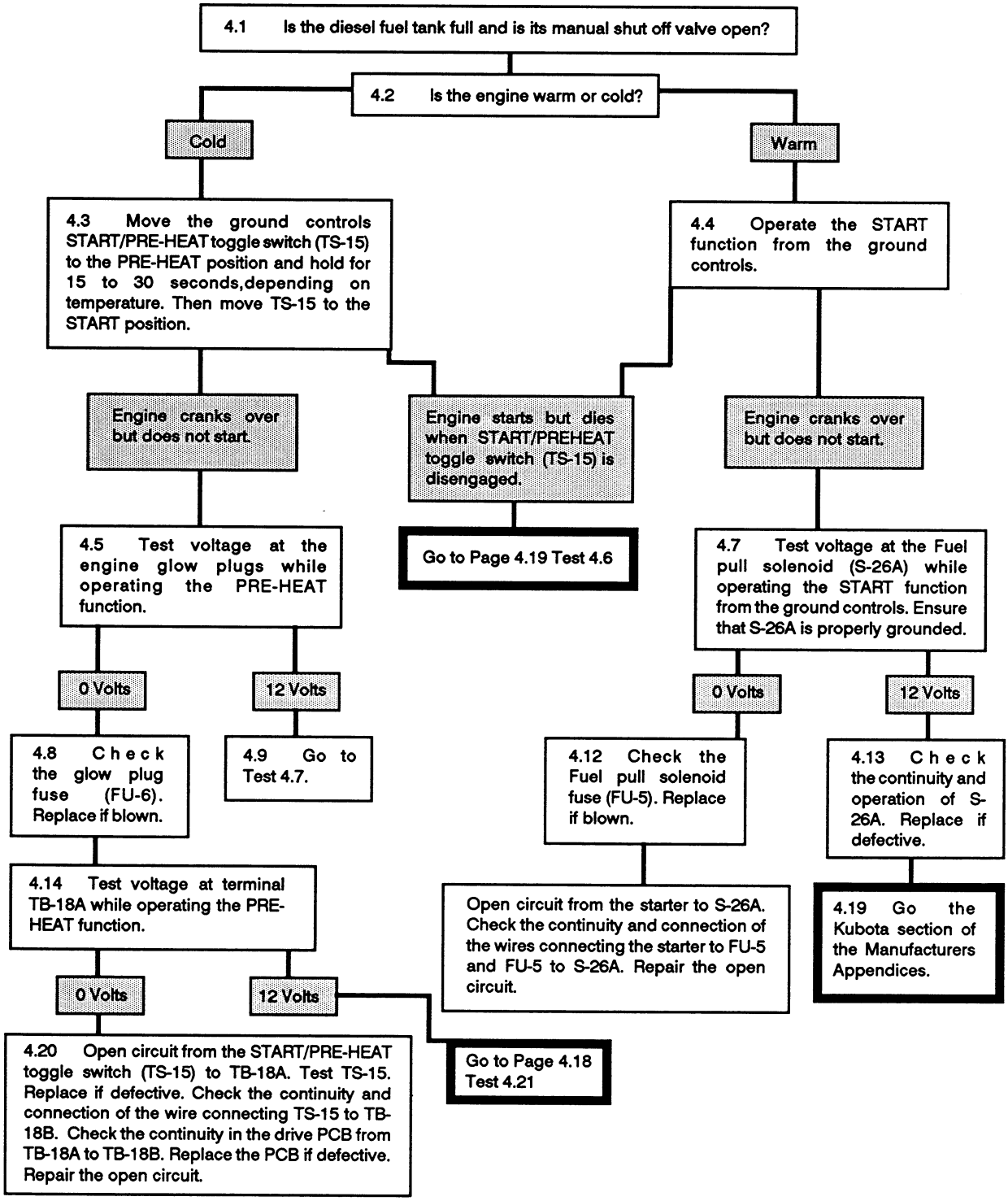

Continiued from Page 4.13 Test 2.17 (Good)
2.20 Test the input voltage to the FUEL SELECT toggle switch (TS-17) while operating the START function from the ground controls.
0 Volts
12 Volts
2.25 Open circuit from the ground controls POWER ON/ OFF button (P-1) to TS-17. Check the continuity and connection of the connecting wires. Repair the open circut.
2.26 Test voltage at the choke solenoid (S-22) while operating the START and CHOKE functions from the ground controls with TS-17 in the GAS position. Ensure S-22 is properly grounded.
0 Volts
12 Volts
2.31 Test voltage at terminal TCC-1 while operating the START and CHOKE functions from the ground controls with TS-17 in the GAS position.
2.32 Check the continuity of S-22. Replace if defective.
0 Volts
12 Volts
2.35 Open circuit from TS-17 to TCC-1. Test TS-17. Replace if defective. Check the continuity and connection of the wire connecting TS-17 to TCC-1. Repair the open circuit.
2.36 Test voltage at terminal TNO-1 while operating the START and CHOKE functions from the ground controls with TS-17 in the GAS position.
0 Volts
12 Volts
2.37 Open circuit from TCC-1 to TNO-1. Inspect the traces on the relay PCB. If good replace the Choke relay (CR-1). If bad repair or replace PCB.
2.38 Open circuit from TNO-1 to S-22. Check the continuity and connection of the connecting wires. Repair the open circuit.

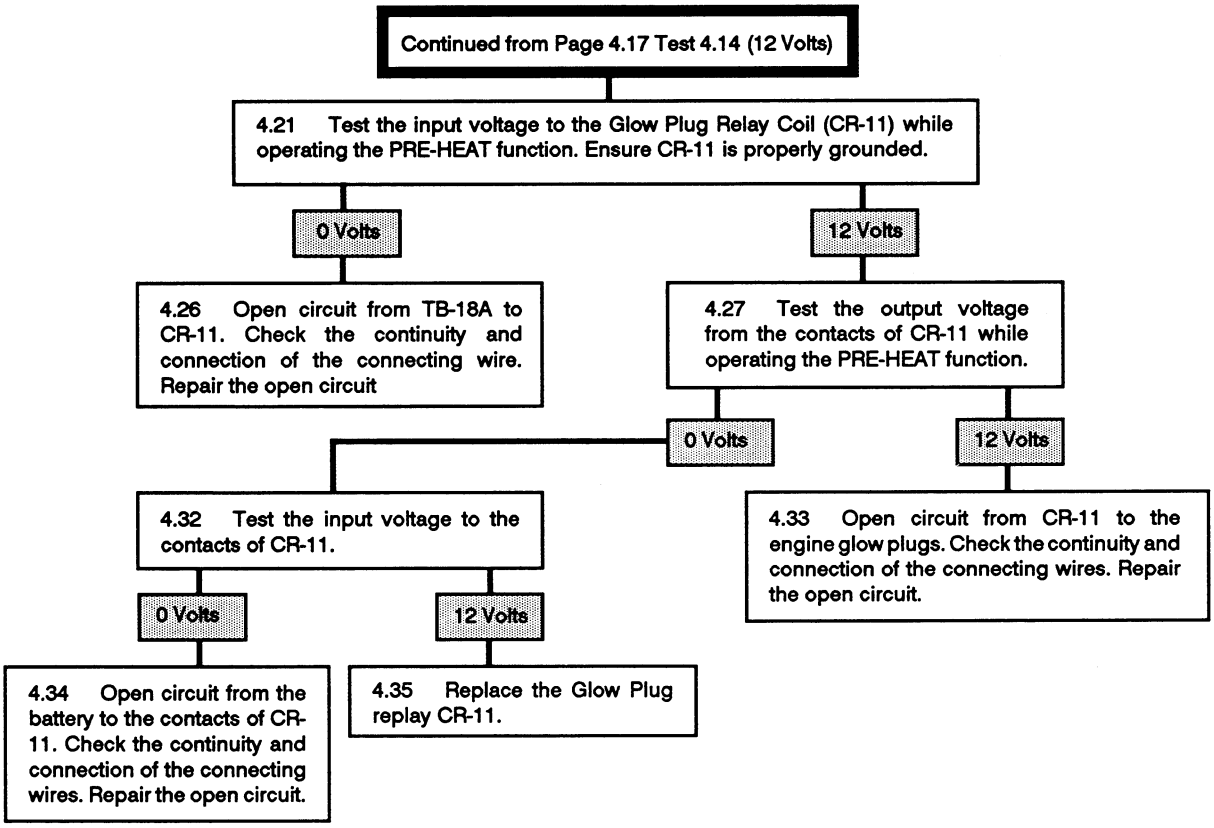

Continued From Page 4.13 Test 2.4 (Engine cranks over but does not start) and Test 2.5 (Yes)
2.8 Test voltage at terminal TC-5 while operating the START function from the ground controls.
0 Volts
12 Volts
2.14 Open circuit from terminal TC-3 to terminal TC-5. Inspect the traces and diode on the relay PCB. Repair or replace PCB if defective.
2.15 Test the input voltage to the FUEL SELECT toggle switch (TS-17) while operating the START function from the ground controls.
0 Volts
12 Volts
2.18 Test voltage at terminal TCC-6 while operating the START function from the ground controls.
2.19 Test TS-17. Replace if defective.
2.24 Test voltage at the engine ignition coil while operating the START function from the ground controls.
0 Volts
12 Volts
2.22 Check continuity from terminal TC-5 to the ground strip on the relay PCB.
2.23 Open circuit from TCC-6 to TS-17. Check the continuity and connection of the wire connecting TCC-6 to the ground controls POWER ON/OFF button (P-1). Test P-1. Replace if defective. Check the continuity and connection of the wires connection P-1, the keyswitch (KS-1) and KS-1 to TS-17. Repair the open circuit.
0 Volts
12 Volts
2.29 Test voltage at terminal TCC-8 while operating the START function from the ground controls.
2.30 Go to the ONAN section of the Manufacturers Appendices.
Good
Bad
2.27 Open circuit from the oil pressure relay (CR-5) to TCC-6. Inspect the traces on the relay PCB. If good replace CR-5. If bad repair or replace PCB.
2.28 Open circuit TC-5 to ground. Inspect the traces on the relay PCB. If good replace the oil pressure relay (CR-5). If bad repair or replace PCB.
0 Volts
12 Volts
2.33 Open circuit from the oil pressure relay (CR-5) to terminal TCC-8. Inspect the traces on the relay PCB. Repair or replace PCB if defective.
2.34 Open circuit from TCC-8 to the engine ignition coil. Check the continuity and connection of the connecting wire. Repair the open circuit.

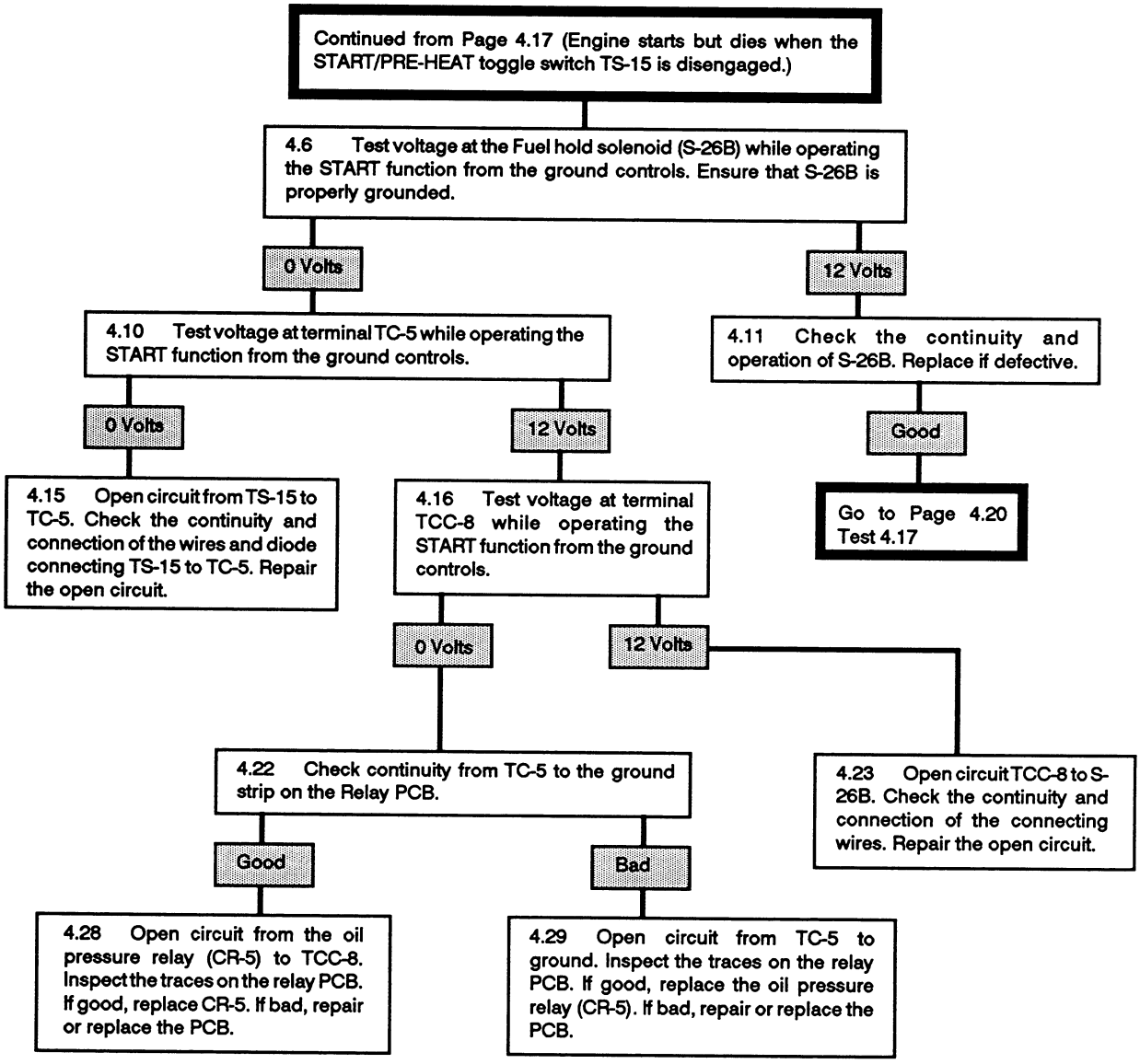
3. Engine cranks over but will not start. (Platform controls only GP & RT models).

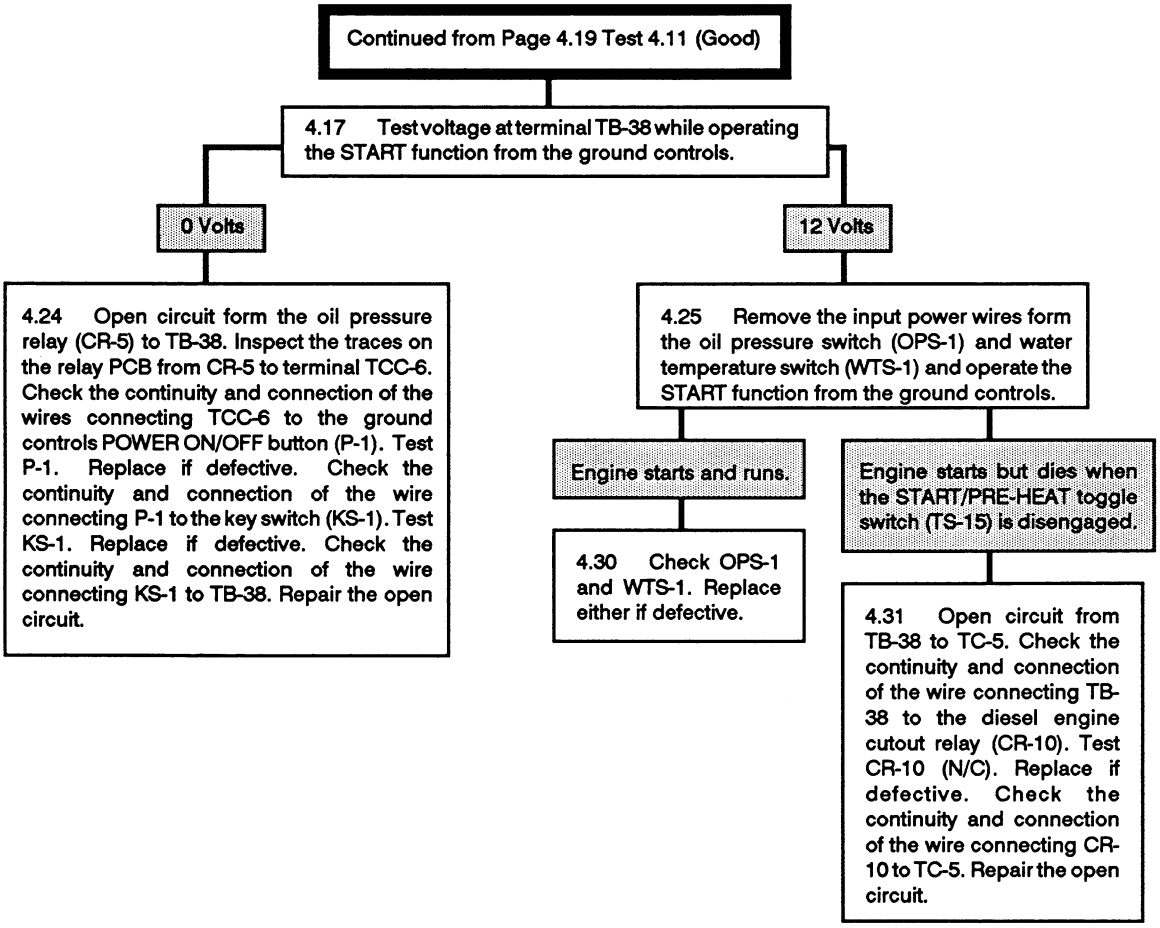


4. Engine cranks over but will not start (D & DRT models).

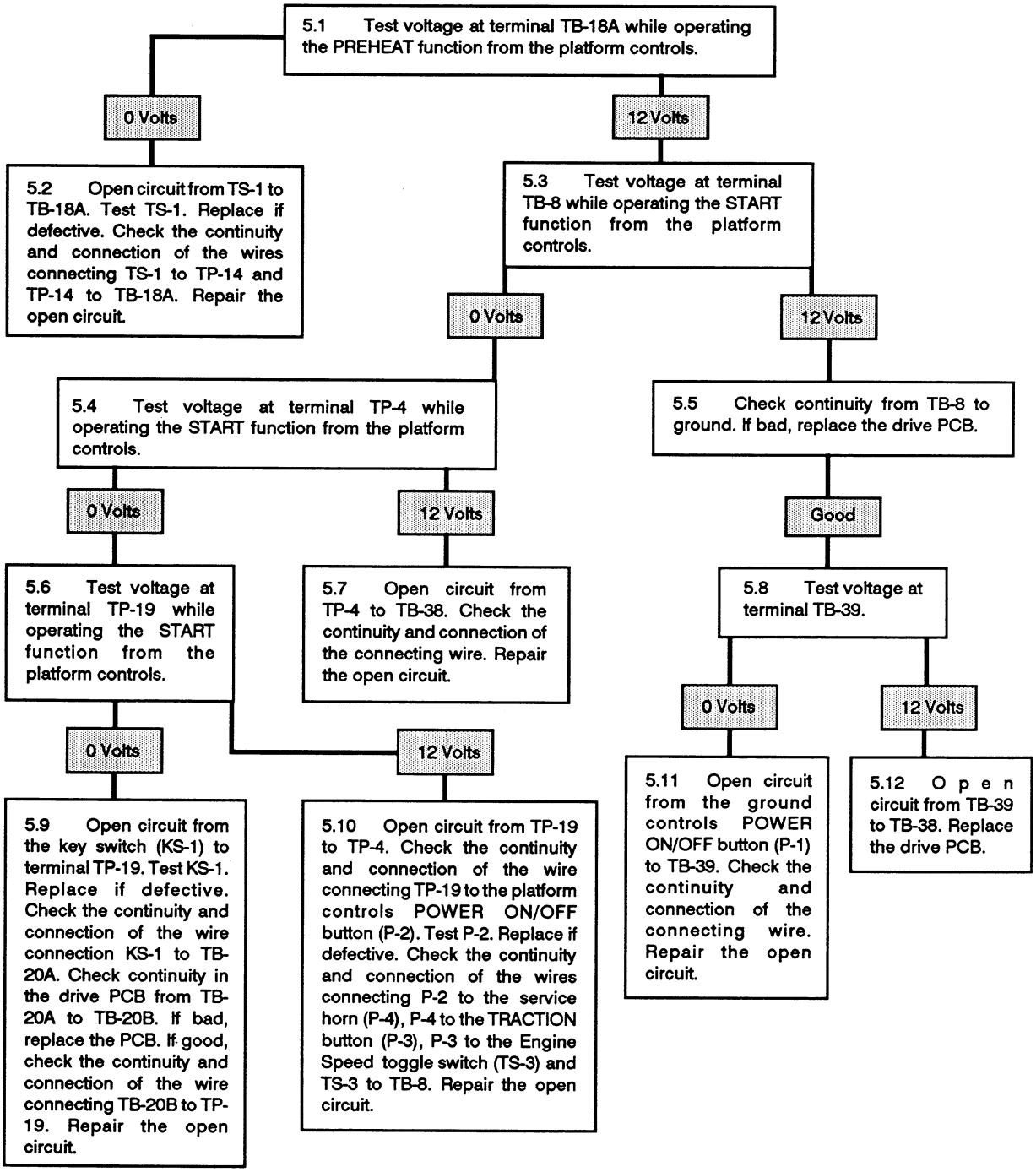



Continued from Page 4.17 Test 4.14 (12 Volts)
4.21 Test the input voltage to the Glow Plug Relay Coil (CR-11) while operating the PRE-HEAT function. Ensure CR-11 is properly grounded.
0 Volts
12 Volts
4.26 Open circuit from TB-18A to CR-11. Check the continuity and connection of the connecting wire. Repair the open circuit
4.27 Test the output voltage from the contacts of CR-11 while operating the PRE-HEAT function.
0 Volts
12 Volts
4.32 Test the input voltage to the contacts of CR-11.
4.33 Open circuit from CR-11 to the engine glow plugs. Check the continuity and connection of the connecting wires. Repair the open circuit.
0 Volts
12 Volts
4.34 Open circuit from the battery to the contacts of CR-11. Check the continuity and connection of the connecting wires. Repair the open circuit.
4.35 Replace the Glow Plug replay CR-11.


Continued from Page 4.17 (Engine starts but dies when the START/PRE-HEAT toggle switch TS-15 is disengaged.)
4.6 Test voltage at the Fuel hold solenoid (S-26B) while operating the START function from the ground controls. Ensure that S-26B is properly grounded.
0 Volts
12 Volts
4.10 Test voltage at terminal TC-5 while operating the START function from the ground controls.
4.11 Check the continuity and operation of S-26B. Replace if defective.
0 Volts
12 Volts
Good
4.15 Open circuit from TS-15 to TC-5. Check the continuity and connection of the wires and diode connecting TS-15 to TC-5. Repair the open circuit.
4.16 Test voltage at terminal TCC-8 while operating the START function from the ground controls.
Go to Page 4.20 Test 4.17
0 Volts
12 Volts
4.22 Check continuity from TC-5 to the ground strip on the Relay PCB.
4.23 Open circuit TCC-8 to S-26B. Check the continuity and connection of the connecting wires. Repair the open circuit.
Good
Bad
4.28 Open circuit from the oil pressure relay (CR-5) to TCC-8. Inspect the traces on the relay PCB. If good, replace CR-5. If bad, repair or replace the PCB.
4.29 Open circuit from TC-5 to ground. Inspect the traces on the relay PCB. If good, replace the oil pressure relay (CR-5). If bad, repair or replace the PCB.

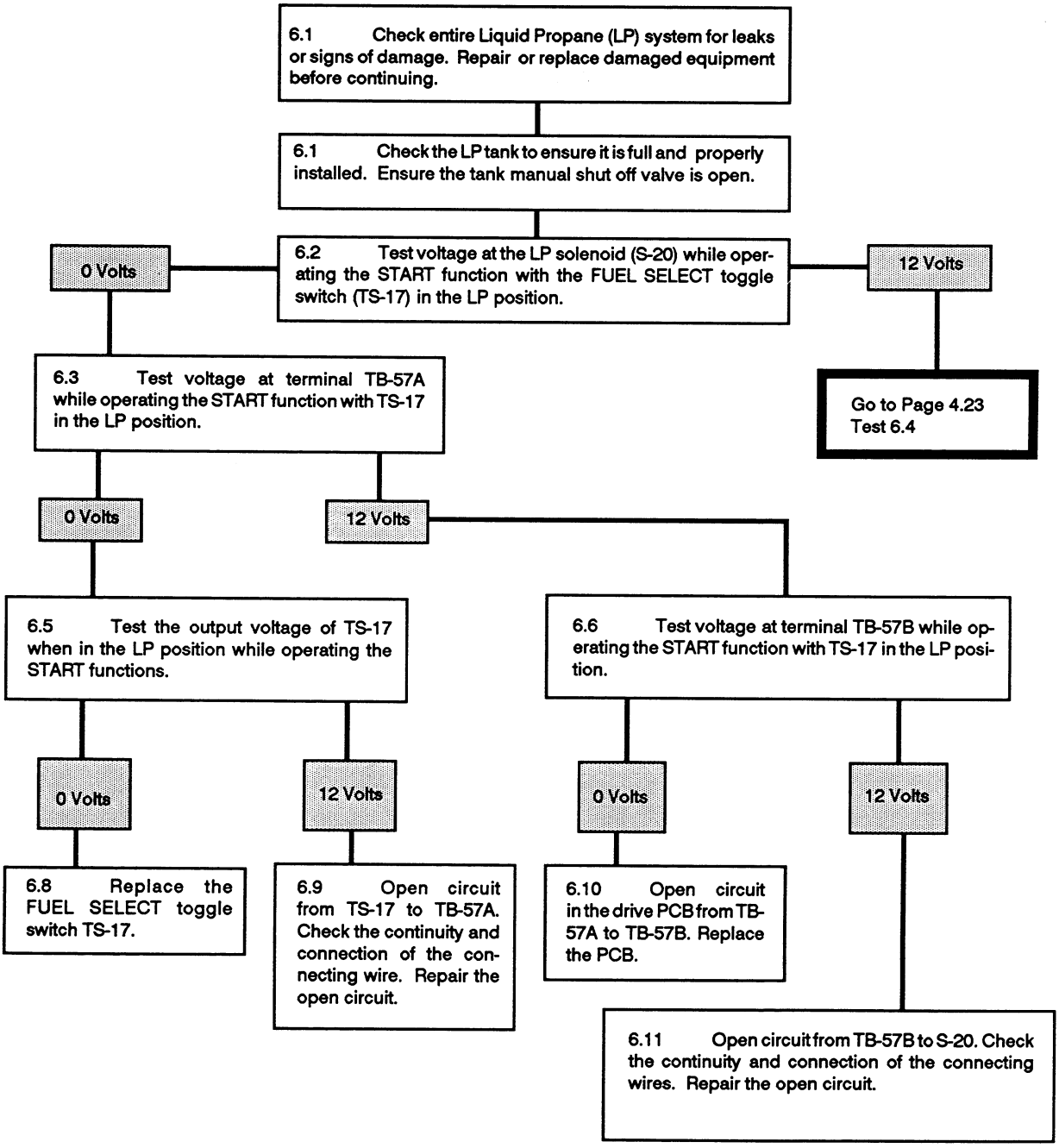

Continued from Page 4.19 Test 4.11 (Good)
4.17 Test voltage at terminal TB-38 while operating the START function from the ground controls.
0 Volts
12 Volts
4.24 Open circuit form the oil pressure relay (CR-5) to TB-38. Inspect the traces on the relay PCB from CR-5 to terminal TCC-6. Check the continuity and connection of the wires connecting TCC-6 to the ground controls POWER ON/OFF button (P-1). Test P-1. Replace if defective. Check the continuity and connection of the wire connecting P-1 to the key switch (KS-1). Test KS-1. Replace if defective. Check the continuity and connection of the wire connecting KS-1 to TB-38. Repair the open circuit.
4.25 Remove the input power wires form the oil pressure switch (OPS-1) and water temperature switch (WTS-1) and operate the START function from the ground controls.
Engine starts and runs.
Engine starts but dies when the START/PRE-HEAT toggle switch (TS-15) is disengaged.
4.30 Check OPS-1 and WTS-1. Replace either if defective.
4.31 Open circuit from TB-38 to TC-5. Check the continuity and connection of the wire connecting TB-38 to the diesel engine cutout relay (CR-10). Test CR-10 (N/C). Replace if defective. Check the continuity and connection of the wire connecting CR-10 to TC-5. Repair the open circuit.

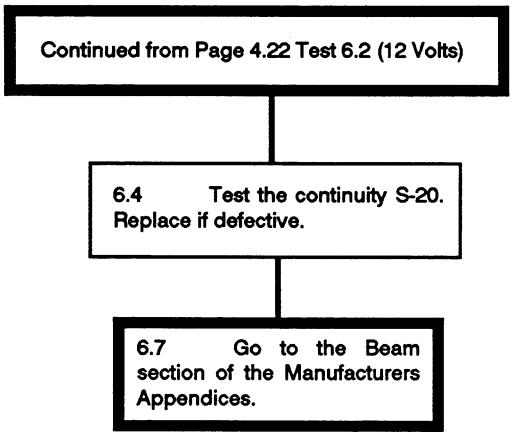
5. Engine cranks over but will not start. (Platform controls only, D & DRT models)



6. Engine starts on gasoline, but not on liquid propane.

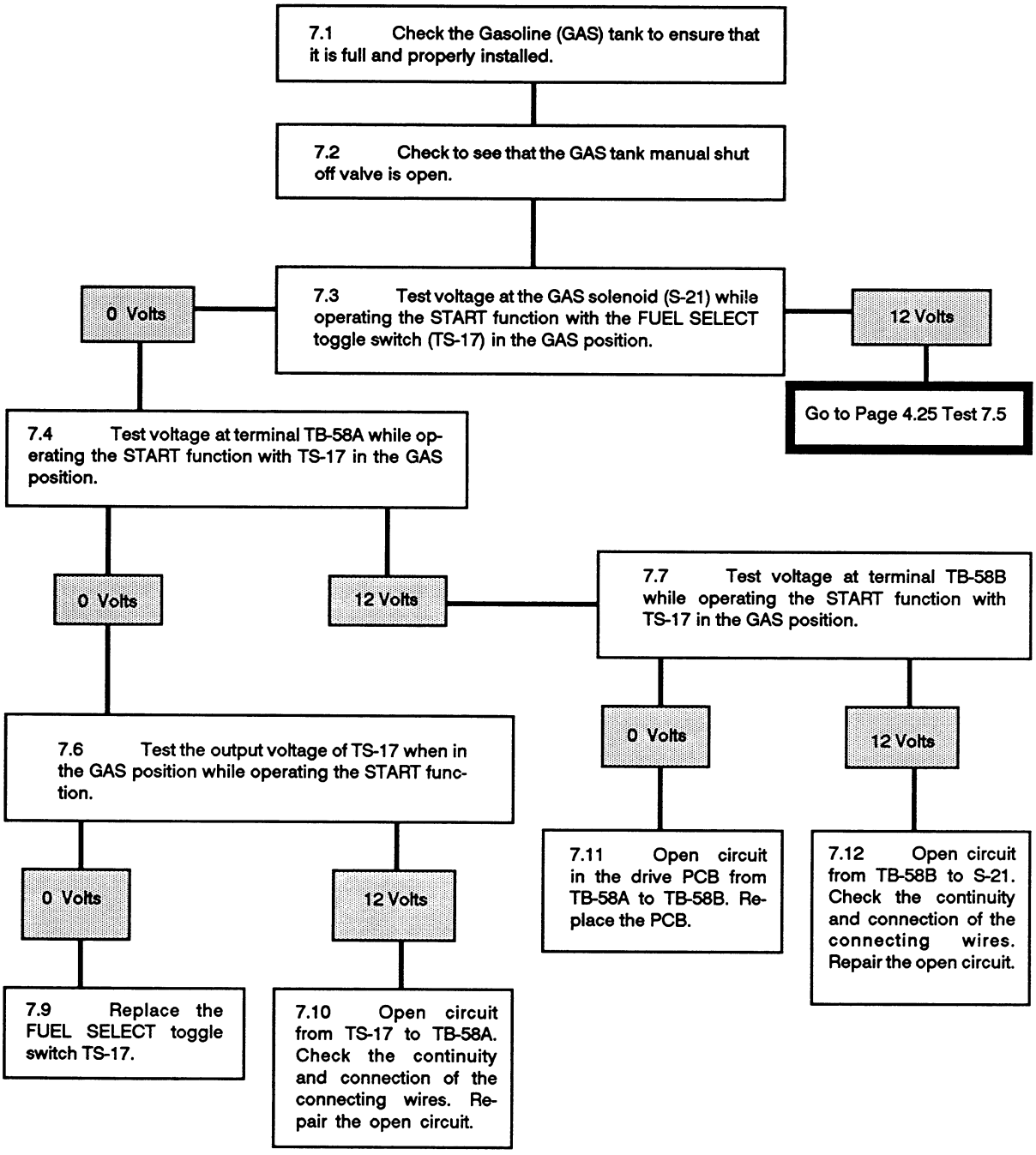
WARNING: Liquid Propane (LP) is extremely flammable. DO NOT attempt to start the engine if you smell LP.

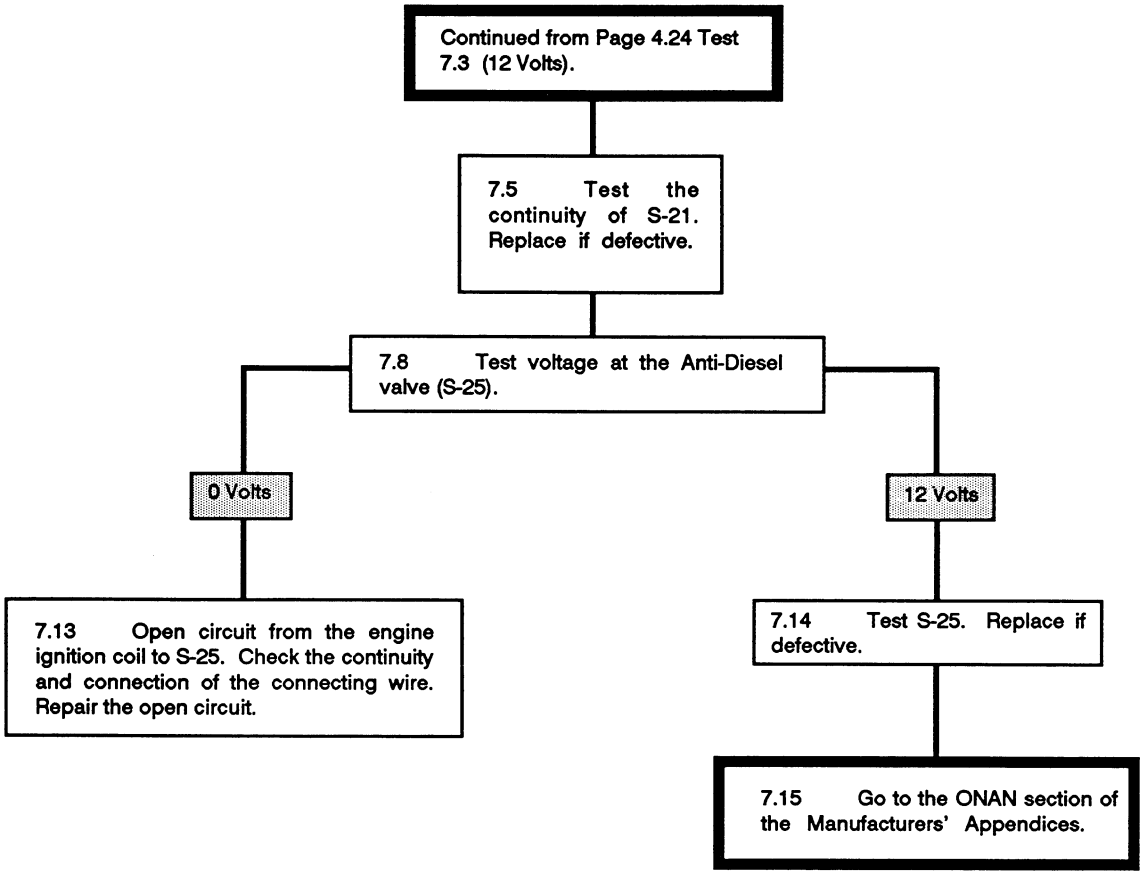



Continued from Page 4.22 Test 6.2 (12 Volts)
6.4 Test the continuity S-20. Replace if defective.
6.7 Go to the Beam section of the Manufacturers Appendices.

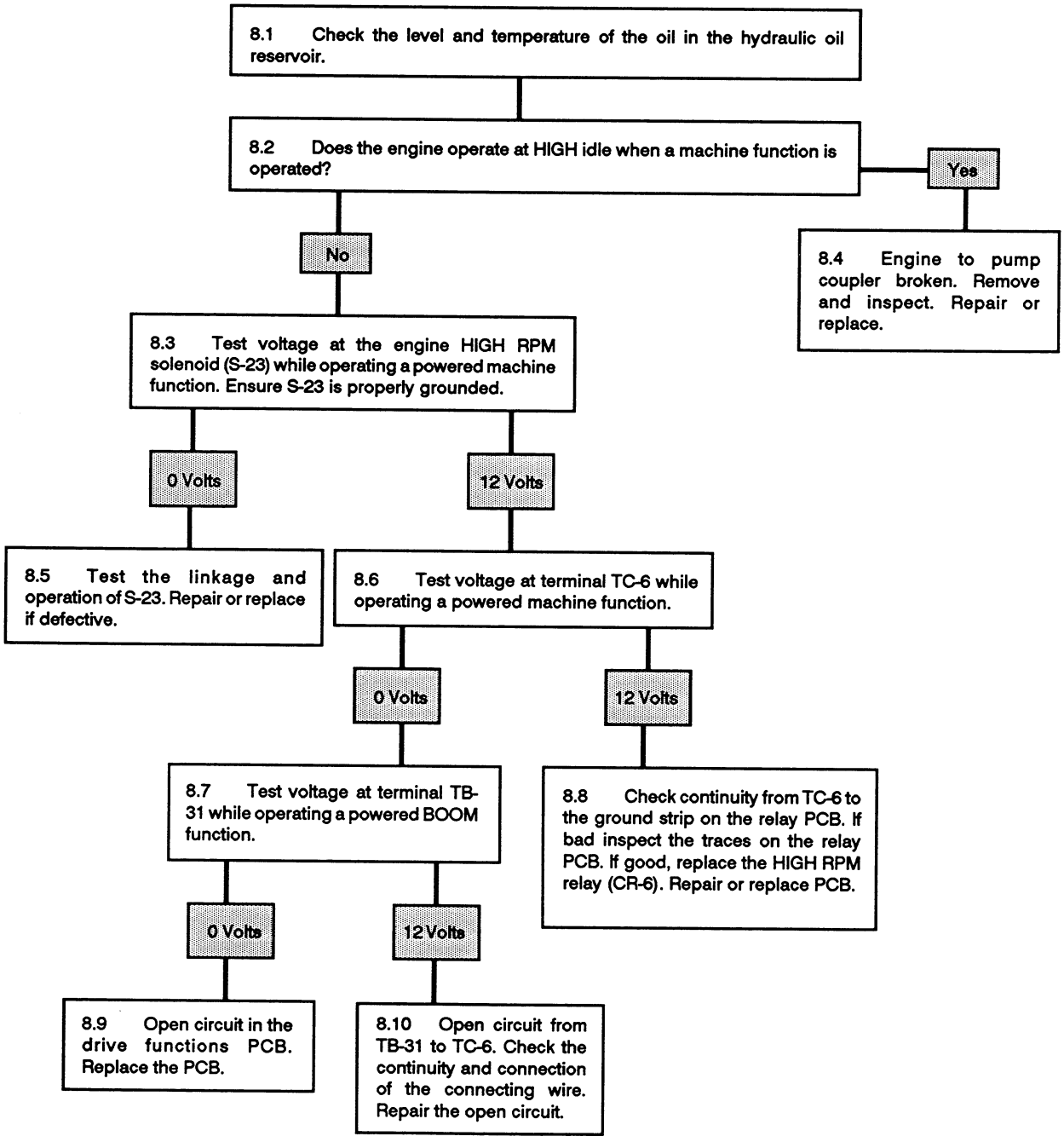
7. Engine starts on liquid propane, but not on gasoline.

WARNING : Gasoline (GAS) is extremely flammable.
DO NOT attempt to start the engine if you smell gasoline.

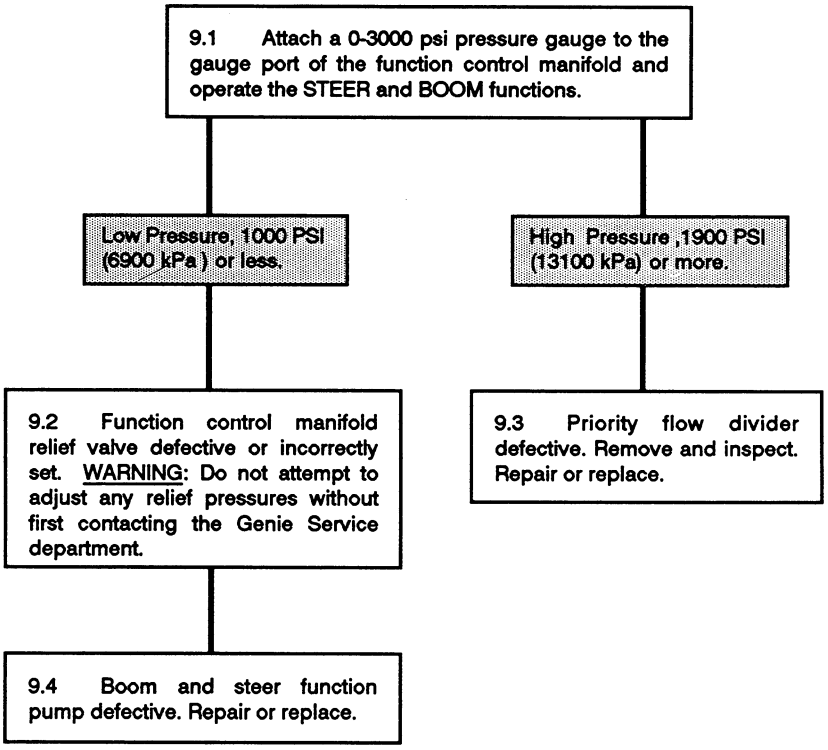



Continued from Page 4.24 Test 7.3 (12 Volts).
7.5 Test the continuity of S-21. Replace if defective.
7.8 Test voltage at the Anti-Diesel valve (S-25).
0 Volts
12 Volts
7.13 Open circuit from the engine ignition coil to S-25. Check the continuity and connection of the connecting wire. Repair the open circuit.
7.14 Test S-25. Replace if defective.
7.15 Go to the ONAN section of the Manufacturers' Appendices.

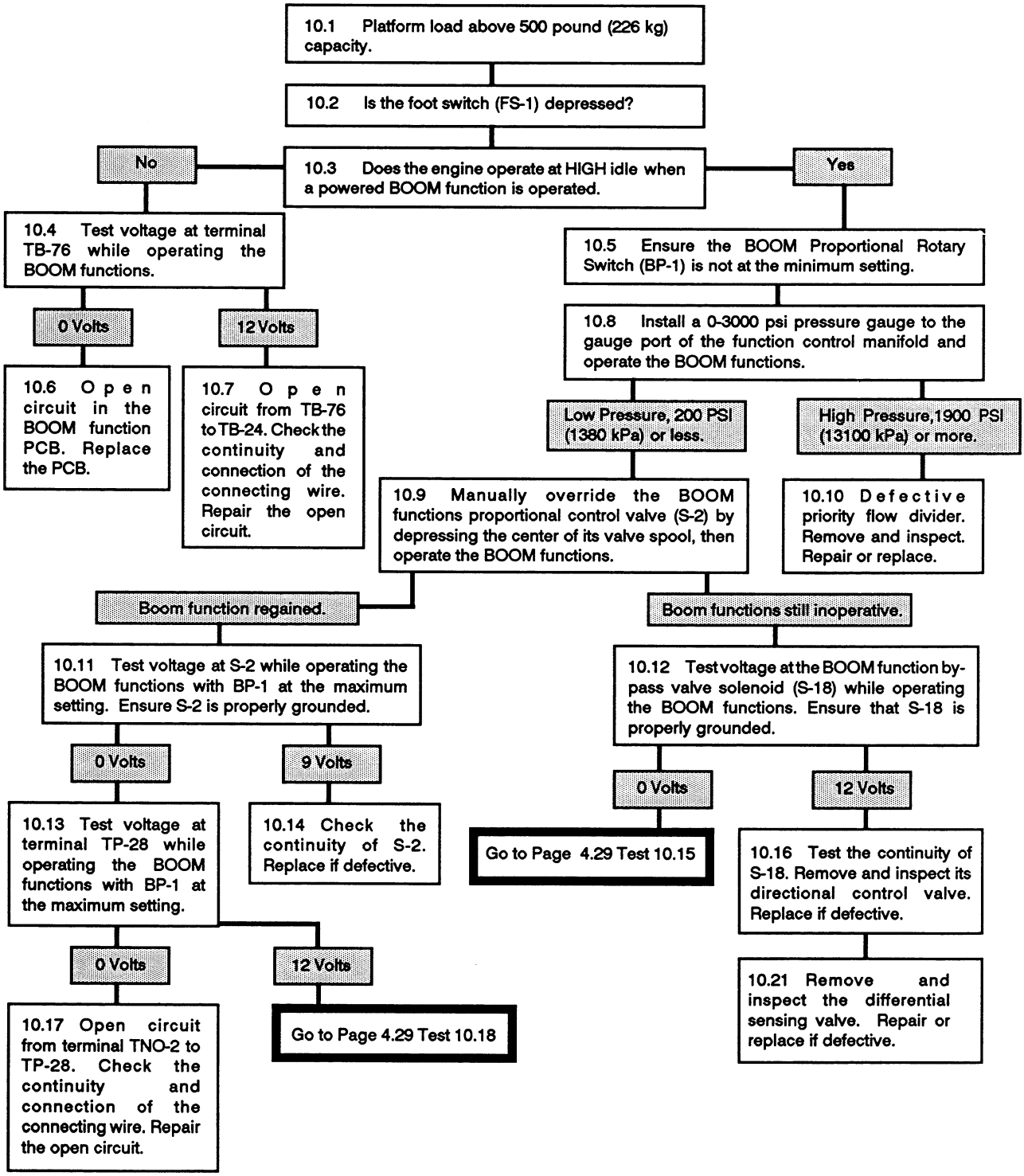
8. Machine will not lift, lower, extend, retract, swing, drive or steer. All powered functions lost. Engine starts and runs.

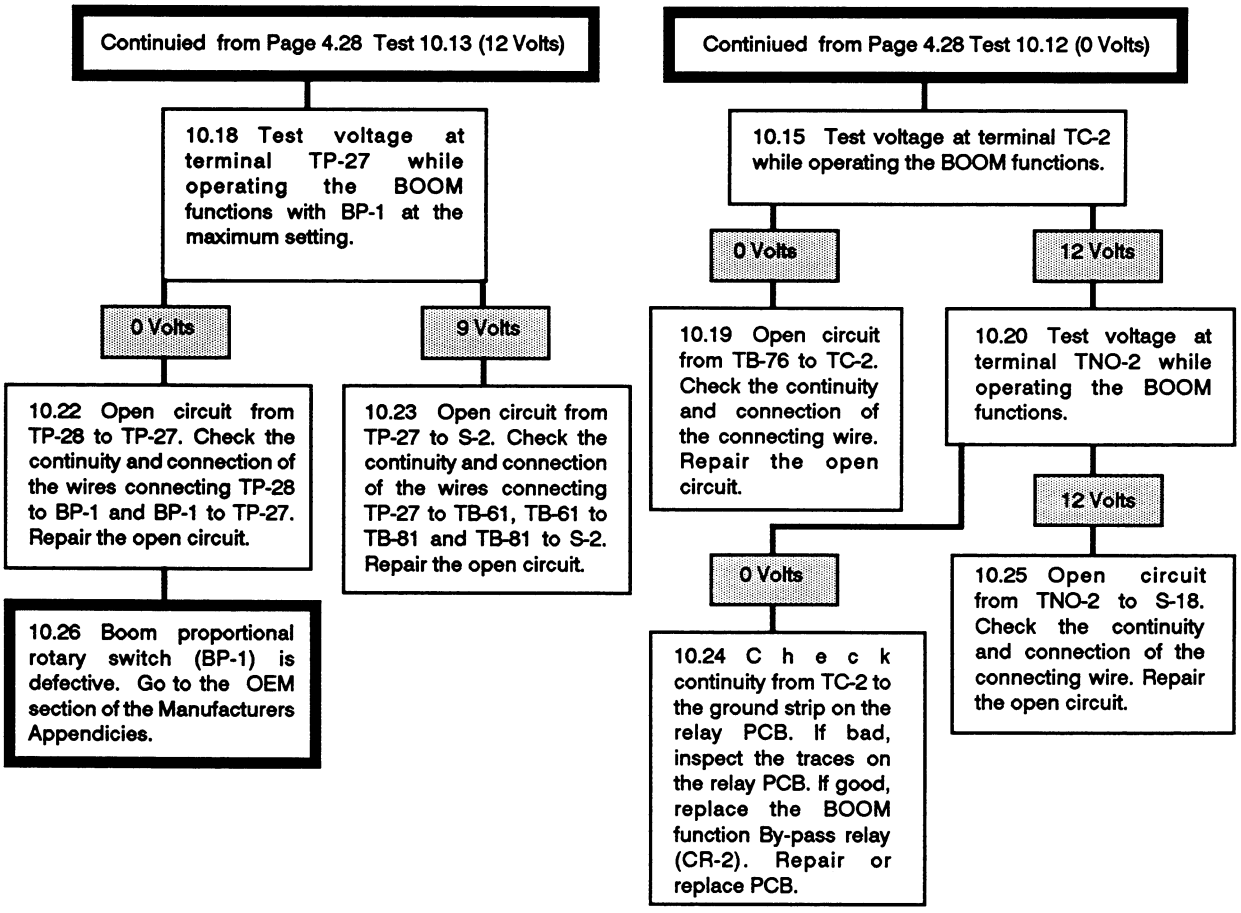


9. Machine will not lift, lower, extend, retract, swing or steer. DRIVE functions operational.

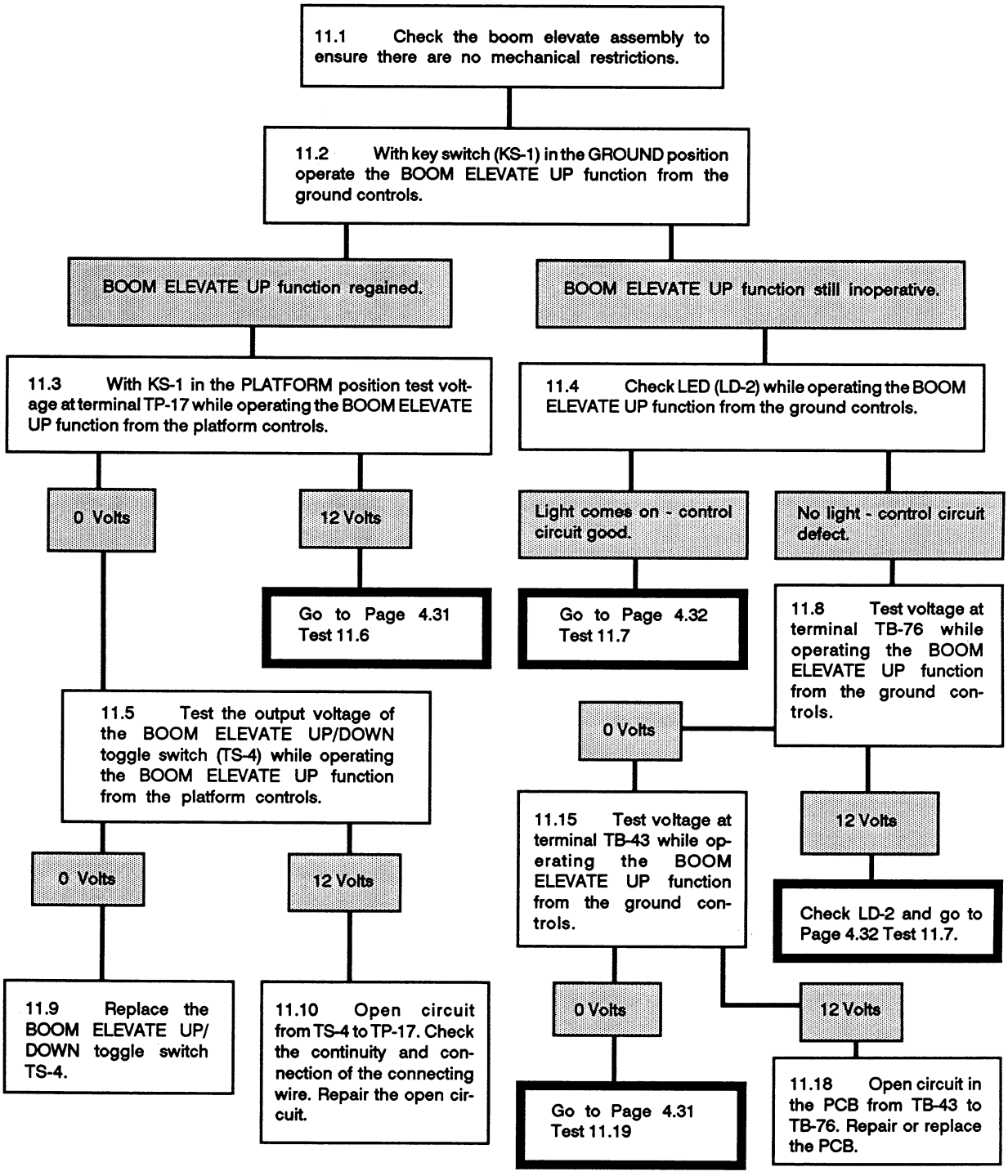


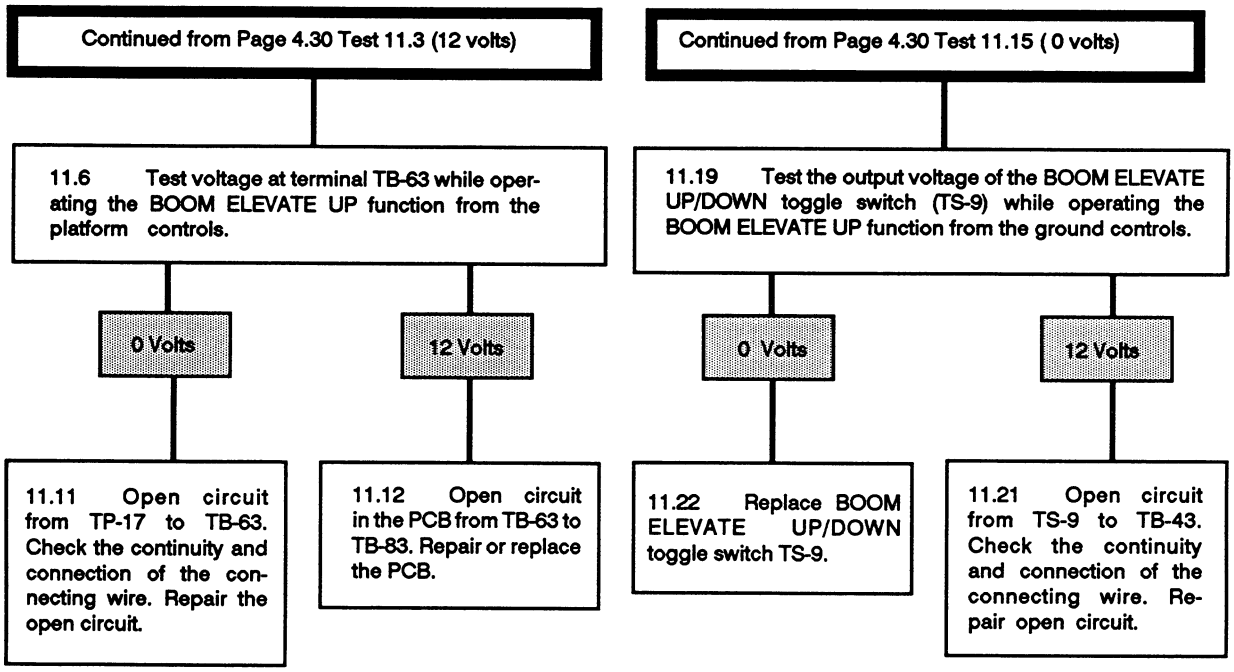
10. Machine will not lift, lower, extend, retract, or swing. DRIVE and STEER functions are operational.

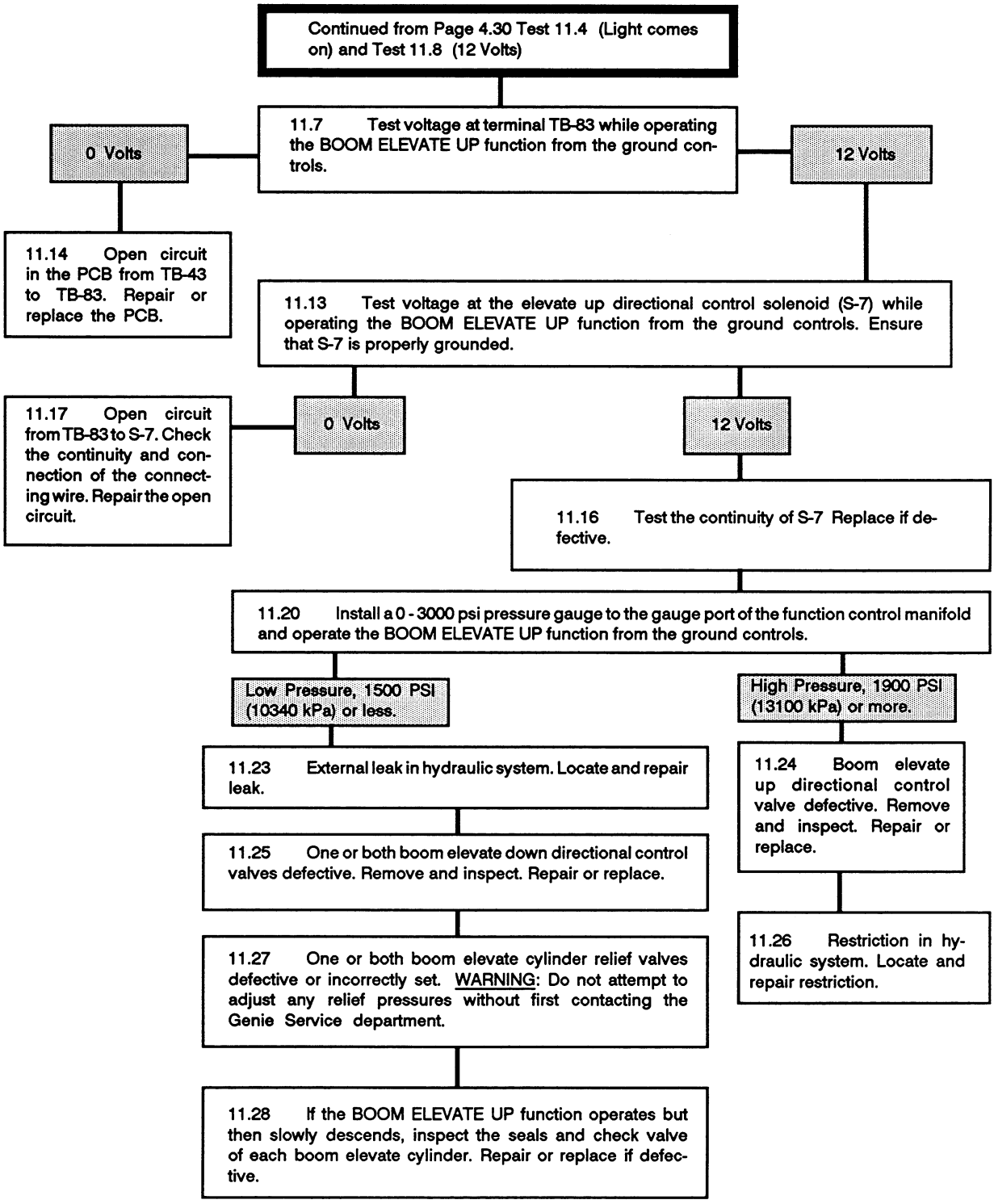



Continuied from Page 4.28 Test 10.13 (12 Volts)
10.18 Test voltage at terminal TP-27 while operating the BOOM functions with BP-1 at the maximum setting.
0 Volts
9 Volts
10.22 Open circuit from TP-28 to TP-27. Check the continuity and connection of the wires connecting TP-28 to BP-1 and BP-1 to TP-27. Repair the open circuit.
10.23 Open circuit from TP-27 to S-2. Check the continuity and connection of the wires connecting TP-27 to TB-61, TB-61 to TB-81 and TB-81 to S-2. Repair the open circuit.
10.26 Boom proportional rotary switch (BP-1) is defective. Go to the OEM section of the Manufacturers Appendicies.
Continiued from Page 4.28 Test 10.12 (0 Volts)
10.15 Test voltage at terminal TC-2 while operating the BOOM functions.
0 Volts
12 Volts
10.19 Open circuit from TB-76 to TC-2. Check the continuity and connection of the connecting wire. Repair the open circuit.
10.20 Test voltage at terminal TNO-2 while operating the BOOM functions.
12 Volts
0 Volts
10.24 Check continuity from TC-2 to the ground strip on the relay PCB. If bad, inspect the traces on the relay PCB. If good, replace the BOOM function By-pass relay (CR-2). Repair or replace PCB.
10.25 Open circuit from TNO-2 to S-18. Check the continuity and connection of the connecting wire. Repair the open circuit.

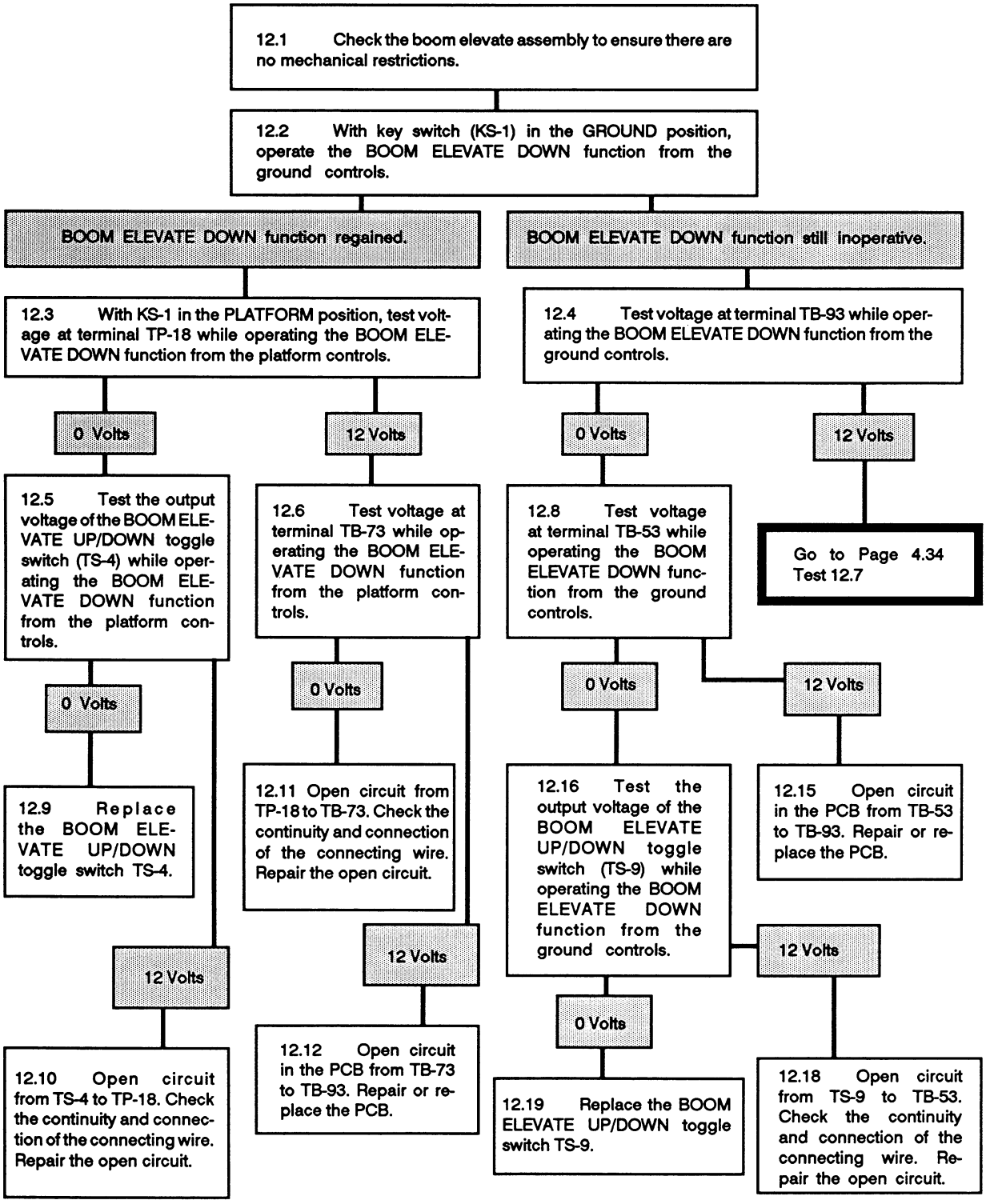
11. BOOM ELEVATE Up function inoperative.

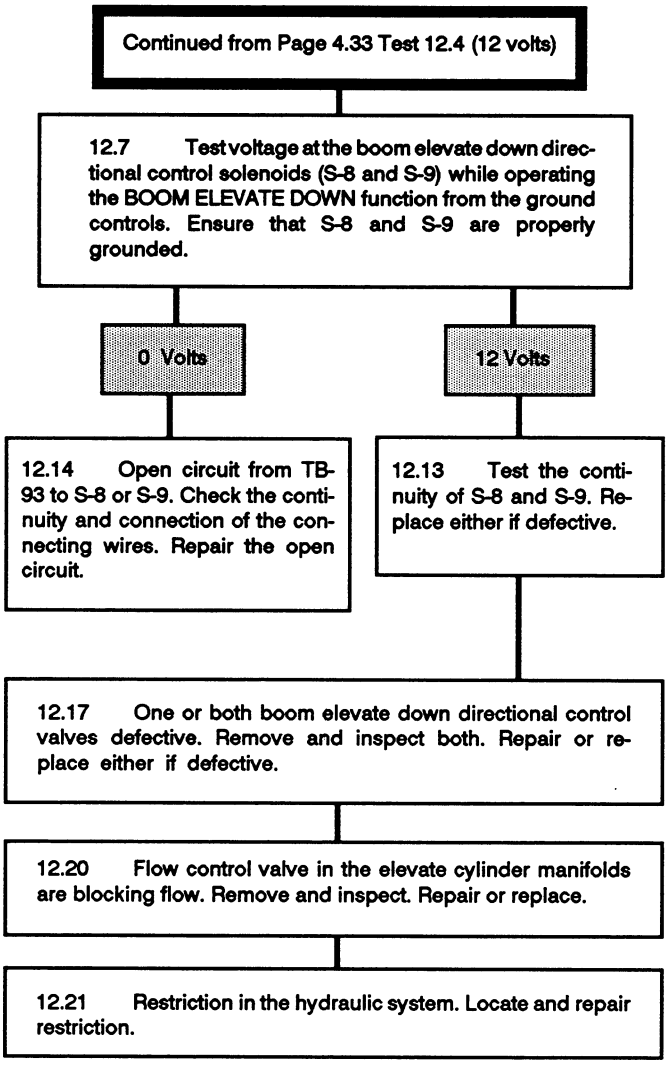



Continued from Page 4.30 Test 11.3 (12 volts)
11.6 Test voltage at terminal TB-63 while operating the BOOM ELEVATE UP function from the platform controls.
0 Volts
12 Volts
11.11 Open circuit from TP-17 to TB-63. Check the continuity and connection of the connecting wire. Repair the open circuit.
11.12 Open circuit in the PCB from TB-63 to TB-83. Repair or replace the PCB.
Continued from Page 4.30 Test 11.15 (0 volts)
11.19 Test the output voltage of the BOOM ELEVATE UP/DOWN toggle switch (TS-9) while operating the BOOM ELEVATE UP function from the ground controls.
0 Volts
12 Volts
11.22 Replace BOOM ELEVATE UP/DOWN toggle switch TS-9.
11.21 Open circuit from TS-9 to TB-43. Check the continuity and connection of the connecting wire. Repair open circuit.

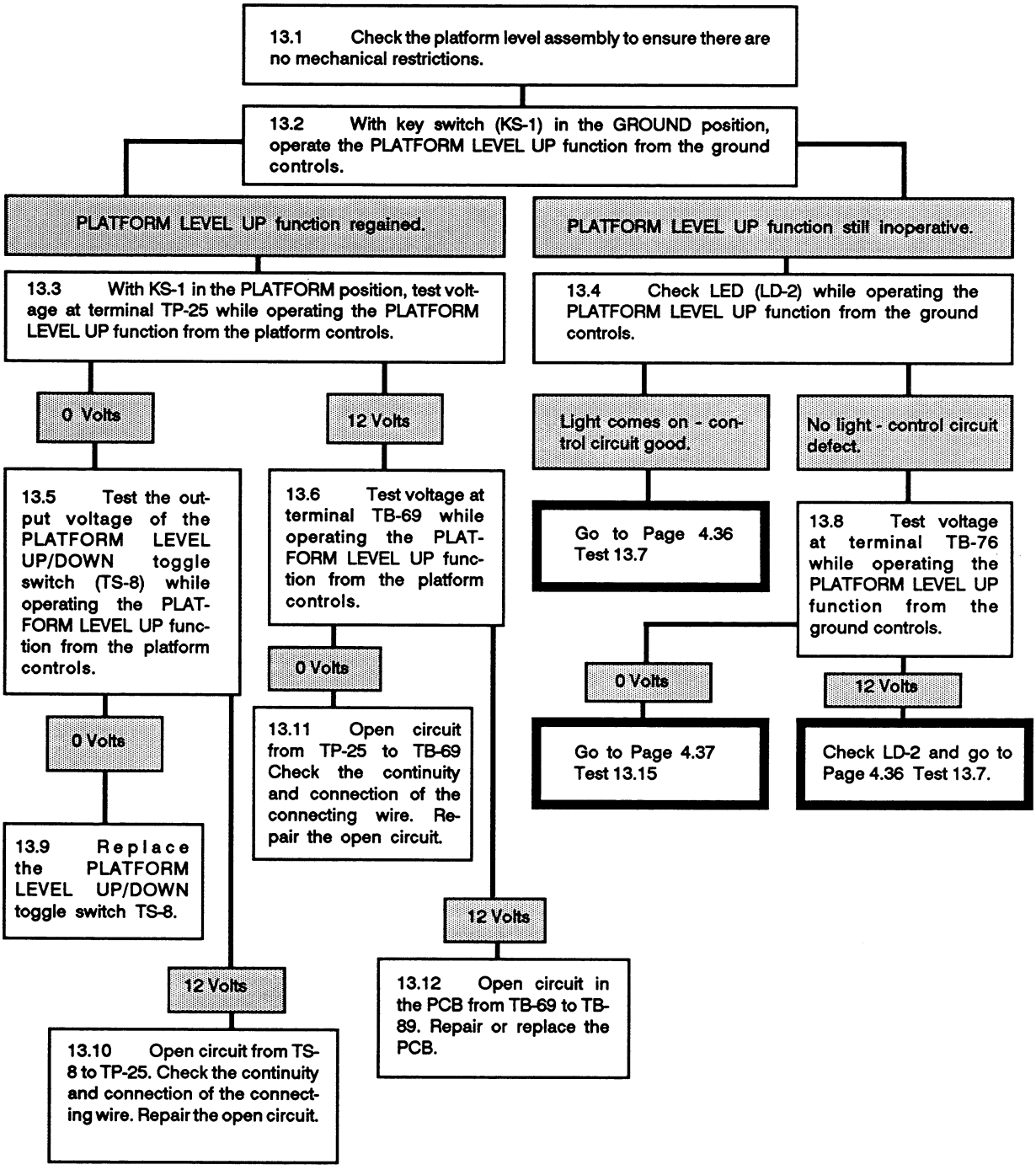

Continued from Page 4.30 Test 11.4 (Light comes on) and Test 11.8 (12 Volts)
11.7 Test voltage at terminal TB-83 while operating the BOOM ELEVATE UP function from the ground controls.
0 Volts
12 Volts
11.14 Open circuit in the PCB from TB-43 to TB-83. Repair or replace the PCB.
11.13 Test voltage at the elevate up directional control solenoid (S-7) while operating the BOOM ELEVATE UP function from the ground controls. Ensure that S-7 is properly grounded.
11.17 Open circuit from TB-83 to S-7. Check the continuity and connection of the connecting wire. Repair the open circuit.
0 Volts
12 Volts
11.16 Test the continuity of S-7 Replace if defective.
11.20 Install a 0 - 3000 psi pressure gauge to the gauge port of the function control manifold and operate the BOOM ELEVATE UP function from the ground controls.
Low Pressure, 1500 PSI (10340 kPa) or less.
High Pressure, 1900 PSI (13100 kPa) or more.
11.23 External leak in hydraulic system. Locate and repair leak.
11.24 Boom elevate up directional control valve defective. Remove and inspect. Repair or replace.
11.25 One or both boom elevate down directional control valves defective. Remove and inspect. Repair or replace.
11.26 Restriction in hydraulic system. Locate and repair restriction.
11.27 One or both boom elevate cylinder relief valves defective or incorrectly set. WARNING: Do not attempt to adjust any relief pressures without first contacting the Genie Service department.
11.28 If the BOOM ELEVATE UP function operates but then slowly descends, inspect the seals and check valve of each boom elevate cylinder. Repair or replace if defective.

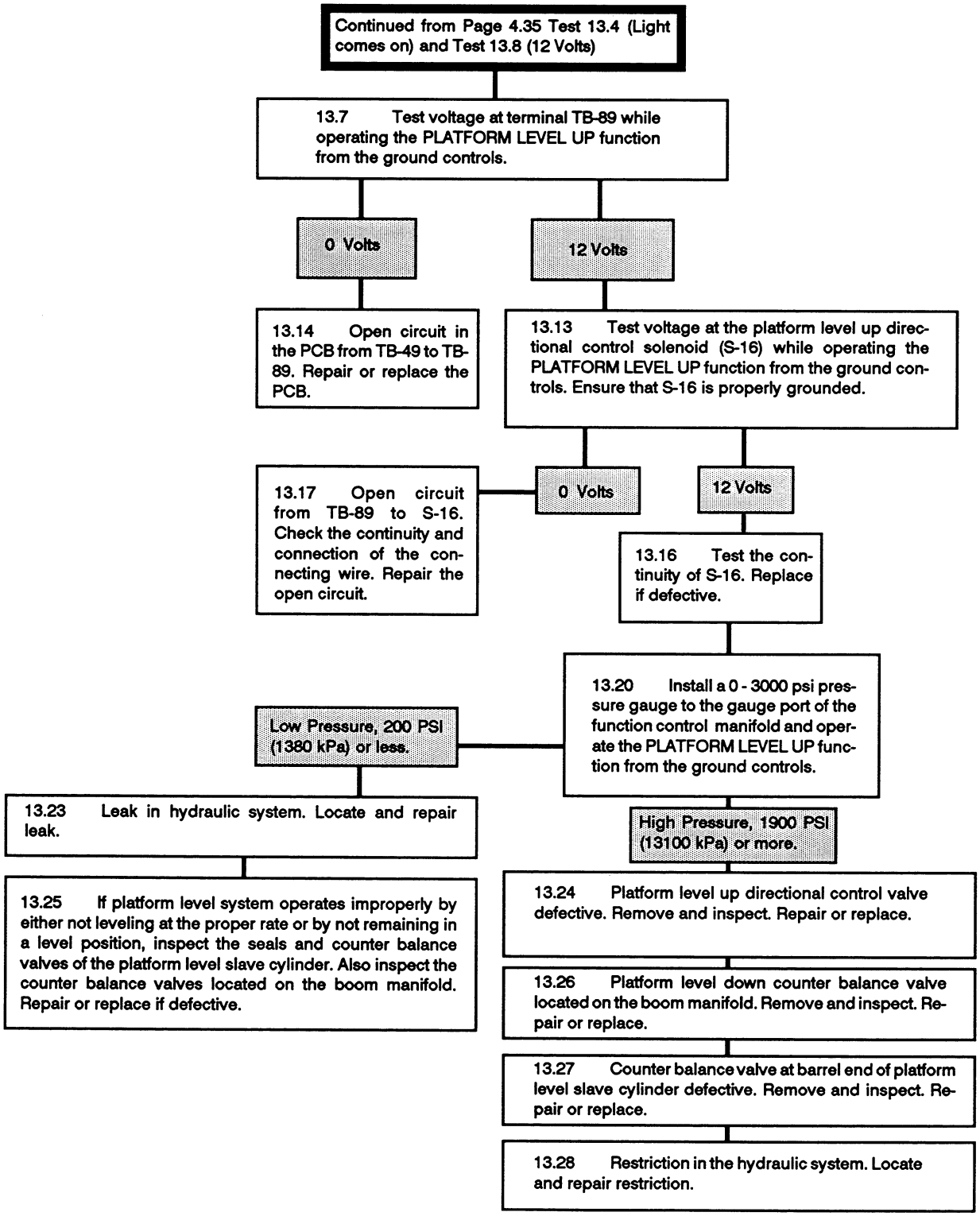
12. BOOM ELEVATE Down function inoperative.

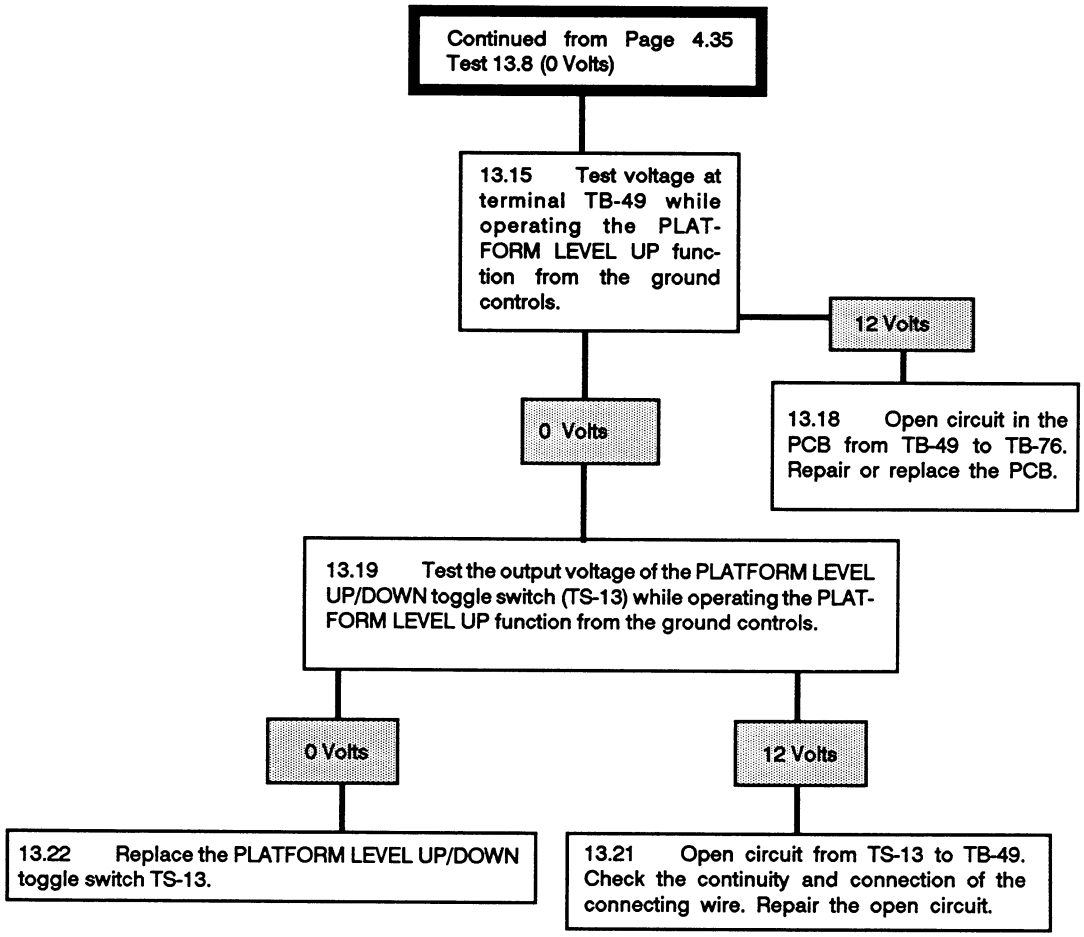



Continued from Page 4.33 Test 12.4 (12 volts)
12.7 Test voltage at the boom elevate down directional control solenoids (S-8 and S-9) while operating the BOOM ELEVATE DOWN function from the ground controls. Ensure that S-8 and S-9 are properly grounded.
0 Volts
12 Volts
12.14 Open circuit from TB-93 to S-8 or S-9. Check the continuity and connection of the connecting wires. Repair the open circuit.
12.13 Test the continuity of S-8 and S-9. Replace either if defective.
12.17 One or both boom elevate down directional control valves defective. Remove and inspect both. Repair or replace either if defective.
12.20 Flow control valve in the elevate cylinder manifolds are blocking flow. Remove and inspect. Repair or replace.
12.21 Restriction in the hydraulic system. Locate and repair restriction.

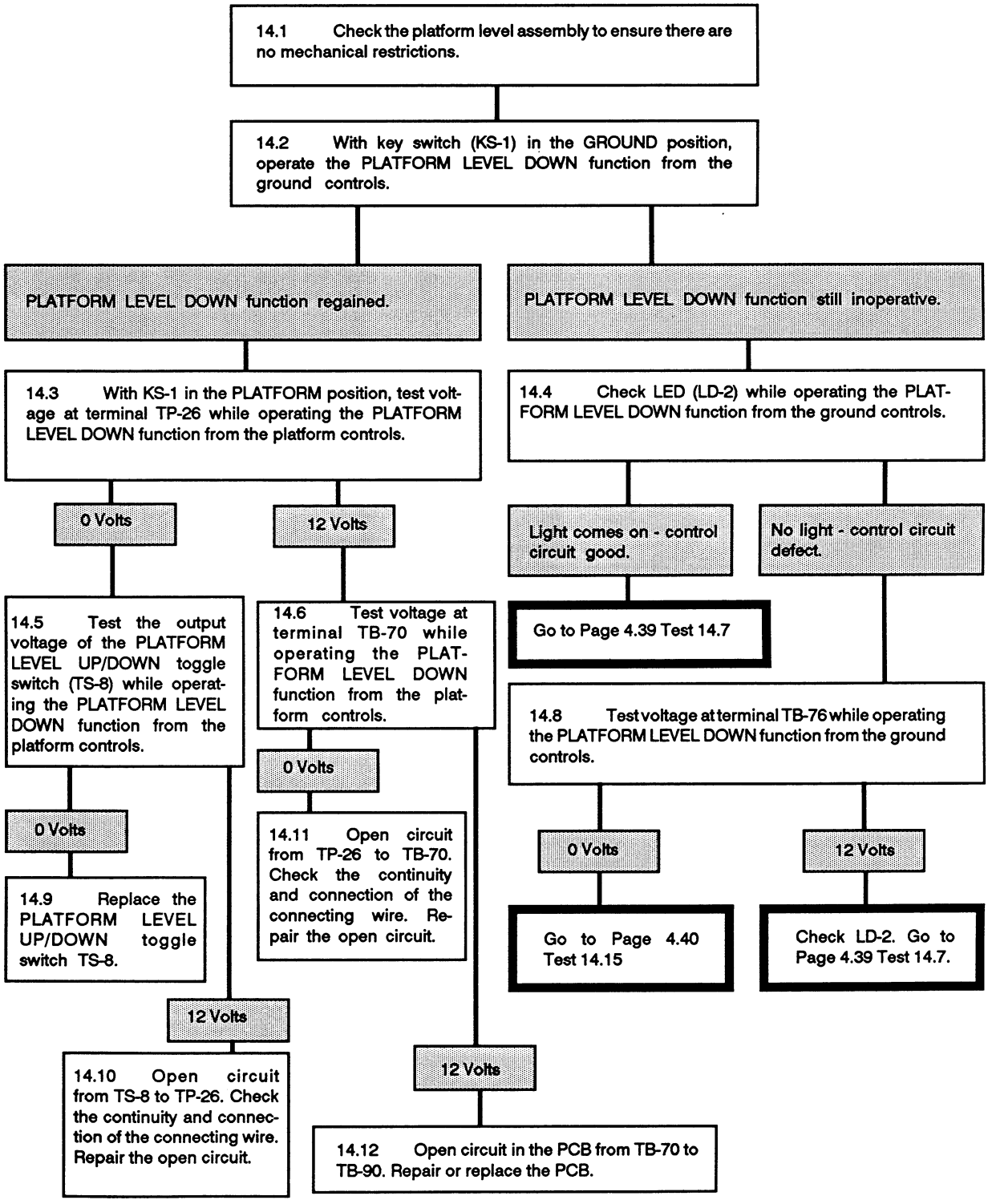
13. PLATFORM LEVEL Up function inoperative.

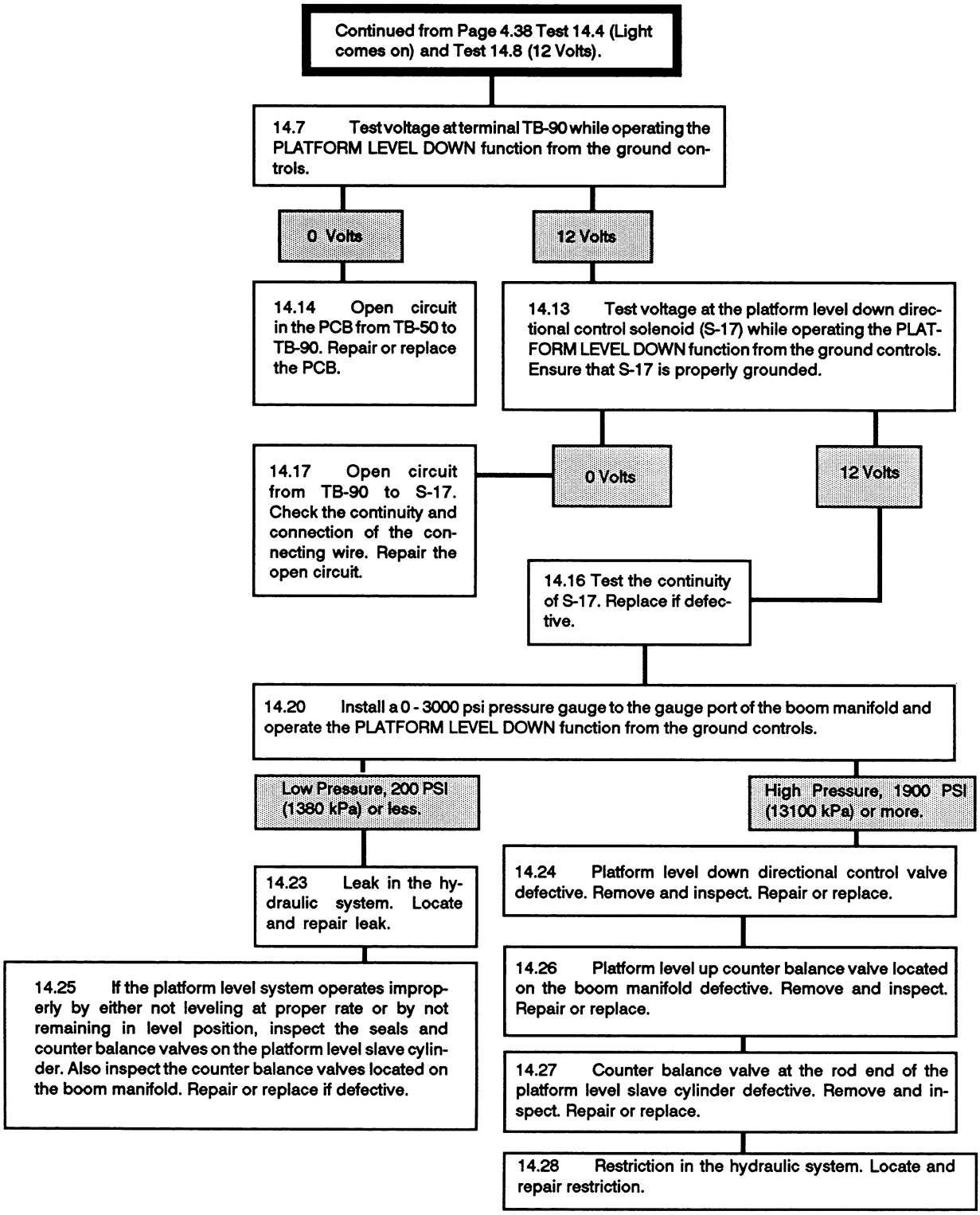


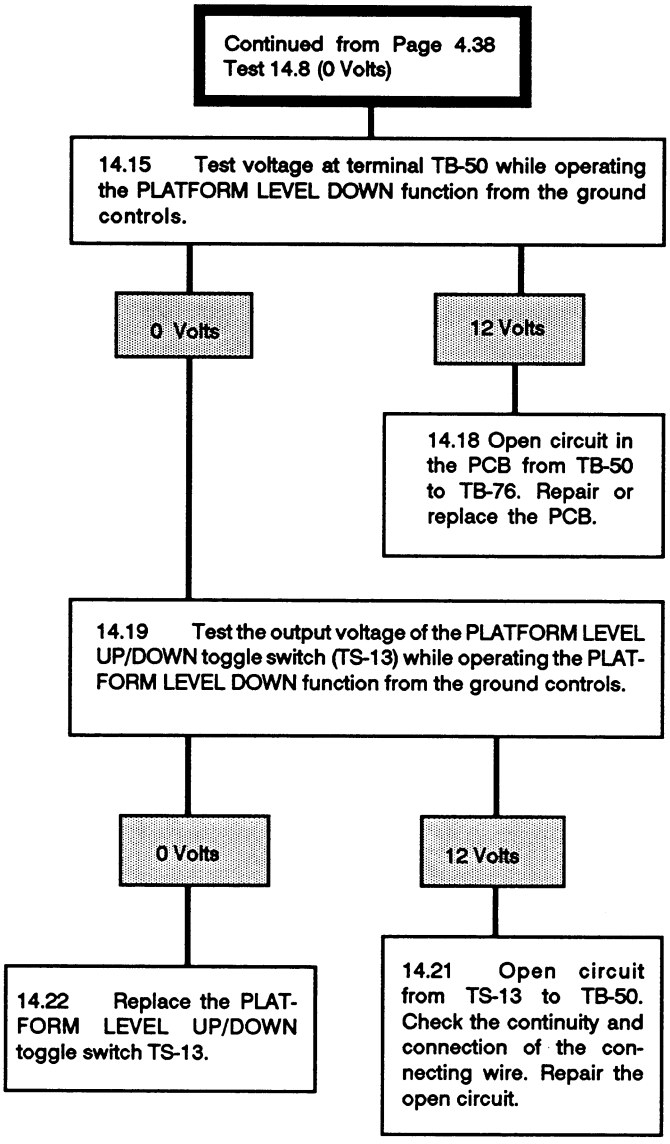

Continued from Page 4.35 Test 13.4 (Light comes on) and Test 13.8 (12 Volts)
13.7 Test voltage at terminal TB-89 while operating the PLATFORM LEVEL UP function from the ground controls.
0 Volts
12 Volts
13.14 Open circuit in the PCB from TB-49 to TB-89. Repair or replace the PCB.
13.13 Test voltage at the platform level up directional control solenoid (S-16) while operating the PLATFORM LEVEL UP function from the ground controls. Ensure that S-16 is properly grounded.
13.17 Open circuit from TB-89 to S-16. Check the continuity and connection of the connecting wire. Repair the open circuit.
0 Volts
12 Volts
13.16 Test the continuity of S-16. Replace if defective.
13.20 Install a 0 - 3000 psi pressure gauge to the gauge port of the function control manifold and operate the PLATFORM LEVEL UP function from the ground controls.
Low Pressure, 200 PSI (1380 kPa) or less.
High Pressure, 1900 PSI (13100 kPa) or more.
13.23 Leak in hydraulic system. Locate and repair leak.
13.25 If platform level system operates improperly by either not leveling at the proper rate or by not remaining in a level position, inspect the seals and counter balance valves of the platform level slave cylinder. Also inspect the counter balance valves located on the boom manifold. Repair or replace if defective.
13.24 Platform level up directional control valve defective. Remove and inspect. Repair or replace.
13.26 Platform level down counter balance valve located on the boom manifold. Remove and inspect. Repair or replace.
13.27 Counter balance valve at barrel end of platform level slave cylinder defective. Remove and inspect. Repair or replace.
13.28 Restriction in the hydraulic system. Locate and repair restriction.


Continued from Page 4.35
Test 13.8 (0 Volts)
13.15 Test voltage at terminal TB-49 while operating the PLATFORM LEVEL UP function from the ground controls.
12 Volts
13.18 Open circuit in the PCB from TB-49 to TB-76. Repair or replace the PCB.
0 Volts
13.19 Test the output voltage of the PLATFORM LEVEL UP/DOWN toggle switch (TS-13) while operating the PLATFORM LEVEL UP function from the ground controls.
0 Volts
12 Volts
13.22 Replace the PLATFORM LEVEL UP/DOWN toggle switch TS-13.
13.21 Open circuit from TS-13 to TB-49. Check the continuity and connection of the connecting wire. Repair the open circuit.

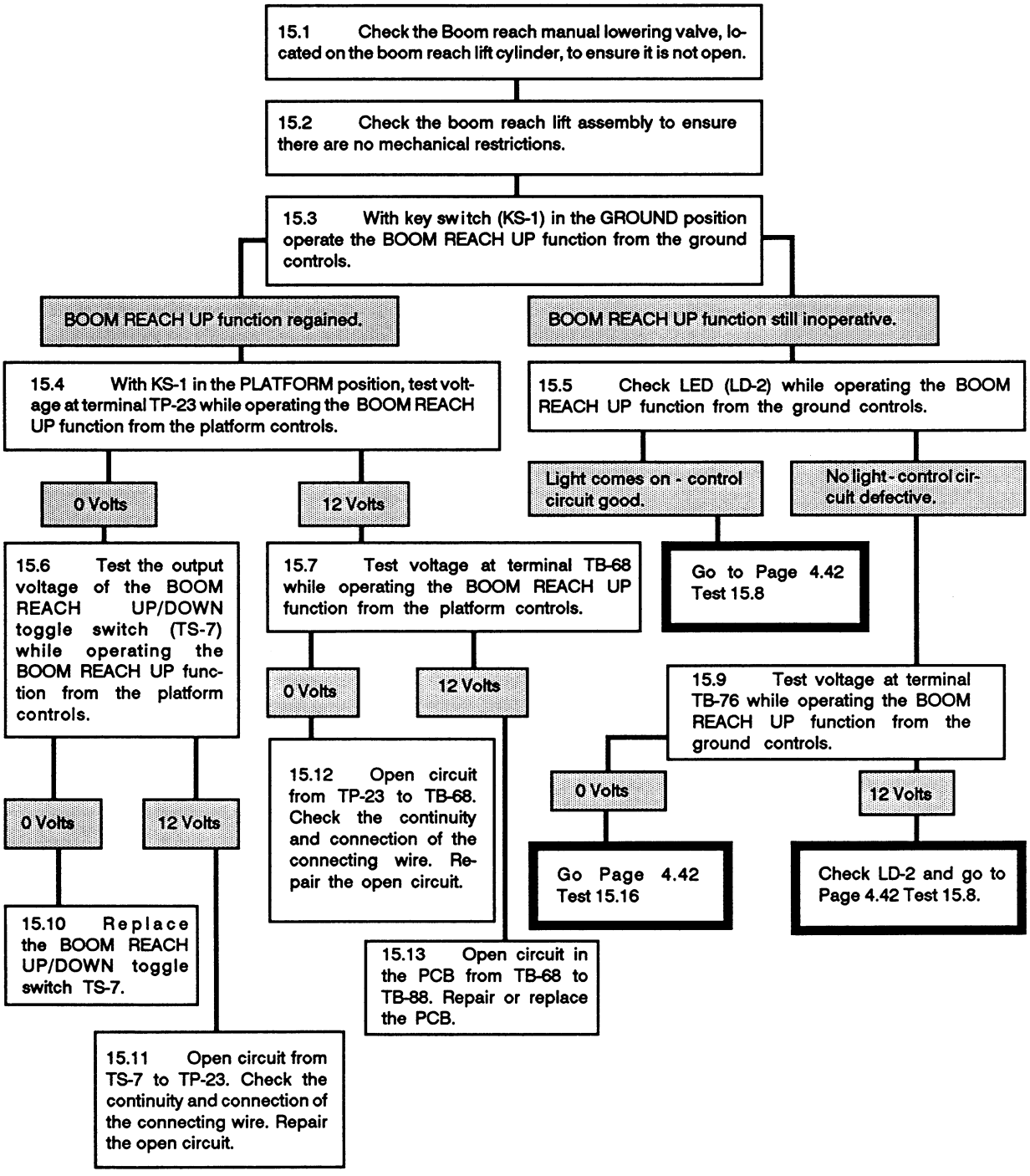
14. PLATFORM LEVEL Down function inoperative.

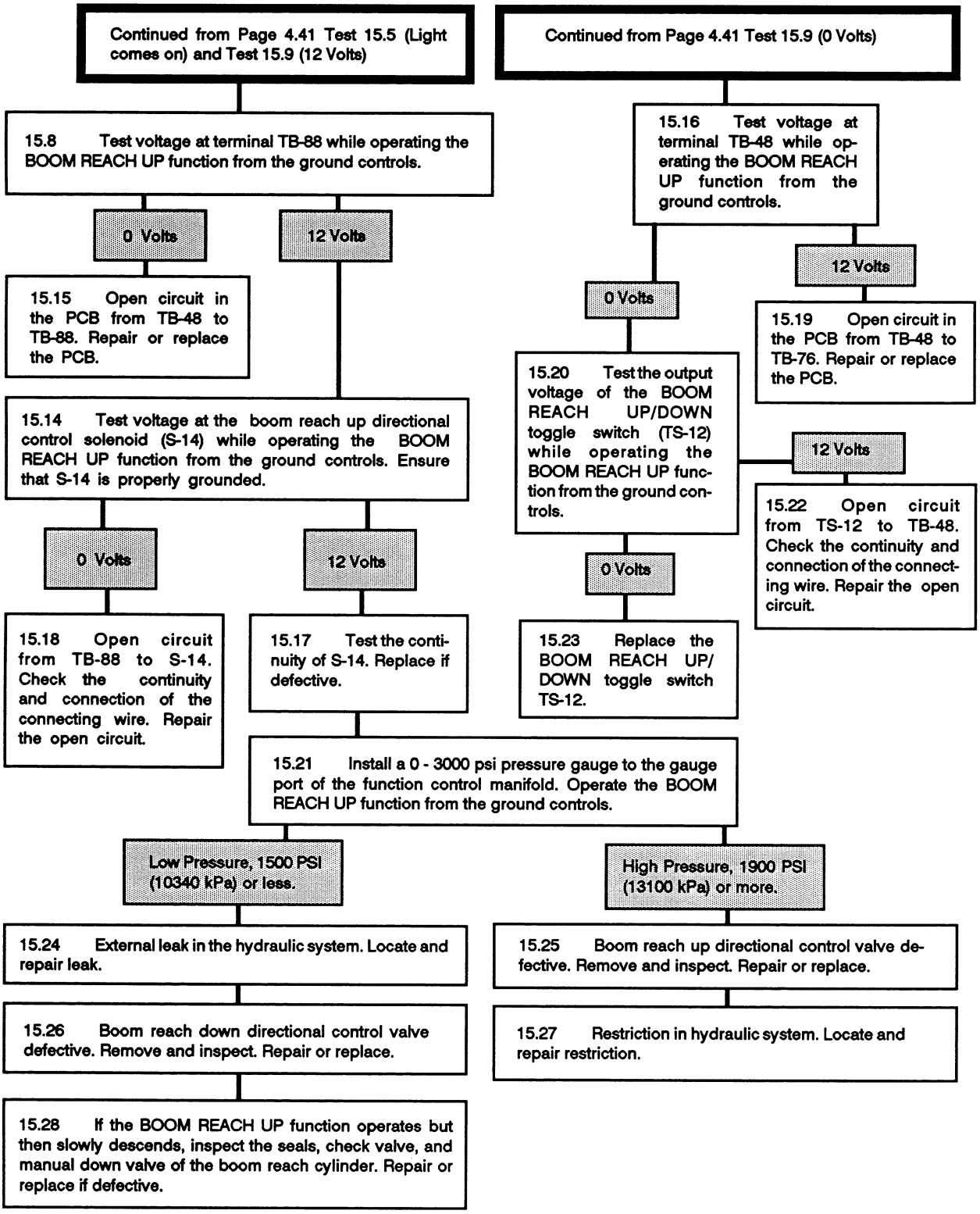



Continued from Page 4.38 Test 14.4 (Light comes on) and Test 14.8 (12 Volts).
14.7 Test voltage at terminal TB-90 while operating the PLATFORM LEVEL DOWN function from the ground controls.
0 Volts
12 Volts
14.14 Open circuit in the PCB from TB-50 to TB-90. Repair or replace the PCB.
14.13 Test voltage at the platform level down directional control solenoid (S-17) while operating the PLATFORM LEVEL DOWN function from the ground controls. Ensure that S-17 is properly grounded.
14.17 Open circuit from TB-90 to S-17. Check the continuity and connection of the connecting wire. Repair the open circuit.
0 Volts
12 Volts
14.16 Test the continuity of S-17. Replace if defective.
14.20 Install a 0 - 3000 psi pressure gauge to the gauge port of the boom manifold and operate the PLATFORM LEVEL DOWN function from the ground controls.
Low Pressure, 200 PSI (1380 kPa) or less.
High Pressure, 1900 PSI (13100 kPa) or more.
14.23 Leak in the hydraulic system. Locate and repair leak.
14.24 Platform level down directional control valve defective. Remove and inspect. Repair or replace.
14.25 If the platform level system operates improperly by either not leveling at proper rate or by not remaining in level position, inspect the seals and counter balance valves on the platform level slave cylinder. Also inspect the counter balance valves located on the boom manifold. Repair or replace if defective.
14.26 Platform level up counter balance valve located on the boom manifold defective. Remove and inspect. Repair or replace.
14.27 Counter balance valve at the rod end of the platform level slave cylinder defective. Remove and inspect. Repair or replace.
14.28 Restriction in the hydraulic system. Locate and repair restriction.

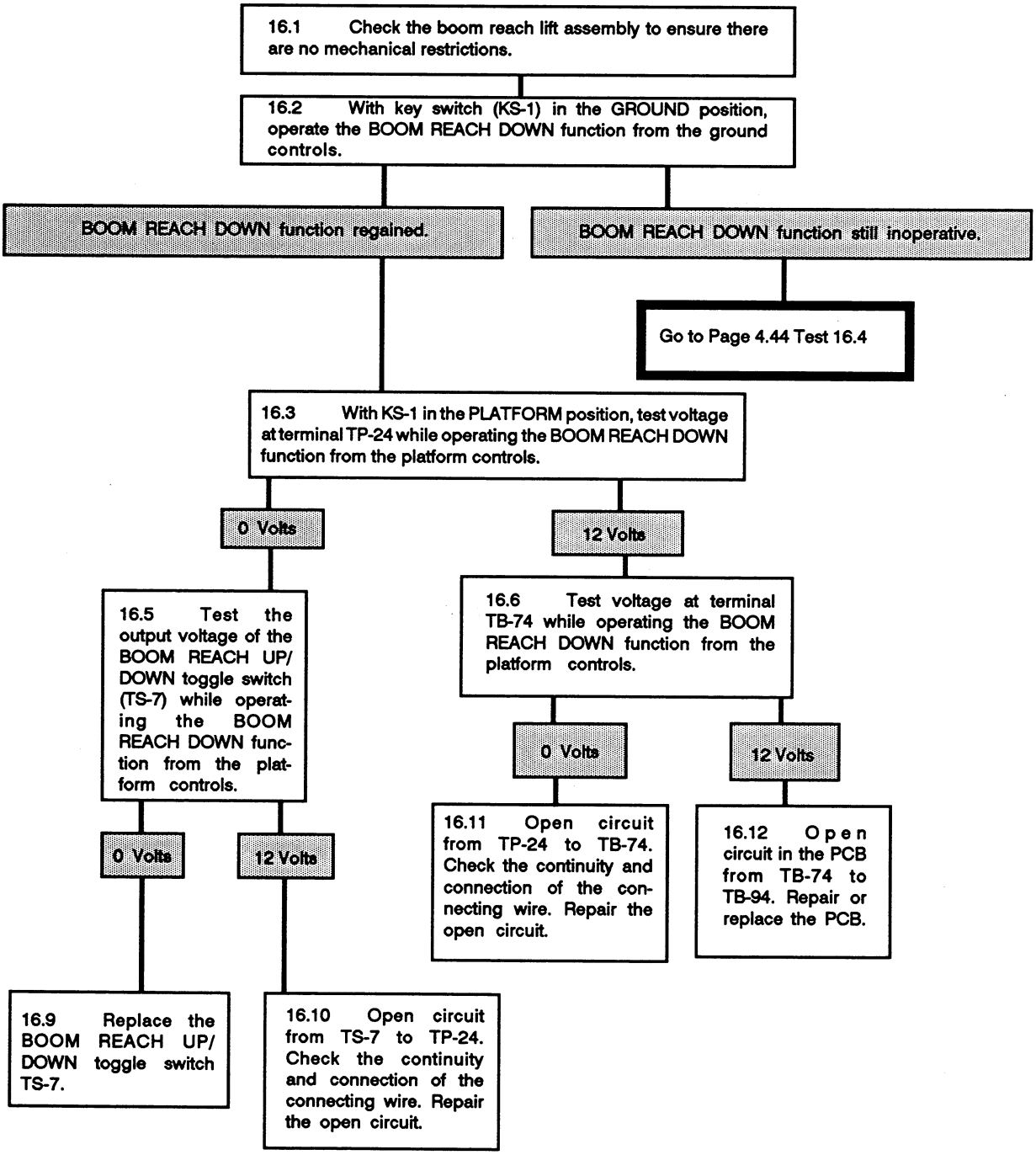

Continued from Page 4.38
Test 14.8 (0 Volts)
14.15 Test voltage at terminal TB-50 while operating the PLATFORM LEVEL DOWN function from the ground controls.
0 Volts
12 Volts
14.18 Open circuit in the PCB from TB-50 to TB-76. Repair or replace the PCB.
14.19 Test the output voltage of the PLATFORM LEVEL UP/DOWN toggle switch (TS-13) while operating the PLATFORM LEVEL DOWN function from the ground controls.
0 Volts
12 Volts
14.22 Replace the PLATFORM LEVEL UP/DOWN toggle switch TS-13.
14.21 Open circuit from TS-13 to TB-50. Check the continuity and connection of the connecting wire. Repair the open circuit.

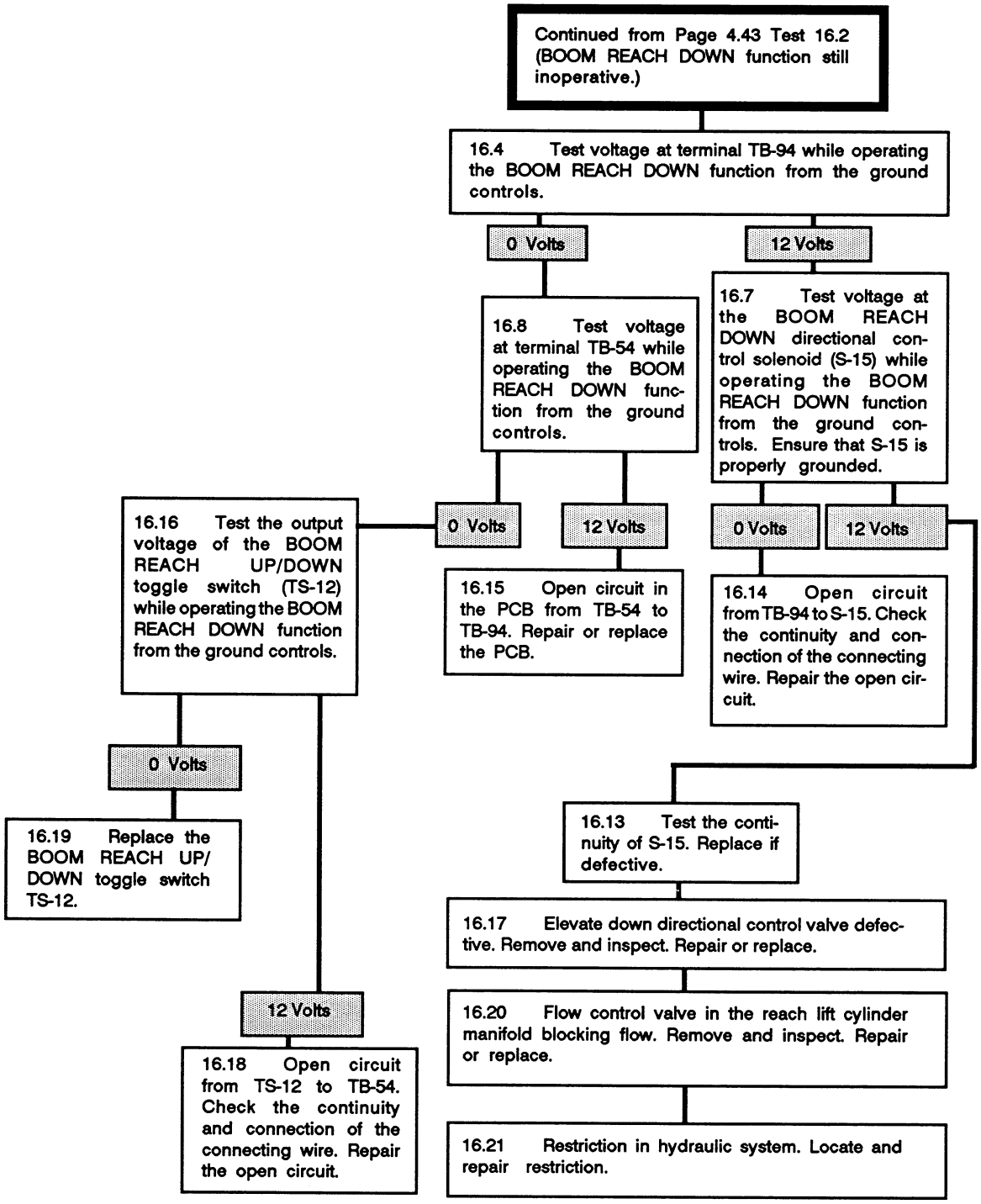
15. BOOM REACH Up function inoperative.



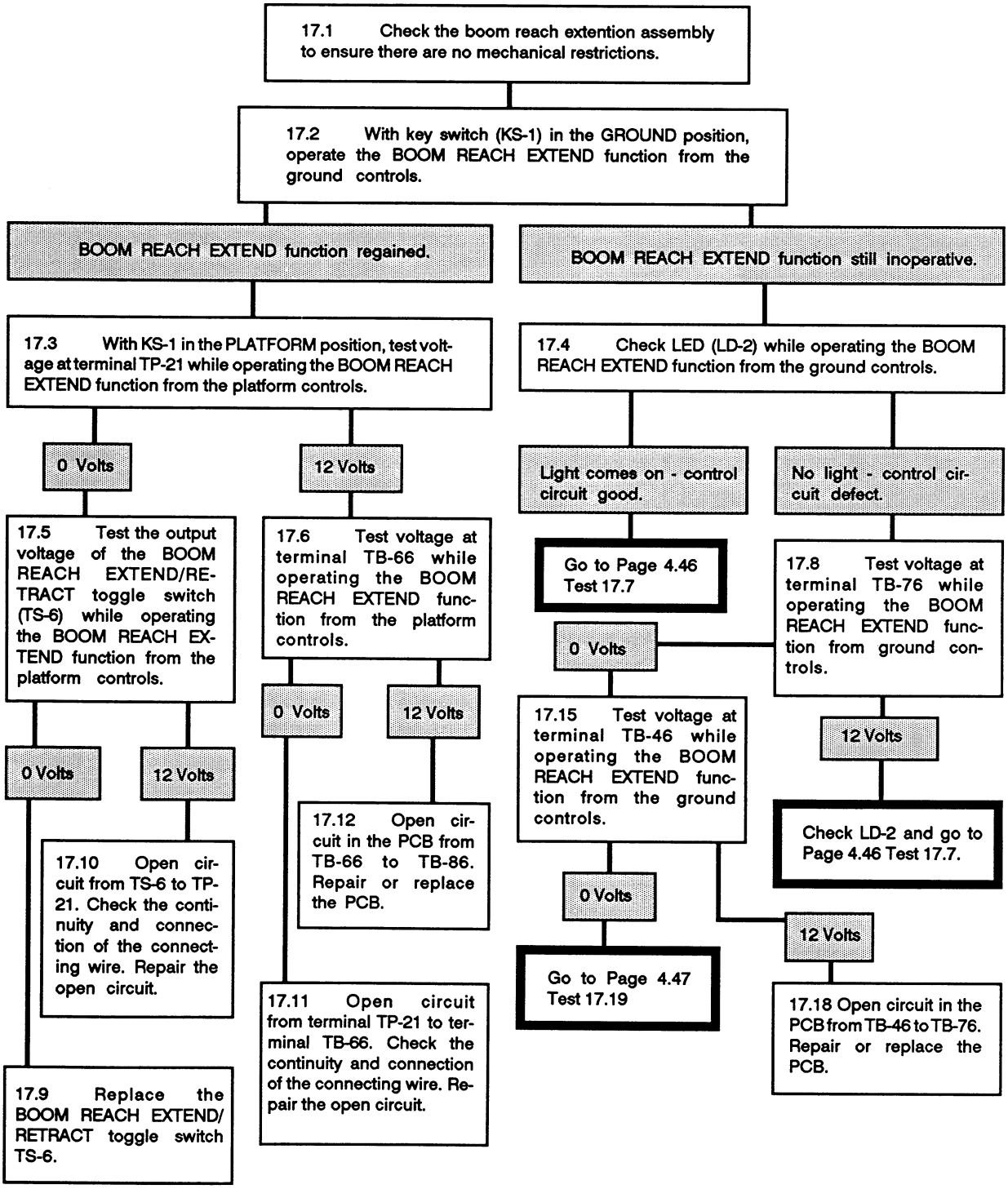

Continued from Page 4.41 Test 15.5 (Light comes on) and Test 15.9 (12 Volts)
15.8 Test voltage at terminal TB-88 while operating the BOOM REACH UP function from the ground controls.
0 Volts
12 Volts
15.15 Open circuit in the PCB from TB-48 to TB-88. Repair or replace the PCB.
15.14 Test voltage at the boom reach up directional control solenoid (S-14) while operating the BOOM REACH UP function from the ground controls. Ensure that S-14 is properly grounded.
0 Volts
12 Volts
15.18 Open circuit from TB-88 to S-14. Check the continuity and connection of the connecting wire. Repair the open circuit.
15.17 Test the continuity of S-14. Replace if defective.
Continued from Page 4.41 Test 15.9 (0 Volts)
15.16 Test voltage at terminal TB-48 while operating the BOOM REACH UP function from the ground controls.
12 Volts
0 Volts
15.19 Open circuit in the PCB from TB-48 to TB-76. Repair or replace the PCB.
15.20 Test the output voltage of the BOOM REACH UP/DOWN toggle switch (TS-12) while operating the BOOM REACH UP function from the ground controls.
12 Volts
15.22 Open circuit from TS-12 to TB-48. Check the continuity and connection of the connecting wire. Repair the open circuit.
0 Volts
15.23 Replace the BOOM REACH UP/DOWN toggle switch TS-12.
15.21 Install a 0 - 3000 psi pressure gauge to the gauge port of the function control manifold. Operate the BOOM REACH UP function from the ground controls.
Low Pressure, 1500 PSI (10340 kPa) or less.
High Pressure, 1900 PSI (13100 kPa) or more.
15.24 External leak in the hydraulic system. Locate and repair leak.
15.26 Boom reach down directional control valve defective. Remove and inspect. Repair or replace.
15.28 If the BOOM REACH UP function operates but then slowly descends, inspect the seals, check valve, and manual down valve of the boom reach cylinder. Repair or replace if defective.
15.25 Boom reach up directional control valve defective. Remove and inspect. Repair or replace.
15.27 Restriction in hydraulic system. Locate and repair restriction.

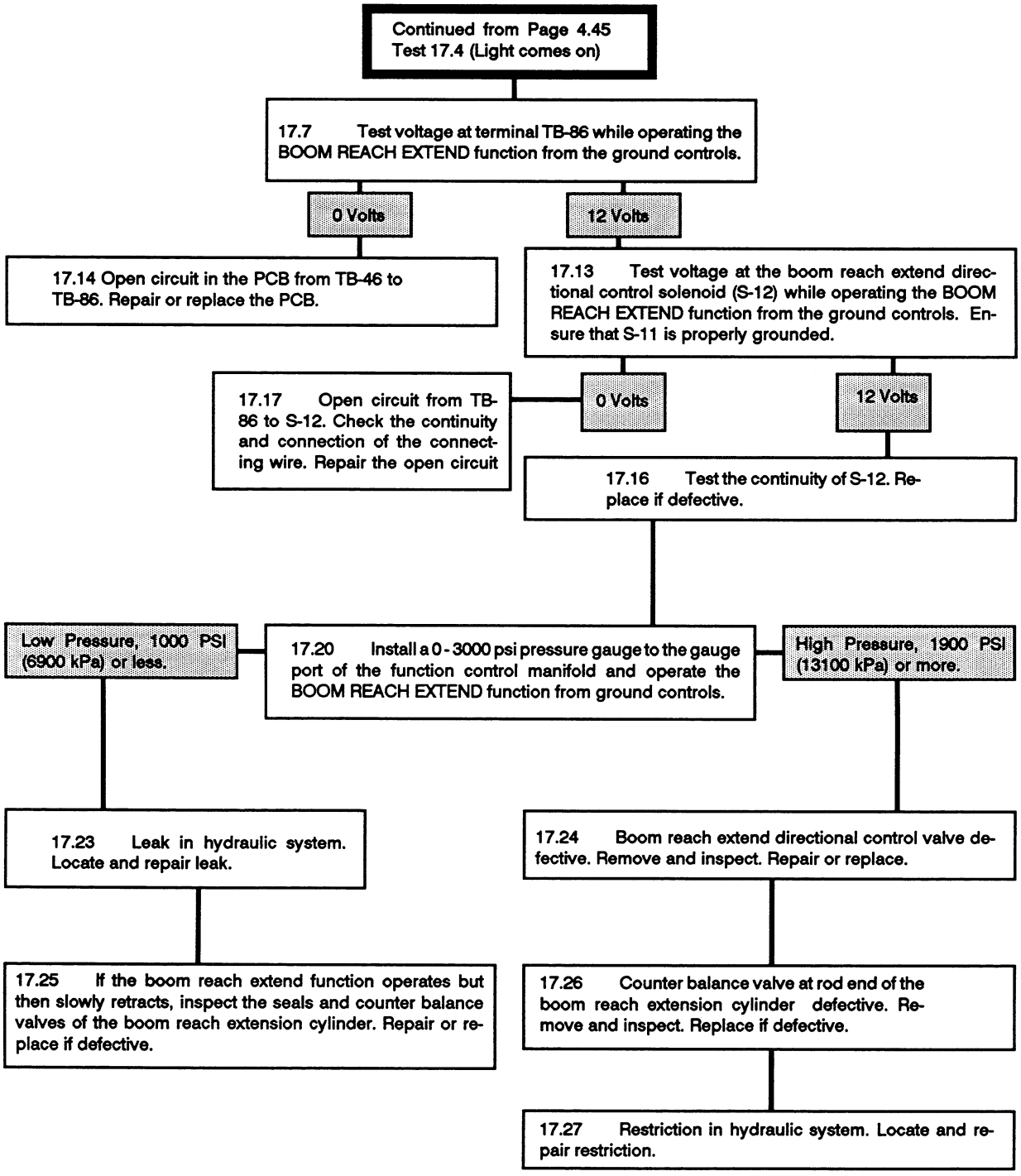
16. BOOM REACH Down function inoperative.

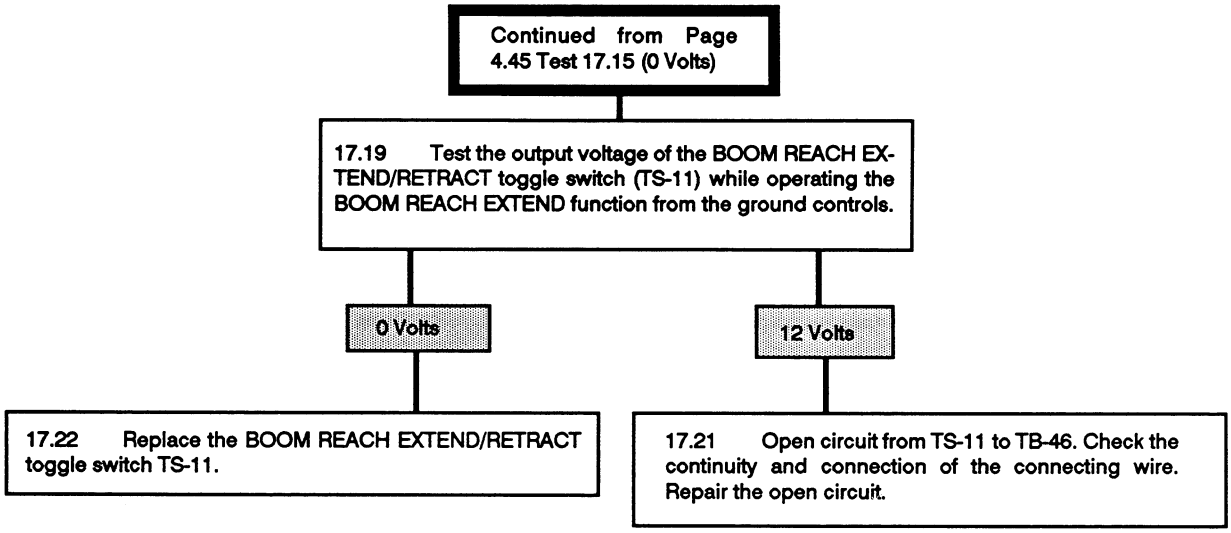



Continued from Page 4.43 Test 16.2 (BOOM REACH DOWN function still inoperative.)
16.4 Test voltage at terminal TB-94 while operating the BOOM REACH DOWN function from the ground controls.
0 Volts
12 Volts
16.8 Test voltage at terminal TB-54 while operating the BOOM REACH DOWN function from the ground controls.
16.7 Test voltage at the BOOM REACH DOWN directional control solenoid (S-15) while operating the BOOM REACH DOWN function from the ground controls. Ensure that S-15 is properly grounded.
16.16 Test the output voltage of the BOOM REACH UP/DOWN toggle switch (TS-12) while operating the BOOM REACH DOWN function from the ground controls.
0 Volts
12 Volts
0 Volts
12 Volts
16.15 Open circuit in the PCB from TB-54 to TB-94. Repair or replace the PCB.
16.14 Open circuit from TB-94 to S-15. Check the continuity and connection of the connecting wire. Repair the open circuit.
0 Volts
16.19 Replace the BOOM REACH UP/DOWN toggle switch TS-12.
16.13 Test the continuity of S-15. Replace if defective.
16.17 Elevate down directional control valve defective. Remove and inspect. Repair or replace.
12 Volts
16.18 Open circuit from TS-12 to TB-54. Check the continuity and connection of the connecting wire. Repair the open circuit.
16.20 Flow control valve in the reach lift cylinder manifold blocking flow. Remove and inspect. Repair or replace.
16.21 Restriction in hydraulic system. Locate and repair restriction.

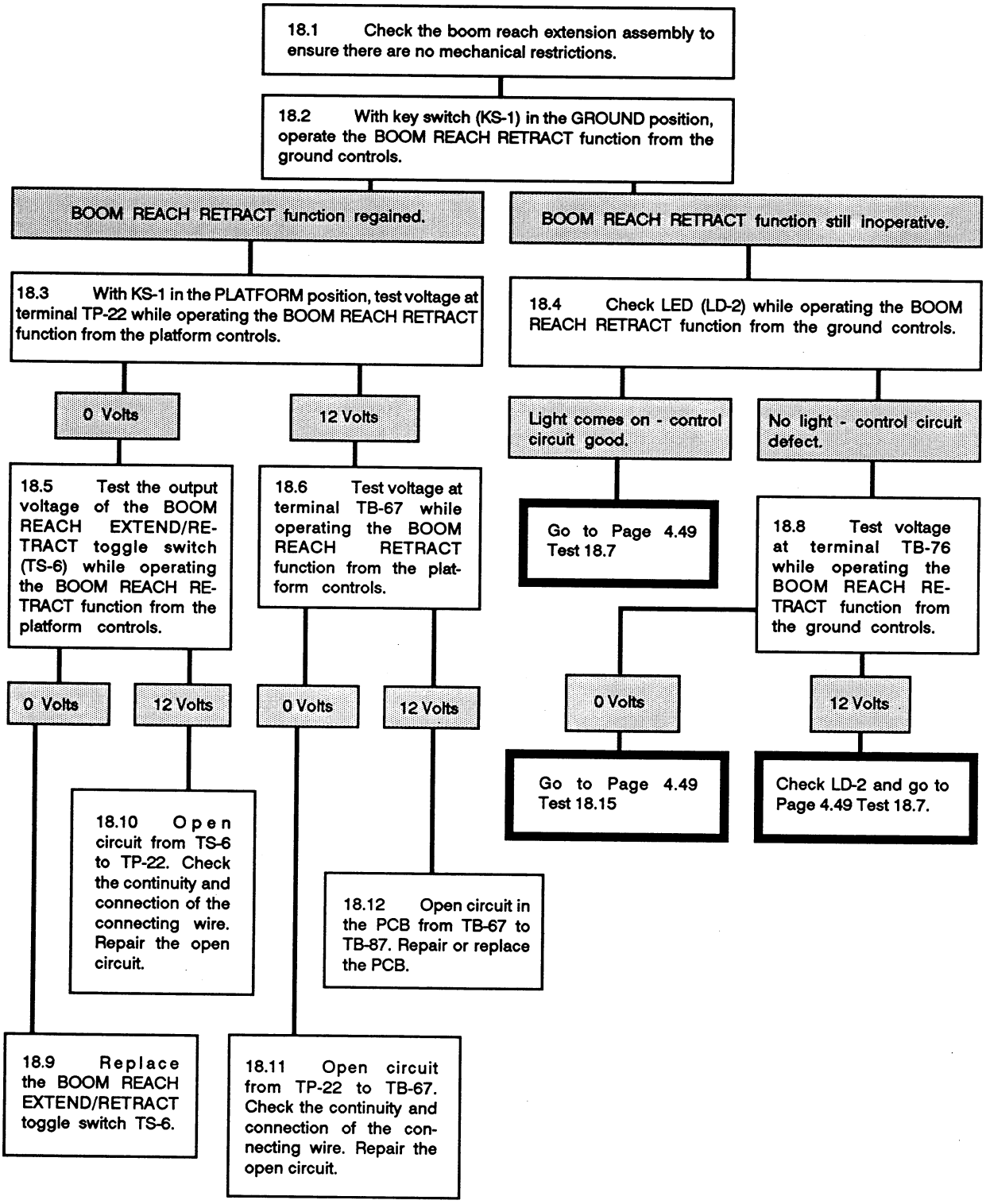
17. BOOM REACH Extend function inoperative.

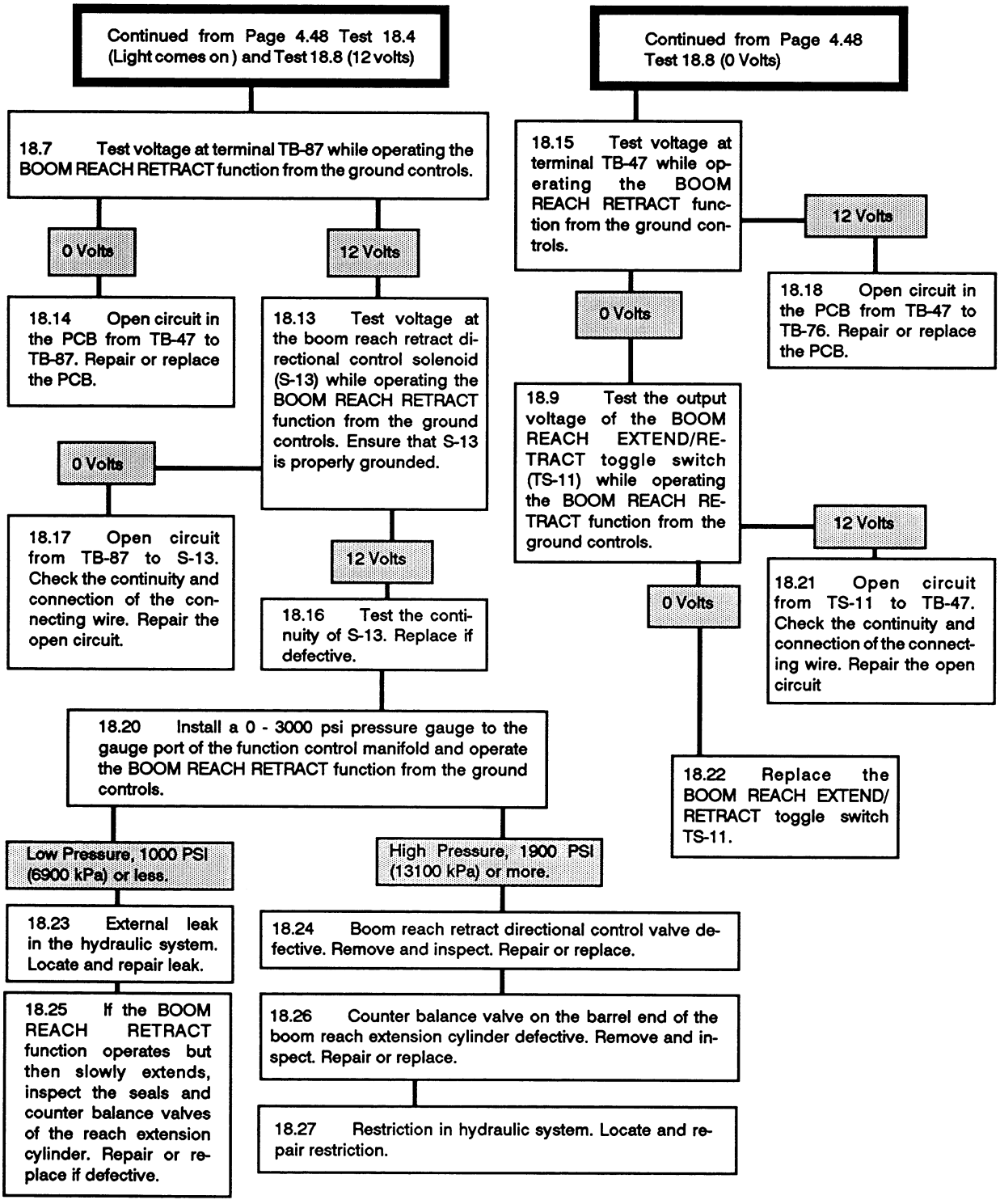



Continued from Page 4.45
Test 17.4 (Light comes on)
17.7 Test voltage at terminal TB-86 while operating the BOOM REACH EXTEND function from the ground controls.
0 Volts
12 Volts
17.14 Open circuit in the PCB from TB-46 to TB-86. Repair or replace the PCB.
17.13 Test voltage at the boom reach extend directional control solenoid (S-12) while operating the BOOM REACH EXTEND function from the ground controls. Ensure that S-11 is properly grounded.
17.17 Open circuit from TB-86 to S-12. Check the continuity and connection of the connecting wire. Repair the open circuit
0 Volts
12 Volts
17.16 Test the continuity of S-12. Replace if defective.
Low Pressure, 1000 PSI (6900 kPa) or less.
17.20 Install a 0 - 3000 psi pressure gauge to the gauge port of the function control manifold and operate the BOOM REACH EXTEND function from ground controls.
High Pressure, 1900 PSI (13100 kPa) or more.
17.23 Leak in hydraulic system. Locate and repair leak.
17.24 Boom reach extend directional control valve defective. Remove and inspect. Repair or replace.
17.25 If the boom reach extend function operates but then slowly retracts, inspect the seals and counter balance valves of the boom reach extension cylinder. Repair or replace if defective.
17.26 Counter balance valve at rod end of the boom reach extension cylinder defective. Remove and inspect. Replace if defective.
17.27 Restriction in hydraulic system. Locate and repair restriction.

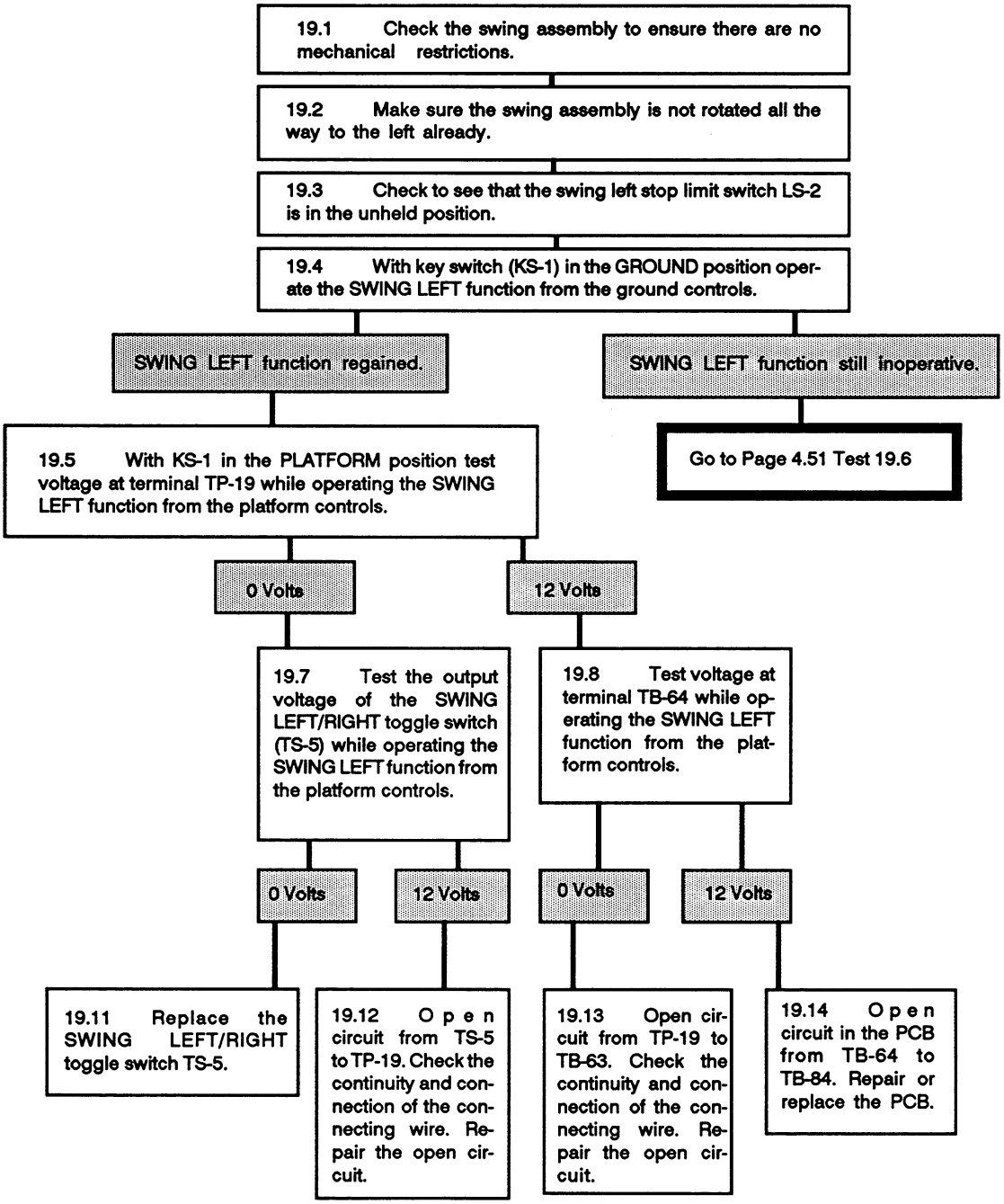

Continued from Page 4.45 Test 17.15 (0 Volts)
17.19 Test the output voltage of the BOOM REACH EXTEND/RETRACT toggle switch (TS-11) while operating the BOOM REACH EXTEND function from the ground controls.
0 Volts
12 Volts
17.22 Replace the BOOM REACH EXTEND/RETRACT toggle switch TS-11.
17.21 Open circuit from TS-11 to TB-46. Check the continuity and connection of the connecting wire. Repair the open circuit.

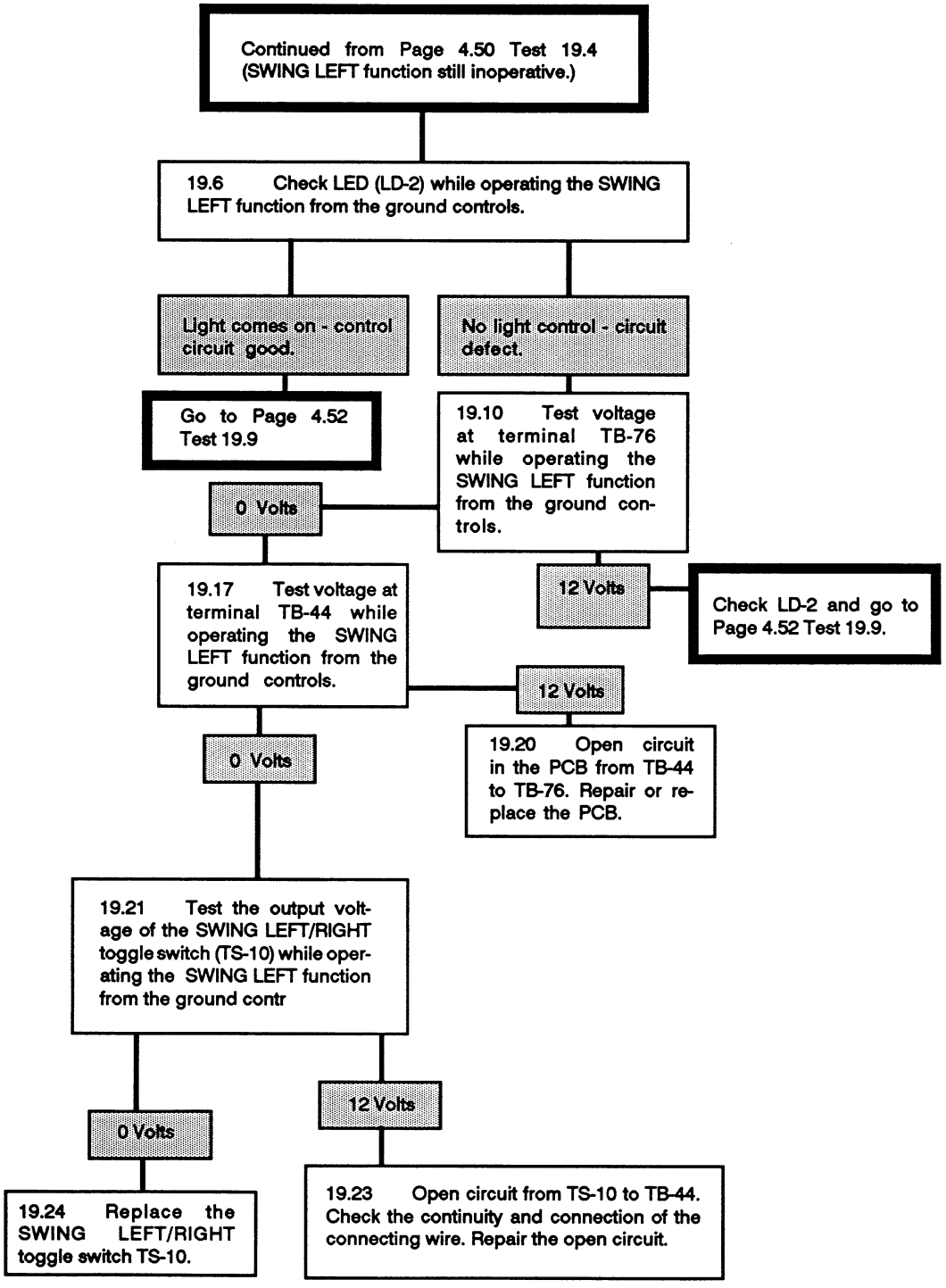
18. BOOM REACH Retract function inoperative.

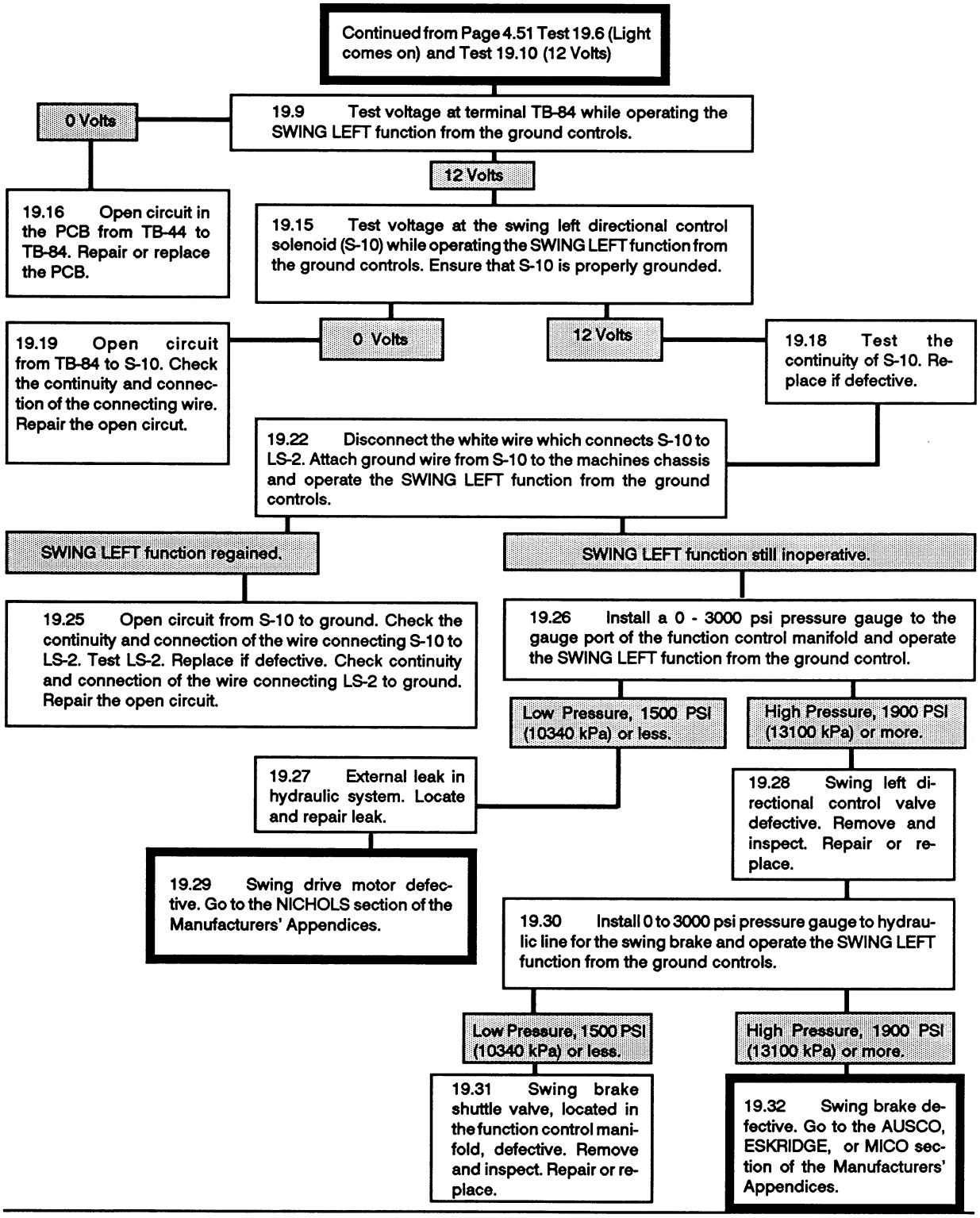



Continued from Page 4.48 Test 18.4 (Light comes on) and Test 18.8 (12 volts)
18.7 Test voltage at terminal TB-87 while operating the BOOM REACH RETRACT function from the ground controls.
0 Volts
12 Volts
18.14 Open circuit in the PCB from TB-47 to TB-87. Repair or replace the PCB.
18.13 Test voltage at the boom reach retract directional control solenoid (S-13) while operating the BOOM REACH RETRACT function from the ground controls. Ensure that S-13 is properly grounded.
0 Volts
18.17 Open circuit from TB-87 to S-13. Check the continuity and connection of the connecting wire. Repair the open circuit.
12 Volts
18.16 Test the continuity of S-13. Replace if defective.
18.20 Install a 0 - 3000 psi pressure gauge to the gauge port of the function control manifold and operate the BOOM REACH RETRACT function from the ground controls.
Low Pressure, 1000 PSI (6900 kPa) or less.
18.23 External leak in the hydraulic system. Locate and repair leak.
18.25 If the BOOM REACH RETRACT function operates but then slowly extends, inspect the seals and counter balance valves of the reach extension cylinder. Repair or replace if defective.
High Pressure, 1900 PSI (13100 kPa) or more.
18.24 Boom reach retract directional control valve defective. Remove and inspect. Repair or replace.
18.26 Counter balance valve on the barrel end of the boom reach extension cylinder defective. Remove and inspect. Repair or replace.
18.27 Restriction in hydraulic system. Locate and repair restriction.
Continued from Page 4.48 Test 18.8 (0 Volts)
18.15 Test voltage at terminal TB-47 while operating the BOOM REACH RETRACT function from the ground controls.
12 Volts
18.18 Open circuit in the PCB from TB-47 to TB-76. Repair or replace the PCB.
0 Volts
18.9 Test the output voltage of the BOOM REACH EXTEND/RETRACT toggle switch (TS-11) while operating the BOOM REACH RETRACT function from the ground controls.
12 Volts
18.21 Open circuit from TS-11 to TB-47. Check the continuity and connection of the connecting wire. Repair the open circuit
0 Volts
18.22 Replace the BOOM REACH EXTEND/RETRACT toggle switch TS-11.

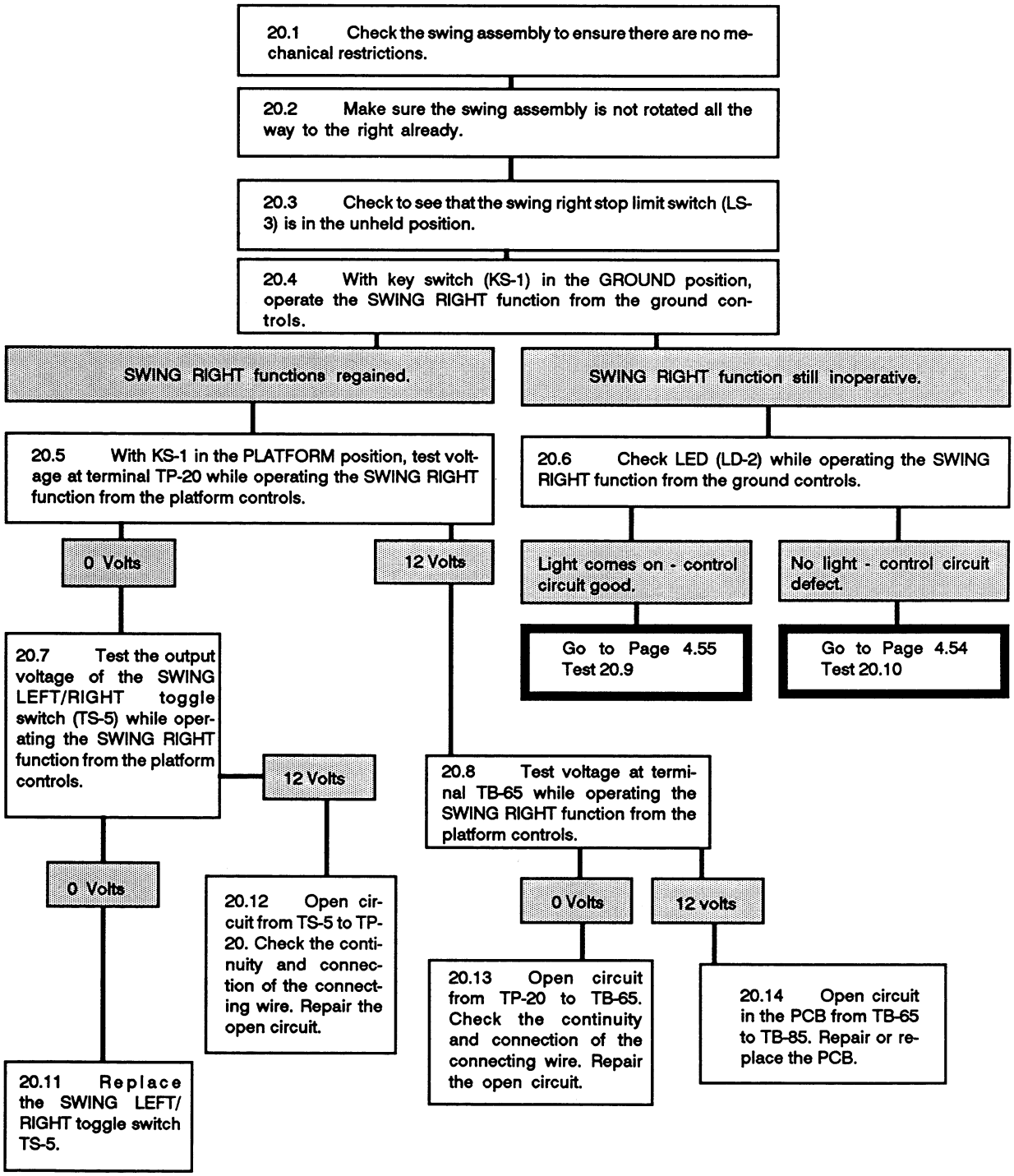
19. SWING Left function inoperative.

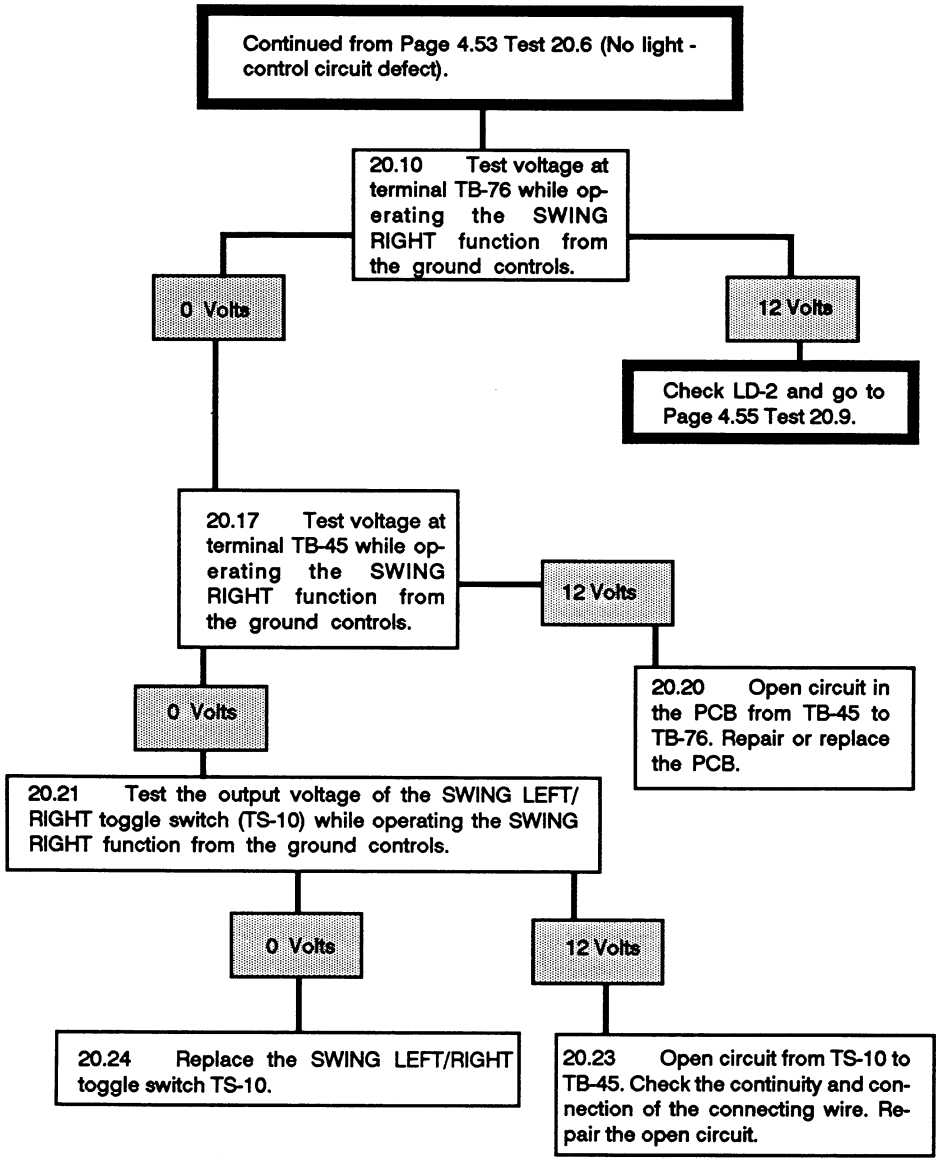


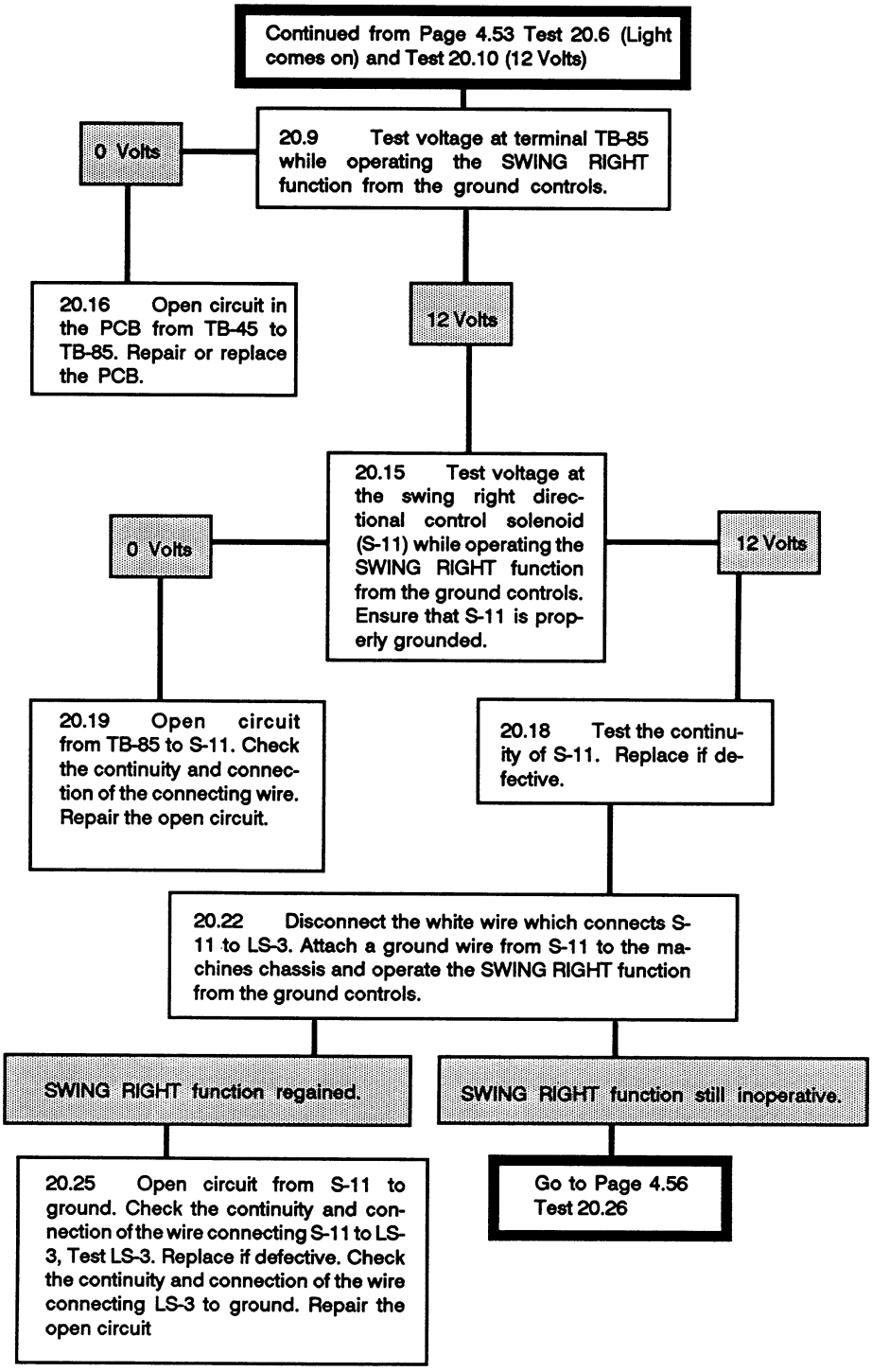

Continued from Page 4.50 Test 19.4 (SWING LEFT function still inoperative.)
19.6 Check LED (LD-2) while operating the SWING LEFT function from the ground controls.
Light comes on - control circuit good.
No light control - circuit defect.
Go to Page 4.52 Test 19.9
19.10 Test voltage at terminal TB-76 while operating the SWING LEFT function from the ground controls.
0 Volts
12 Volts
Check LD-2 and go to Page 4.52 Test 19.9.
19.17 Test voltage at terminal TB-44 while operating the SWING LEFT function from the ground controls.
12 Volts
0 Volts
19.20 Open circuit in the PCB from TB-44 to TB-76. Repair or replace the PCB.
19.21 Test the output voltage of the SWING LEFT/RIGHT toggle switch (TS-10) while operating the SWING LEFT function from the ground contr
12 Volts
0 Volts
19.24 Replace the SWING LEFT/RIGHT toggle switch TS-10.
19.23 Open circuit from TS-10 to TB-44. Check the continuity and connection of the connecting wire. Repair the open circuit.

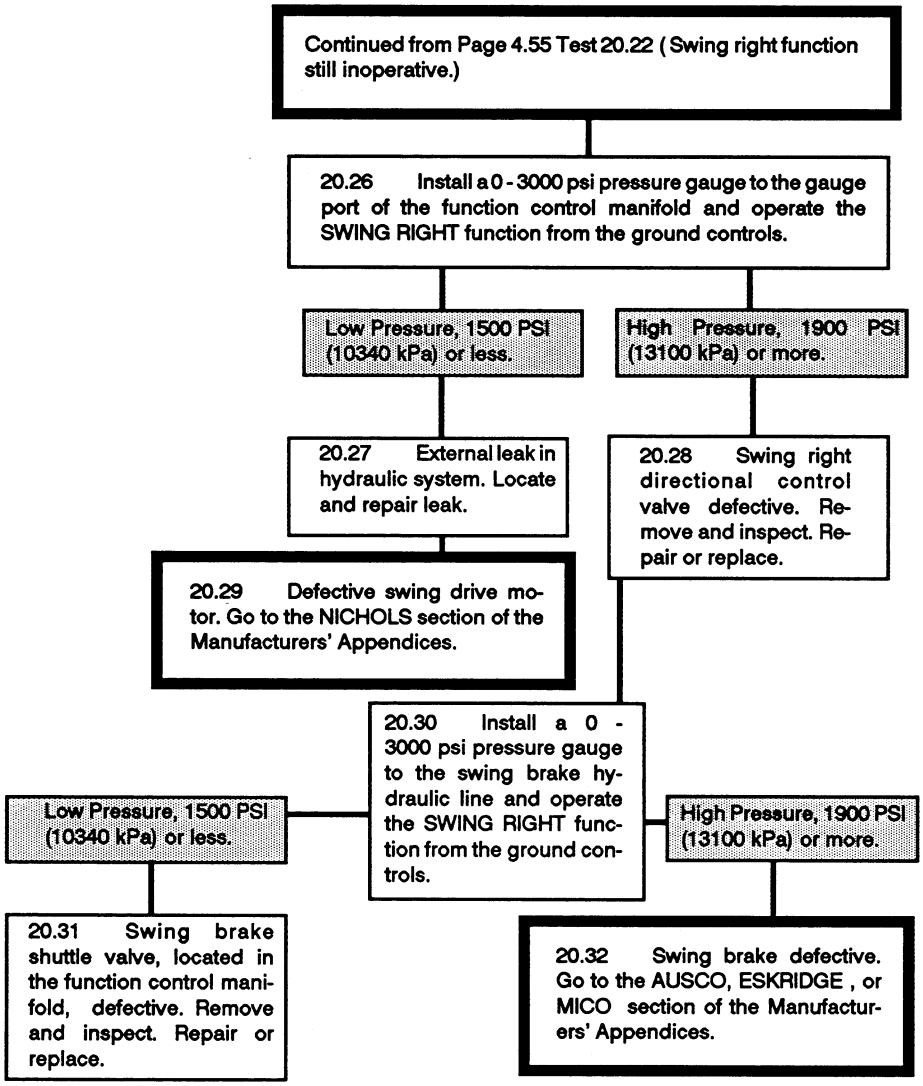

Continued from Page 4.51 Test 19.6 (Light comes on) and Test 19.10 (12 Volts)
19.9 Test voltage at terminal TB-84 while operating the SWING LEFT function from the ground controls.
0 Volts
12 Volts
19.16 Open circuit in the PCB from TB-44 to TB-84. Repair or replace the PCB.
19.15 Test voltage at the swing left directional control solenoid (S-10) while operating the SWING LEFT function from the ground controls. Ensure that S-10 is properly grounded.
19.19 Open circuit from TB-84 to S-10. Check the continuity and connection of the connecting wire. Repair the open circut.
0 Volts
12 Volts
19.18 Test the continuity of S-10. Replace if defective.
19.22 Disconnect the white wire which connects S-10 to LS-2. Attach ground wire from S-10 to the machines chassis and operate the SWING LEFT function from the ground controls.
SWING LEFT function regained.
SWING LEFT function still inoperative.
19.25 Open circuit from S-10 to ground. Check the continuity and connection of the wire connecting S-10 to LS-2. Test LS-2. Replace if defective. Check continuity and connection of the wire connecting LS-2 to ground. Repair the open circuit.
19.26 Install a 0 - 3000 psi pressure gauge to the gauge port of the function control manifold and operate the SWING LEFT function from the ground control.
Low Pressure, 1500 PSI (10340 kPa) or less.
High Pressure, 1900 PSI (13100 kPa) or more.
19.27 External leak in hydraulic system. Locate and repair leak.
19.28 Swing left directional control valve defective. Remove and inspect. Repair or replace.
19.29 Swing drive motor defective. Go to the NICHOLS section of the Manufacturers' Appendices.
19.30 Install 0 to 3000 psi pressure gauge to hydraulic line for the swing brake and operate the SWING LEFT function from the ground controls.
Low Pressure, 1500 PSI (10340 kPa) or less.
High Pressure, 1900 PSI (13100 kPa) or more.
19.31 Swing brake shuttle valve, located in the function control manifold, defective. Remove and inspect. Repair or replace.
19.32 Swing brake defective. Go to the AUSCO, ESKRIDGE, or MICO section of the Manufacturers' Appendices.

20. SWING Right function inoperative.

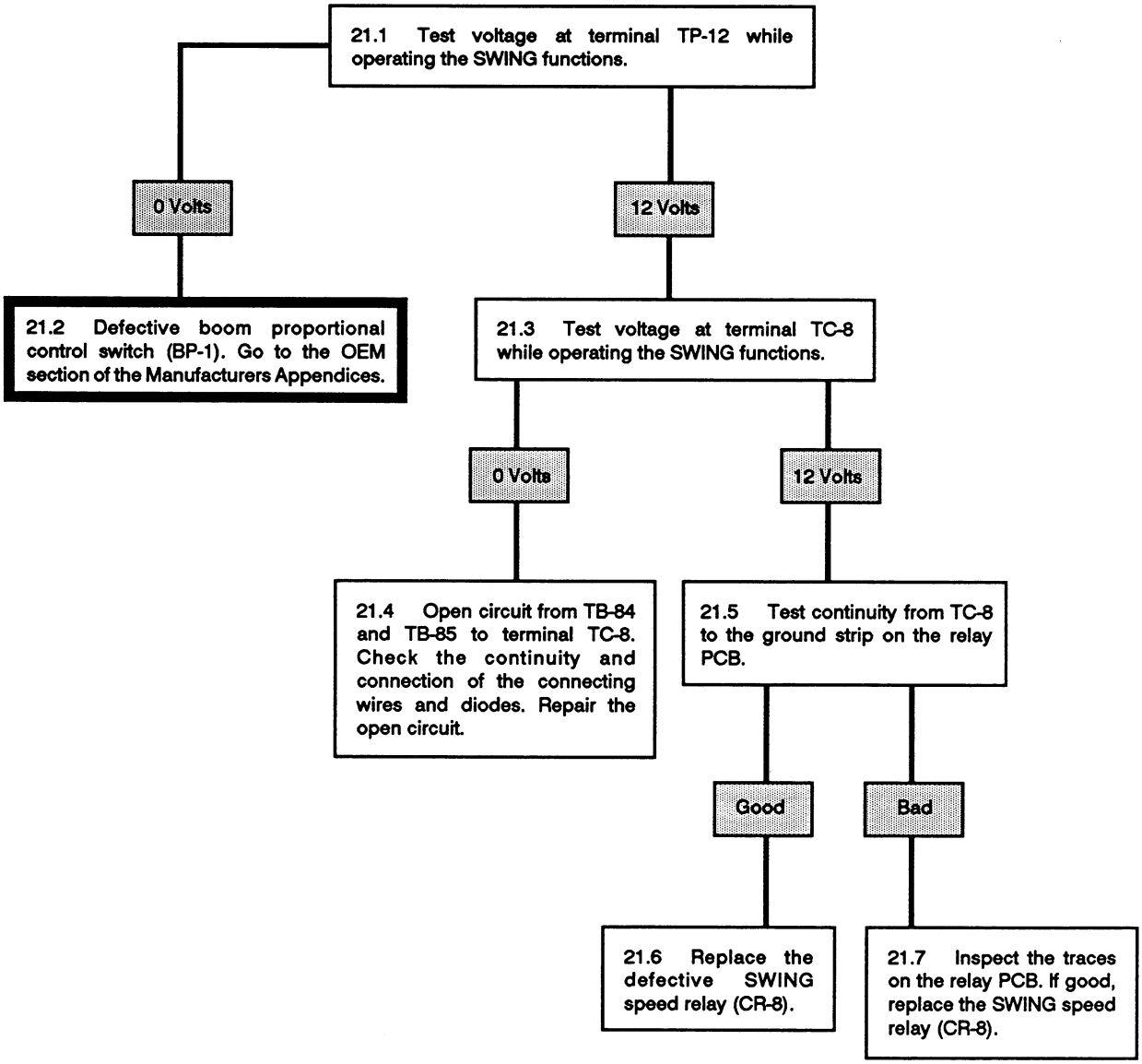



Continued from Page 4.53 Test 20.6 (No light - control circuit defect).
20.10 Test voltage at terminal TB-76 while operating the SWING RIGHT function from the ground controls.
0 Volts
12 Volts
Check LD-2 and go to Page 4.55 Test 20.9.
20.17 Test voltage at terminal TB-45 while operating the SWING RIGHT function from the ground controls.
12 Volts
0 Volts
20.20 Open circuit in the PCB from TB-45 to TB-76. Repair or replace the PCB.
20.21 Test the output voltage of the SWING LEFT/RIGHT toggle switch (TS-10) while operating the SWING RIGHT function from the ground controls.
0 Volts
12 Volts
20.24 Replace the SWING LEFT/RIGHT toggle switch TS-10.
20.23 Open circuit from TS-10 to TB-45. Check the continuity and connection of the connecting wire. Repair the open circuit.

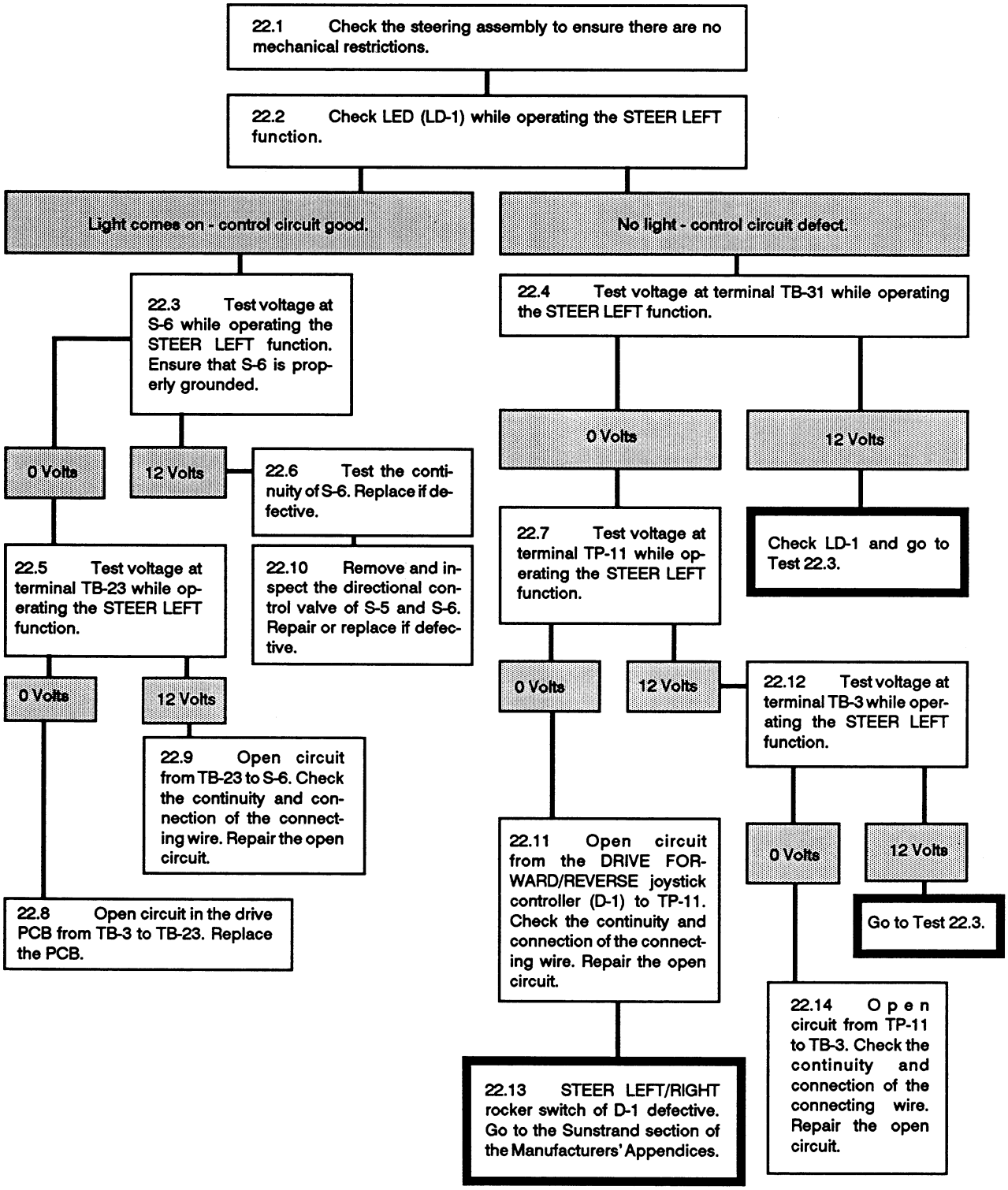

Continued from Page 4.53 Test 20.6 (Light comes on) and Test 20.10 (12 Volts)
20.9 Test voltage at terminal TB-85 while operating the SWING RIGHT function from the ground controls.
0 Volts
12 Volts
20.16 Open circuit in the PCB from TB-45 to TB-85. Repair or replace the PCB.
20.15 Test voltage at the swing right directional control solenoid (S-11) while operating the SWING RIGHT function from the ground controls. Ensure that S-11 is properly grounded.
0 Volts
12 Volts
20.19 Open circuit from TB-85 to S-11. Check the continuity and connection of the connecting wire. Repair the open circuit.
20.18 Test the continuity of S-11. Replace if defective.
20.22 Disconnect the white wire which connects S-11 to LS-3. Attach a ground wire from S-11 to the machines chassis and operate the SWING RIGHT function from the ground controls.
SWING RIGHT function regained.
SWING RIGHT function still inoperative.
20.25 Open circuit from S-11 to ground. Check the continuity and connection of the wire connecting S-11 to LS-3, Test LS-3. Replace if defective. Check the continuity and connection of the wire connecting LS-3 to ground. Repair the open circuit
Go to Page 4.56 Test 20.26


Continued from Page 4.55 Test 20.22 (Swing right function still inoperative.)
20.26 Install a 0 - 3000 psi pressure gauge to the gauge port of the function control manifold and operate the SWING RIGHT function from the ground controls.
Low Pressure, 1500 PSI (10340 kPa) or less.
High Pressure, 1900 PSI (13100 kPa) or more.
20.27 External leak in hydraulic system. Locate and repair leak.
20.28 Swing right directional control valve defective. Remove and inspect. Repair or replace.
20.29 Defective swing drive motor. Go to the NICHOLS section of the Manufacturers' Appendices.
20.30 Install a 0 - 3000 psi pressure gauge to the swing brake hydraulic line and operate the SWING RIGHT function from the ground controls.
Low Pressure, 1500 PSI (10340 kPa) or less.
High Pressure, 1900 PSI (13100 kPa) or more.
20.31 Swing brake shuttle valve, located in the function control manifold, defective. Remove and inspect. Repair or replace.
20.32 Swing brake defective. Go to the AUSCO, ESKRIDGE , or MICO section of the Manufacturers' Appendices.

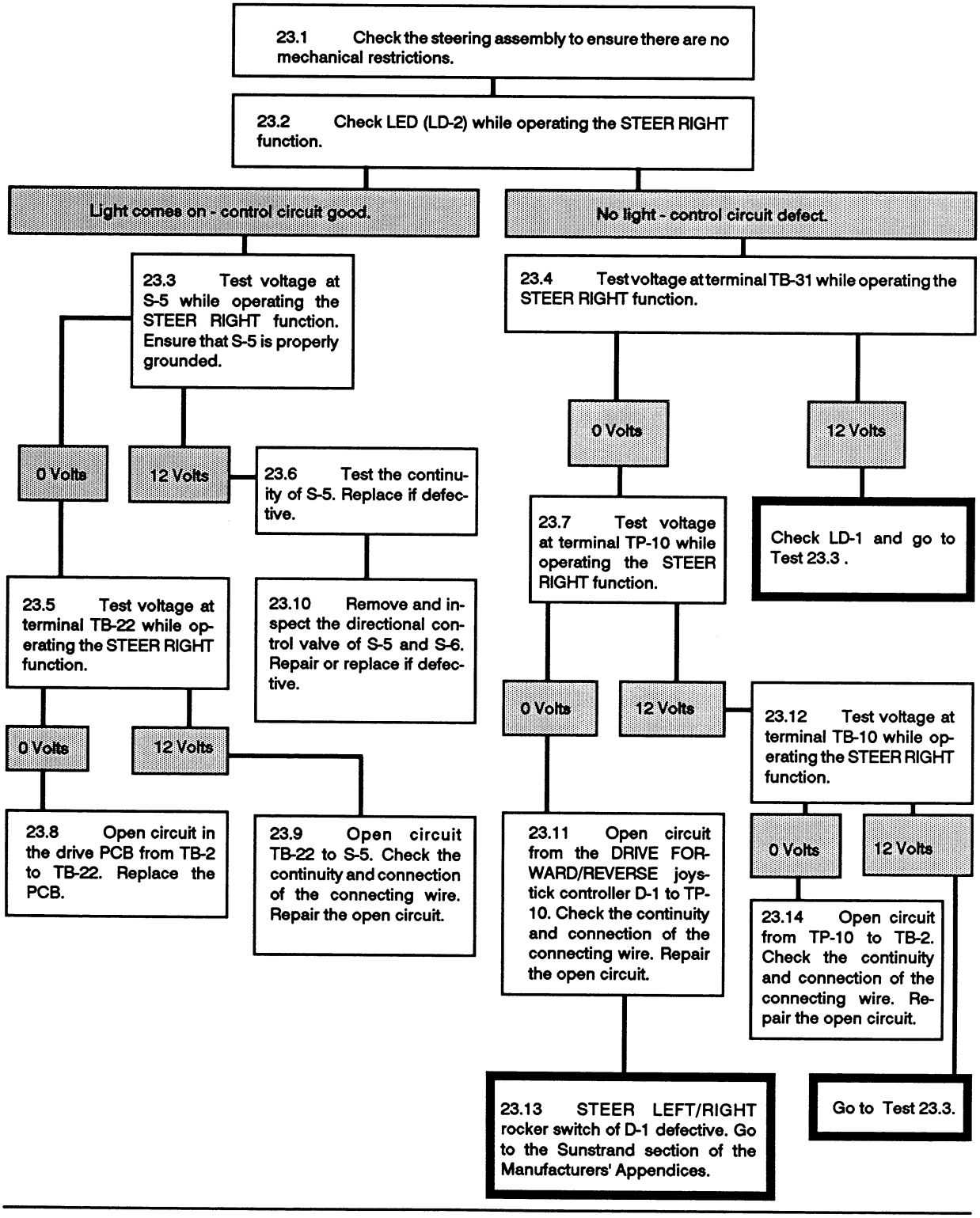
21. SWING functions operate at wrong rate.



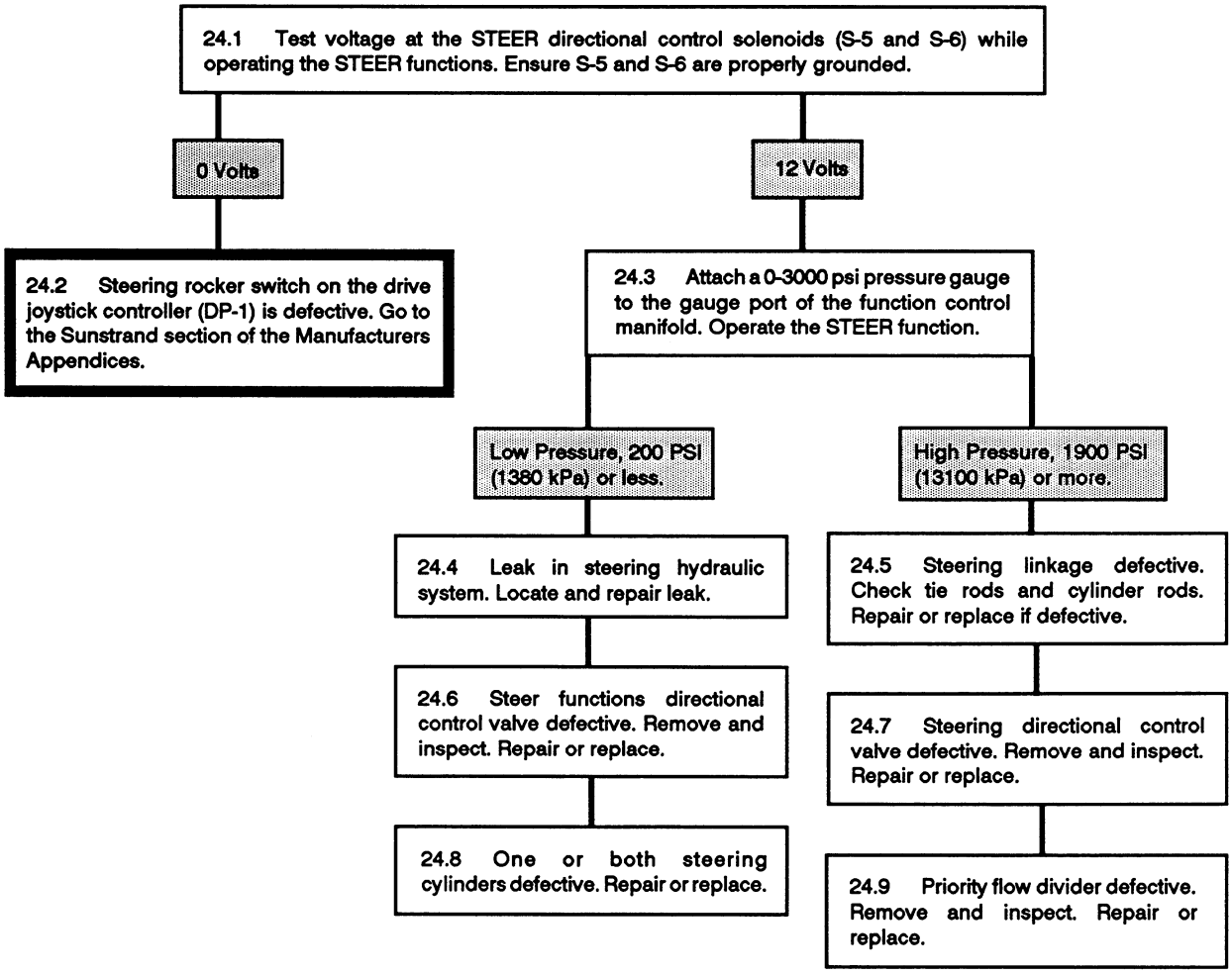
22. STEER Left function inoperative.



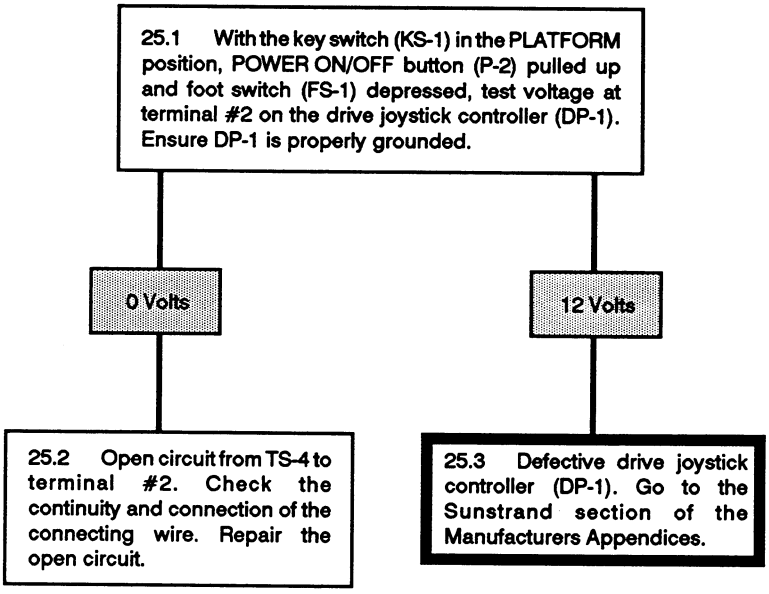
23. STEER Right function inoperative,



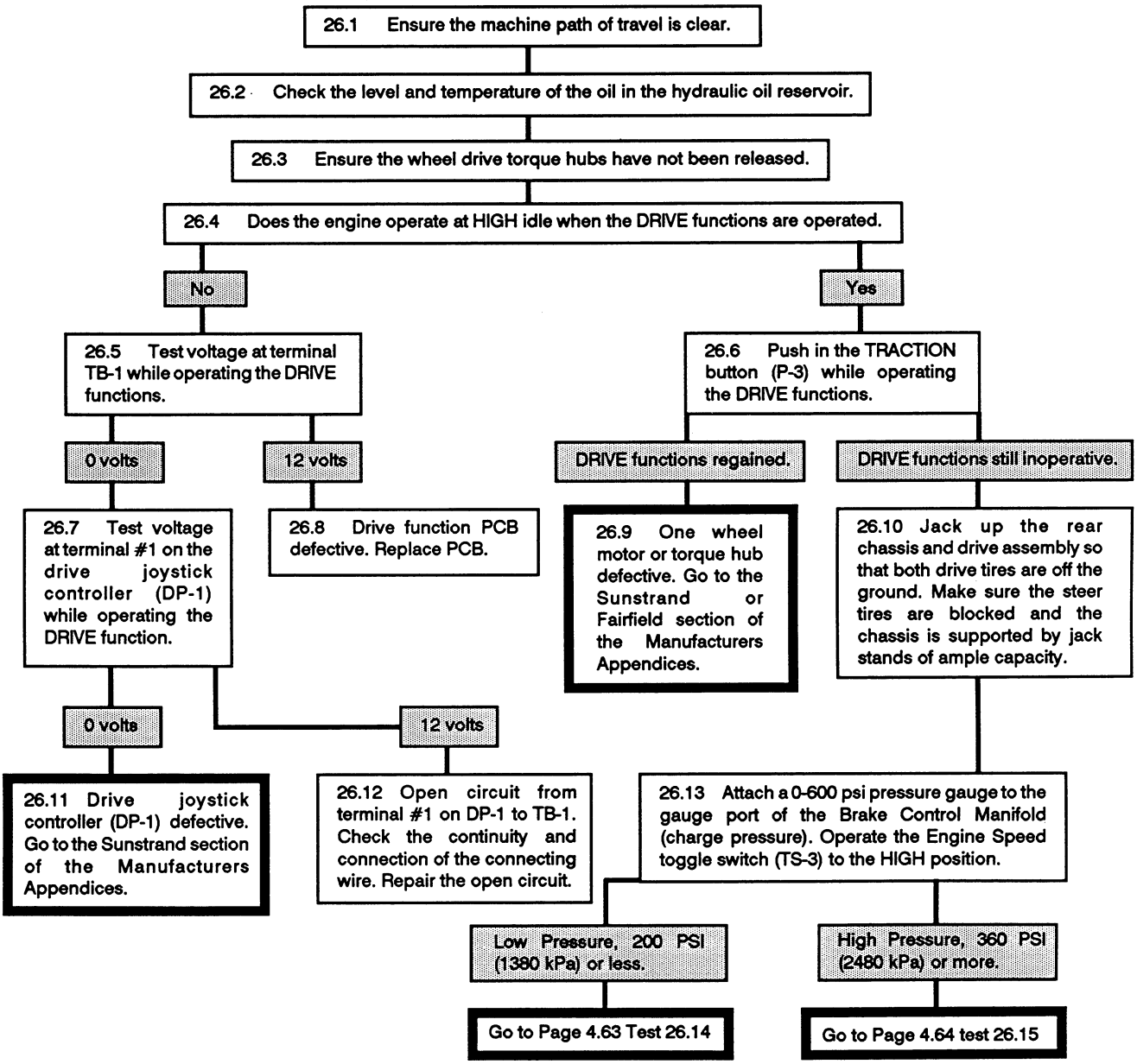
24. All STEER functions lost.

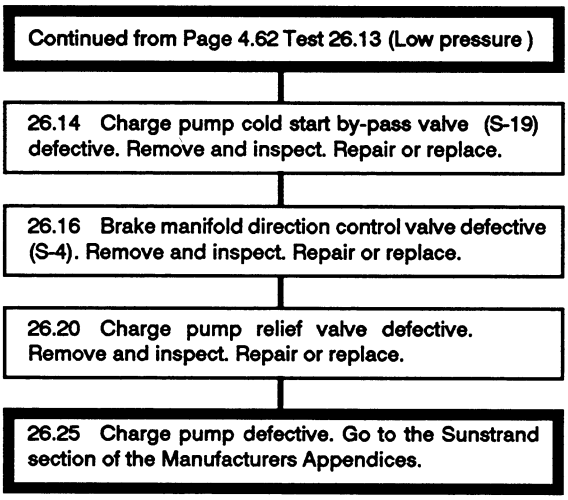


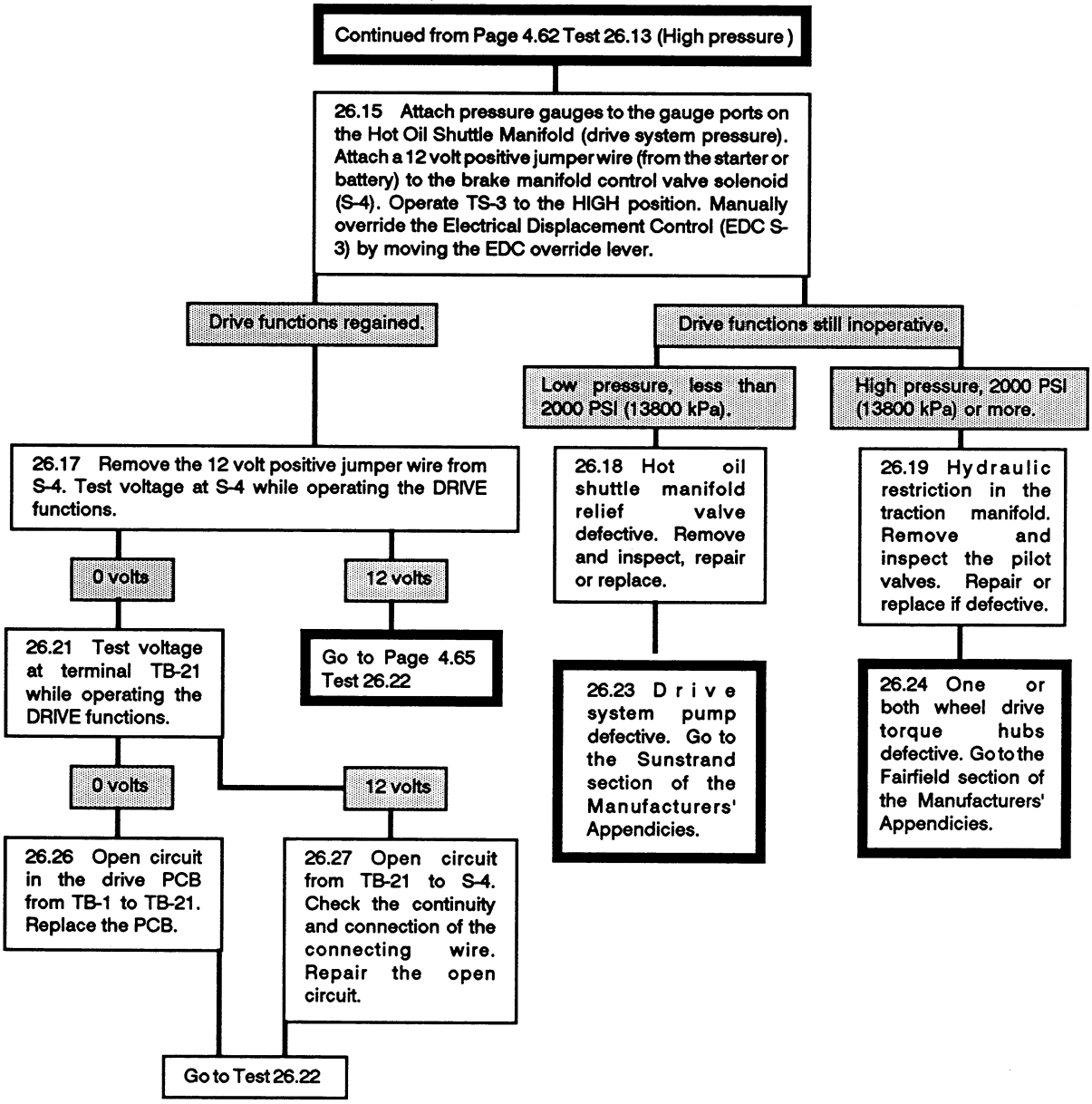
25. Machine will not DRIVE or STEER. BOOM functions are operational.

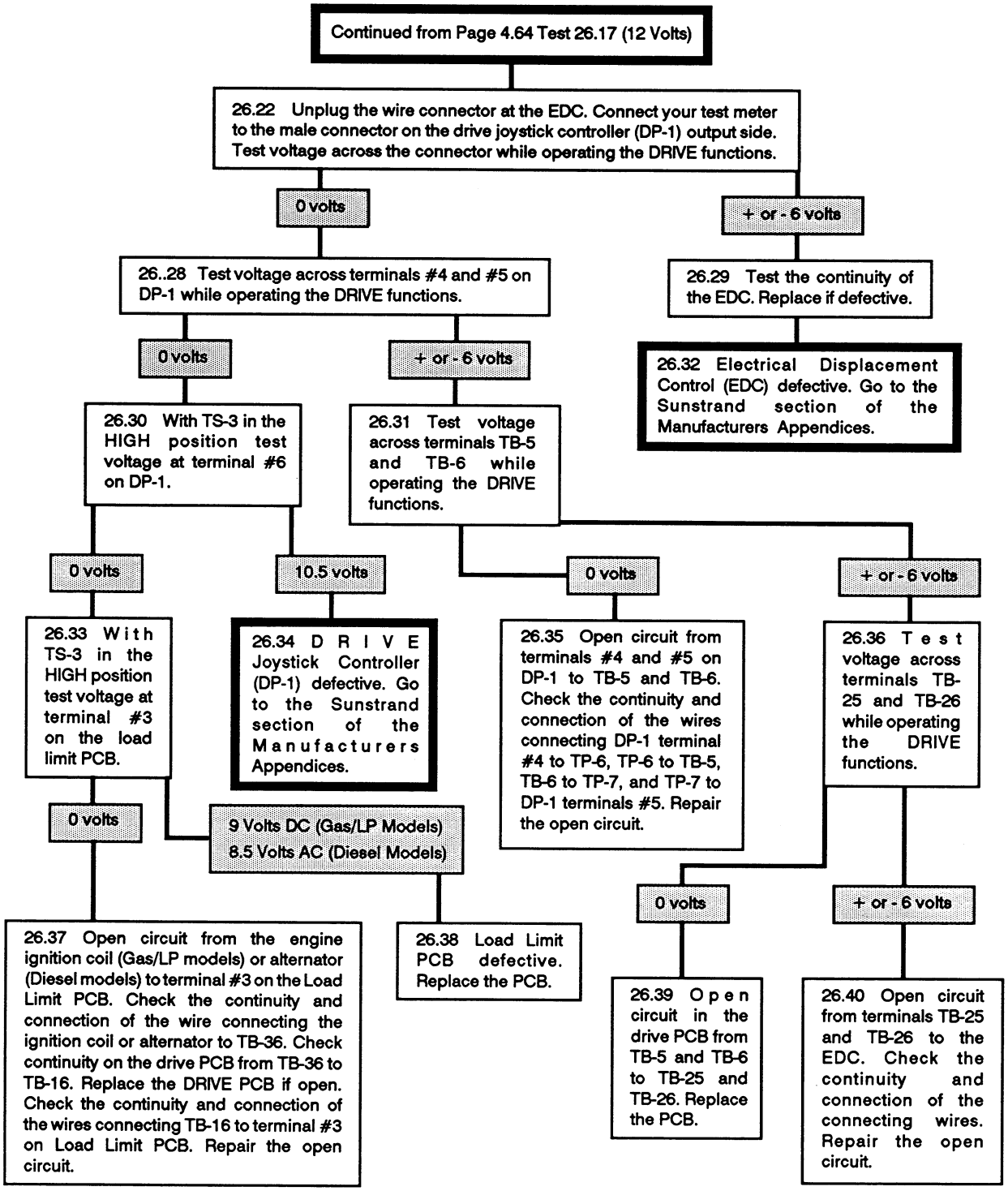


26. Machine will not DRIVE. STEER and BOOM functions are operational.

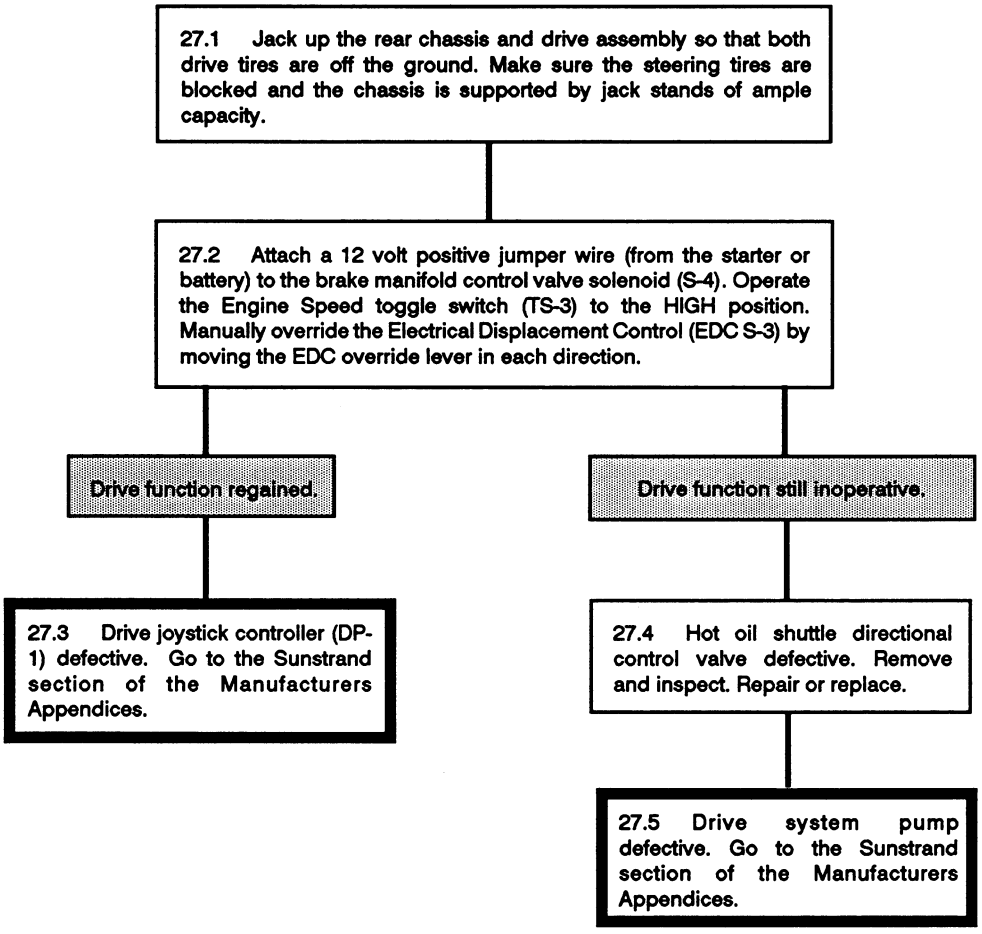



Continued from Page 4.62 Test 26.13 (Low pressure)
26.14 Charge pump cold start by-pass valve (S-19) defective. Remove and inspect. Repair or replace.
26.16 Brake manifold direction control valve defective (S-4). Remove and inspect. Repair or replace.
26.20 Charge pump relief valve defective. Remove and inspect. Repair or replace.
26.25 Charge pump defective. Go to the Sunstrand section of the Manufacturers Appendices.

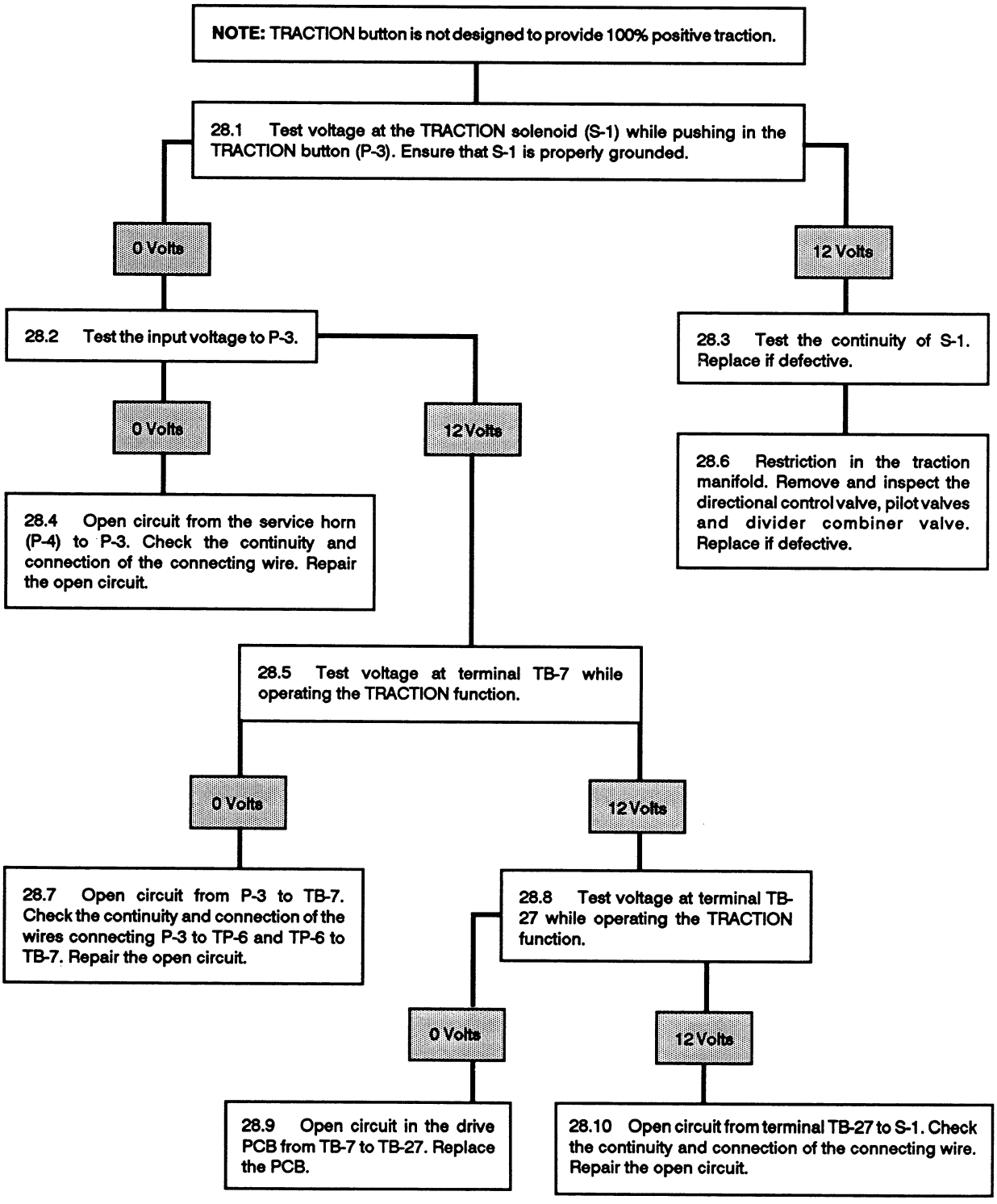

Continued from Page 4.62 Test 26.13 (High pressure)
26.15 Attach pressure gauges to the gauge ports on the Hot Oil Shuttle Manifold (drive system pressure). Attach a 12 volt positive jumper wire (from the starter or battery) to the brake manifold control valve solenoid (S-4). Operate TS-3 to the HIGH position. Manually override the Electrical Displacement Control (EDC S-3) by moving the EDC override lever.
Drive functions regained.
Drive functions still inoperative.
Low pressure, less than 2000 PSI (13800 kPa).
High pressure, 2000 PSI (13800 kPa) or more.
26.17 Remove the 12 volt positive jumper wire from S-4. Test voltage at S-4 while operating the DRIVE functions.
26.18 Hot oil shuttle manifold relief valve defective. Remove and inspect, repair or replace.
26.19 Hydraulic restriction in the traction manifold. Remove and inspect the pilot valves. Repair or replace if defective.
0 volts
12 volts
26.21 Test voltage at terminal TB-21 while operating the DRIVE functions.
Go to Page 4.65 Test 26.22
26.23 Drive system pump defective. Go to the Sunstrand section of the Manufacturers' Appendicies.
26.24 One or both wheel drive torque hubs defective. Go to the Fairfield section of the Manufacturers' Appendicies.
0 volts
12 volts
26.26 Open circuit in the drive PCB from TB-1 to TB-21. Replace the PCB.
26.27 Open circuit from TB-21 to S-4. Check the continuity and connection of the connecting wire. Repair the open circuit.
Go to Test 26.22


Continued from Page 4.64 Test 26.17 (12 Volts)
26.22 Unplug the wire connector at the EDC. Connect your test meter to the male connector on the drive joystick controller (DP-1) output side. Test voltage across the connector while operating the DRIVE functions.
0 volts
+ or - 6 volts
26..28 Test voltage across terminals #4 and #5 on DP-1 while operating the DRIVE functions.
26.29 Test the continuity of the EDC. Replace if defective.
0 volts
+ or - 6 volts
26.32 Electrical Displacement Control (EDC) defective. Go to the Sunstrand section of the Manufacturers Appendices.
26.30 With TS-3 in the HIGH position test voltage at terminal #6 on DP-1.
26.31 Test voltage across terminals TB-5 and TB-6 while operating the DRIVE functions.
0 volts
10.5 volts
0 volts
+ or - 6 volts
26.33 With TS-3 in the HIGH position test voltage at terminal #3 on the load limit PCB.
26.34 DRIVE Joystick Controller (DP-1) defective. Go to the Sunstrand section of the Manufacturers Appendices.
26.35 Open circuit from terminals #4 and #5 on DP-1 to TB-5 and TB-6. Check the continuity and connection of the wires connecting DP-1 terminal #4 to TP-6, TP-6 to TB-5, TB-6 to TP-7, and TP-7 to DP-1 terminals #5. Repair the open circuit.
26.36 Test voltage across terminals TB-25 and TB-26 while operating the DRIVE functions.
0 volts
9 Volts DC (Gas/LP Models)
8.5 Volts AC (Diesel Models)
0 volts
+ or - 6 volts
26.37 Open circuit from the engine ignition coil (Gas/LP models) or alternator (Diesel models) to terminal #3 on the Load Limit PCB. Check the continuity and connection of the wire connecting the ignition coil or alternator to TB-36. Check continuity on the drive PCB from TB-36 to TB-16. Replace the DRIVE PCB if open. Check the continuity and connection of the wires connecting TB-16 to terminal #3 on Load Limit PCB. Repair the open circuit.
26.38 Load Limit PCB defective. Replace the PCB.
26.39 Open circuit in the drive PCB from TB-5 and TB-6 to TB-25 and TB-26. Replace the PCB.
26.40 Open circuit from terminals TB-25 and TB-26 to the EDC. Check the continuity and connection of the connecting wires. Repair the open circuit.

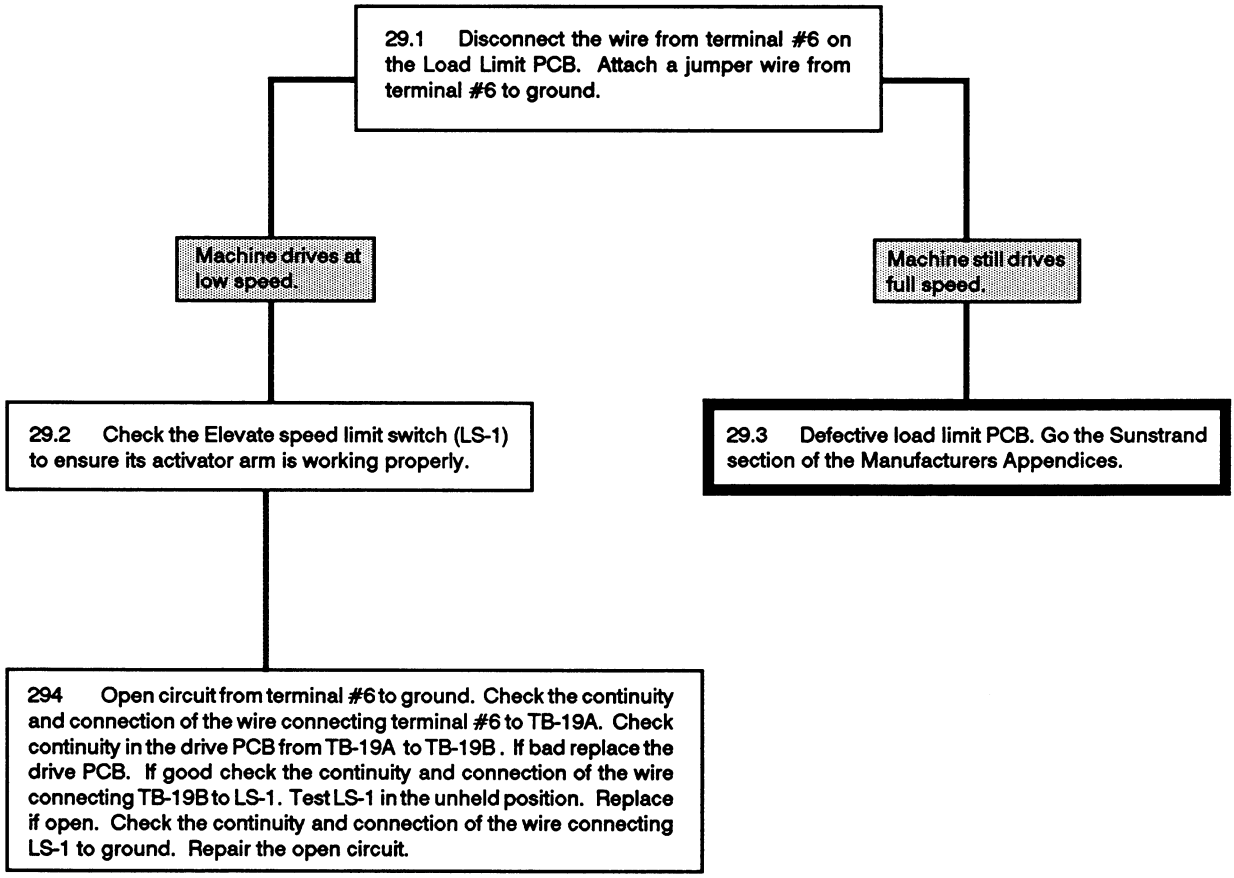
27. Machine only drives one direction.



28. Machine TRACTION function inoperative.



29. Machine drives at full speed with platform elevated.



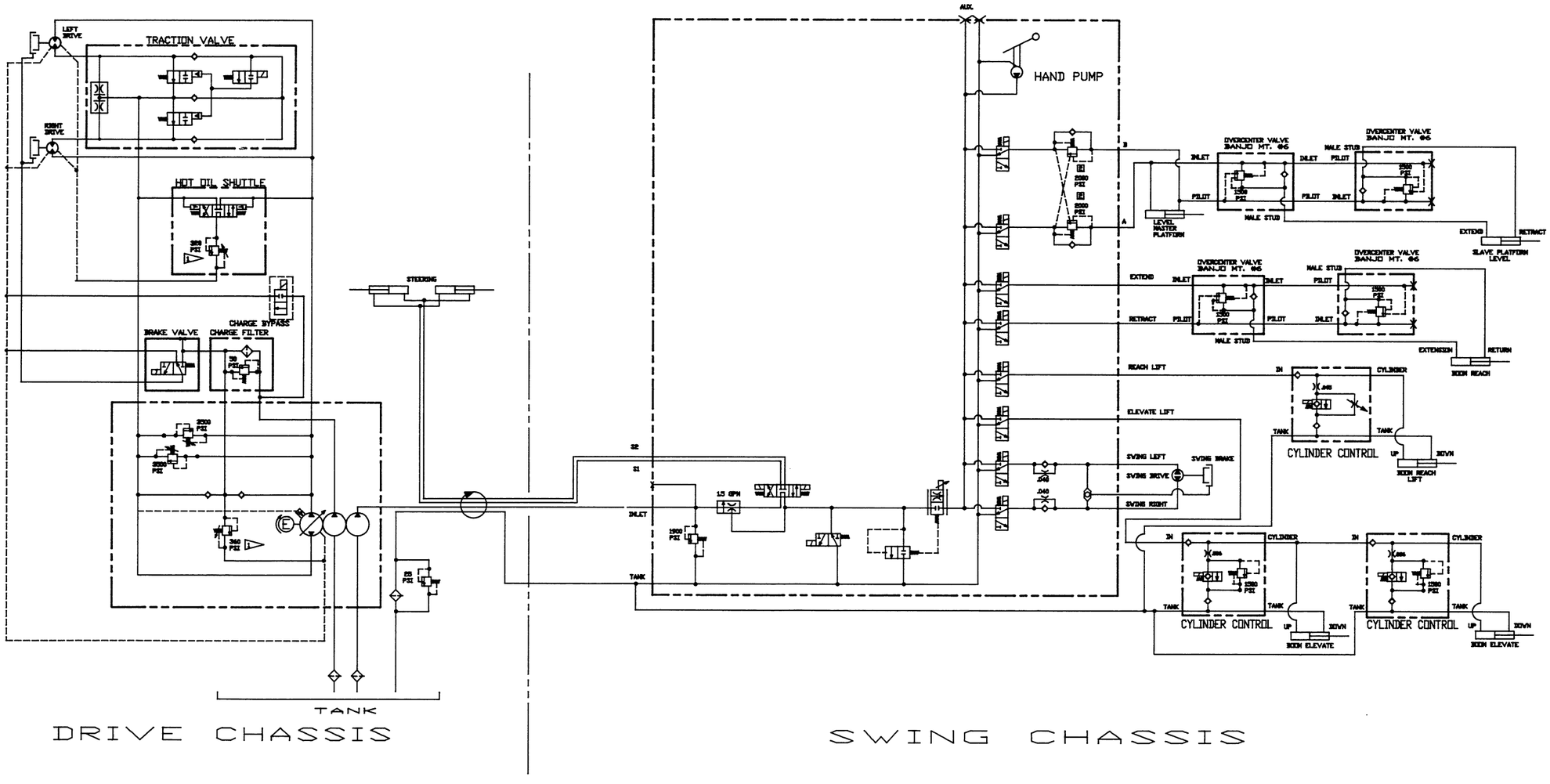
SCHEMATICS

5.1 SCHEMATICS AND DIAGRAMS

Illustration **Page**

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1. Genie BOOM Z-45/22 Gas/Liquid Propane or Diesel Models Hydraulic Schematic

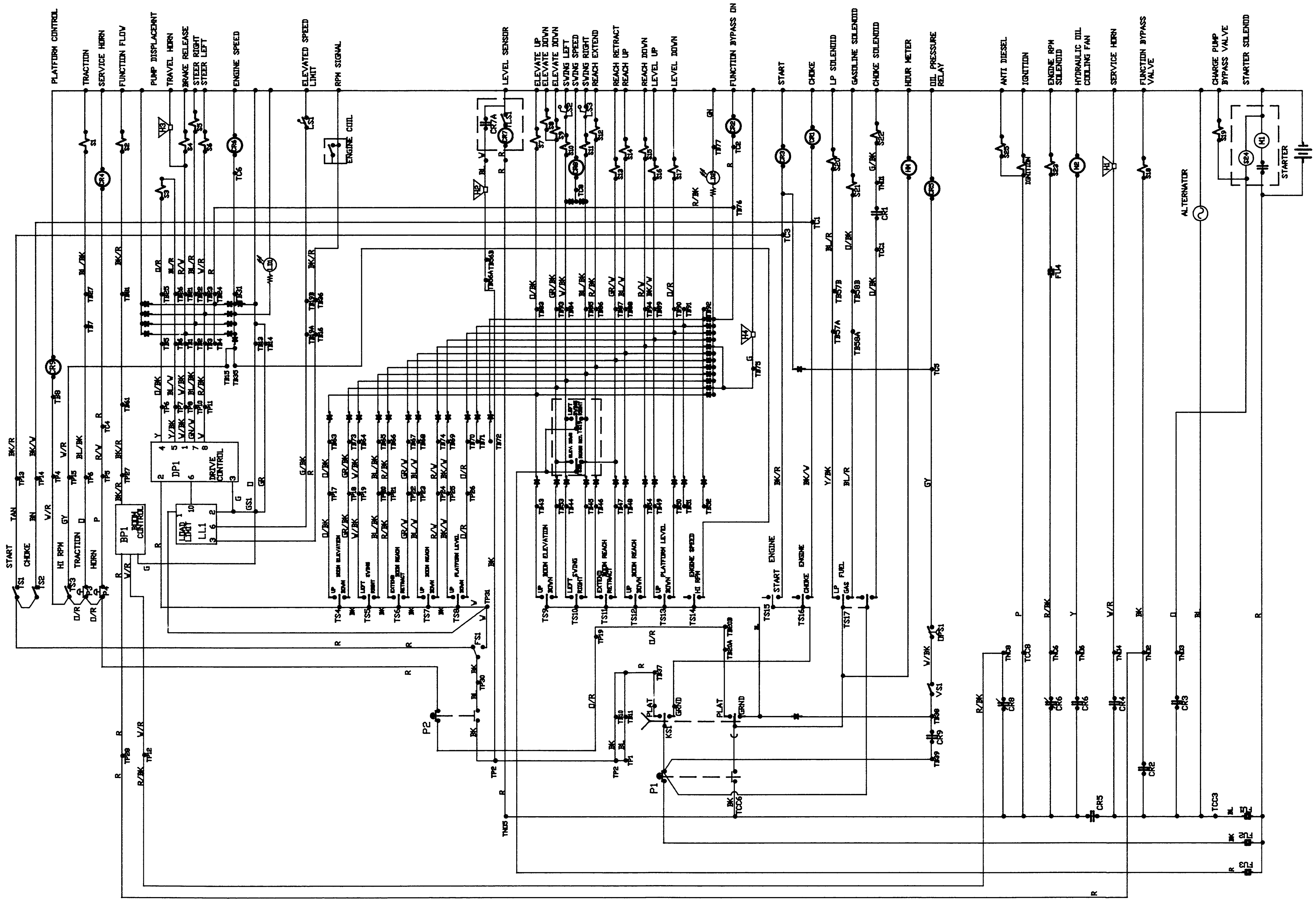


NOTES:

1. RELIEF VALVES SET AT 90-100°F & 3000 RPM.

Section 5.1 **Schematics & Diagrams** Continued

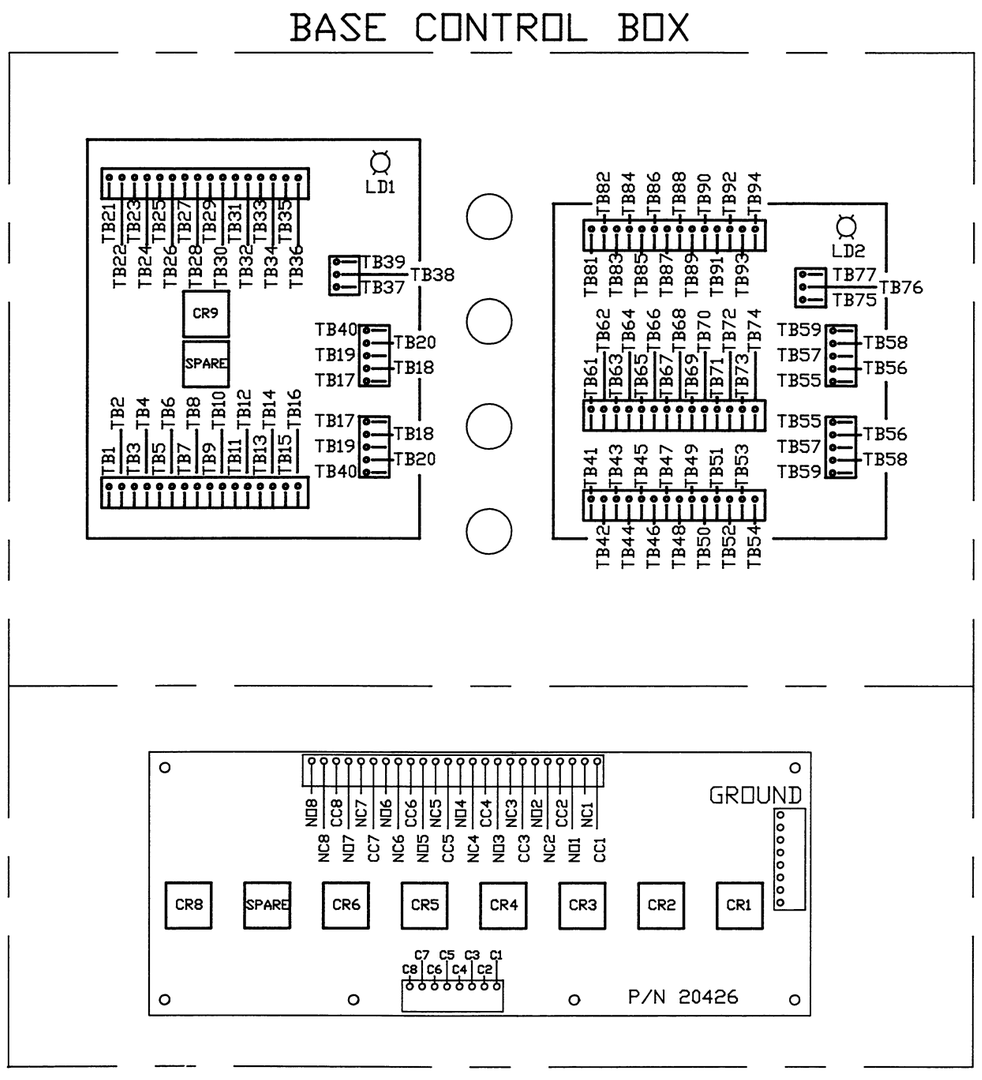
2. Genie BOOM Z-45/22GP and Z-45/22RT Electrical Schematic

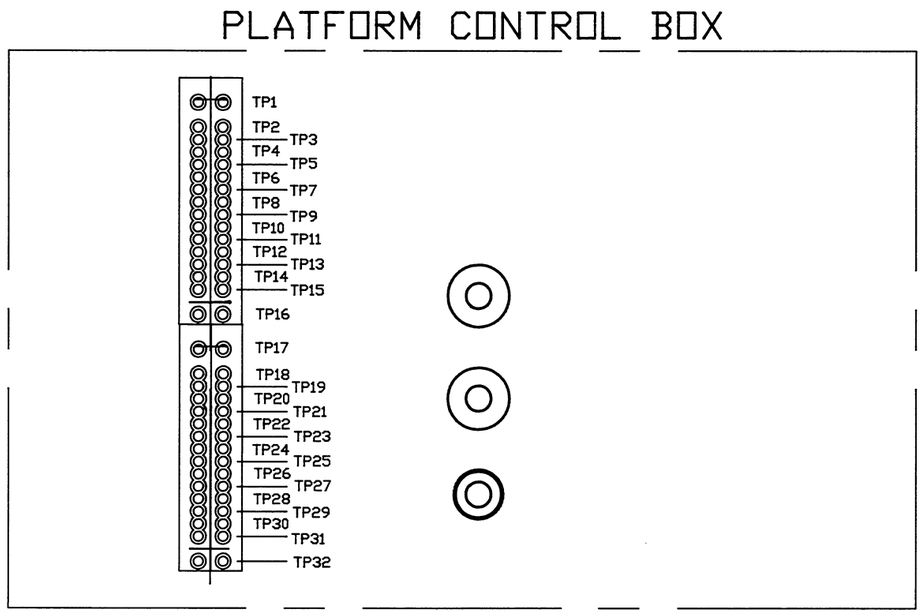


3. Genie BOOM Z-45/22GP and Z-45/22RT Electrical Schematic Legend

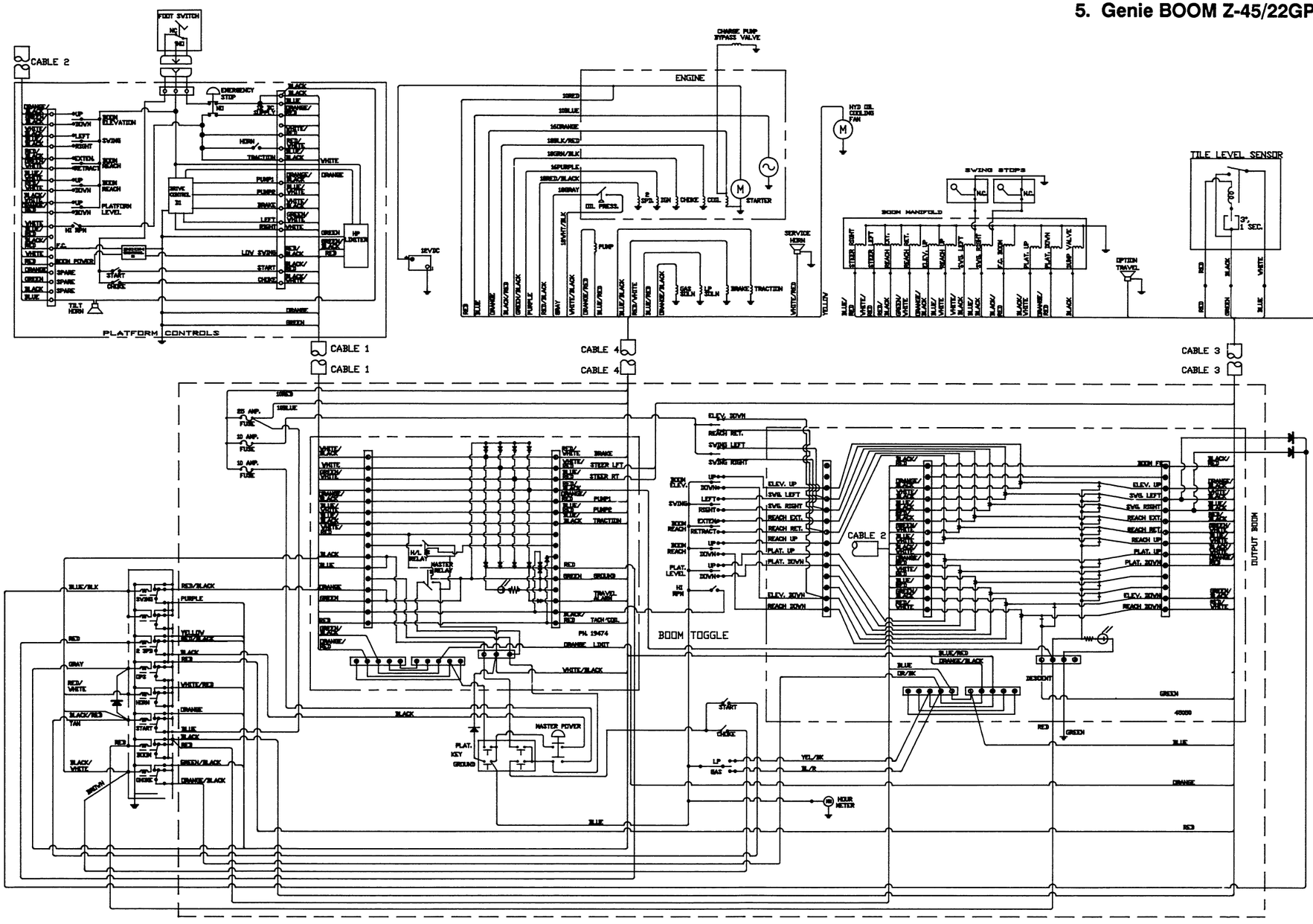
LABEL	PART ID	LOCATION
BP1	BOOM SPEED CONTROL	PLATFORM CONTROL STATION
CR1	ENGINE CHOKE RELAY, 12V	GROUND CONTROL STATION
CR2	FUNCTION BYPASS CONTROL RELAY, 12V	GROUND CONTROL STATION
CR3	ENGINE STARTER RELAY, 12V	GROUND CONTROL STATION
CR4	HORN RELAY, 12V	GROUND CONTROL STATION
CR5	ENGINE OIL PRESSURE SWITCH RELAY, 12V	GROUND CONTROL STATION
CR6	ENGINE SPEED RELAY, 12V	GROUND CONTROL STATION
CR7	TILT SENSOR RELAY, 12V (GP & RT ONLY)	GROUND CONTROL STATION
CR8	SWING SPEED RELAY, 12V	GROUND CONTROL STATION
CR9	CONTROL ACTIVATE RELAY, 12V (PLATFORM)	GROUND CONTROL STATION
DP1	DRIVE & STEERING CONTROL	PLATFORM CONTROL STATION
FS1	POWER ON/OFF FOOT SWITCH	PLATFORM CONTROL STATION
FU1	MASTER FUSE, 30 AMP	GROUND CONTROL STATION
FU2	CONTROL CIRCUIT FUSE, 15 AMP	GROUND CONTROL STATION
FU3	AUXILIARY BOOM CIRCUIT FUSE, 15 AMP	GROUND CONTROL STATION
FU4	ENGINE SPEED FUSE, 15 AMP	GROUND CONTROL STATION
GS1	CHASSIS GROUNDSTUD	PLATFORM CONTROL STATION
H1	SERVICE HORN	PLATFORM CONTROL STATION
H2	TILT LEVEL INDICATOR HORN	PLATFORM CONTROL STATION
H3	TRAVEL ALARM HORN (OPTIONAL)	GROUND CONTROL STATION
H4	DESCENT HORN (OPTIONAL)	GROUND CONTROL STATION
HM	RUNNING HOURS, HOUR METER	GROUND CONTROL STATION
KS1	CHOOSE CONTROL LOCATION, KEY SWITCH	GROUND CONTROL STATION
LD1	DRIVE FUNCTIONS LED	GROUND CONTROL STATION
LD2	BOOM FUNCTIONS LED	GROUND CONTROL STATION
LL1	DRIVE PUMP HORSEPOWER LIMIT	PLATFORM CONTROL STATION
LS1	BOOM ELEVATE VS. SPEED LIMIT SWITCH	BOOM
LS2	SWING LEFT STOP LIMIT SWITCH	GROUND CONTROL STATION
LS3	SWING RIGHT STOP LIMIT SWITCH	GROUND CONTROL STATION
M1	ENGINE STARTER MOTOR	INTERNAL COMBUSTION ENGINE
M2	HYDRAULIC OIL COOLING FAN MOTOR	GROUND CONTROL STATION
OPS1	LOW OIL PRESS. ENGINE CUTOUT SWITCH	INTERNAL COMBUSTION ENGINE
P1	POWER ON/OFF BUTTON	GROUND CONTROL STATION
P2	POWER ON/OFF BUTTON	PLATFORM CONTROL STATION
P3	TRACTION BUTTON	PLATFORM CONTROL STATION
P4	HORN BUTTON	PLATFORM CONTROL STATION
S1	TRACTION SOLENOID	CHASSIS
S2	BOOM PROPORTIONAL VALVE SOLENOID	CHASSIS
S3	DRIVE PUMP DISPLACEMENT SOLENOID (EDC)	CHASSIS
S4	DRIVE BRAKE RELEASE SOLENOID	CHASSIS
S5	STEER RIGHT SOLENOID	CHASSIS
S6	STEER LEFT SOLENOID	CHASSIS
S7	BOOM ELEVATE UP SOLENOID	CHASSIS
S8	BOOM ELEVATE DOWN SOLENOID	CHASSIS
S9	BOOM ELEVATE DOWN SOLENOID	CHASSIS
S10	BOOM SWING LEFT SOLENOID	CHASSIS
S11	BOOM SWING RIGHT SOLENOID	CHASSIS
S12	BOOM REACH EXTEND SOLENOID	CHASSIS
S13	BOOM REACH RETRACT SOLENOID	CHASSIS
S14	BOOM REACH UP SOLENOID	CHASSIS
S15	BOOM REACH DOWN SOLENOID	CHASSIS
S16	PLATFORM LEVEL UP SOLENOID	CHASSIS
S17	PLATFORM LEVEL DOWN SOLENOID	CHASSIS
S18	BOOM FUNCTION BYPASS SOLENOID	CHASSIS
S19	CHARGE PUMP BYPASS SOLENOID	CHASSIS
S20	LP SOLENOID	CHASSIS
S21	GASOLINE SOLENOID	CHASSIS
S22	CHOKE SOLENOID	INTERNAL COMBUSTION ENGINE
S23	ENGINE RPM SOLENOID	INTERNAL COMBUSTION ENGINE
S24	STARTER SOLENOID	INTERNAL COMBUSTION ENGINE
S25	ANTI DIESEL SOLENOID	INTERNAL COMBUSTION ENGINE
TB1–TB16	INPUT TERMINALS	GROUND CONTROL STATION
TB21–TB36	OUTPUT TERMINALS	GROUND CONTROL STATION
TB37–TB39	OUTPUT TERMINALS	GROUND CONTROL STATION
TB41–TB54	INPUT TERMINALS	GROUND CONTROL STATION
TB61–TB74	INPUT TERMINALS	GROUND CONTROL STATION
TB75–TB77	OUTPUT TERMINALS	GROUND CONTROL STATION
TB81–TB94	OUTPUT TERMINALS	GROUND CONTROL STATION
TC1–TC8	RELAY COIL TERMINALS	GROUND CONTROL STATION
TCC1–TCC8	RELAY COMMAN CONTACTS TERMINALS	GROUND CONTROL STATION
TLS1	3 DEG. TILT LEVEL INDICATOR (NO) SWITCH	GROUND CONTROL STATION
TNC1–TNC8	RELAY N.C. CONTACTS TERMINALS	GROUND CONTROL STATION
TNO1–TNO8	RELAY N.O. CONTACTS TERMINALS	GROUND CONTROL STATION
TP1–TP32	INPUT/OUTPUT TERMINALS	PLATFORM CONTROL STATION
TS1	ENGINE START TOGGLE SWITCH	PLATFORM CONTROL STATION
TS2	ENGINE CHOKE TOGGLE SWITCH	PLATFORM CONTROL STATION
TS3	ENGINE SPEED TOGGLE SWITCH	PLATFORM CONTROL STATION
TS4	BOOM ELEVATE UP/DOWN TOGGLE SWITCH	PLATFORM CONTROL STATION
TS5	BOOM SWING LEFT/RIGHT TOGGLE SWITCH	PLATFORM CONTROL STATION
TS6	BOOM REACH EXTEND/RETRACT TOGGLE SWITCH	PLATFORM CONTROL STATION
TS7	BOOM REACH UP/DOWN TOGGLE SWITCH	PLATFORM CONTROL STATION
TS8	PLATFORM LEVEL UP/DOWN TOGGLE SWITCH	PLATFORM CONTROL STATION
TS9	BOOM ELEVATE UP/DOWN TOGGLE SWITCH	GROUND CONTROL STATION
TS10	BOOM SWING LEFT/RIGHT TOGGLE SWITCH	GROUND CONTROL STATION
TS11	BOOM REACH EXTEND/RETRACT TOGGLE SWITCH	GROUND CONTROL STATION
TS12	BOOM REACH UP/DOWN TOGGLE SWITCH	GROUND CONTROL STATION
TS13	PLATFORM LEVEL UP/DOWN TOGGLE SWITCH	GROUND CONTROL STATION
TS14	ENGINE SPEED TOGGLE SWITCH	GROUND CONTROL STATION
TS15	ENGINE START TOGGLE SWITCH	GROUND CONTROL STATION
TS16	ENGINE CHOKE TOGGLE SWITCH	GROUND CONTROL STATION
TS17	FUEL SELECT TOGGLE SWITCH	GROUND CONTROL STATION
TS18	AUX. CONTROL, ELEV. DOWN/BOOM RETRACT TOGGLE	GROUND CONTROL STATION
TS19	AUX. CONTROL, SWING LEFT/RIGHT TOGGLE SWITCH	GROUND CONTROL STATION
VS1	ANTI BACKFIRE VACUUM SWITCH	INTERNAL COMBUSTION ENGINE

4. Genie BOOM Z-45/22GP and Z-45/22RT Printed Circuit Boards and Wire Terminal Diagram

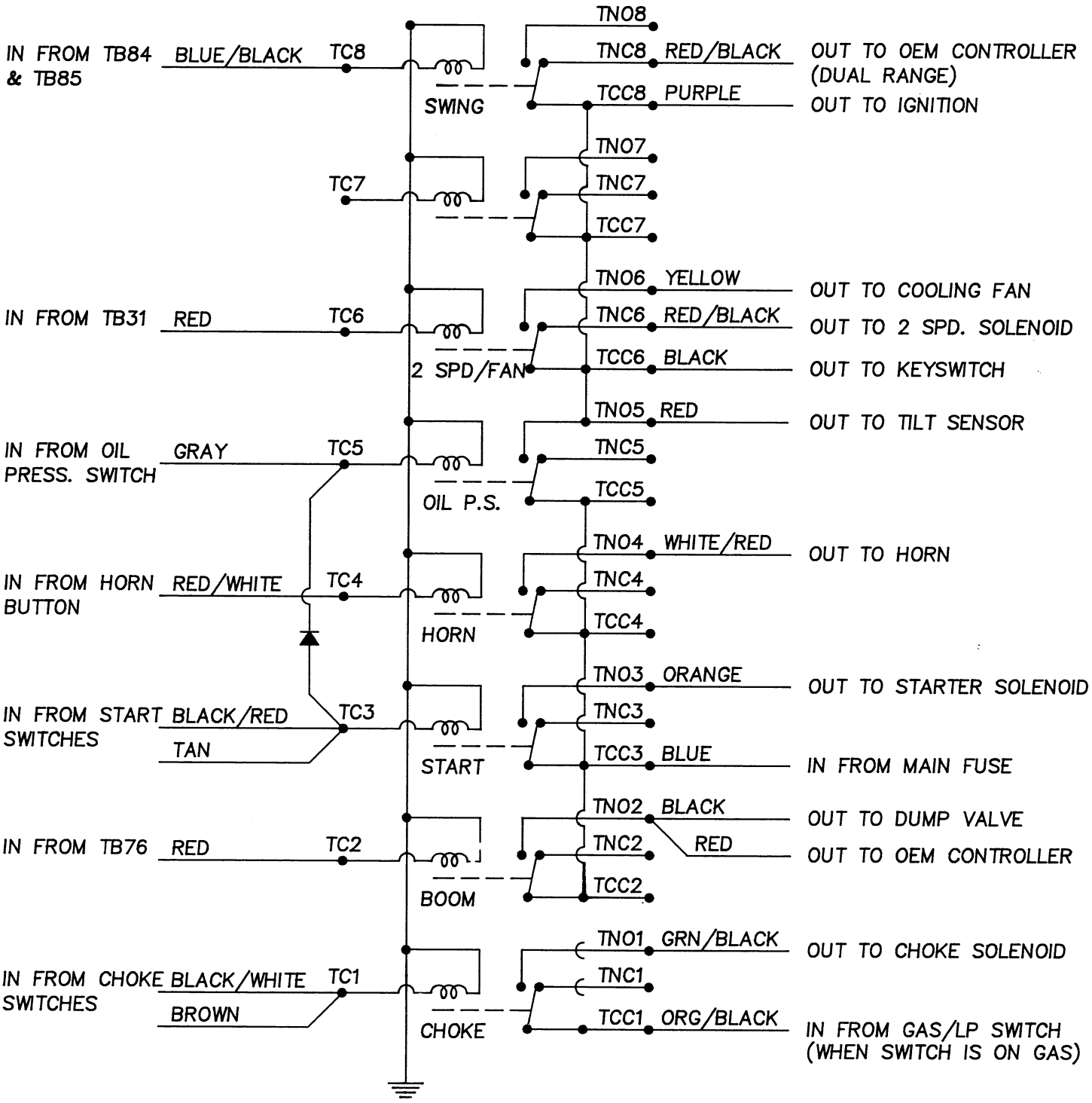




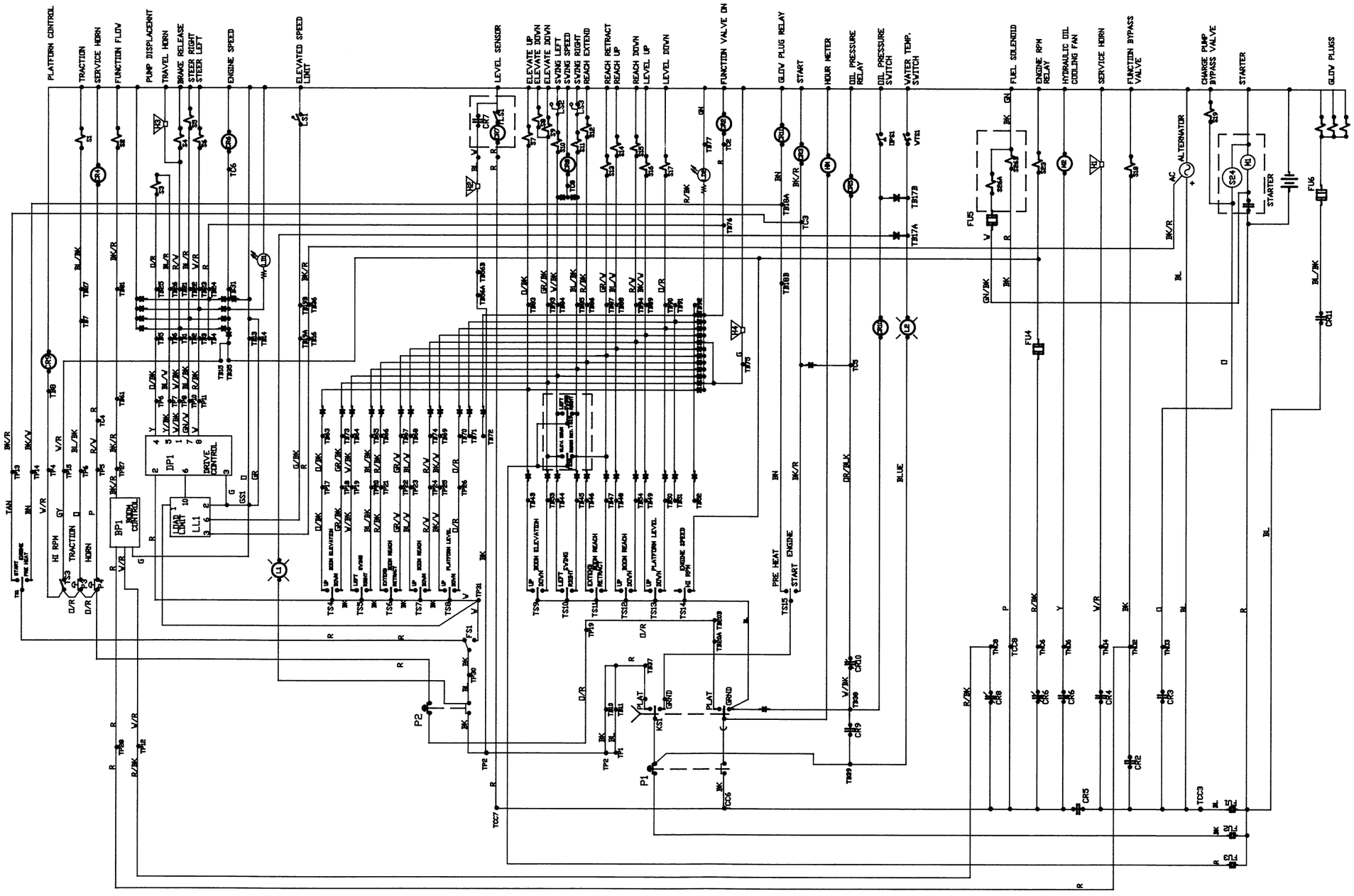
5. Genie BOOM Z-45/22GP and Z-45/22RT Wiring Diagram



6. Genie BOOM Z-45/22GP and Z-45/22RT Relay Printed Circuit Board Diagram



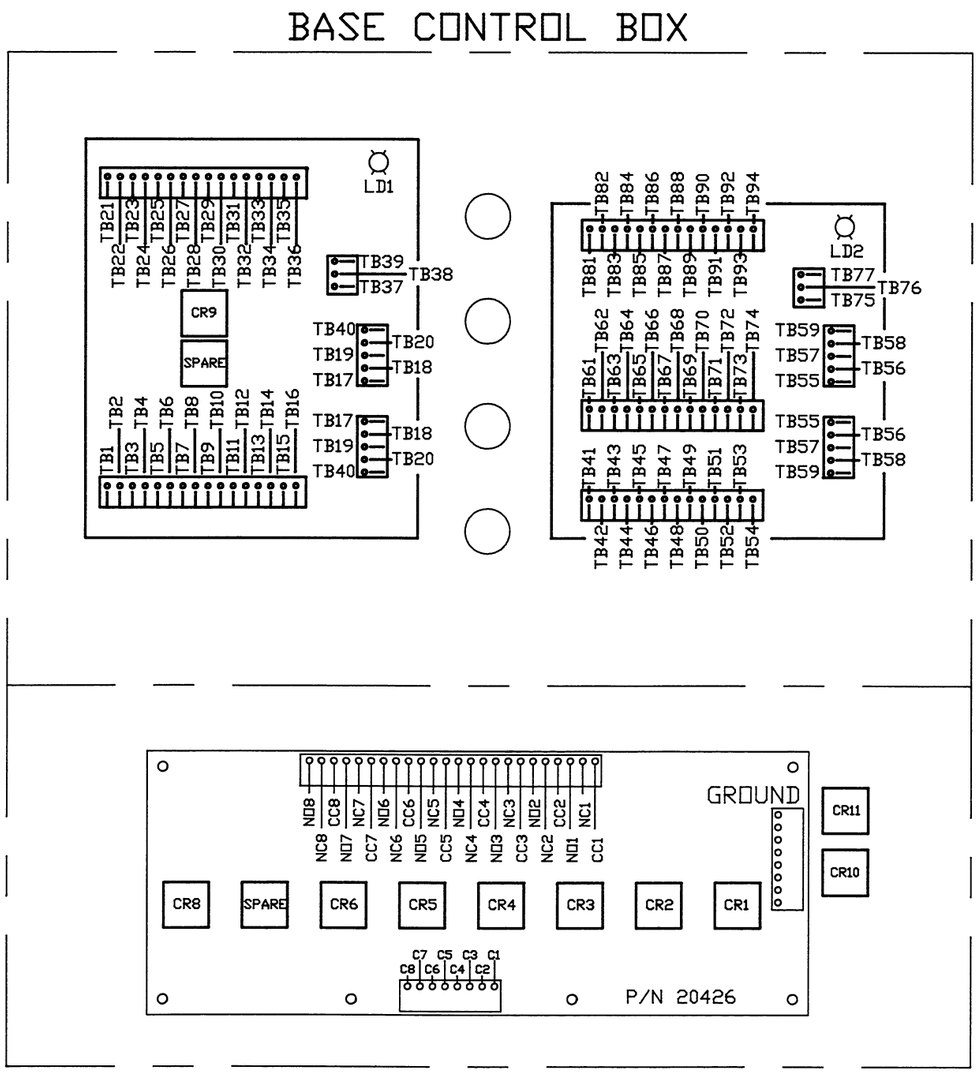
7. Genie BOOM Z-45/22D and Z-45/22DRT Electrical Schematic

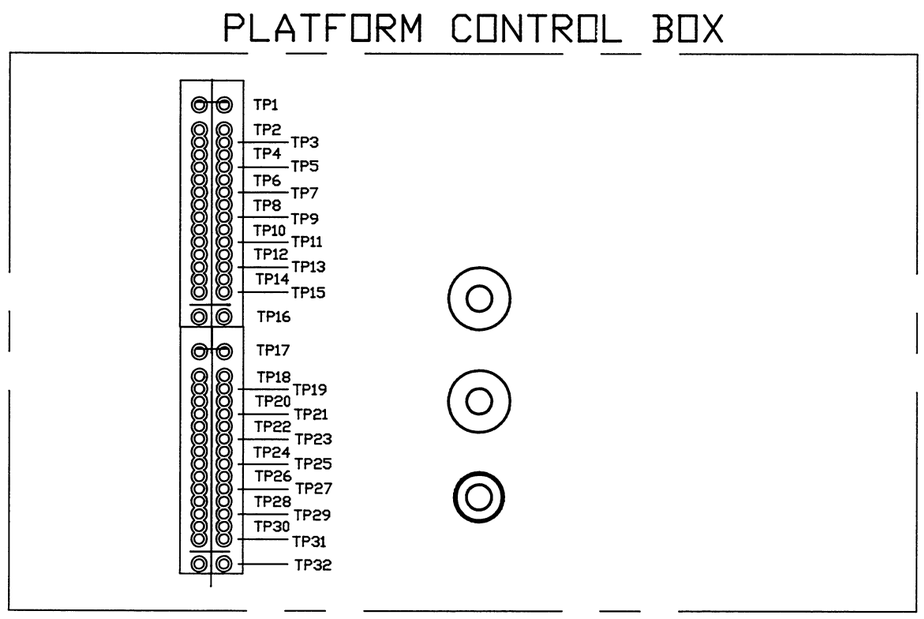


8. Genie BOOM Z-45/22D and Z-45/22DRT Electrical Schematic Legend

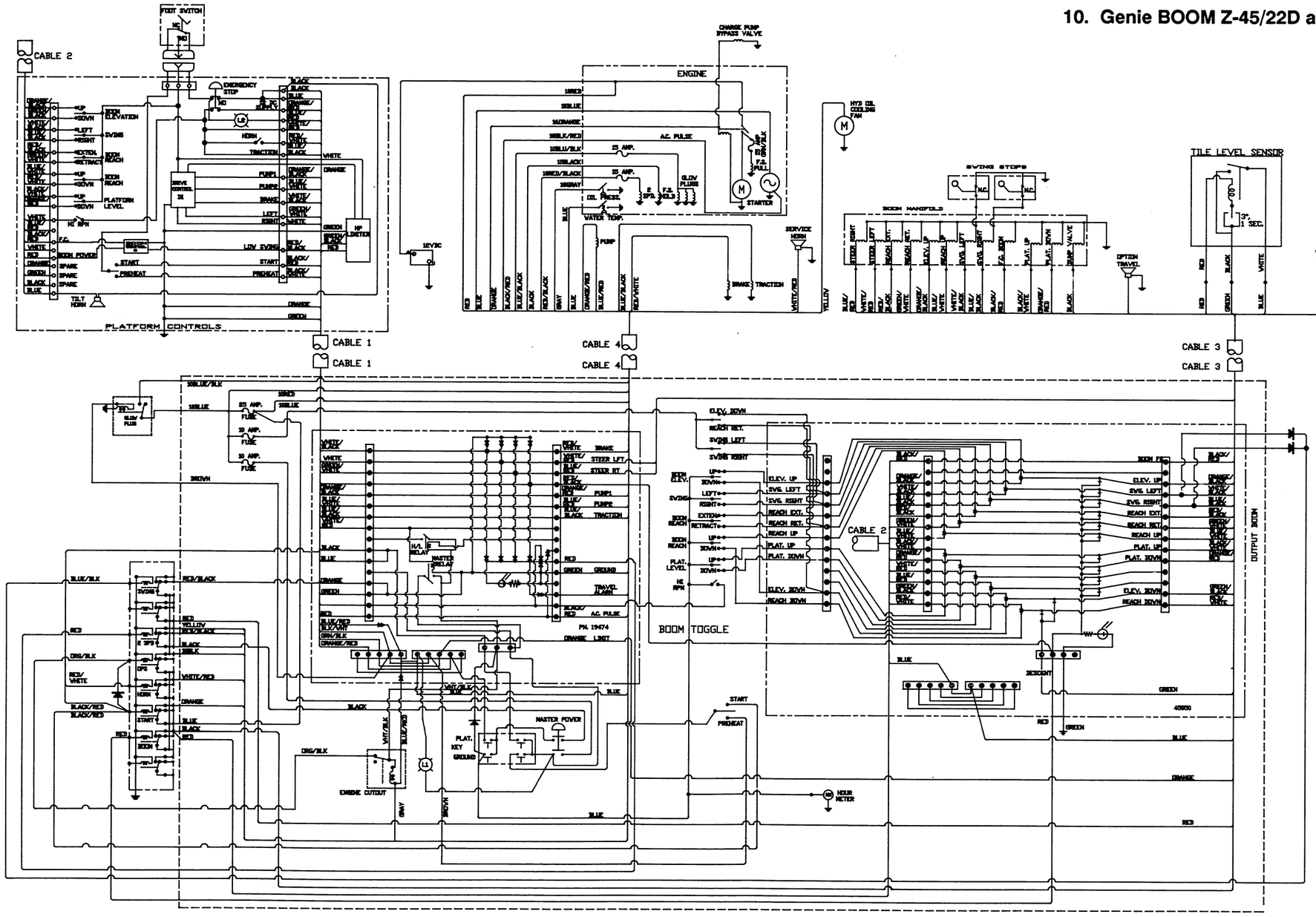
LABEL	PART ID	LOCATION
BP1	BOOM SPEED CONTROL	PLATFORM CONTROL STATION
CR2	FUNCTION BYPASS CONTROL RELAY, 12V	GROUND CONTROL STATION
CR3	ENGINE STARTER RELAY, 12V	GROUND CONTROL STATION
CR4	HORN RELAY, 12V	GROUND CONTROL STATION
CR5	ENGINE OIL PRESSURE SWITCH RELAY, 12V	GROUND CONTROL STATION
CR6	ENGINE SPEED RELAY, 12V	GROUND CONTROL STATION
CR7	TILT SENSOR RELAY, 12V	GROUND CONTROL STATION
CR8	SWING SPEED RELAY, 12V	GROUND CONTROL STATION
CR9	CONTROL ACTIVATE RELAY, 12V (PLATFORM)	GROUND CONTROL STATION
CR10	DIESEL ENGINE CUTOUT RELAY, 12V	GROUND CONTROL STATION
CR11	GLOW PLUGS RELAY, 12V	GROUND CONTROL STATION
DP1	DRIVE & STEERING CONTROL	PLATFORM CONTROL STATION
FS1	POWER ON/OFF FOOT SWITCH	PLATFORM CONTROL STATION
FU1	MASTER FUSE, 30 AMP	GROUND CONTROL STATION
FU2	CONTROL CIRCUIT FUSE, 15 AMP	GROUND CONTROL STATION
FU3	AUXILIARY BOOM CIRCUIT FUSE, 15 AMP	GROUND CONTROL STATION
FU4	ENGINE SPEED FUSE, 15 AMP	GROUND CONTROL STATION
FU5	FUEL PULL SOLENOID FUSE, 15 AMP	GROUND CONTROL STATION
FU6	ENGINE GLOW PLUGS FUSE, 30 AMP	GROUND CONTROL STATION
GS1	CHASSIS GROUNDSTUD	PLATFORM CONTROL STATION
H1	SERVICE HORN	PLATFORM CONTROL STATION
H2	TILT LEVEL INDICATOR HORN	PLATFORM CONTROL STATION
H3	TRAVEL ALARM HORN (OPTIONAL)	CHASSIS
H4	DESCENT HORN (OPTIONAL)	CHASSIS
HM	RUNNING HOURS, HOUR METER	GROUND CONTROL STATION
KS1	CHOOSE CONTROL LOCATION, KEY SWITCH	GROUND CONTROL STATION
L1	WATER TEMP. LIGHT GROUND	GROUND CONTROL STATION
L2	WATER TEMP. LIGHT PLATFORM	PLATFORM CONTROL STATION
LD1	DRIVE FUNCTIONS LED	GROUND CONTROL STATION
LD2	BOOM FUNCTIONS LED	GROUND CONTROL STATION
LL1	DRIVE PUMP HORSEPOWER LIMIT	PLATFORM CONTROL STATION
LS1	BOOM ELEVATE VS. SPEED LIMIT SWITCH	BOOM
LS2	SWING LEFT STOP LIMIT SWITCH	GROUND CONTROL STATION
LS3	SWING RIGHT STOP LIMIT SWITCH	GROUND CONTROL STATION
M1	ENGINE STARTER MOTOR	INTERNAL COMBUSTION ENGINE
M2	HYDRAULIC OIL COOLING FAN MOTOR	CHASSIS
OPS1	LOW OIL PRESS. ENGINE CUTOUT SWITCH	INTERNAL COMBUSTION ENGINE
P1	POWER ON/OFF BUTTON	GROUND CONTROL STATION
P2	POWER ON/OFF BUTTON	PLATFORM CONTROL STATION
P3	TRACTION BUTTON	PLATFORM CONTROL STATION
P4	HORN BUTTON	PLATFORM CONTROL STATION
S1	TRACTION SOLENOID	CHASSIS
S2	BOOM PROPORTIONAL VALVE SOLENOID	CHASSIS
S3	DRIVE PUMP DISPLACEMENT SOLENOID (EDC)	CHASSIS
S4	DRIVE BRAKE RELEASE SOLENOID	CHASSIS
S5	STEER RIGHT SOLENOID	CHASSIS
S6	STEER LEFT SOLENOID	CHASSIS
S7	BOOM ELEVATE UP SOLENOID	CHASSIS
S8	BOOM ELEVATE DOWN SOLENOID	CHASSIS
S9	BOOM ELEVATE DOWN SOLENOID	CHASSIS
S10	BOOM SWING LEFT SOLENOID	CHASSIS
S11	BOOM SWING RIGHT SOLENOID	CHASSIS
S12	BOOM REACH EXTEND SOLENOID	CHASSIS
S13	BOOM REACH RETRACT SOLENOID	CHASSIS
S14	BOOM REACH UP SOLENOID	CHASSIS
S15	BOOM REACH DOWN SOLENOID	CHASSIS
S16	PLATFORM LEVEL UP SOLENOID	CHASSIS
S17	PLATFORM LEVEL DOWN SOLENOID	CHASSIS
S18	BOOM FUNCTION BYPASS SOLENOID	CHASSIS
S19	CHARGE PUMP BYPASS SOLENOID	CHASSIS
S23	ENGINE RPM SOLENOID	INTERNAL COMBUSTION ENGINE
S24	STARTER SOLENOID	INTERNAL COMBUSTION ENGINE
S26A	FUEL PULL SOLENOID	INTERNAL COMBUSTION ENGINE
S26B	FUEL HOLD SOLENOID	INTERNAL COMBUSTION ENGINE
TB1–TB16	INPUT TERMINALS	GROUND CONTROL STATION
TB21–TB36	OUTPUT TERMINALS	GROUND CONTROL STATION
TB37–TB39	OUTPUT TERMINALS	GROUND CONTROL STATION
TB41–TB54	INPUT TERMINALS	GROUND CONTROL STATION
TB61–TB74	INPUT TERMINALS	GROUND CONTROL STATION
TB75–TB77	OUTPUT TERMINALS	GROUND CONTROL STATION
TB81–TB94	OUTPUT TERMINALS	GROUND CONTROL STATION
TC1–TC8	RELAY COIL TERMINALS	GROUND CONTROL STATION
TCC1–TCC8	RELAY COMMAN CONTACTS TERMINALS	GROUND CONTROL STATION
TLS1	3 DEG. TILT LEVEL INDICATOR (NO) SWITCH	GROUND CONTROL STATION
TNC1–TNC8	RELAY N.C. CONTACTS TERMINALS	GROUND CONTROL STATION
TNO1–TNO8	RELAY N.O. CONTACTS TERMINALS	GROUND CONTROL STATION
TP1–TP32	INPUT/OUTPUT TERMINALS	PLATFORM CONTROL STATION
TS1	ENGINE START/PREHEAT TOGGLE SWITCH	PLATFORM CONTROL STATION
TS3	ENGINE SPEED TOGGLE SWITCH	PLATFORM CONTROL STATION
TS4	BOOM ELEVATE UP/DOWN TOGGLE SWITCH	PLATFORM CONTROL STATION
TS5	BOOM SWING LEFT/RIGHT TOGGLE SWITCH	PLATFORM CONTROL STATION
TS6	BOOM REACH EXTEND/RETRACT TOGGLE SWITCH	PLATFORM CONTROL STATION
TS7	BOOM REACH UP/DOWN TOGGLE SWITCH	PLATFORM CONTROL STATION
TS8	PLATFORM LEVEL UP/DOWN TOGGLE SWITCH	PLATFORM CONTROL STATION
TS9	BOOM ELEVATE UP/DOWN TOGGLE SWITCH	GROUND CONTROL STATION
TS10	BOOM SWING LEFT/RIGHT TOGGLE SWITCH	GROUND CONTROL STATION
TS11	BOOM REACH EXTEND/RETRACT TOGGLE SWITCH	GROUND CONTROL STATION
TS12	BOOM REACH UP/DOWN TOGGLE SWITCH	GROUND CONTROL STATION
TS13	PLATFORM LEVEL UP/DOWN TOGGLE SWITCH	GROUND CONTROL STATION
TS14	ENGINE SPEED TOGGLE SWITCH	GROUND CONTROL STATION
TS15	ENGINE START/PREHEAT TOGGLE SWITCH	GROUND CONTROL STATION
TS18	AUX. CONTROL, ELEV. DOWN/BOOM RETRACT TOGGLE	GROUND CONTROL STATION
TS19	AUX. CONTROL, SWING LEFT/RIGHT TOGGLE SWITCH	GROUND CONTROL STATION
WTS1	WATER TEMP. ENGINE CUTOUT SWITCH	INTERNAL COMBUSTION ENGINE

9. Genie BOOM Z-45/22D and Z-45/22DRT Printed Circuit Boards and Wire Terminal Diagram





10. Genie BOOM Z-45/22D and Z-45/22DRT Wiring Diagram



APPENDICES

6.1 COMPONENT LIST

This section will provide you with a brief description of major Genie BOOM components.

POWER SYSTEM

Component	Description
Engine (GP & RT)	T260 dual fuel, 24 horsepower air cooled with 12 volt 35 amp flywheel alternator.
Engine (D & DRT)	D850 B-2 diesel fueled, 20 horsepower water cooled with 12 volt 37 amp external belt driven alternator.

DRIVE SYSTEM

Component	Description
Drive torque hub	35:1 double planetary drive torque hub
Drive brake	Spring-applied hydraulically released brake
Drive hydraulic motor	2.3 cu. in./rev piston drive.
Steering cylinders	Dual, parallel plumbed, 2 in. (51 mm) bore x 6 in. (152 mm) stroke

DRIVE SYSTEM Continued

Component	Description
Wheel/tire	**GP & D** - 9 x 14.5 in. (229 x 369 mm) 12 ply tubeless pneumatic **RT & DRT** - 31 x 15.5 x 13 in. (787 x 381 x 343 mm) 8 ply, air filled (front), 31 x 15.5 x 15 in. (787 x 394 x 381 mm) 8 ply, air filled (rear)

SWING CHASSIS SYSTEM

Component	Description
Swing torque hub	4.1:1 single planetary torque hub
Swing brake	Spring applied hydraulically released brake
Swing hydraulic motor	16.4 cu. in. (269 cm^3)(internally generated rotor)
Swing chassis bearing	External gear, ball thrust bearing, 18 in. (457 mm) diameter

ELEVATING SYSTEM

Component	Description
Elevate cylinders	Dual, parallel plumbed, 2.5 in. (63 mm) bore x 28 in. (711 mm) stroke
Manifold assembly	Lift cylinder control valve
Pivot bearings	Teflon filled glass composite (no lube)
Pivot pins	Hard chrome plated and ground, high strength steel

REACH SYSTEM

Component	Description
Reach lift cylinder	4 in. (102 mm) bore x 24 in. (610 mm) stroke
Manifold assembly	Lift cylinder control valve
Reach extend cylinder	2.5 in. (63 mm) bore x 105 in. (2.7 m) stroke
Cylinder manifold	Dual overcenter load holding valves, cylinder mounted
Pivot bearings	Teflon filled glass composite (no lube)
Pivot pins	Hard chrome plated and ground, high strength steel

PLATFORM LEVEL SYSTEM

Component	Description
Master cylinder	4 in. (102 mm) bore x 5.63 in. (143 mm) stroke
Slave cylinder	3 in. (76 mm) bore x 9.5 in. (241 mm) stroke
Cylinder manifold	Dual overcenter load holding valves, cylinder mounted

HYDRAULIC SYSTEM

Component	Description
Control valves	12 volts DC, solenoid operated
Hydraulic hose	SAE-100R7, SAE-100R8
Function control assembly	Integrated hydraulic module
Cylinder manifold	Lift cylinder control valve, cylinder mounted

HYDRAULIC SYSTEM Continued

Component	Description
Drive pump	2.8 cu. in./rev, bi-directional, variable displacement, 0-37 gpm, piston pump w/.85 cu. in./rev, fixed displacement, 11 gpm, gerotor pump.
Boom & steer pump	.39 cu. in./rev, single stage, fixed displacement, 5 gpm, gear pump.
Oil filter	Full flow 10 micron return line filter

ELECTRICAL SYSTEM

Component	Description
Drive controller	Variable current pump control joystick with steering rocker switch.
Boom speed controller	Pulse-width modulation, variable current, 130 HZ dither, friction retained knob.
Drive system	Printed circuit board with diode and relay logic board logic, and LED diagnostics
Boom function logic board	Printed circuit board with diode and relay logic, and LED diagnostics
Machine function switches	Single pole double throw toggle, hermetically sealed
Key and master switches	Single switch and contact block actuator assemblies, positive opening contact system
Control cables	Dual 19 conductor 18 gauge vinyl jacketed U.V. protected
Battery	Two (2) 12 volt batteries

CHARGING SYSTEM

Component	Description
Limit switches	Roller arm, sealed housing
Level sensor	Multi-axis tilt sensor, 3.5 degree trip angle with one second time delay
Alternator (GP & RT)	Flywheel mounted, 12 volt, 35 amp.
Alternator (D & DRT)	Belt driven, external mounted, 12 volt, 37 amp

6.2 MANUFACTURERS APPENDICES

This section provides the technical information needed to service major components on the Genie BOOM. It is designed for use in conjunction with section 4.4, Troubleshooting.

Manufacturer	Component
AUSCO	Wheel Drive Brake Swing Brake
BEAM	Carburetor and Regulator/Vaporizor Mixture and RPM Adjustments
ESKRIDGE	Wheel Drive and Swing Brake
FAIRFIELD	Wheel Drive Torque Hub Swing Torque Hub
KUBOTA	Internal Combustion Engine (Diesel)
MICO	Wheel Drive and Swing Brake
NICHOLS	Swing Hydraulic Motor
OEM	Boom Proportional Rotary Switch
ONAN	Internal Combustion Engine (Gas/Liquid Propane)
SUNSTRAND	Drive Hydraulic Pump Drive Hydraulic Wheel Motor Drive Joystick Controller Load Limiter-Anti Stall Electrical Displacement Control (EDC)

AUSCO®

"B" SERIES
FAILSAFE BRAKE

BRAKE ASSEMBLY SUFFIX:
H - HORIZONTAL MOUNT
V - VERTICAL MOUNT

37285 H/V	37305 H/V
37000 H/V	37500 H/V
37030 H/V	37845 H/V
37165 H/V	38125 H/V
	39065 H/V
	39225 H/V

BRAKE FUNCTION

The Failsafe Brake is spring loaded to apply the brake and hydraulic pressure is required to release or "hold off" the brake. Normal operation is to have the brake pressurized in the released position with the vehicle hydraulic system running. Any function which reduces the hydraulic system pressure below the release pressure of the brake, will cause a brake application.

The brake is designed to fit with a gear reducer and a hydraulic motor. The common mounting surfaces of the brake, the motor, and the gear reducer are machined to close tolerances and should be protected from damage during installation and removal.

INSTALLATION INSTRUCTIONS (Ref: Fig. 1)

1. Place the gasket onto the mounting face of the brake.
2. Place the brake shaft into the gear reducer with the brake bleeder screw in the vertical position.
3. Move the brake into position with gear reducer assuring proper gasket location. Align the mounting bolt holes by rotating the engaged brake into position. If this is not possible, the brake may be rotated after pressure has been applied to the brake inlet. This will release the brake and allow it to be rotated into position.
4. Similarly place a gasket onto the flange of the motor.
5. Insert the shaft of the motor into the brake and push into position, assuring proper gasket location.
6. Insert the two half-inch bolts (Grade 5) thru the motor flange, the gasket, the brake, the second gasket, and into the threaded hole in the gear reducer mounting flange. Insure that the bolts are not too long so that they do not bottom out in the reducer before clamping.
7. Run bolts in alternately to prevent binding, until snug. Then torque the bolts to 75-85 lb.ft.
   Note: Both Shafts must slide together freely - DO NOT use bolts to force the units together.
8. With motor and brake bolted into position, remove cap plug and connect "inlet" hydraulic line to brake. (If not done for shaft alignment - Step 3). Brake Inlet is .250 tubing O.D., Straight thread O-ring boss (.438-20, UNF 2B Thd.)
9. Bleed air from brake via bleeder screw.
   Note: Maximum pressure to brake is 3000 psi.

BRAKE DISASSEMBLY PROCEDURE: (Ref: Fig. 2)

1. With shaft protrusion downward, disassemble in the following order:
2. Bolts (21) alternately, Power Plate (20), Gasket (2). Bearing (18) is pressed onto Shaft (7) and must be removed before removal of Rotating Discs (11) and Stationary Discs (12).
3. Further disassembly is not recommended and should not be attempted unless necessary for the replacement of specific parts, i.e., Bearing (3), Seal (4) and Shaft (7) from Housing (1), if necessary proceed as follows:
   A) Remove shaft and stack sub-assembly from housing by lightly tapping or pressing on the small external spline end of the shaft and removing the shaft, bearings and stack from the Housing (1).
   B) Remove Bearing (18), Stationary Disc (12), Rotating Disc (11), Springs (10) and Primary Disc (9).
   C) Remove Bearing (3) from shaft. Use care not to damage the Seal (4). Remove Seal (4) and inspect sealing lip and O.D. for damage. If damaged, replace per reassembly instructions.
   D) Remove Springs (6) and Spring Retainer (5) from Housing (1).
4. Remove the Piston (13) from the Power Plate (20) by introducing low pressure air - 15 psi - into the hydraulic inlet. Make sure piston is directed away from the operator. Remove O-rings (15 & 17), and Back-up Rings (14 & 16) from the piston O.D. and I.D. grooves. Back-up Rings will be damaged and should not be removed if replacement is not planned.
5. Pressure Relief Valve (22) can be removed and inspected to assure spring-loaded ball moves freely and is free of contamination.

BRAKE RE-ASSEMBLY PROCEDURE

1. All parts must be thoroughly clean prior to re-assembly.
2. IMPORTANT: There may be more parts in a service kit than your brake requires. Check parts list carefully for the exact quantity. In the case of springs, space the required quantity equally. See opposite page.
3. Generally use the reverse of the disassembly procedure to re-assemble the brake.
4. Cylinder of the power plate, piston and O-rings must be clean prior to assembly, and pre-lubed with system hydraulic fluid.
5. Assemble Piston (13) into Power Plate (20) using a shop press, being careful not to damage the O-rings or the Teflon backup rings. Visually align the center of the cutouts in Piston (13) with Torque Pin (8) holes in Power Plate (20). Avoid pushing the piston all the way to the bottom of the cylinder in the power plate. Generally, try to keep the top surface of the piston flush to 1/8" below the machined surface of the power plate.
6. When pressing the bearing onto the shaft, press on the inner race of the bearing and support the shaft properly.
7. Rotating discs must be clean and dry. There should be no pressence of oil on any lining material or mating surfaces of the stationary discs. Worn or heavily scored rotating discs must be replaced.
8. Press Bearing (3) into Housing (1). Bearing must be seated against shoulder in housing.
9. Before installing Seal (4), lubricate the lip of the seal with system hydraulic fluid or other suitable lubricant. Use a shop press to install Seal (4). Face the lip of the seal toward the outside of the brake in order to keep the gear box oil or other external contaminants out of the brake.
10. Install Seal (4) into housing by pressing evenly around O.D. of the seal. Use care to avoid cocking. The back of the seal must be installed flush to surface of housing. See Fig. 3.
11. Install Shaft (7) into housing. Support the inner race of Bearing (3) when pressing shaft into bearing.
12. Install Gasket (2). Be sure to properly align. After installing all the remaining internal components of the brake, install Bearing (18). Properly support the shaft when pressing the bearing onto shaft.
13. Install the power plate sub-assembly. Use a shop press to evenly lower plate into position. There should be no gap athe O.D. when the power plate is properly seated against housing. If a shop press is not available, use the Assembly Bolts (21). Tighten sequentially one turn at a time until the power plate is properly seated. Torque to 50-60 lb-ft.
14. If replacement of Pressure Relief Valve (22) is necessary, install 1/2 to 3/4 turns beyond finger tight.

SERVICE KITS

The following kits are available as service items. All other parts may be ordered individually.

	BRAKE ASSEMBLY			
	37285 H/V 37165 H/V 38125 H/V 37000 H/V 37305 H/V 39065 H/V 37030 H/V 37500 H/V 39225 H/V			37845 H/V
O-ring Kit Consists of Items: 2,14,15,16,17	PK 956			PK 956
Stack Kit Consists of Items: 6,8,9,10,11,12	PK 959			PK 979
Bearing Kit Consists of Items: 3,4,18	PK 957			PK 957
Gasket Kit Consists of Item : 24	PK 664			PK 664

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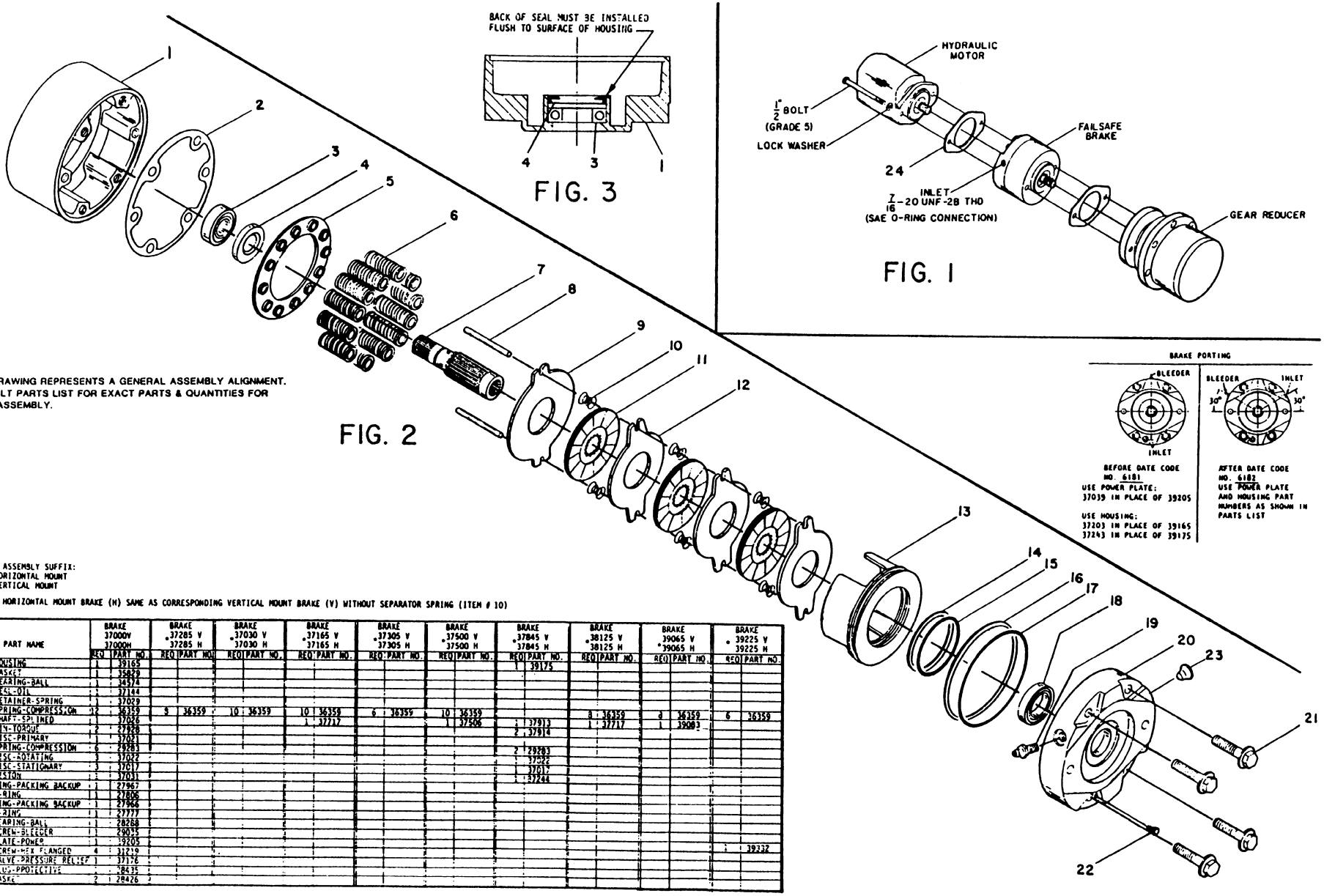


FIG. 2

FIG. 3

FIG. 1

THIS DRAWING REPRESENTS A GENERAL ASSEMBLY ALIGNMENT. CONSULT PARTS LIST FOR EXACT PARTS & QUANTITIES FOR EACH ASSEMBLY.

BRAKE PORTING

BEFORE DATE CODE NO. 6181
USE POWER PLATE: 37039 IN PLACE OF 39205
USE HOUSING: 37203 IN PLACE OF 39165; 37243 IN PLACE OF 39175

AFTER DATE CODE NO. 6182
USE POWER PLATE AND HOUSING PART NUMBERS AS SHOWN IN PARTS LIST

BRAKE ASSEMBLY SUFFIX:
H - HORIZONTAL MOUNT
V - VERTICAL MOUNT

NOTE: HORIZONTAL MOUNT BRAKE (H) SAME AS CORRESPONDING VERTICAL MOUNT BRAKE (V) WITHOUT SEPARATOR SPRING (ITEM # 10)

ITEM	PART NAME	BRAKE 37000V 37000H		BRAKE *37285 V 37285 H		BRAKE 37030 V 37030 H		BRAKE *37165 V 37165 H		BRAKE *37305 V 37305 H		BRAKE 37500 V *37500 H		BRAKE *37845 V 37845 H		BRAKE *38125 V 38125 H		BRAKE 39065 V *39065 H		BRAKE * 39225 V 39225 H	
		REQ	PART NO.	REQ	PART NO.	REQ	PART NO.	REQ	PART NO.	REQ	PART NO.	REQ	PART NO.	REQ	PART NO.	REQ	PART NO.	REQ	PART NO.	REQ	PART NO.
1	HOUSING	1	39165											1	39175						
2	GASKET	1	35829																		
3	BEARING-BALL	1	34574																		
4	SEAL-OIL	1	37144																		
5	RETAINER-SPRING	1	37029																		
6	SPRING-COMPRESSION	12	36359	9	36359	10	36359	10	36358	6	36359	10	36359			8	36359	8	36359	6	36359
7	SHAFT-SPLINED	1	37026					1	37717			1	37506	1	37913	1	37717	1	39083		
8	PIN-TORQUE	2	29828											2	37914						
9	DISC-PRIMARY	1	37021																		
10	SPRING-COMPRESSION	6	29283											2	29283						
11	DISC-ROTATING	3	37022												37026						
12	DISC-STATIONARY	3	37017												37017						
13	PISTON	1	37031											1	37244						
14	RING-PACKING BACKUP	1	27967																		
15	O-RING	1	27805																		
16	RING-PACKING BACKUP	1	27966																		
17	O-RING	1	27777																		
18	BEARING-BALL	1	28268																		
19	SCREW-BLEEDER	1	29055																		
20	PLATE-POWER	1	39205																		
21	SCREW-HEX FLANGED	4	31219																	1	39132
22	VALVE-PRESSURE RELIEF	1	37176																		
23	PLUG-PROTECTIVE		28435																		
24	GASKET	2	28426																		

*ALL ITEMS ARE IDENTICAL TO BRAKE 37000 EXCEPT AS SHOWN

"B" SERIES
FAILSAFE BRAKE
38370 H/V
38455 H/V
38725 H/V
39940 H/V

BRAKE ASSEMBLY SUFFIX:
H - HORIZONTAL MOUNT
V - VERTICAL MOUNT

BRAKE FUNCTION

The Failsafe Brake is spring loaded to apply the brake and hydraulic pressure is required to release or "hold off" the brake. Normal operation is to have the brake pressurized in the released position with the vehicle hydraulic system running. Any function which reduces the hydraulic system pressure below the release pressure of the brake, will cause a brake application.

The brake is designed to fit with a hydraulic motor. The common mounting surfaces of the brake and the motor are machined to close tolerances and should be protected from damage during installation and removal.

CAUTION: Brake Shaft does not have bearings for position and axial location control. Proper axial location of the Brake Shaft is controlled by the mating motor shaft. The motor shaft must be of proper dimension to prevent movement of the Brake Shaft when Brake is installed and in operation. If need for dimension check and verification, contact Ausco Engineering.

INSTALLATION INSTRUCTIONS (Ref. Fig. 1)

1. Place O-ring (26) onto the mounting face of the motor.
2. Place the brake onto the shaft of the motor with the bleeder screw in the vertical position.
3. Move the brake into position with the motor, assuring proper O-ring (26) location. Align the mounting bolt holes by rotating the engaged brake into position. If this is not possible, the brake may be rotated after pressure has been applied to the brake inlet. This will release the brake and allow it to be rotated into position.
4. Insert the two half-inch bolts (Grade 5) thru the brake and into the threaded hole in the motor. Insure that the bolts are not too long so that they do not bottom out before clamping.
5. Run bolts in alternately to prevent binding, until snug. Then torque the bolts to 55-65 LB-FT if plated or lubricated, 75-85 LB-FT if unplated.
6. Note: Both shafts must slide together freely - DO NOT use bolts to force the unit together.
7. With brake bolted into position, remove cap plug and connect "inlet" hydraulic line to brake. (If not done for shaft alignment - Step 3). Brake inlet is .250 tubing OD, straight thread o-ring boss (.438-20, UNF-2B thd.).
8. Bleed air from brake via bleeder screw. Note: Maximum pressure to brake is 3,000 psi.

BRAKE DISASSEMBLY PROCEDURE (Ref. Fig. 2)

1. With shaft end downward, disassemble in the following order:
2. Bolts (1) and Lock Washers (2) alternately.
3. Turn brake over and remove Power Plate (23), Gasket (4), Stationary Discs (14), Springs (12), Rotating Discs (13), Primary Disc (11), Shaft (10), Pins (9), Springs (6 & 7) and Spring Retainer (5).
4. It is not necessary to remove Snap Ring (8) from Shaft (10) unless snap ring is damaged.
5. Remove the Piston (15) from the Power Plate (23) by introducing low pressure air - 15 psi - into the hydraulic inlet and make sure piston is directed away from the operator. Remove O-rings (17 & 19) and Backup Rings (16 & 18) from the piston OD and ID grooves. Backup rings will be damaged and should not be removed if replacement is not planned.
6. Pressure Relief Valve (24) can be removed and inspected to assure spring-loaded ball moves freely and is free of contamination.

ASSEMBLY PROCEDURE

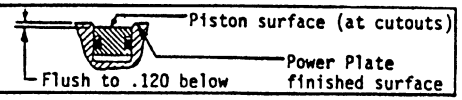
IMPORTANT: There may be more parts in a service kit than your brake requires. Check the parts list carefully for the exact quantity. In the case of springs, space the required quantity equally.

All parts must be thoroughly clean prior to reassembly.

Use the reverse of the disassembly procedure with the following notes and additions:

1. Worn O-rings and damaged or worn teflon backup rings must be replaced prior to reassembly.
2. Cylinder of the power plate, piston and o-rings must be clean prior to assembly and pre-lubed with the system hydraulic fluid.
3. If replacement of Pressure Relief Valve (24) is necessary, install 1/2 to 3/4 turns beyond finger tight.
4. Assemble Piston (15) into Power Plate (23) using a shop press, being careful not to damage the o-rings or teflon backup rings. Visually align the center of the cut-outs in the piston with the Torque Pin (9) holes in the Power Plate (23).

Depth of piston installation into the power plate is critical. DO NOT exceed .120 depth or piston will cock, resulting in a complete loss of braking.



5. If Snap Ring (8) was removed from Shaft (10), install snap ring onto shaft.
6. Rotating discs must be clean and dry. There should be no presence of oil on any lining material or mating surfaces of the stationary discs.
7. Install Bolts (1) thru Lock Washers (2) into Housing (3). Tighten sequentially, one turn at a time, until Power Plate (23) is properly seated. Torque to 55-65 lb ft.

SERVICE KITS

The following kits are available as service items. All other parts may be ordered individually.

	BRAKE ASSEMBLY		
	38370 H/V	38455 H/V 38725 H/V	39940 H/V
O-ring Kit Consists of: Items 4, 16, 17, 18, 19 and 26	PK 956	PK 956	PK 956
Stack Kit Consists of: Items 6, 7, 8, 9, 11, 12, 13 and 14	PK 1014	PK 1015	PK 1140
Gasket Kit Consists of: Item 25	PK 815	PK 815	PK 815

F38805
N0V-87

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St. Joseph, Michigan 49085 • Phone 616/983-2373

Printed in U.S.A.

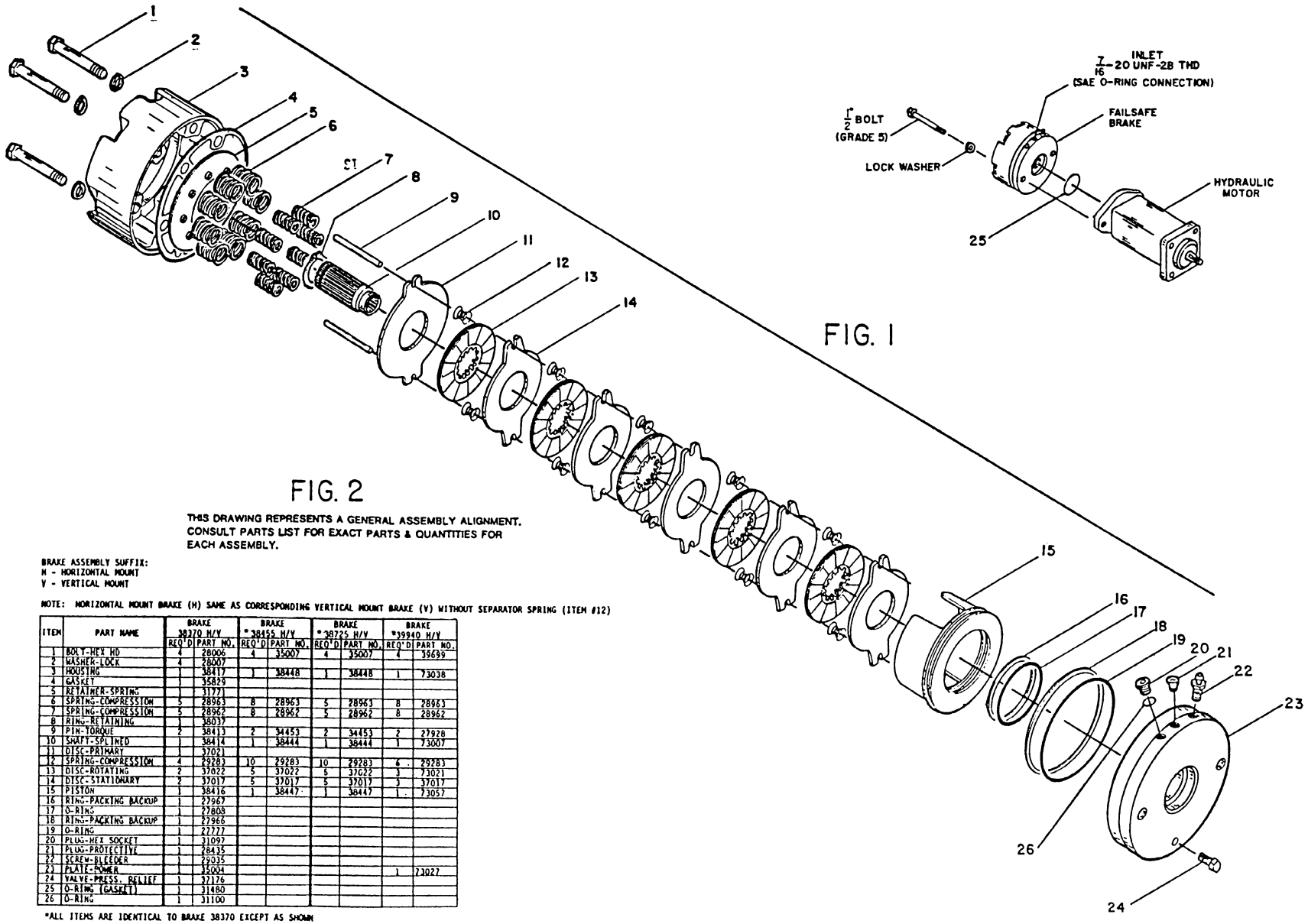


FIG. 1

FIG. 2

THIS DRAWING REPRESENTS A GENERAL ASSEMBLY ALIGNMENT. CONSULT PARTS LIST FOR EXACT PARTS & QUANTITIES FOR EACH ASSEMBLY.

BRAKE ASSEMBLY SUFFIX:
H - HORIZONTAL MOUNT
V - VERTICAL MOUNT

NOTE: HORIZONTAL MOUNT BRAKE (H) SAME AS CORRESPONDING VERTICAL MOUNT BRAKE (V) WITHOUT SEPARATOR SPRING (ITEM #12)

ITEM	PART NAME	BRAKE 38370 H/V		BRAKE *38455 H/V		BRAKE *38725 H/V		BRAKE *39940 H/V	
		REQ'D	PART NO.	REQ'D	PART NO.	REQ'D	PART NO.	REQ'D	PART NO.
1	BOLT-HEX HD	4	28006	4	35007	4	35007	4	39699
2	WASHER-LOCK	4	28007						
3	HOUSING	1	38417	1	38448	1	38448	1	73038
4	GASKET	1	35828						
5	RETAINER-SPRING	1	31771						
6	SPRING-COMPRESSION	5	28963	8	28963	5	28963	8	28963
7	SPRING-COMPRESSION	5	28962	8	28962	5	28962	8	28962
8	RING-RETAINING	1	38037						
9	PIN-TORQUE	2	38413	2	34453	2	34453	2	27928
10	SHAFT-SPLINED	1	38414	1	38444	1	38444	1	73007
11	DISC-PRIMARY	1	37021						
12	SPRING-COMPRESSION	4	29283	10	29283	10	29283	6	29283
13	DISC-ROTATING	2	37022	5	37022	5	37022	3	73021
14	DISC-STATIONARY	2	37017	5	37017	5	37017	3	37017
15	PISTON	1	38416	1	38447	1	38447	1	73057
16	RING-PACKING BACKUP	1	27967						
17	O-RING	1	27808						
18	RING-PACKING BACKUP	1	27966						
19	O-RING	1	27777						
20	PLUG-HEX SOCKET	1	31097						
21	PLUG-PROTECTIVE	1	28435						
22	SCREW-BLEEDER	1	29035						
23	PLATE-POWER	1	35004					1	73027
24	VALVE-PRESS. RELIEF	1	37176						
25	O-RING (GASKET)	1	31480						
26	O-RING	1	31100						

*ALL ITEMS ARE IDENTICAL TO BRAKE 38370 EXCEPT AS SHOWN

BEAM/ONAN

Carburetor and Regulator/Vaporizer Mixture and RPM Adjustments

1. Attach a tachometer to the engine.

2. With the FUEL SELECT toggle switch in the Gas position, START the engine. Using the carburetor idle screw set low, idle at 1800 RPM.

3. With the engine RPM toggle switch in the High position, use the engine governor to set engine high RPM at 3000.

4. Switch the FUEL SELECT toggle switch to the Off position and let the engine stop.

5. Switch the FUEL SELECT toggle switch to the LP position and operate START function. If the engine doesn't start, slowly turn the low idle screw on the regulator/vaporizer clockwise or counterclockwise while cranking until engine starts.

6. Regulator/vaporizer main jet adjustment.

   With the engine running operate the REACH Retract function. This will place the engine under a load and on high RPM.

   Turn the regulator/vaporizer main jet clockwise until the engine hesitates, then turn the main jet counterclockwise until engine operation returns to maximum high RPM.

7. Regulator/vaporizer low idle screw adjustment.

   With the engine running and on low idle, turn the regulator/vaporizer low idle screw counterclockwise until engine RPM drops. Then turn the low idle screw clockwise until low idle returns to maximum low idle RPM.

THE ESKRIDGE BRAKE
Model 90B (90 Series/SAE 'B' Output)

The 90B Eskridge brake is manufactured for two specific types of holding torque requirements, the standard "fail-safe" requirement and the "slip protection" requirement. Both types are spring loaded (normally applied) with a hydraulic pressure required for release.

All brakes are individually tested at the factory for function, leaks and static breakaway torque. Fail-safe type brakes are tested to be assured they are in excess of 110% of the Fail-safe torque rating for the unit. A fail-safe brake should be used when the only requirement is a minimum static holding torque.

A slip protection brake should be used where an accurate specified torque is required, such as a side load protection on a crane or a overload protection in a drivetrain. These brakes are tested to be within +\- 10% of the slip protection rating for the unit.

Of course, temperature, wear and contamination of the friction surfaces may affect the performance of the brake and should be taken into consideration when specifying a required torque rating. Care should be taken to avoid damaging the splines or mounting surfaces during installation.

INSTALLATION INSTRUCTIONS:

1. Mount 90B BRAKE with two 1/2-13 capscrews through brake mounting flange and gasket holes. Torque bolts to 75 ft.-lbs. On horizontal shaft mountings, one o-ring port should be oriented as close to top as practical (bleeder port). Some installations may require that brake be "released" so it can be rotated to align bolt holes (see Step 4 of installation instructions).

2. Attach motor to input end of brake with appropriate sized bolts through motor flange and gasket to give approximately 1/2" thread engagement. Torque 1/2" bolts to 75 ft.-lbs.

3. Remove plastic protective plug from pressure port of brake and attach a pressure line with 7/16-20 UNF-2B straight thread o-ring fitting.

4. Apply low pressure (20-30 psi) to brake release port. Loosen Hollow Hex Plug, opposite of pressure port, just enough to allow hydraulic fluid to bleed from cavity. After air has been bled from brake, tighten plug.

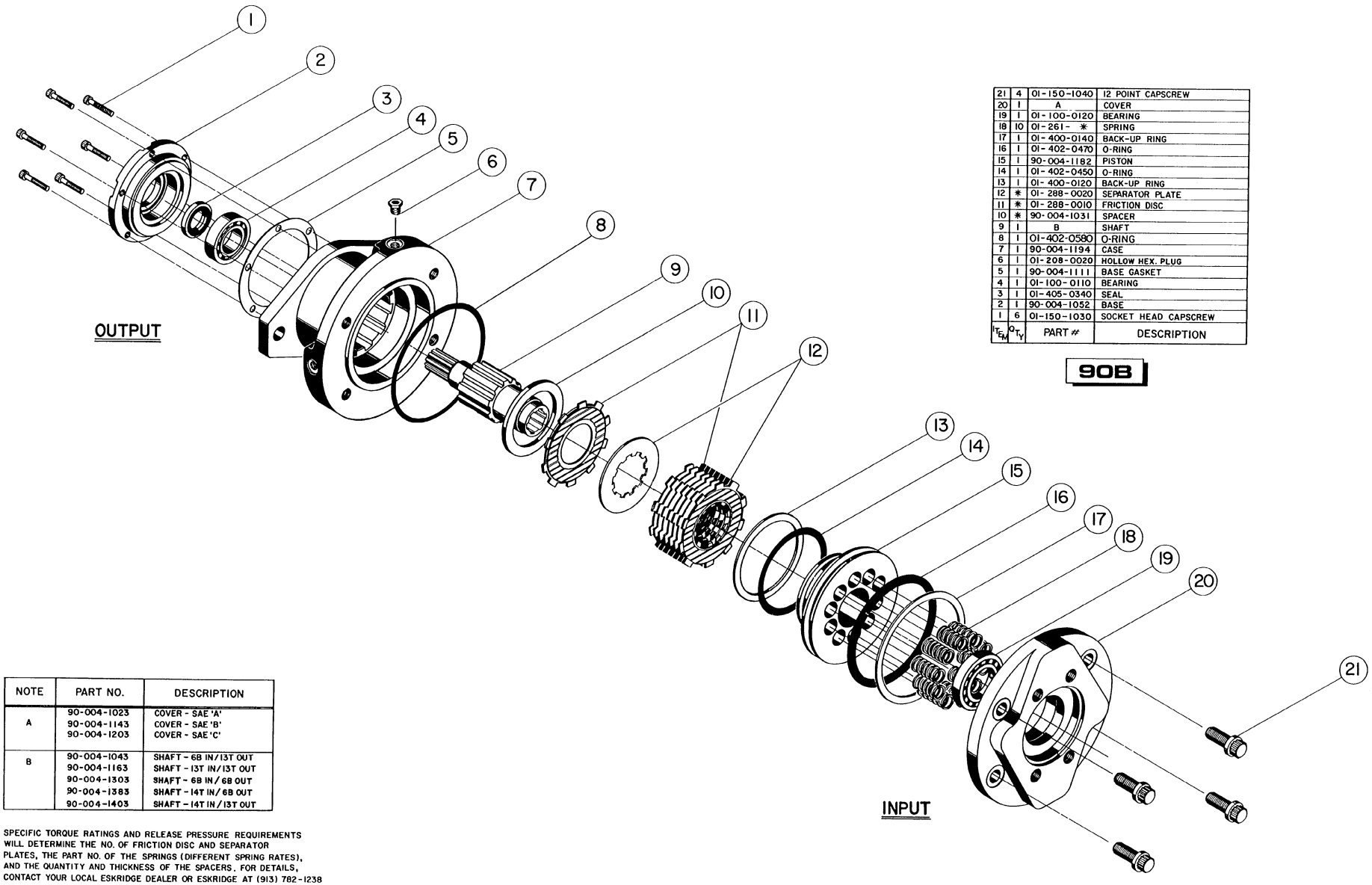
DISASSEMBLY PROCEDURE:

1. Remove motor from brake.

2. Loosen four 1/2-13 12-Point Capscrews (21). Alternately unscrew capscrews 1/2 turn at a time until all internal spring force is relieved. Remove cover (20).

   Caution: Do not clamp or otherwise restrain cover while removing cover bolts (21) since the brake is under high compressive spring load.

3. Apply low air pressure (20-30 psi) to brake release port while holding one hand on top of piston (15) and springs (18). The air will force piston out of case (7).



ITEM	QTY	PART #	DESCRIPTION
21	4	01-150-1040	12 POINT CAPSCREW
20	1	A	COVER
19	1	01-100-0120	BEARING
18	10	01-261- *	SPRING
17	1	01-400-0140	BACK-UP RING
16	1	01-402-0470	O-RING
15	1	90-004-1182	PISTON
14	1	01-402-0450	O-RING
13	1	01-400-0120	BACK-UP RING
12	*	01-288-0020	SEPARATOR PLATE
11	*	01-288-0010	FRICTION DISC
10	*	90-004-1031	SPACER
9	1	B	SHAFT
8	1	01-402-0580	O-RING
7	1	90-004-1194	CASE
6	1	01-208-0020	HOLLOW HEX. PLUG
5	1	90-004-1111	BASE GASKET
4	1	01-100-0110	BEARING
3	1	01-405-0340	SEAL
2	1	90-004-1052	BASE
1	6	01-150-1030	SOCKET HEAD CAPSCREW

90B

NOTE	PART NO.	DESCRIPTION
A	90-004-1023	COVER - SAE 'A'
	90-004-1143	COVER - SAE 'B'
	90-004-1203	COVER - SAE 'C'
B	90-004-1043	SHAFT - 6B IN/13T OUT
	90-004-1163	SHAFT - 13T IN/13T OUT
	90-004-1303	SHAFT - 6B IN/6B OUT
	90-004-1383	SHAFT - 14T IN/6B OUT
	90-004-1403	SHAFT - 14T IN/13T OUT

* SPECIFIC TORQUE RATINGS AND RELEASE PRESSURE REQUIREMENTS WILL DETERMINE THE NO. OF FRICTION DISC AND SEPARATOR PLATES, THE PART NO. OF THE SPRINGS (DIFFERENT SPRING RATES), AND THE QUANTITY AND THICKNESS OF THE SPACERS. FOR DETAILS, CONTACT YOUR LOCAL ESKRIDGE DEALER OR ESKRIDGE AT (913) 782-1238

4. Remove shaft (9).

5. Friction discs (11), separator plates (12) and spacers (10) will vary, depending on brake specifications. Brake specifications requiring a full complement of friction discs (qty=8) and separator plates (qty=7) will not include any spacers.

ALTERNATE DISASSEMBLY PROCEDURE:

1. To replace bearing (4), base gasket (5), or seal (3), it is not necessary to remove cover. Invert brake and remove six 3/8-16 base bolts (1). Remove base (2). Base gasket (5), bearing (4), or seal (3) may now be removed if needed. When reassembling, torque 3/8-16 capscrews (1) to 32 ft.-lbs.

   NOTE: Loss of fluid media may occur through input area when inverting brake to remove base (2). Bolt motor or install plastic protective plug (used during shipping) to brake input to prevent any loss of fluid. If fluid is lost during this disassembly procedure, additional fluid must be added to brake before operation. To add fluid media*, fully reassemble brake and position with input facing upward. Remove cover and piston (DISASSEMBLY PROCEDURE Steps 2 and 3). Pour fluid over friction plates until fluid level is even with top friction disc (11). Reassemble brake.

ASSEMBLY PROCEDURE:

Assembly should be in reverse order of disassembly with the following additional instructions.

1. With base (2) already bolted to case (7), install shaft (9). Push shaft downward through bearing (4) and seal (3) until bearing shoulder on shaft is seated against bearing.

2. Friction pack (spacer #10, friction disc #11, and separator plates #12) must be installed in exactly the same order as it was removed. There must always be a stator (friction disc #11) on top and bottom ends of stack of plates. If a separator plates (12) is placed next to the piston (15) or spacer (10) the unit will overhead and seize up. Be careful not to contaminate the friction surfaces with dirt, grease or fluid media* other than what is specified for your particular brake.

   Note: If installing new friction discs (11), soak all discs in specified fluid media* for approximately 10 minutes before installation.

3. Pour fluid media* over the friction plates or until the fluid level is even with top friction disc (11).

4. If replacing piston o-rings (14, 16), be sure o-rings are nearest each other with backup rings (13, 17) to the outside after installing onto piston. Gently slide piston (15) into case (7) until larger o-ring (16) touches case. Press down firmly on piston using heel of both hands. This will squeeze o-rings into case and set piston against friction plates.

5. Insert springs (18) into piston (15).

6. Install cover o-ring (8) around lip on case (7).

7. Set cover (20) on top of piston springs (18) over input end of shaft (9). Bearing (19) should start onto shaft before cover touches springs. Start four cover bolts (21) through cover and into case with your fingers. Alternately tighten cover bolts 1/2 turn at a time until cover is tight against case. Torque bolts (21) to 110 ft.-lbs.

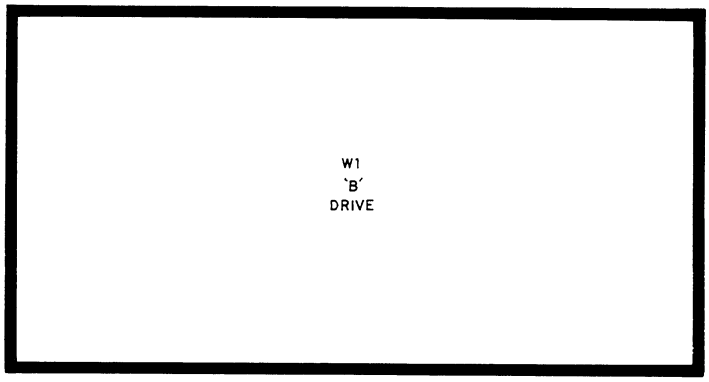
* Unless otherwise specified, Series 90 brakes use automatic transmission fluid (ATF-TYPE F) as a fluid media. ATF-Dexron will give somewhat different torque characteristics. Some brakes are specifically designed to use hydraulic oil, gear lube or other fluid media.

NOTES:

1. Maximum operating pressure is 3,000 psi. Operation above this pressure is detrimental to the lift of the brake and could be dangerous.

Torque-Hub® Final Drives

Service Manual



Fairfield Manufacturing Company, Inc.
South Concord Road, Lafayette, Indiana 47902, U.S.A. 317/474-3474

Fairfield

THE DRIVE PEOPLE

Introduction

This Service Manual is a step-by-step guide designed for the customer or shop mechanic who is servicing or repairing a particular model of Torque-Hub Final Drive. (The model covered by this copy of the Manual is specified on the Manual cover.)

Included are —

1. assembly and exploded view drawings
2. disassembly procedure
3. main assembly procedure (assuming all sub-assemblies to be intact)
4. sub-assembly procedures.

At the time of printing, this Manual was complete for the specific Torque-Hub model designated. However, Fairfield Manufacturing Co., Inc., reserves the right to update and improve its products at any time. All specifications and procedures are therefore subject to change without notice.

Safety

Standard safety practices should be followed during the disassembly and assembly procedures described. Safety glasses and safety shoes should be worn; heavy, heat resistant gloves should be used when heated components are handled. Be especially alert when you see a caution symbol (⚠). This symbol indicates that a particular operation could cause personal injury if not performed properly or if certain safety procedures are not followed.

W1A-W1B
Disassembly Procedure

1. Loosen all 16 Cover Bolts and drain the oil from the unit.

2. Remove the 16 Cover Bolts and lift off the Cover Sub-Assembly. Discard the 'O' ring Seal from the Cover counterbore.

3. Lift out the Carrier Sub-Assembly and the top Thrust Washer. The Thrust Washer may stick inside the Cover.

4. Pry the Ring Gear loose and remove it. Discard the 'O' ring Seal from the Hub counterbore.

5. Remove the Input Shaft, Input Gear, and the Thrust Spacers that are on the Input Shaft.

6. Lift out the Internal Gear and Thrust Washer. The Thrust Washer may stick to the bottom of the Carrier.

7. Remove the Retaining Ring from the Spindle and discard; then lift the hub off the Spindle.

8. The inside Bearing Cone and the Bearing Shim can now be removed.

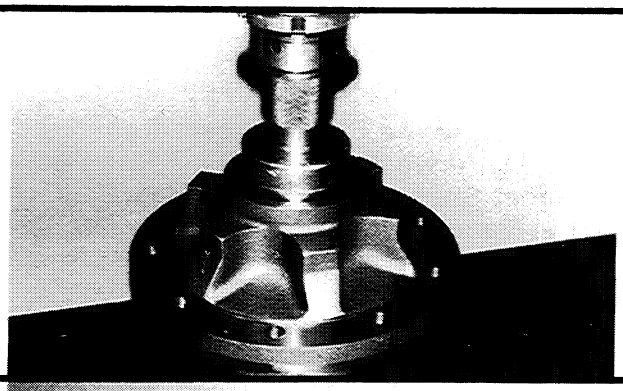
9. The Seal can be pried out of the Hub with a screw driver or pry bar. This will also allow the outside Bearing to be removed.

   Note: If bearing replacement is necessary, the Bearing Cups can be removed with a "slide hammer puller" or driven out with a punch.

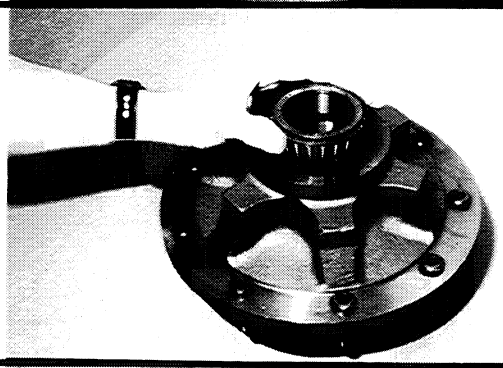
10. To remove the Cluster Gears from the Carrier, drive the anti-roll pin into the Planet Shaft of the Cluster Gear. After the Planet Shaft is removed the roll pin should be driven out of the Planet Shaft.

WARNING: When rebuilding the unit, the 'O' rings and Retaining Rings should <u>always</u> be replaced.

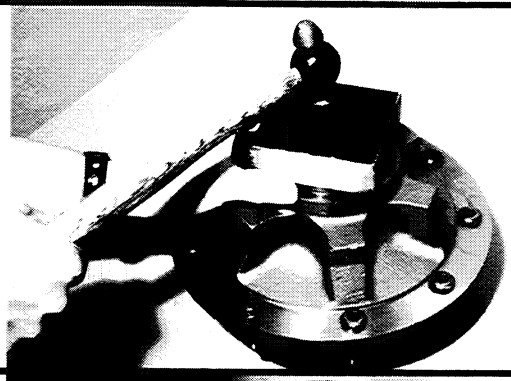
Main Assembly Procedure



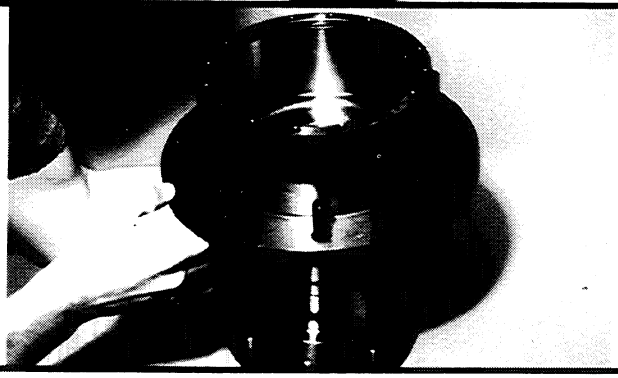
1. Using an arbor type press if available, press Bearing Cups with large inside diameters facing out, into Hub counterbores. Cup #JLM506810 will go into small end of Hub, and Cup #JM205110 will go into large end of Hub. If Studs are being used, they can be pressed in at this time. Solid support must be used in this operation.



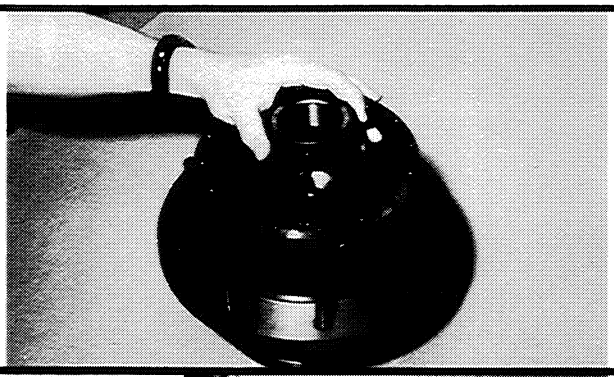
2. Place Bearing cone #JLM506849 into Bearing Cup in small end of Hub.



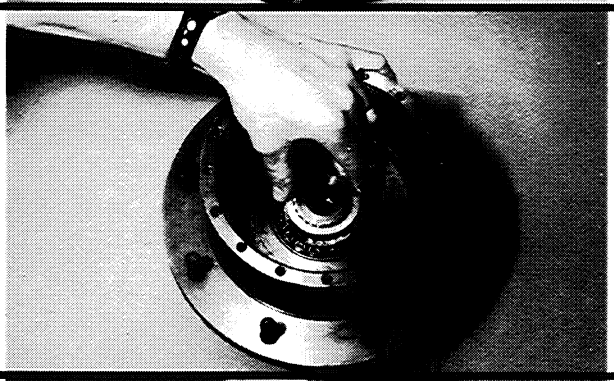
3. Press Seal into Hub counterbore with flat metal side facing in. Use a flat object to assure that Seal is pressed evenly and is flush with Hub face.



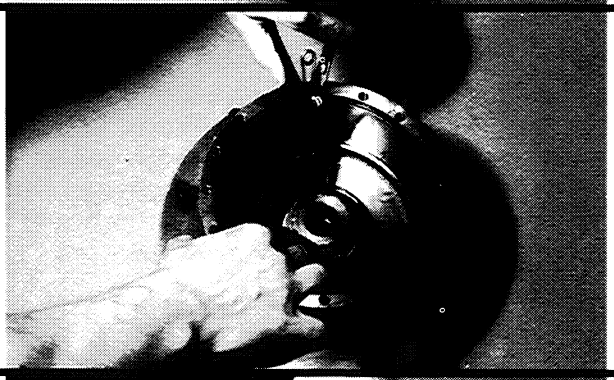
4. Lower Hub onto Spindle with large open end up.



5. Place Bearing Cone #JM205149 over end of Spindle and into Bearing cup.

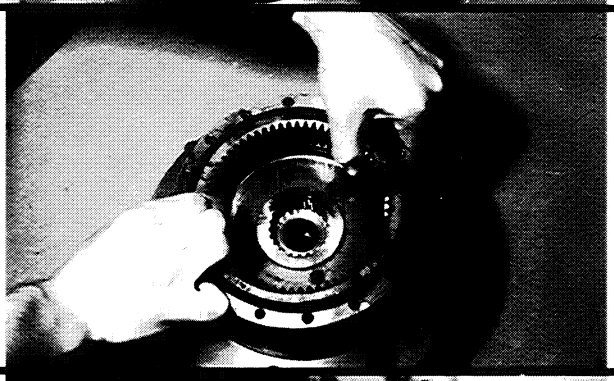


6. Place Bearing Shim over end of Spindle and against Bearing Cone.

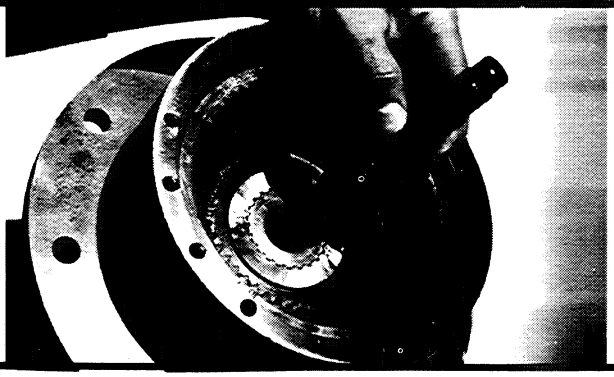


7. Secure Retaining Ring completely into Spindle groove and against Bearing Shim. Be sure that Retaining Ring is entirely in groove.

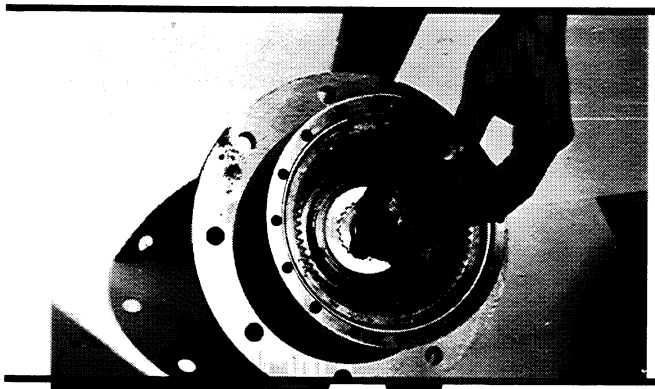
   ⚠ Eye protection should be worn during Retaining Ring installation.



8. Place Internal Gear onto end of Spindle.



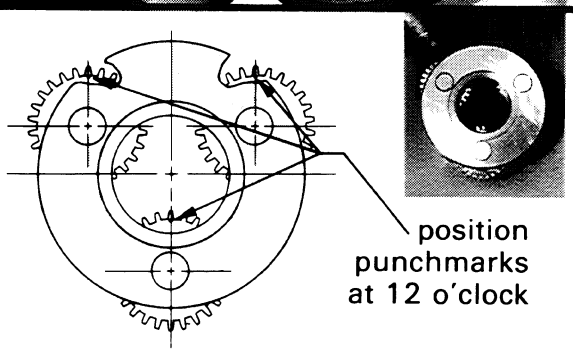
9. Place Input Shaft Assembly into Spindle bore with unsplined end facing out.



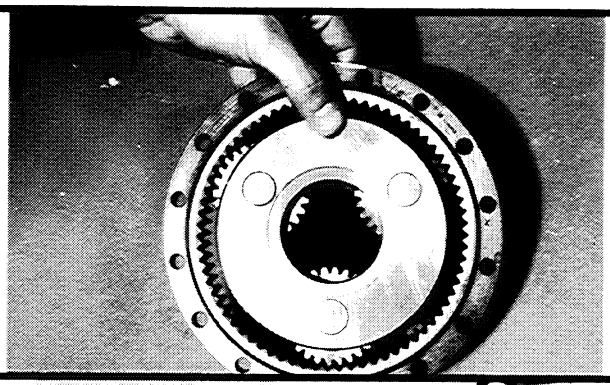
10. Place narrow Thrust Spacer over Input Shaft with counterbore side facing Spindle.



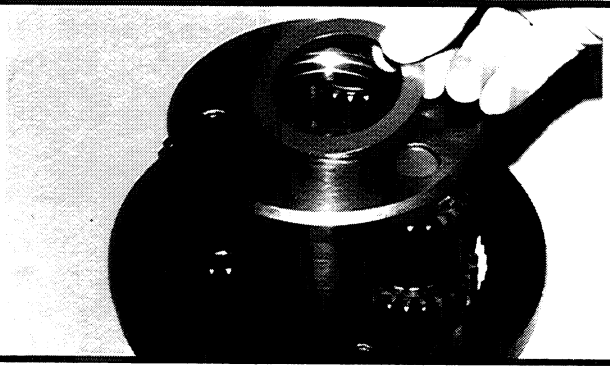
11. Place 'O' Ring into Hub counterbore. Use petroleum jelly or grease to hold 'O' Ring in place. Slight stretching of the 'O' Ring may be necessary to insure proper seating.



12. Place Carrier Assembly on a flat surface with the large gears up and positioned as shown. Find the punch marked tooth on each large gear and locate at 12 o'clock (straight-up) from each planet pin. Marked tooth will be located just under the Carrier on upper two gears.



13. With shoulder side of Ring Gear facing down, place Ring Gear over (into mesh with) large gears. Be sure that punch marks remain in correct location during Ring Gear installation.

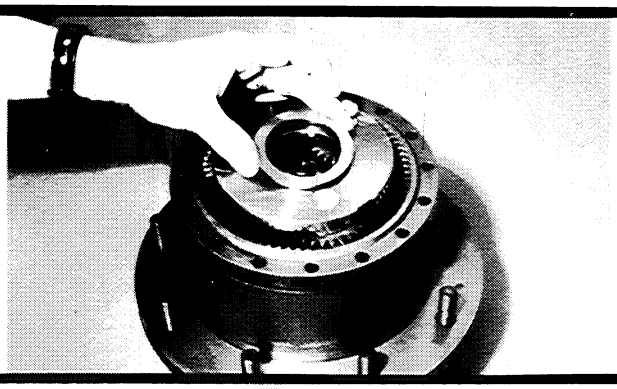


14. Turn over Carrier Assembly and Ring Gear while keeping gears in mesh. Place Thrust Washer into Carrier counterbore. Use petroleum jelly or grease to hold washer in place.



15. While holding Ring Gear, Input Gear and Cluster Gears in mesh, place small side of Cluster Gears into mesh with the Internal Gear. On the Ring Gear locate the hole marked "X" over one of the counterbored holes in Hub. Mark these holes on outside diameter for later use.

Note: If gears do not mesh easily or Carrier Assembly does not rotate freely, then remove the Carrier and Ring Gear and check the Cluster Gear timing.

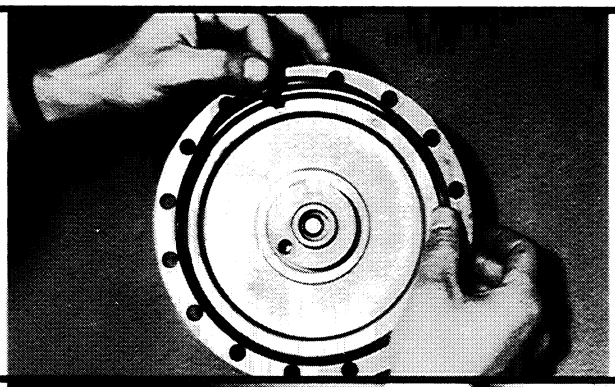


16. Place Thrust Washer into Carrier counterbore.

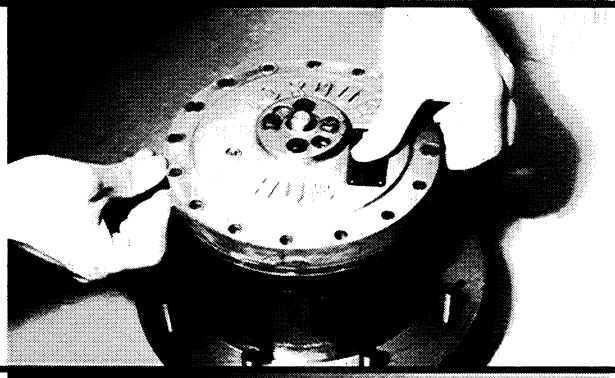


17. The Input Gear is now installed into the carrier meshing with the large diameter cluster gear. The counterbore in the bore of the Input Gear must be to the inside of this assembly.





19. Place 'O' Ring into Cover Assembly counterbore. Use petroleum jelly or grease to hold 'O' Ring in place.



20. Place Cover Assembly over Ring Gear with oil level check plug in Cover located approximately 90° from oil fill plug in Hub.



21. Locate four Shoulder Bolts with flat washers, 90° apart into counterbored holes in Hub marked in step 16. Torque Shoulder Bolts to 23-27 ft. lbs.



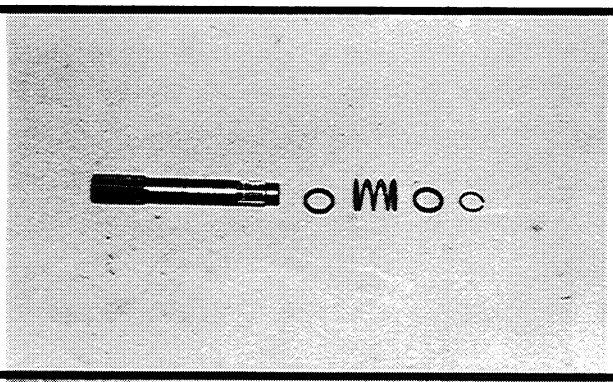
22. Use standard grade 8-5/16-18x2¼ bolts with flat washers in remaining holes. Torque to 23-27 ft. lbs.



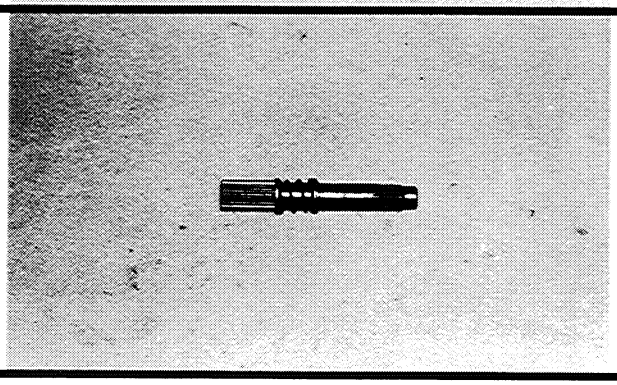
23. Place Coupling into Spindle and onto Input Shaft.

This completes the Torque-Hub Assembly. The unit must be filled one-half full of EP90 lubricant before operation.

Assembly Procedure
For Sub-Assemblies
Input Shaft Sub-Assembly



1. Place Washer, Spring and Washer, in that order, onto Input Shaft.



2. Install Retaining Ring into Input Shaft groove to secure Spacers and Spring to shaft.

   ⚠ Eye protection should be worn during Retaining Ring installation.

Carrier Sub-Assembly



1. Apply a coat of grease or petroleum jelly to Cluster Gear bore.



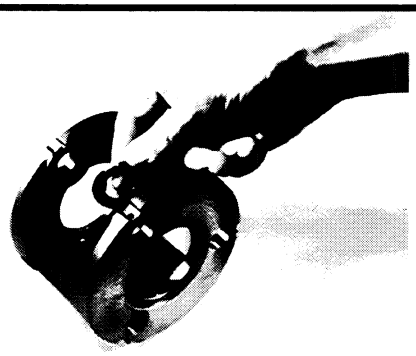
2. Place sixteen Needle Rollers into Cluster Gear bore.



3. Place Spacer washer into opposite side of Cluster Gear and against Needle Rollers.

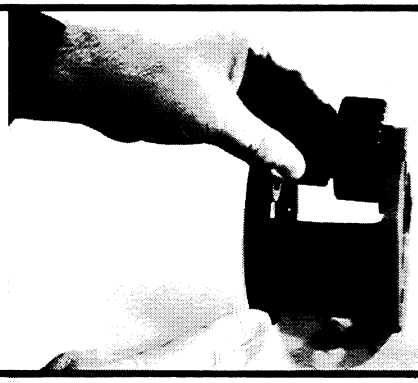


4. Place second set of sixteen Needle Rollers into Cluster Gear.

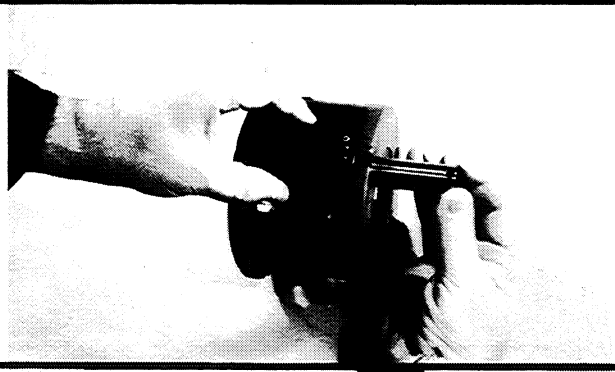


5. Apply grease or petroleum jelly to the tang side of two Thrust Washers. Place Thrust Washers against bosses in Carrier with washer tang fitting into slot in Carrier outside diameter.

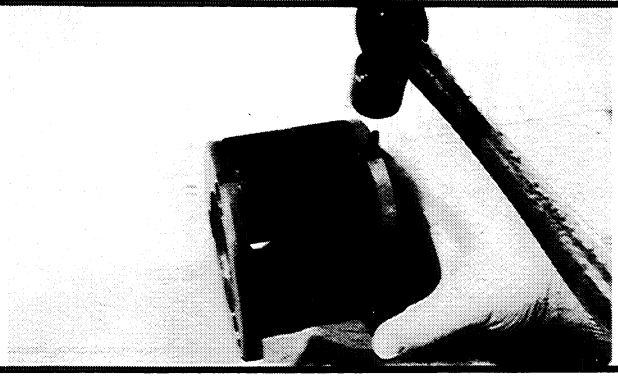
   Note: Some old style Carriers will not have slots and tangs should be located inside boss relief.



6. While keeping Thrust Washers in place, slide Cluster Gear into Carrier with the larger gear on the side with the small pin hole.



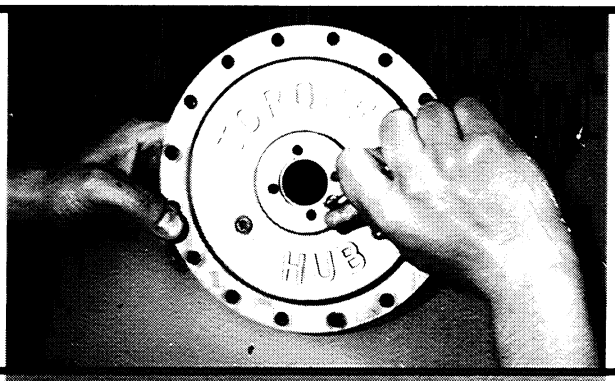
7. Line up Cluster Gear and thrust Washers with hole in Carrier and slide Planet Shaft through. Line up chamfered side of hole in Planet Shaft with pin hole in Carrier.



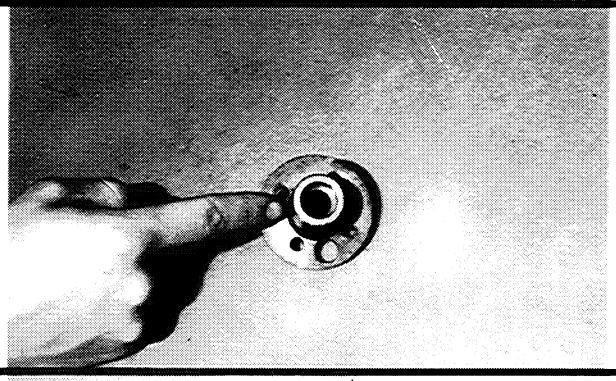
8. Drive Anti-Roll Pin flush into Carrier hole, thereby locking Planet Shaft into place.

   Repeat these steps for remaining two Cluster Gears to complete Carrier Sub Assembly.

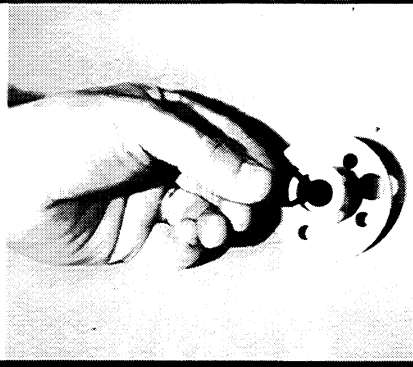
Cover Sub-Assembly



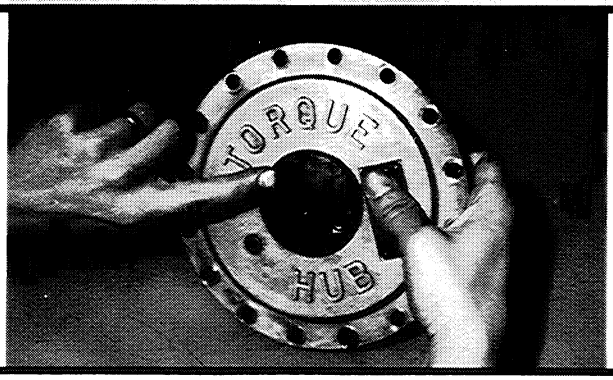
1. Screw Pipe Plug into Cover.



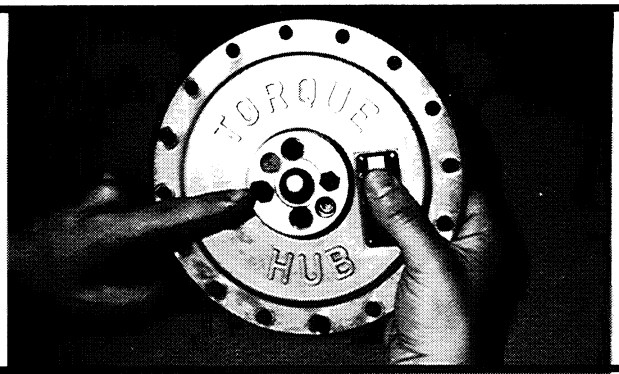
2. Slip 'O' Ring over Cover Cap and against face.



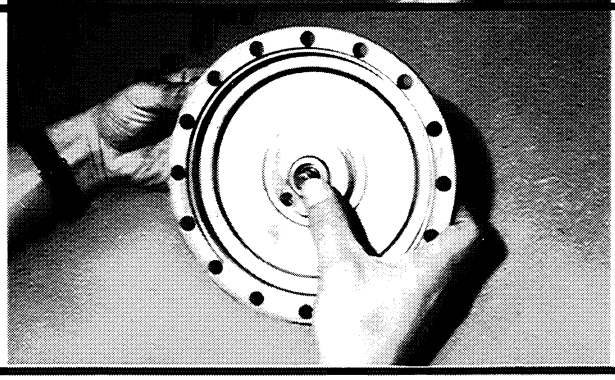
3. Place 'O' Ring into Cover Cap internal groove. The Disconnect Rod may be used to push 'O' Ring into groove.



4. Place Cover Cap into Cover with large hole located over Pipe Plug. Secure Cover Cap to Cover with two ¼-20x¾ bolts. Torque bolts to 70-80 in. lbs.

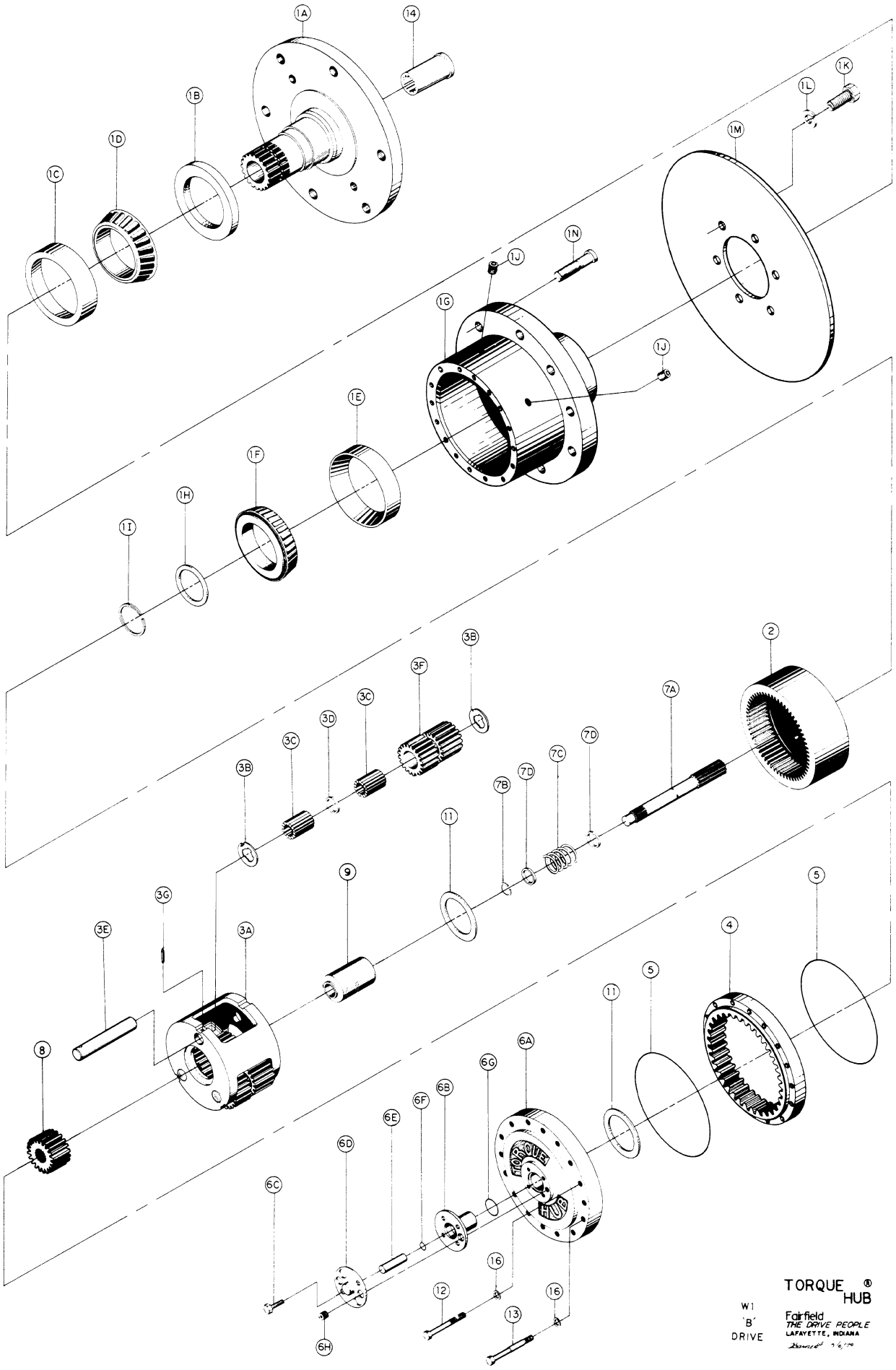


5. Place Disconnect Cap over Cover Cap with nipple facing out. Secure Disconnect Cap to Cover with two ¼-20x¾ bolts. Torque bolts 70-80 in. lbs.



6. Turn Cover over and push Disconnect Rod into Cover Cap. Rod will be held in place by friction from the 'O' Ring.

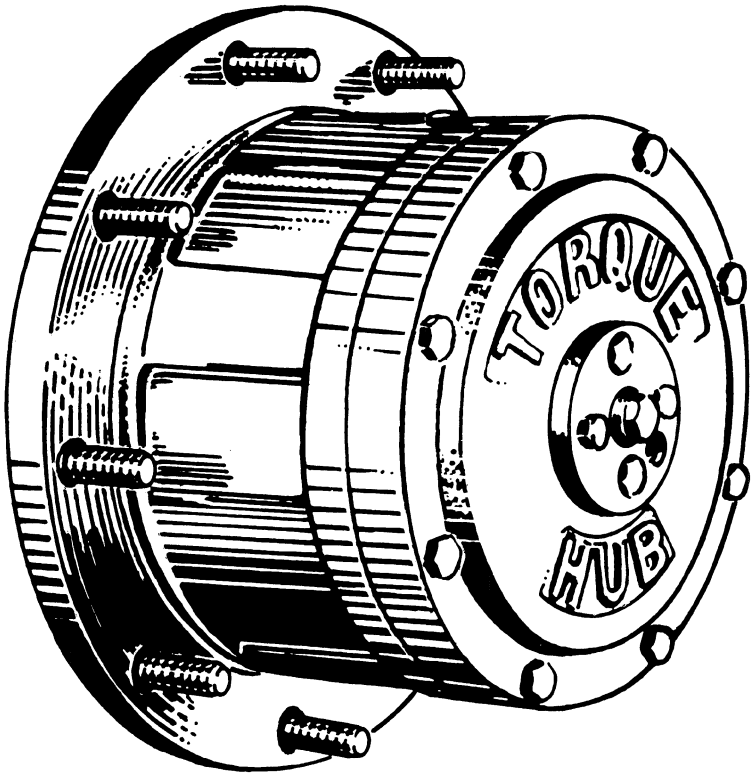
Cover Sub-Assembly



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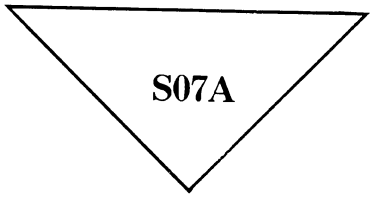
THE DRIVE PEOPLE

TORQUE-HUB®

Final Drives

ASSEMBLY-DISASSEMBLY MANUAL

FOR THE



UNIT

Fairfield Manufacturing Company Inc.

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INTRODUCTION

This manual is a step-by-step guide to assembly and disassembly of torque-hub units. It is designed for the customer or shop mechanic who is repairing a particular model of torque-hub final drive. Users of this manual should note that each part mentioned is followed by an indentification number enclosed in parentheses. These part numbers may be referred to in the Parts List section of this manual and on the cross-sectional view of this unit. A print of each tool discussed in this manual is shown in the Tooling section. Users should familiarize themselves with the procedures for roll and leak testing and bolt tightening and torquing found on the following two pages before getting started.

SAFETY

Standard safety practices should be followed during the disassembly and assembly procedures described. Safety glasses and safety shoes should be worn. Heavy, heat resistant gloves should be used when heated components are handled. Be especially alert when you see the word CAUTION. This indicates that a particular operation could cause personal injury if not performed properly or if certain safety procedures are not followed.

ROLL and LEAK TESTING

Torque-hub units should always be roll and leak tested before disassembly and after assembly to make sure that the unit's gears and sealants are working properly. The following information briefly outlines what to look for when performing these tests.

THE ROLL TEST

The purpose of a roll test is to determine if the unit's gears are rotating freely and properly. You should be able to rotate the gears in your unit by applying a constant force to the roll checker. If you feel more drag in the gears only at certain points, then the gears are not rolling freely and should be examined for proper installation or defects. Some gear packages roll with more difficulty than others. Do not be concerned if the gears in your unit seem to roll hard as long as they roll with consistency.

THE LEAK TEST

The purpose of a leak test is to make sure the unit is air tight. You can tell if your unit has a leak if the pressure gauge reading on your air checker starts to fall once the unit has been pressurized. Leaks will most likely occur at the main seal or wherever "O" rings or gaskits are located. The exact location of a leak can usually be detected by brushing a soap and water solution around the main seal and where "O" rings or gaskits meet the exterior of the unit then checking for air bubbles. If a leak is detected in a seal, "O" ring, or gaskit, the part must be replaced.

TIGHTENING and TORQUING BOLTS

If an air impact wrench is used to tighten bolts, extreme care should be taken to insure that the bolts are not tightened beyond their indicated torque specification. Never use an impact wrench to tighten shoulder bolts, all shoulder bolts should be tightened by hand.

The following steps describe the proper procedure for tightening and torquing bolts or socket head cap screws in a bolt circle.

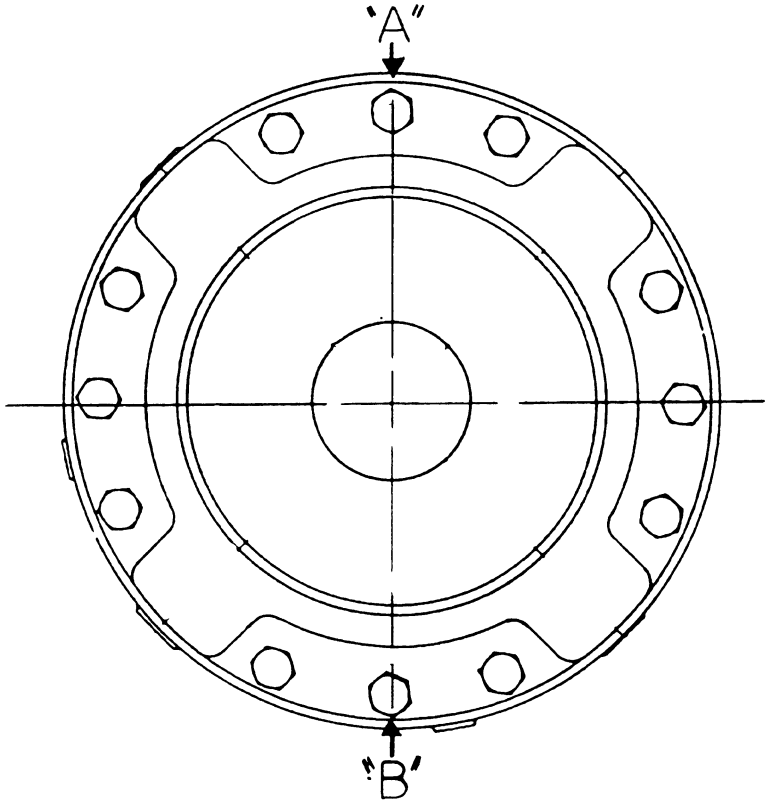
1. Tighten (but do not torque) bolt "A" until snug.

2. Go to the opposite side of the bolt circle and tighten bolt "B" until equally snug.

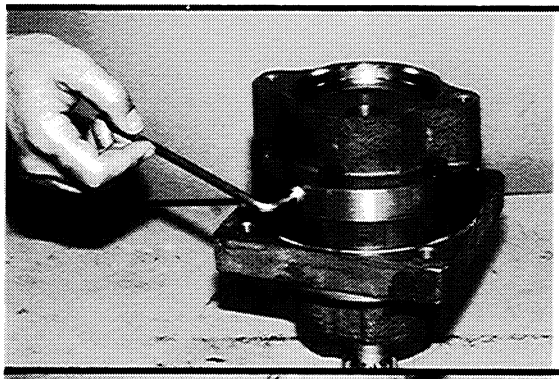
3. Continue around the bolt circle and tighten the remaining bolts.

4. Now use a torque wrench to apply the specified torque to bolt "A".

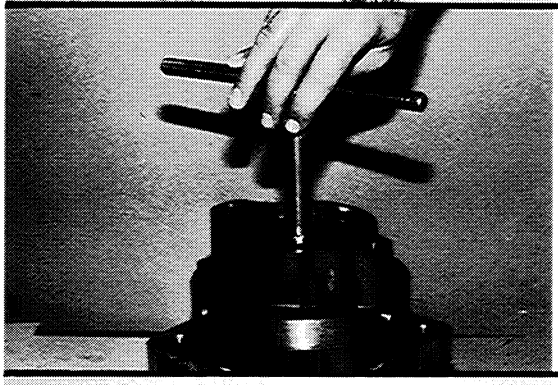
5. Continue around the bolt circle and apply an equal torque to the remaining bolts.



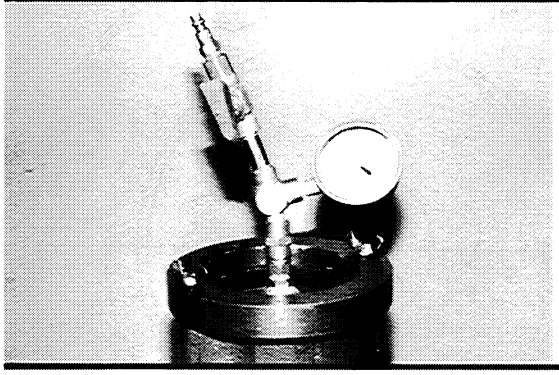
MAIN DISASSEMBLY



1. Remove the four **pipe plugs(4)** from **cover(6)** and drain the oil from the unit.

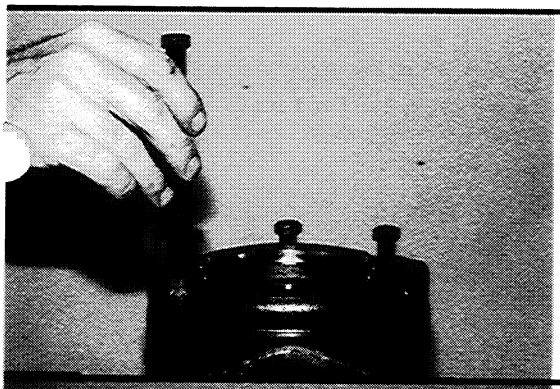


2. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns in each direction as the ratio of the unit. This number is the same as the last two digits in the model number found on the ID tag of the unit. For example, if the model number of this unit is S07A33304, then it should be rolled four times in each direction.

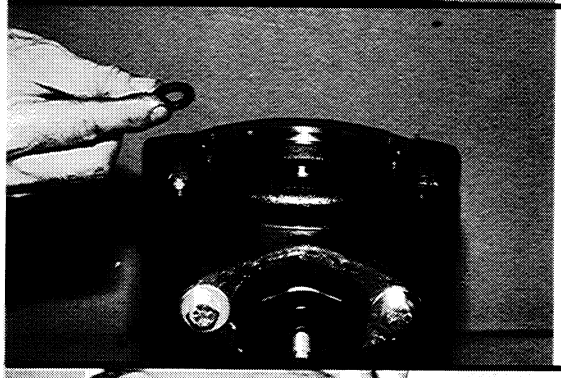


3. Leak test the unit at a pressure of 5 psi for 2-3 minutes.

4. **IF YOUR UNIT HAS A BRAKE:** follow steps 4a-e.



a) Remove the five **bolts(21)** from the brake's **cover(6)**.

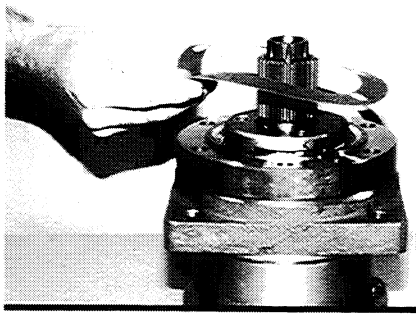


b) Remove **lock washers(22)** from **brake(6)**.

NOTE: The lock washers may have remained attached to the bolts when they were removed. If this is the case, remove the lock washers from the bolts.



c) Lift **brake(6)** off of **hub(1G)**.



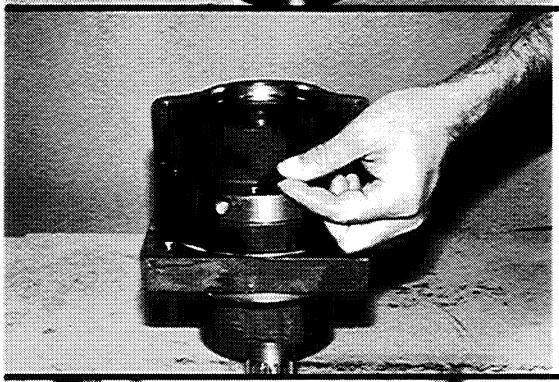
d) Remove **gaskit(27)** from **hub(1G)**.

e) Continue to <u>step #6</u>.

5. **IF YOUR UNIT DOES NOT HAVE A BRAKE:** follow steps 5a-f.



a) Remove the six **bolts(12)** from the hub's **cover(6)**.



b) Remove **lock washers(14)** from **cover(6)**.

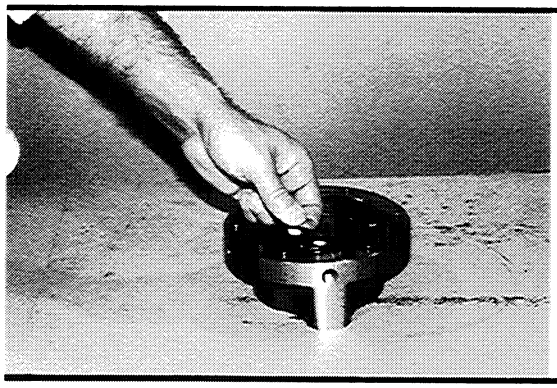
NOTE: The lock washers may have remained attached to the bolts when they were removed. If this is the case, remove the lock washers from the bolts.



c) Lift **cover(6)** off of **hub(1G)**.

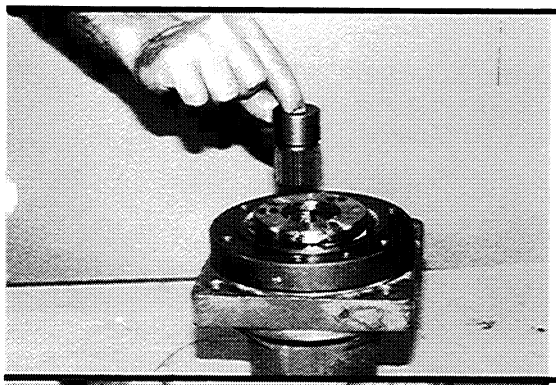


d) Remove **thrust washer(11)** from the counterbore inside **cover(6)**.



e) Remove **"O" ring(5)** from the counterbore around the edge of **cover(6)**. Discard the "O" ring.

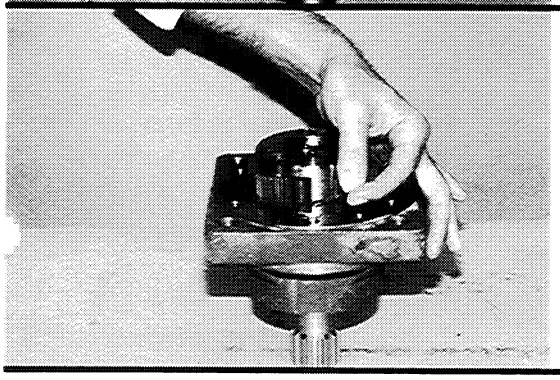
f) Continue to step #6.



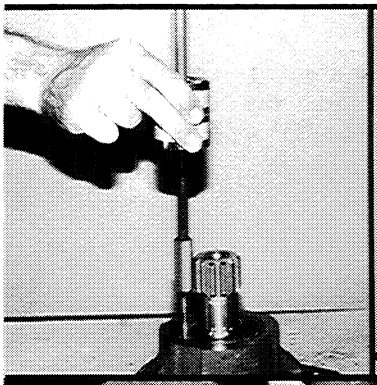
6. Remove **input gear(9)** from mesh with **planet gears(1W)**.

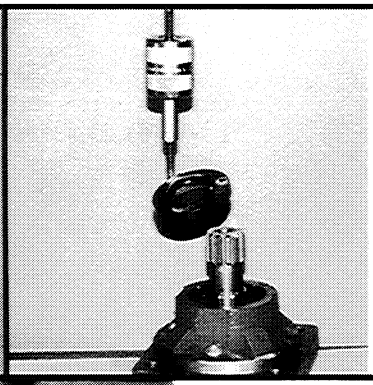


7. Remove **ring gear(2)** from **hub(1G)**.

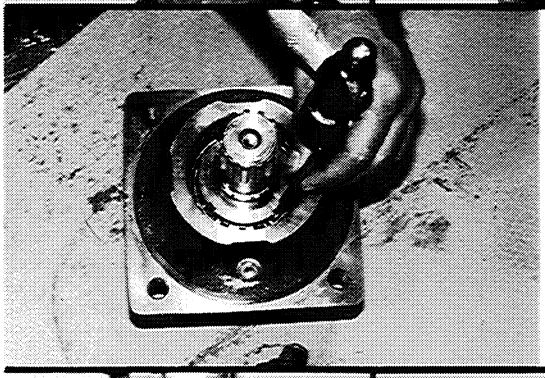


8. Remove **"O" ring(5)** from the counterbore in **hub(1G)**.

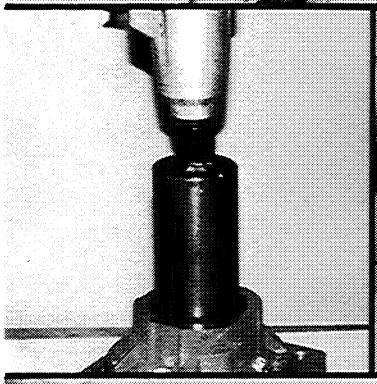


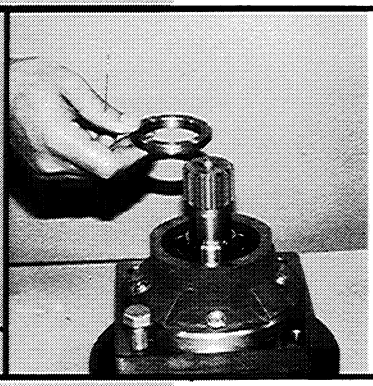


9. With **hub(1G)** on its carrier end, use a slide hammer to remove **seal (1B)** from the hub's small end. Discard the seal.

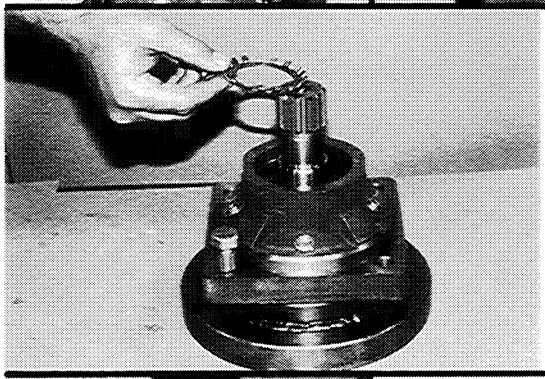


10. With a punch and hammer, straighten out the tang on **lockwasher(1F)** that has been bent into the notch in **locknut(1E)**.

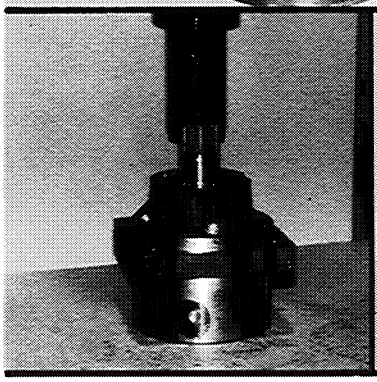


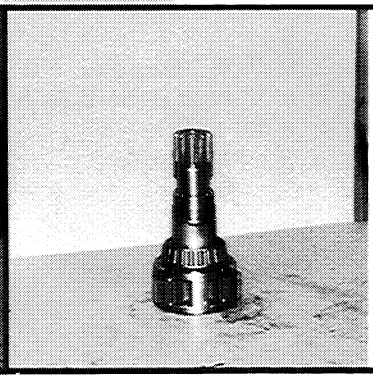


11. Using a locknut wrench (tool no. T-152999), remove **locknut(1E)** from **output shaft/carrier(1T)** and discard.

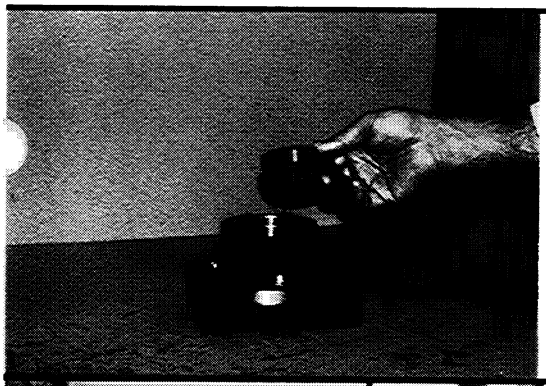


12. Remove **lockwasher(1F)** from **output shaft/carrier(1T)** and discard.

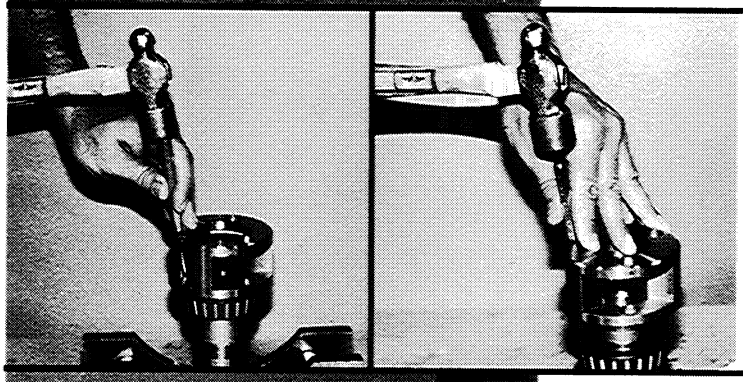




13. Raise **hub(1G)** above your work surface so that **output shaft/carrier (1T)** will fall through the bottom of the hub. Press **output shaft/carrier (1T)** out of **hub(1G)**.



14. Lift **bearing cone(1D)** out of **hub (1G)**.



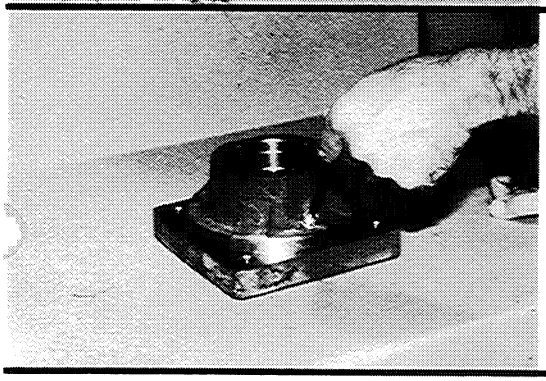
15. Using a punch and hammer, remove **bearing cone(1D)** from **output shaft/carrier(1T)**.



16. Lift out **bearing cup(1C)** from the large diameter end of **hub(1G)** or if necessary, set the hub on its large diameter end and use a punch and hammer to remove the cup.



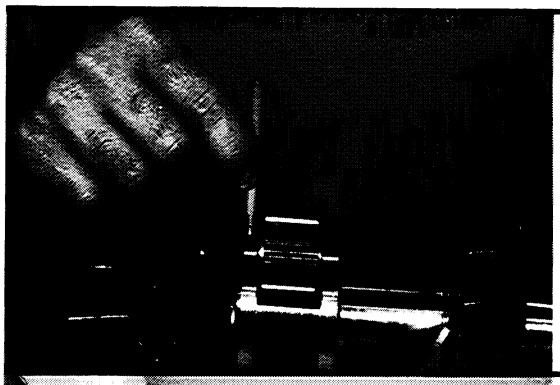
17. Set **hub(1G)** on its small diameter end. Using a punch and hammer, remove the other **bearing cup(1C)** from the hub's small diameter end.



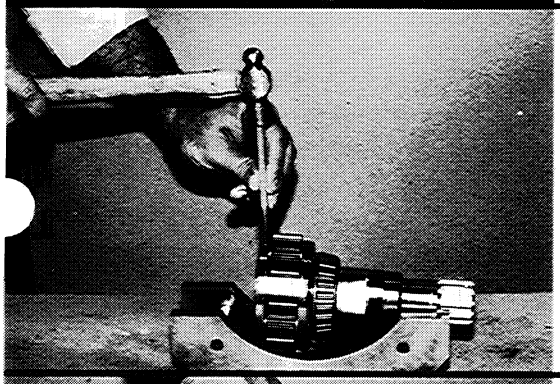
18. Remove the three **magnetic pipe plugs(1K)** from **hub(1G)**.

19. At this point the main disassembly is complete.

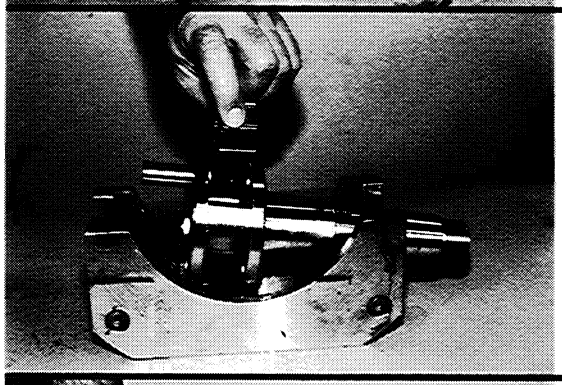
UTPUT SHAFT/CARRIER DISASSEMBLY



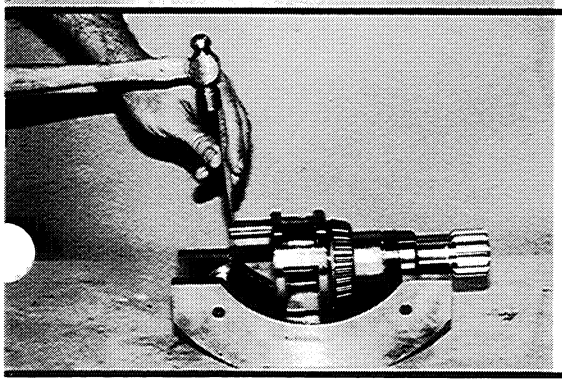
1. Locate **spring pin(1Y)** which holds **planet shaft(1V)** in **carrier housing (1T).**



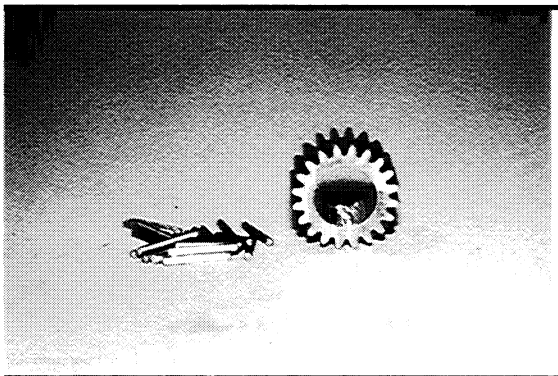
2. Drive **spring pin(1Y)** down into **planet shaft(1V)** until it bottoms against the carrier housing. If the spring pin is not completely driven into the planet shaft, damage to the carrier could occur when the shaft is removed.



3. Remove **planet shaft(1V)** from **carrier housing(1T).** The four **thrust washers(3B)** and **planet gear(1W)** will slide off.

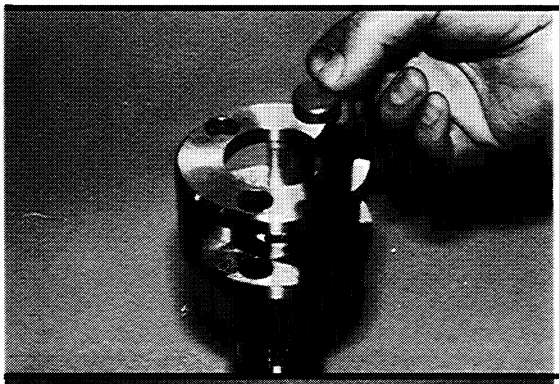


4. Drive **spring pin(1Y)** out of **planet shaft(1V).**



5. Remove **needle rollers(1X)** from inside **planet gear(1W).**

6. Repeat steps 1-6 to remove the two remaining planet gears.



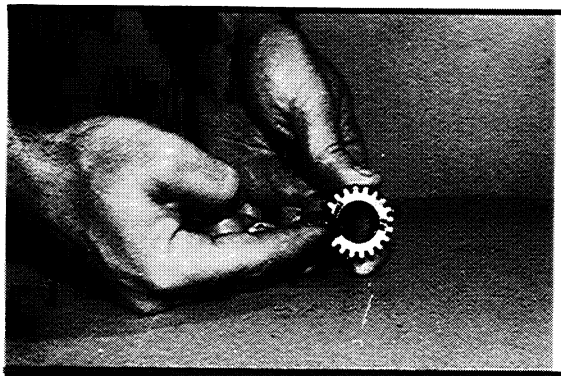
7a. **IF YOUR UNIT HAS A BRAKE:** remove **thrust spacer(29)** from the counterbore in **output shaft/carrier (1T).**



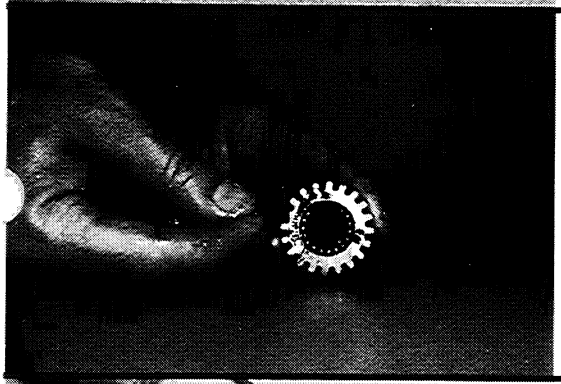
7b. **IF YOUR UNIT DOES NOT HAVE A BRAKE:** remove **thrust washer(1S)** from the counterbore in **output shaft/carrier(1T).**

8. At this point the output shaft/ carrier disassembly is complete.

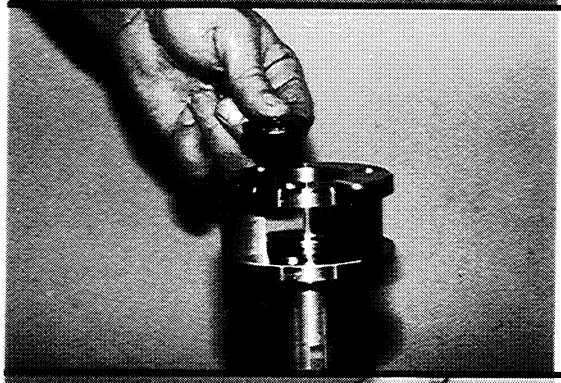
OUTPUT SHAFT/CARRIER SUB-ASSEMBLY



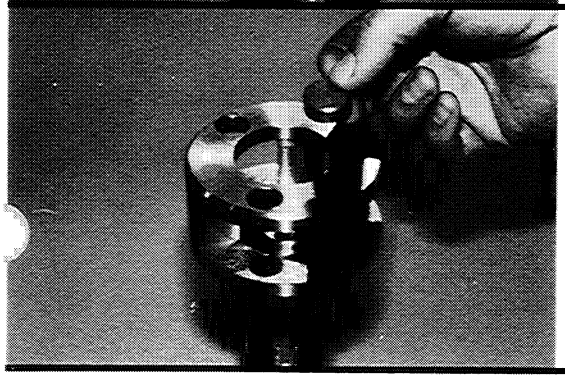
1. Apply grease to the inside of one **planet gear(1W).**



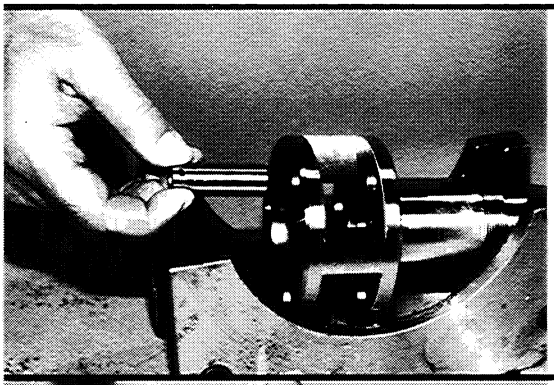
2. Line the inside of **planet gear(1W)** with 19 **needle rollers(1X).**



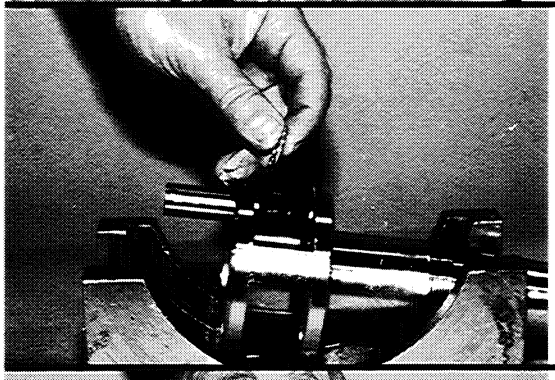
3a. **IF YOUR UNIT DOES NOT HAVE A BRAKE:** Grease one side of **thrust washer (1S)** and place it greased side down into the counterbore in **output shaft/carrier(1T).**



3b. **IF YOUR UNIT HAS A BRAKE:** Place **thrust spacer(29)** into the counterbore in **output shaft/carrier (1T).**

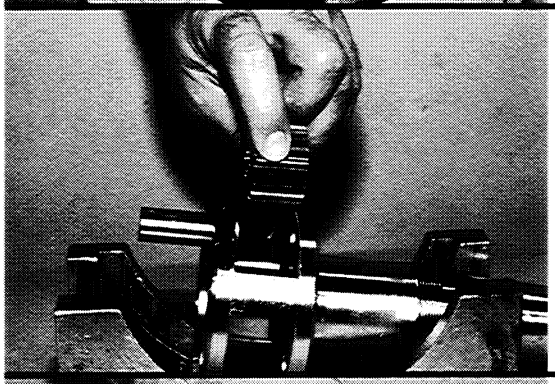


4. Holding a **planet shaft(1V)** so that its spring pin hole is in the end nearest your hand, insert the planet shaft into one of the planet shaft holes that also has a spring pin hole in **output shaft/carrier (1T).**

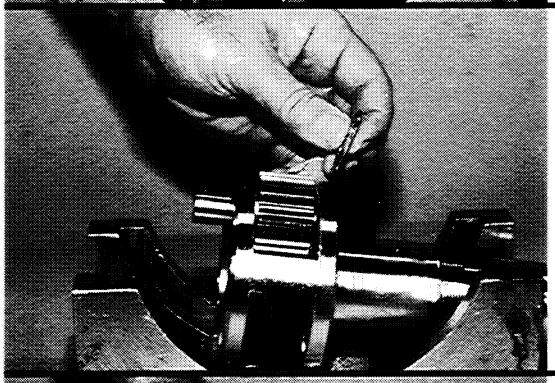


5. Place two **thrust washers(1Z)** onto the end of **planet shaft(1V).**

NOTE: Grease or petroleum jelly may be used to keep the washers together and in place on the planet shaft.

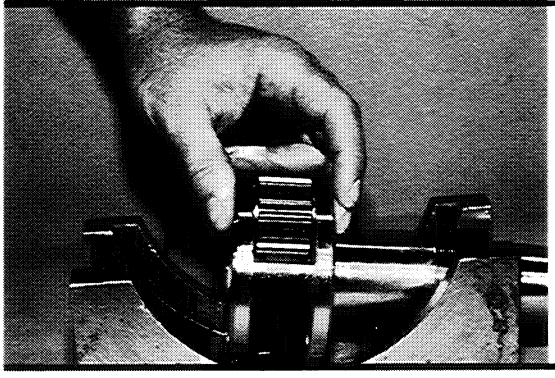


6. Following the thrust washers place **planet gear(1W),** with needle rollers, onto **planet shaft(1V).**

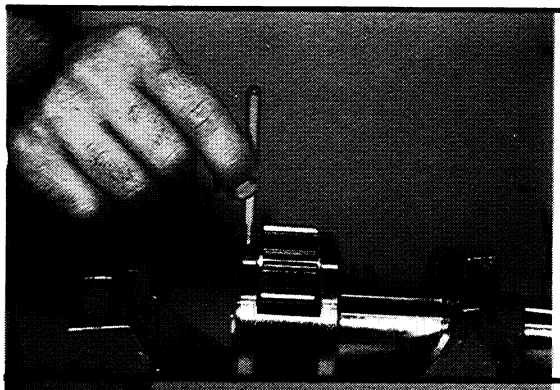


7. Following the planet gear place two more **thrust washers(1Z)** onto **planet shaft(1V).**

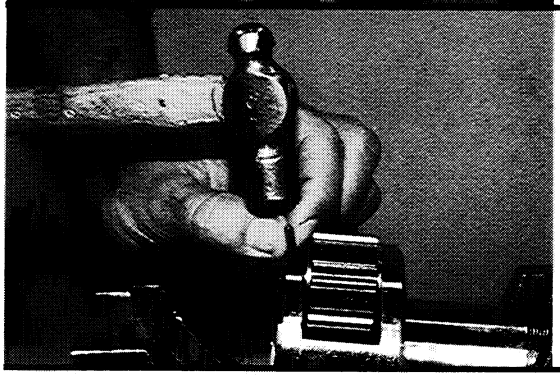
NOTE: Grease or petroleum jelly may be used to hold the washers together and in place on the planet shaft.



8. Now insert **planet shaft(1V)** through the opposite planet shaft hole in **output shaft/carrier(1T).**



9. Using an alignment punch, align the spring pin holes in **output shaft/ carrier(1T)** and **planet shaft(1V)**.

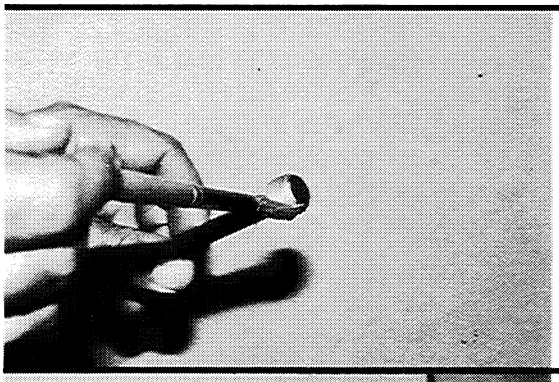


10. Drive **spring pin(1Y)** into the aligned spring pin holes.

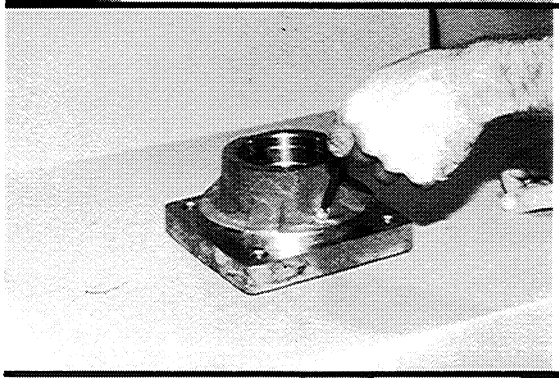
11. Repeat steps 1-2 and 4-10 to install the two remaining planet gears.

12. At this point the output shaft/ carrier sub-assembly is complete.

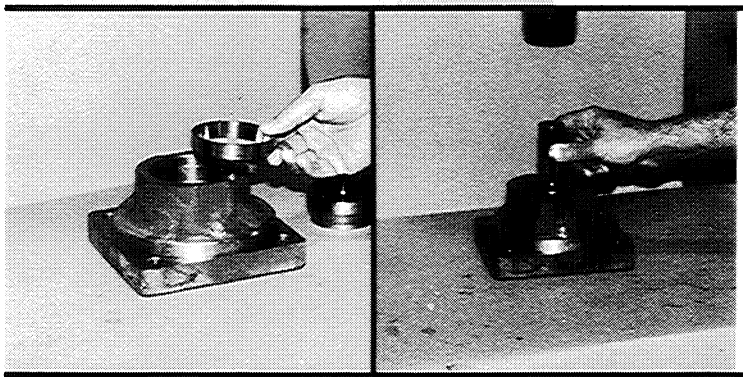
HUB-SHAFT SUB-ASSEMBLY



1. Apply a light coat of "never-seize" to the three **magnetic pipe plugs(1K)**.

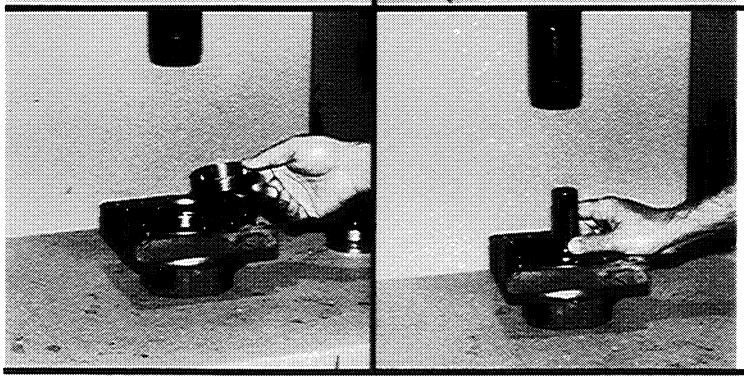


2. Tighten **magnetic pipe plugs(1K)** into the three pipe plug holes in **hub(1G)**.



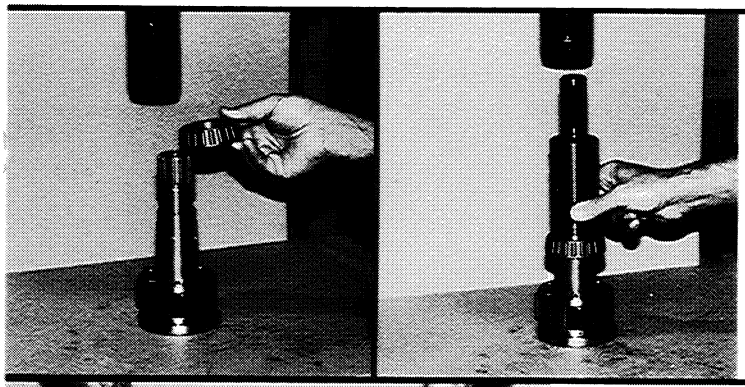
3. Using a bearing cup pressing fixture (tool no. T-139353), press **bearing cup(1C)** into the counterbore in the small diameter end of **hub(1G)**.

NOTE: Make sure that the cup sits square with the counterbore before pressing.

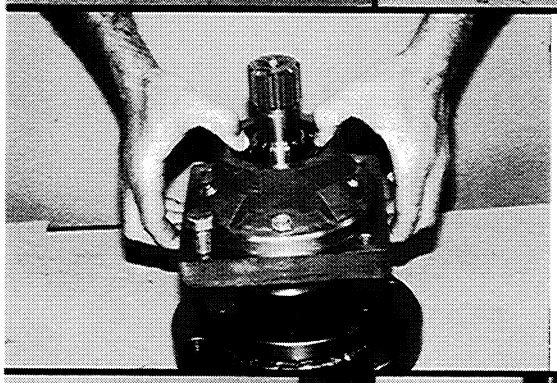


4. Depending on the width of the second **bearing cup(1C)**, the cup may slip fit into the counterbore in the large diameter end of **hub(1G)** or it may have to be pressed in. Place or press (using tool no. T-139353) **bearing cup(1C)** into the counterbore in the large diameter end of **hub(1G)**.

NOTE: Make sure that the cup sits square with the counterbore before pressing.

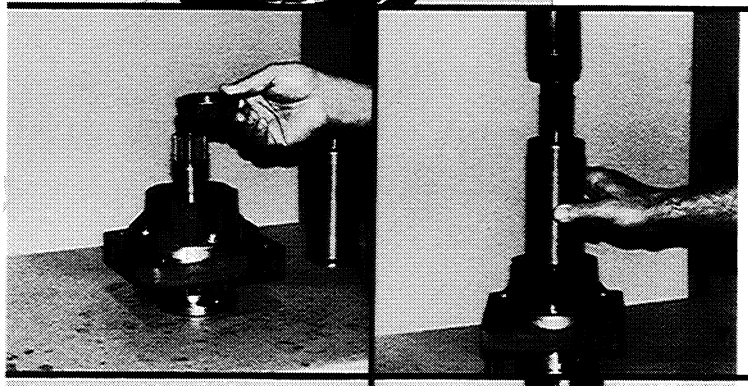


5. Using a bearing cone pressing fixture (tool no. T-148242), press **bearing cone(1D)** onto **output shaft/ carrier(1T)** so that the cone is flush against the carrier housing.

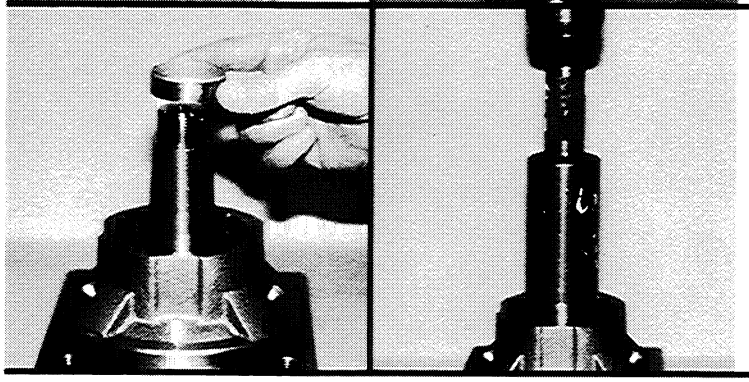


6. With large diameter end down, lower **hub(1G)** onto **output shaft/ carrier(1T)**.

NOTE: The accompanying photograph shows the output shaft/carrier in an assembly base.

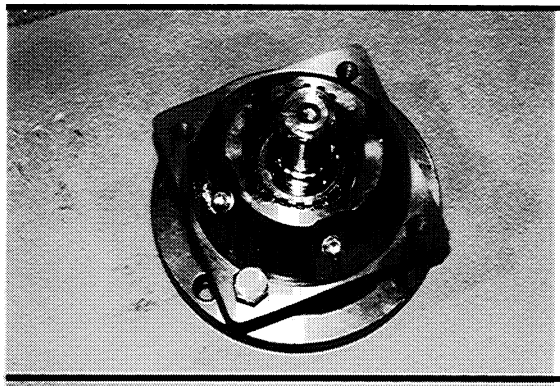


7. Using a bearing cone pressing fixture (tool no. T-148242), press **bearing cone(1D)** onto **output shaft/carrier(1T)**.

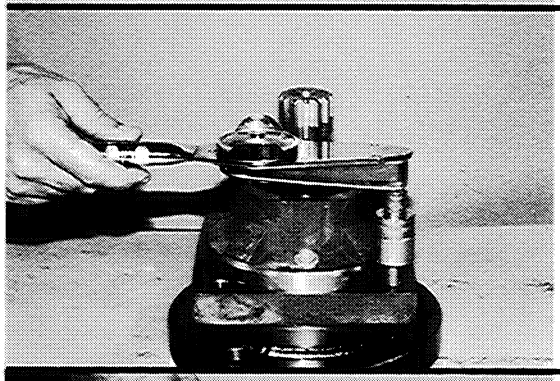


8. Using seal sleave pressing tool no. T-152878, press **seal sleave(10)** onto **output shaft/carrier(1T)**.

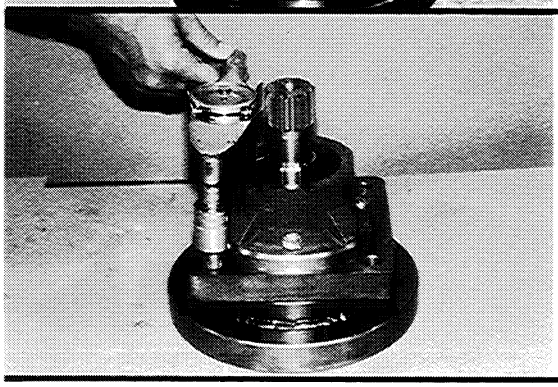
9. Measure the initial rolling torque of **hub(1G)**. To do this follow steps 9a-d.



a) Tighten a bolt into one of the bolt holes in the hub.



b) Place a torque wrench on the bolt so that the arm of the wrench lines up on a tangent to the circumference of the hub as shown in figure 1.



c) Keeping the wrench in this position at all times, use the arm of the wrench to guide the hub slowly around in one rotation.

d) Read the gauge on the torque wrench. The initial rolling torque should be 5-10 in.-lbs. Measure the rolling torque several times to insure an accurate reading.

IMPORTANT: If the initial rolling torque is lower than 5 in.-lbs., apply more pressure to **bearing cone(1D)** until the rolling torque falls within the 5-10 in.-lb. range. If the rolling torque is higher than 10 in.-lbs., strike the top of **spindle(1A)** once or twice with a soft face hammer to release the load on the spindle; then repeat steps 9b-d. Apply pressure as needed to the bearing cone to reach 5-10 in.-lbs.

THE CORRECT READING CAN ONLY BE MADE IF THE TORQUE WRENCH IS PULLED SLOWLY (APPROX. 3.5 R.P.M.) AND SMOOTHLY TOWARDS YOU.

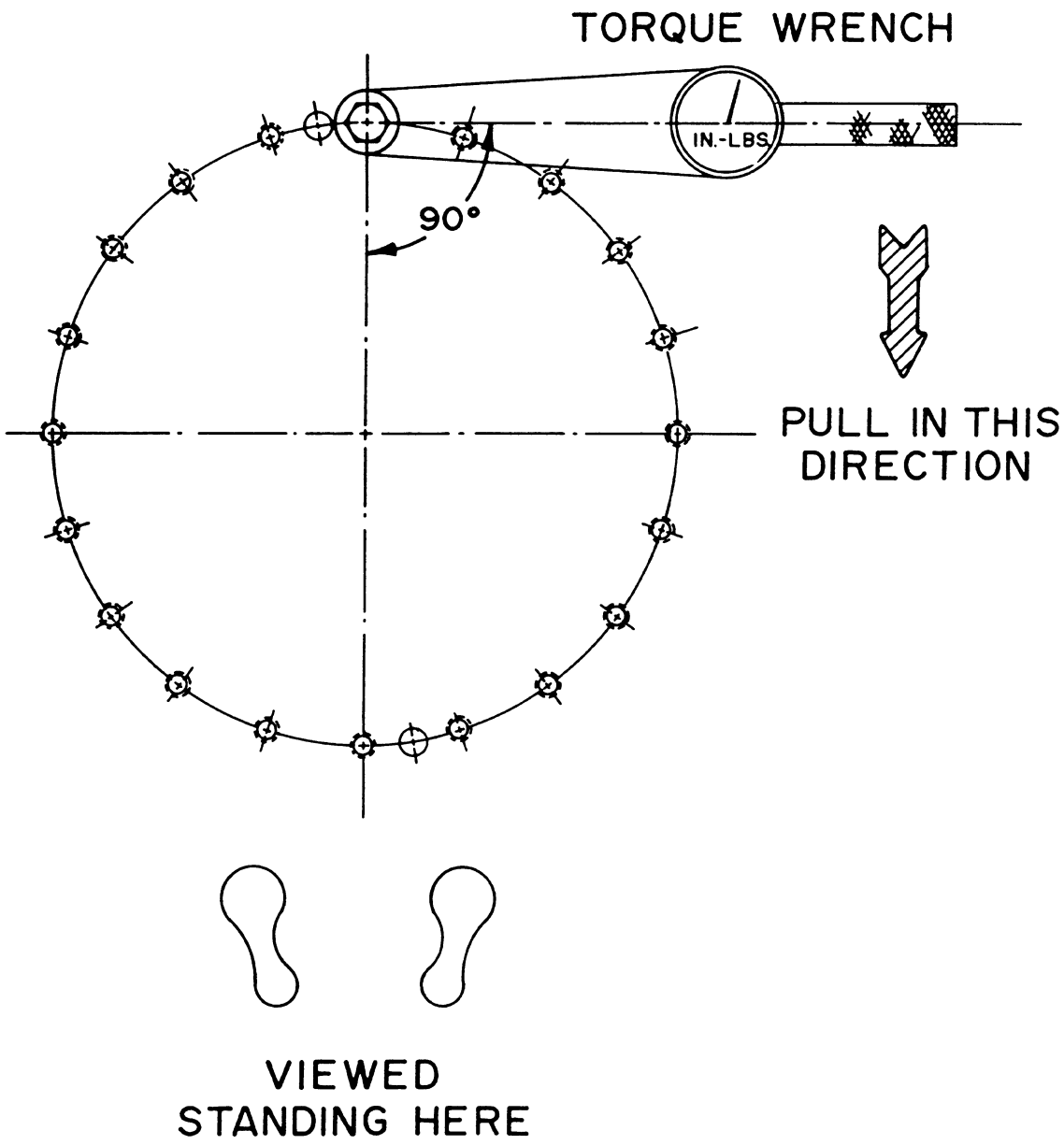
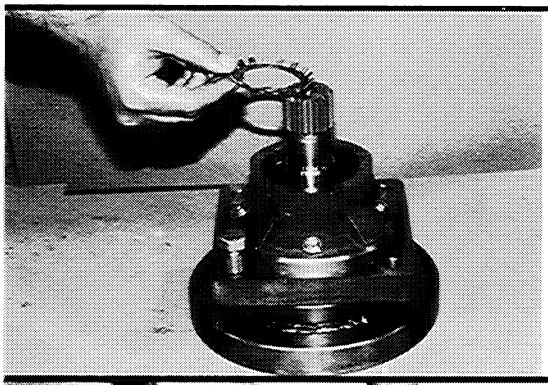


Figure 1



10. Place **lockwasher(1F)** onto **output shaft/carrier(1T)**.

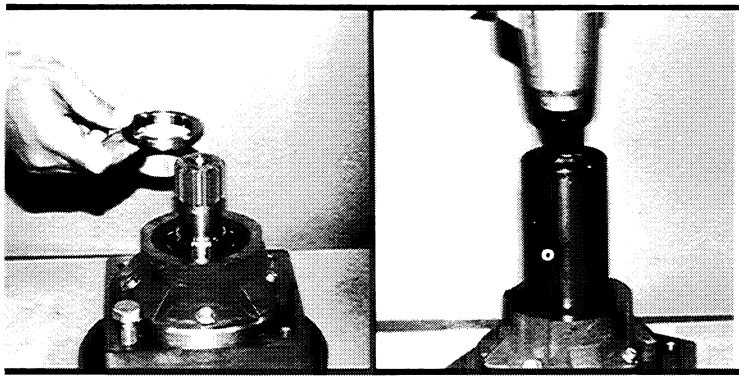


11. Spray **locknut(1E)** and **output shaft/carrier(1T)** with Locquic Primer T. Allow two minutes drying time.



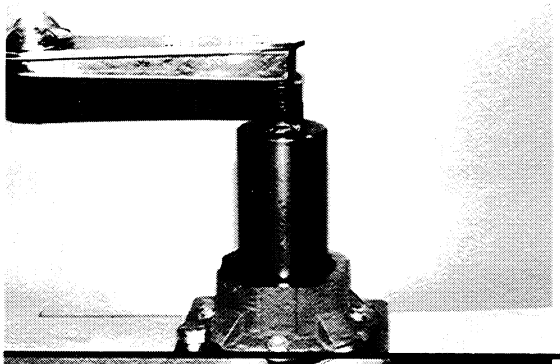
12. Apply Loctite 271 to the second screwthread from the bottom of **locknut(1E)**. The bottom of the locknut has a chamfered or gradually sloped edge.

NOTE: Loctite 271 is an anaerobic adhesive. Once it has been removed from contact with air, it sets. Therefore once the locknut has been placed on the output shaft it must be tightened and torqued immediately or the adhesive will make it difficult to turn.

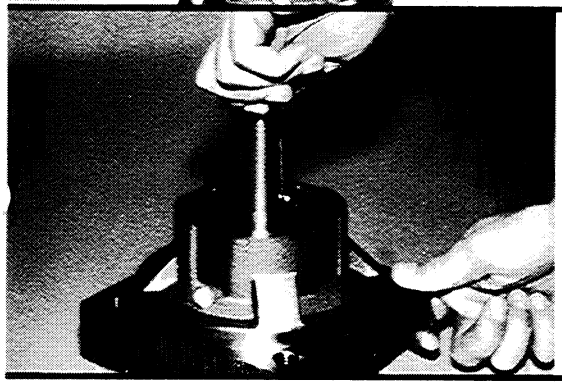


13. Using a locknut wrench (tool no. T-152999), tighten **locknut(1E)** onto **output shaft/carrier(1T)**.

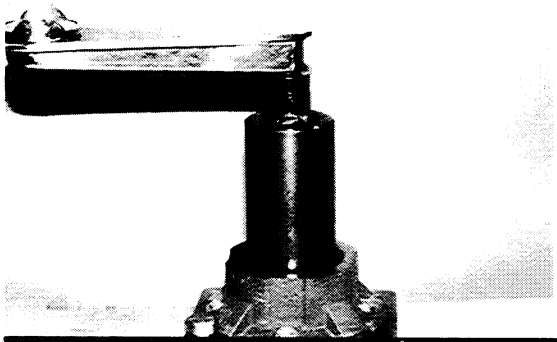
14. Using a torque wrench and locknut wrench T-152999, apply a total of 100 ft.-lbs. of torque to **locknut(1E)** as follows in steps 14a-d.



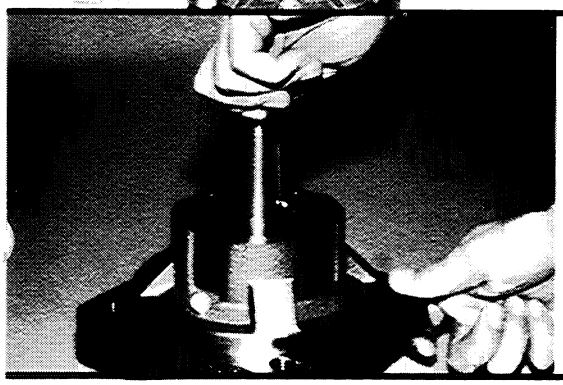
a. Apply 50 ft.-lbs. of torque to **locknut(1E)**.



b. Rotate **hub(1G)** several times in both clockwise and counterclockwise directions.



c. Continue to torque **locknut(1E)** to 100 ft.-lbs.

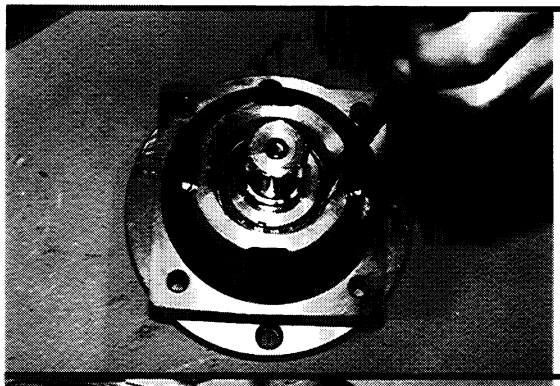


d. Rotate **hub(1G)** several times once again in both clockwise and counterclockwise directions.

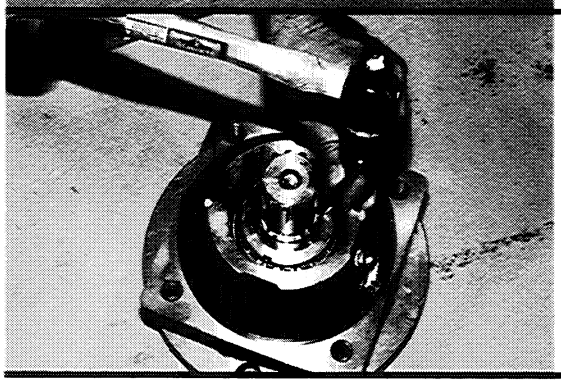
IMPORTANT: One tang on **lockwasher(1F)** must line up with one notch on **locknut(1E)**. If this is not the case, apply sufficient increased torque to **locknut(1E)** until one tang and one notch are aligned. Never loosen the locknut.

15. Measure the final rolling torque of **hub(1G)** using the same method described in steps 9a-d. The final rolling torque should be 10-15 in.-lbs. Remove the bolt from the hub.

IMPORTANT: If the rolling torque is below 10 in.-lbs., a maximum total torque of 125 ft.-lbs. may be applied to **locknut(1E)** in order to increase the rolling torque. If the rolling torque is above 15 in.-lbs., remove **locknut(1E)** using a locknut wrench (tool no. T-152999) and repeat steps 9-15.



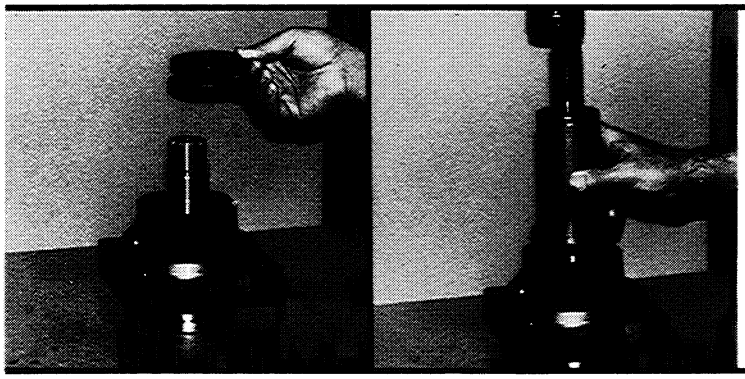
16. Bend the aligned tang on **lockwasher(1F)** up into the notch on **locknut(1E)**.



17. Using a center punch and hammer, stake **locknut(1E)** at four equally spaced points around the locknut and at a distance of 1/8 in. from its inside edge.

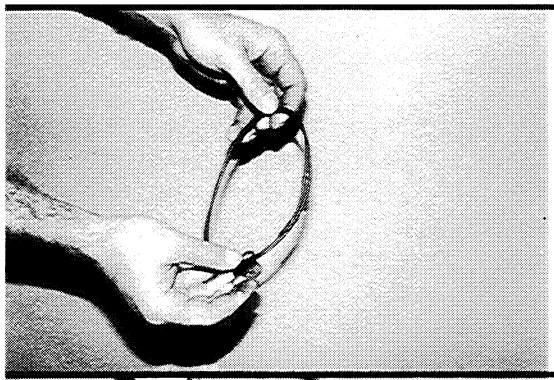
18. At this point the hub-shaft sub-assembly is complete.

MAIN ASSEMBLY

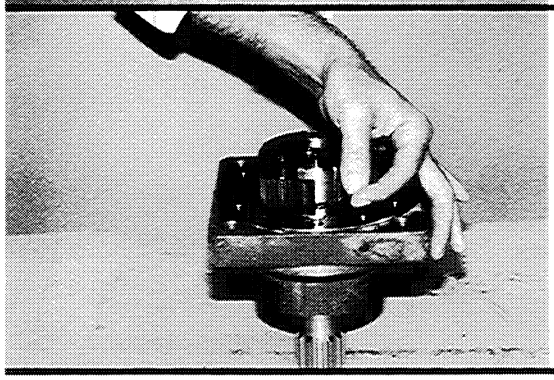


1. Using a seal pressing fixture (tool no. T-144581), press **seal(1B)** into the small diameter end of **hub(1G)**. The closed face of the seal should be up.

2. Turn **hub(1G)** over onto its output shaft.



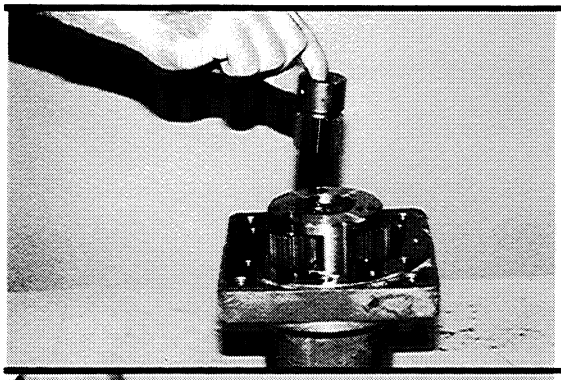
3. Grease **"O" ring(5)**.



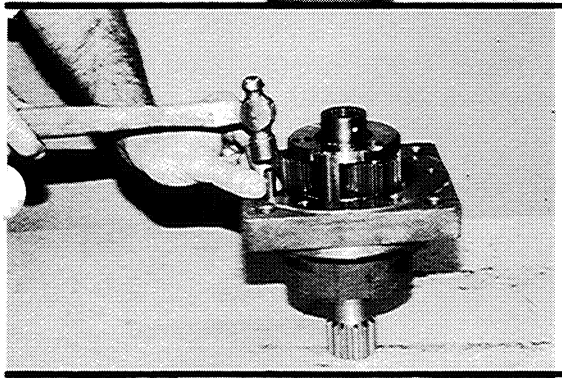
4. Place **"O" ring(5)** into the counterbore of **hub(1G)**.

CAUTION: Beware of sharp edges and burrs around the counterbore when installing the "O" ring.

NOTE: "O" rings may be stretched to fit the counterbore. If an "O" ring has been stretched too much simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.



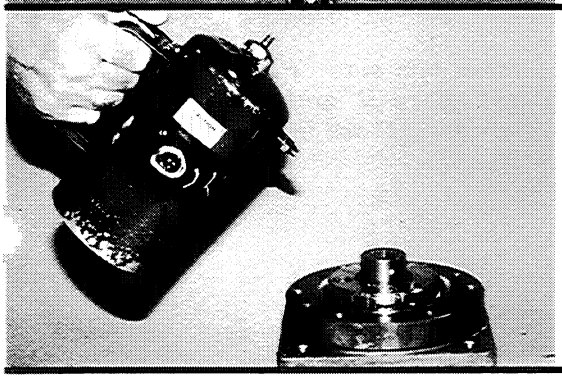
5. Insert **input gear(9)**, with gear teeth down, into mesh with **planet gears(1W)**.



6. Hammer **dowel pins(26)** into the two holes in the bolt circle in **hub(1G)** that do not have threads. The chamfered or sloped end of each dowel pin should be inserted first.

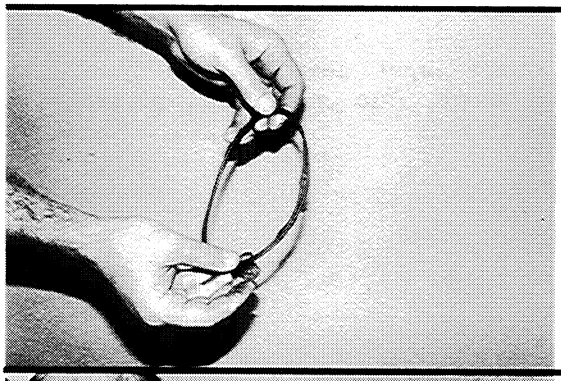


7. Place **ring gear(2)** onto **hub(1G)**. The side of the ring gear marked with an "X" should be toward the hub. Make sure that the two bolt holes on the ring gear without threads are aligned over the **dowel pins(26)**.



8. Oil all exposed surfaces inside **hub(1G)**.

NOTE: If your unit has a brake instead of a cover, go to the brake assembly procedure on page 26. If your unit does not have a brake continue to step # 9.



9. Grease **"O" ring(5).**



10. Place **"O" ring(5)** into the counterbore in **cover(6).**

CAUTION: Beware of sharp edges and burrs around the counterbore when installing the "O" ring.

NOTE: "O" rings may be stretched to fit the counterbore. If an "O" ring has been stretched too much simply squeeze the "O" ring together bit by bit as you place it around the counterbore. It can be made to fit exactly.



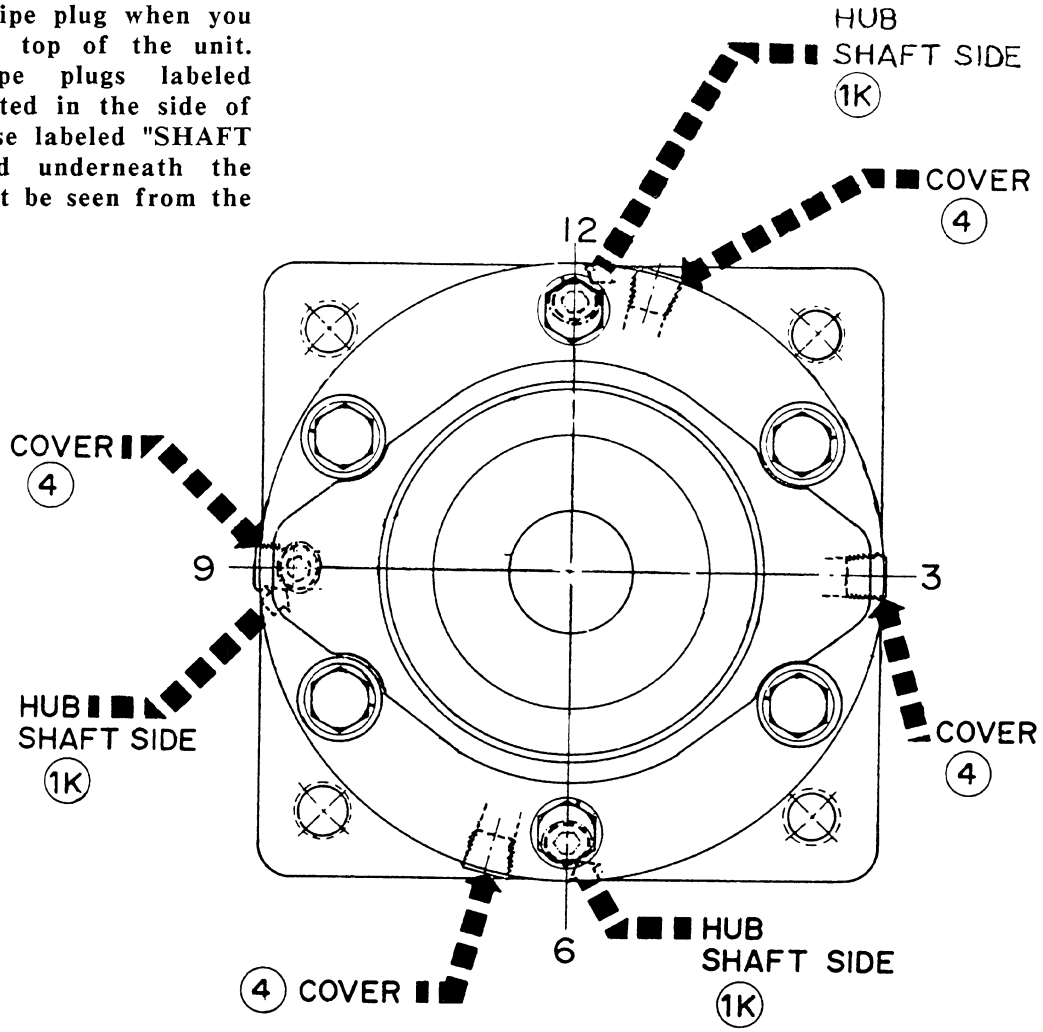
11. Grease one side of **thrust washer (11)** and place it greased side down into the counterbore in **cover(6).**



12. Place **cover(6)** onto **hub(1G)**. Align the pipe plug holes in **cover(6)** with those in **hub(1G)** as shown in figure 2. Make sure the bolt holes in the hub and cover are also aligned.

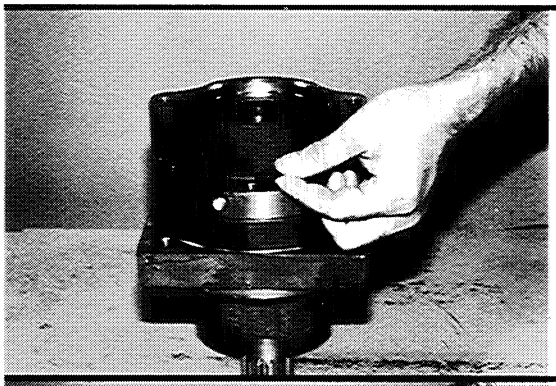
Pipe Plug Timing

This figure shows the relative location of each pipe plug when you look down at the top of the unit. Actually, the pipe plugs labeled "COVER" are located in the side of the cover and those labeled "SHAFT SIDE" are located underneath the hub, so they cannot be seen from the view presented.



This is the most common pipe plug timing for this series. However, pipe plug timings may vary among units with different model numbers. Refer to an original assembly print of your unit to determine its correct pipe plug timing.

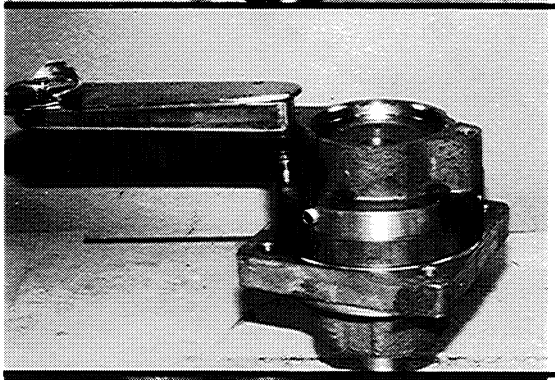
Figure 2



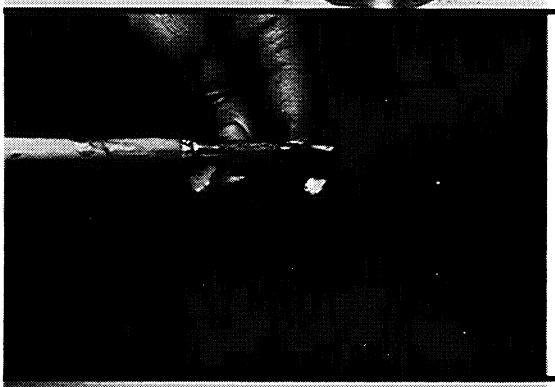
13. Place the six **lock washers(14)**, with flat sides down, over the bolt holes in **cover(6)**.



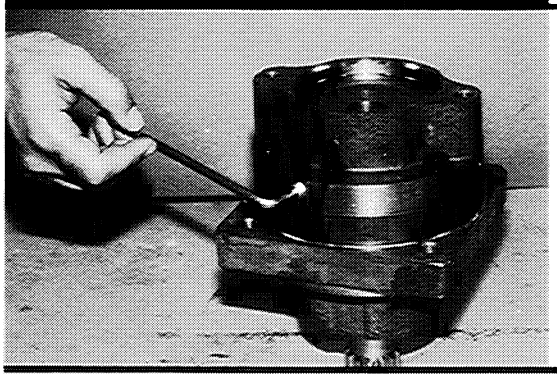
14. Insert the six **bolts(12)** into the bolt holes in **cover(6)** and tighten.



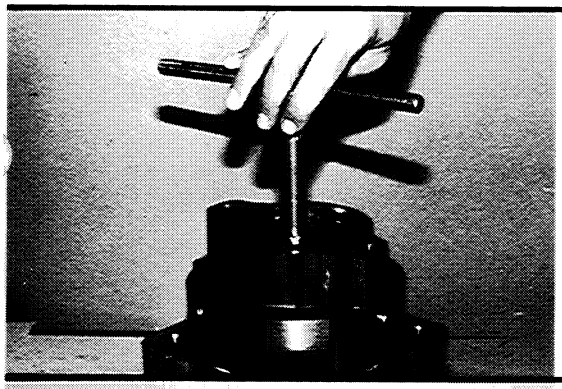
15. Apply 55-70 ft.-lbs. of torque to each bolt.



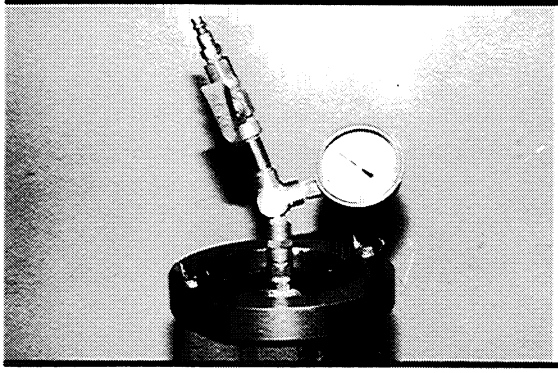
16. Apply a light coat of "never-seize" to the four **pipe plugs(4)**.



17. Tighten **pipe plugs(4)** into the four pipe plug holes in **cover(6)**.



18. Roll test the unit in both clockwise and counterclockwise directions. Perform the same number of turns in each direction as the ratio of the unit. This number is the same as the last two digits in the model number found on the ID tag of the unit. For example, if the model number of this unit is S07A33304, then the unit should be rolled four times in each direction.

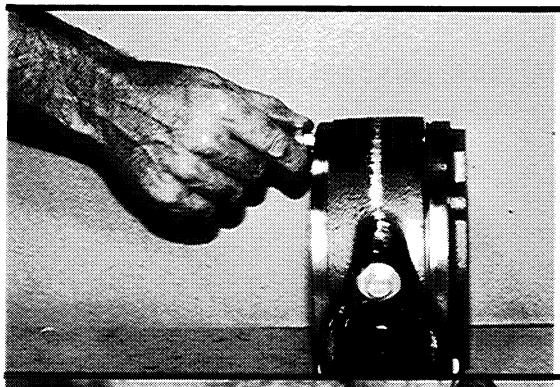


19. Leak test the unit at a pressure of 5 psi for 2-3 minutes.

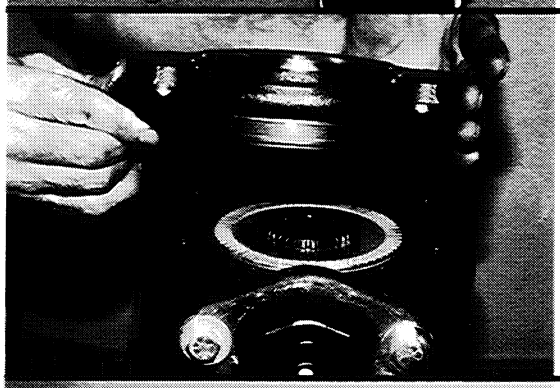
20. At this point the main assembly is complete.

BRAKE ASSEMBLY

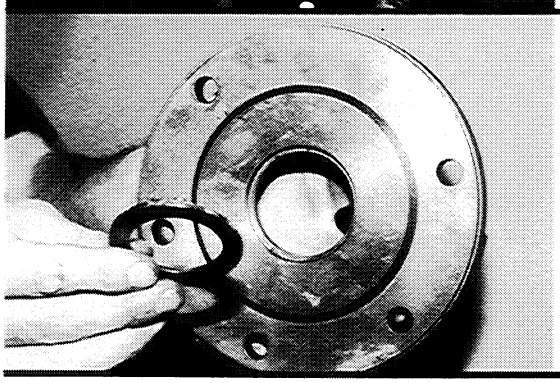
Some applications of the S07A torque-hub unit require a brake to be installed. The following steps tell how to install an assembled brake.



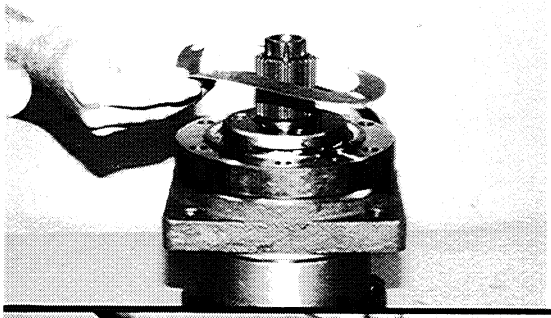
1. Remove the 5 bolts from the cover of **brake(6)** if this has not already been done.



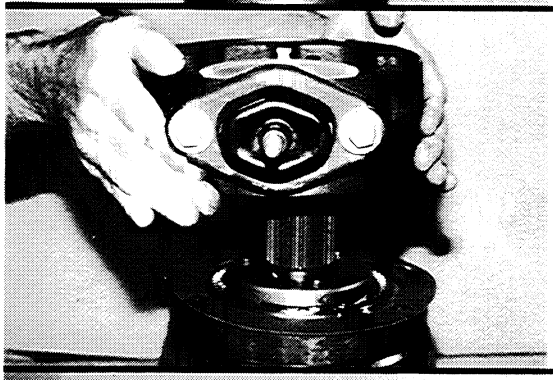
2. Remove the cover from **brake(6).**



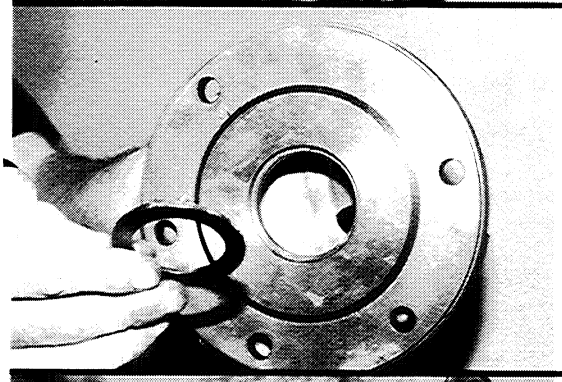
3. Remove the thrust washer from the counterbore in the center of the brake's cover.



4. Align **gaskit(27)** over the bolt holes in **hub(1G)**.



5. Place **brake(6)**, without its cover, onto **hub(1G)** and align the bolt holes.

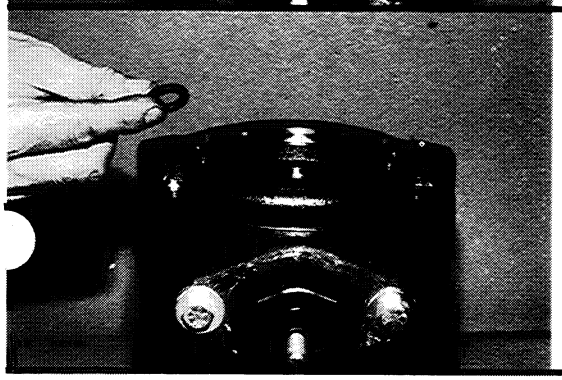


6. Grease one side of the thrust washer that was removed from the cover of **brake(6)** and place it greased side down back into the cover's counterbore.



7. Place the cover onto **brake(6)** and align the pipe plug holes in the hub and cover according to figure 3. Make sure the bolt holes in the hub and cover are aligned.

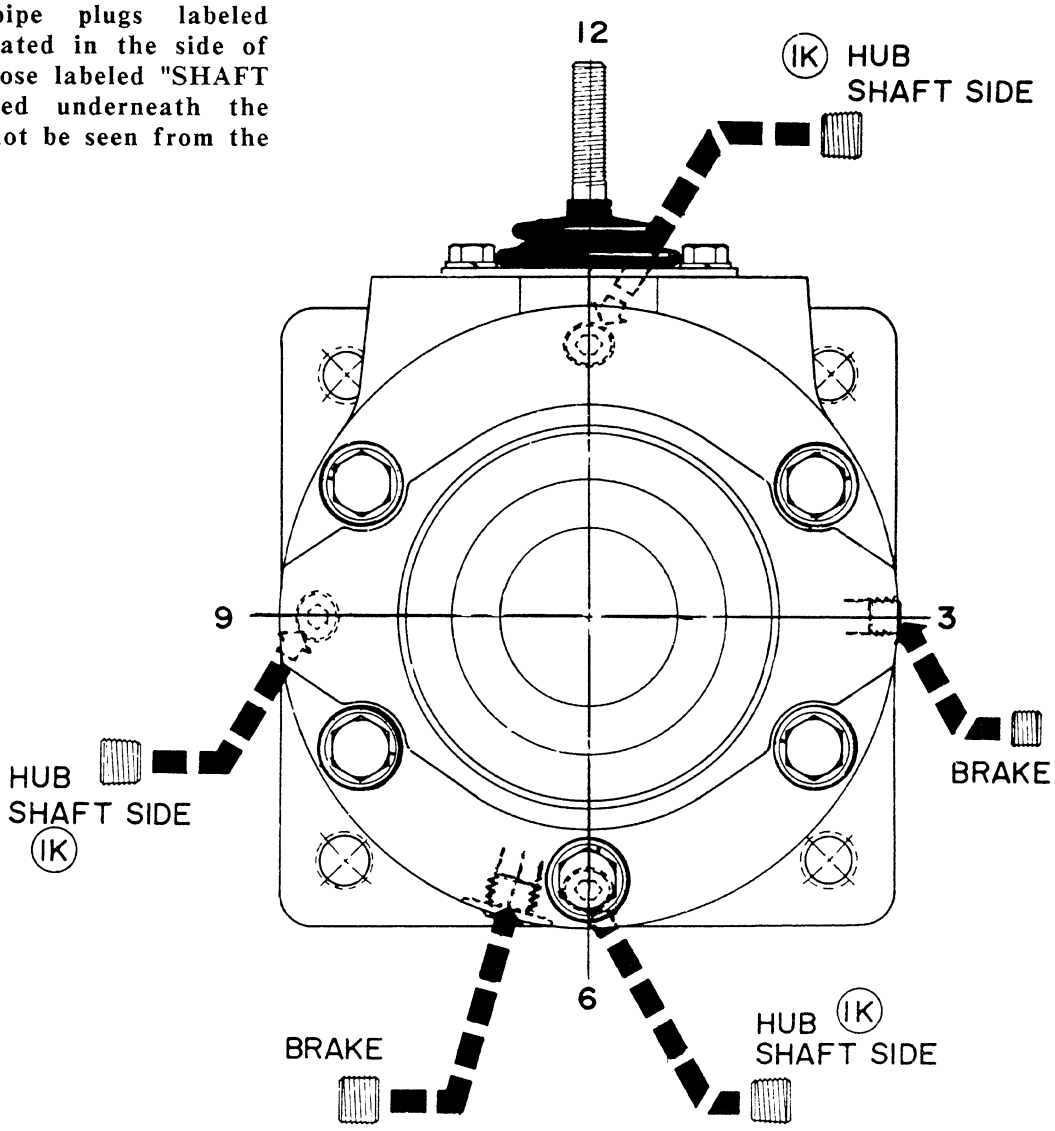
NOTE: Make sure that the gaskit already in the brake that fits underneath the brake's cover is aligned over the bolt holes in the brake before putting the cover on.



8. Place **lock washers(22)**, with flat sides down, over the five bolt holes in the cover of **brake(6)**.

Pipe Plug Timing

This figure shows the relative location of each pipe plug when you look down at the top of the unit. Actually, the pipe plugs labeled "BRAKE" are located in the side of the brake and those labeled "SHAFT SIDE" are located underneath the hub, so they cannot be seen from the view presented.



This is the most common pipe plug timing for this series. However, pipe plug timings may vary among units with different model numbers. Refer to an original assembly print of your unit to determine its correct pipe plug timing.

Figure 3



9. Insert **bolts(21)** into the five bolt holes in the cover of **brake(6)** and tighten.

10. Apply a torque of 55-70 ft.-lbs. to each **bolt(21)**.

11. At this point the brake installation is complete.

TOOLING

The following specialized tools are used in the assembly of this unit. The tool diagrams included in this manual are intended for the customer who may wish to have a tool made. All tools exist as one piece and must be made from mild steel. All dimensions are given in inches.

OPTIONAL: In order to improve tool life, tools may be carborized and hardened. If this is done, however, the tools must be ground on all surfaces labeled with a "G" on the tool diagram.

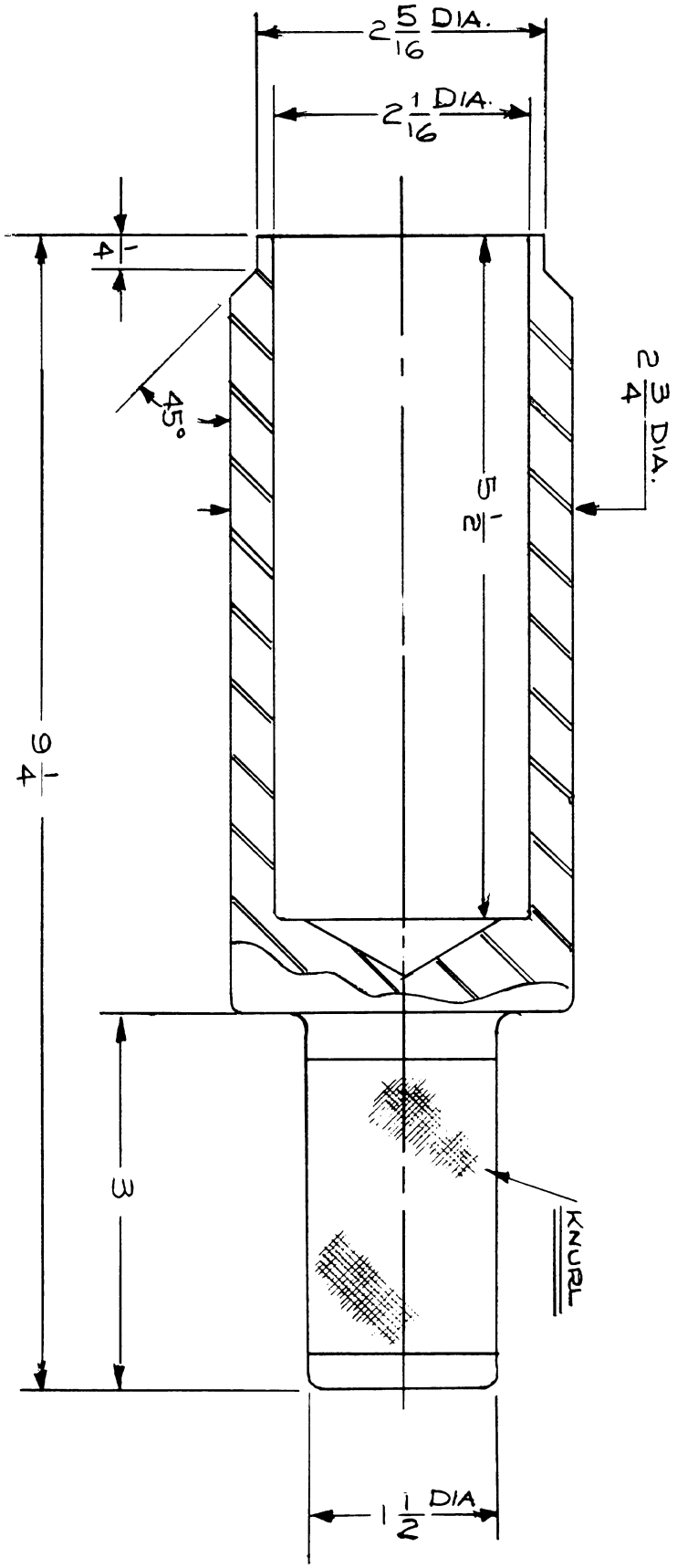
1) TOOL NO. T-148242
   BEARING CONE PRESSING FIXTURE for CONE(1D)

2) TOOL NO. T-139353
   BEARING CUP PRESSING FIXTURE for CUP(1C)

3) TOOL NO. T-152999
   LOCKNUT WRENCH for LOCKNUT(1E)

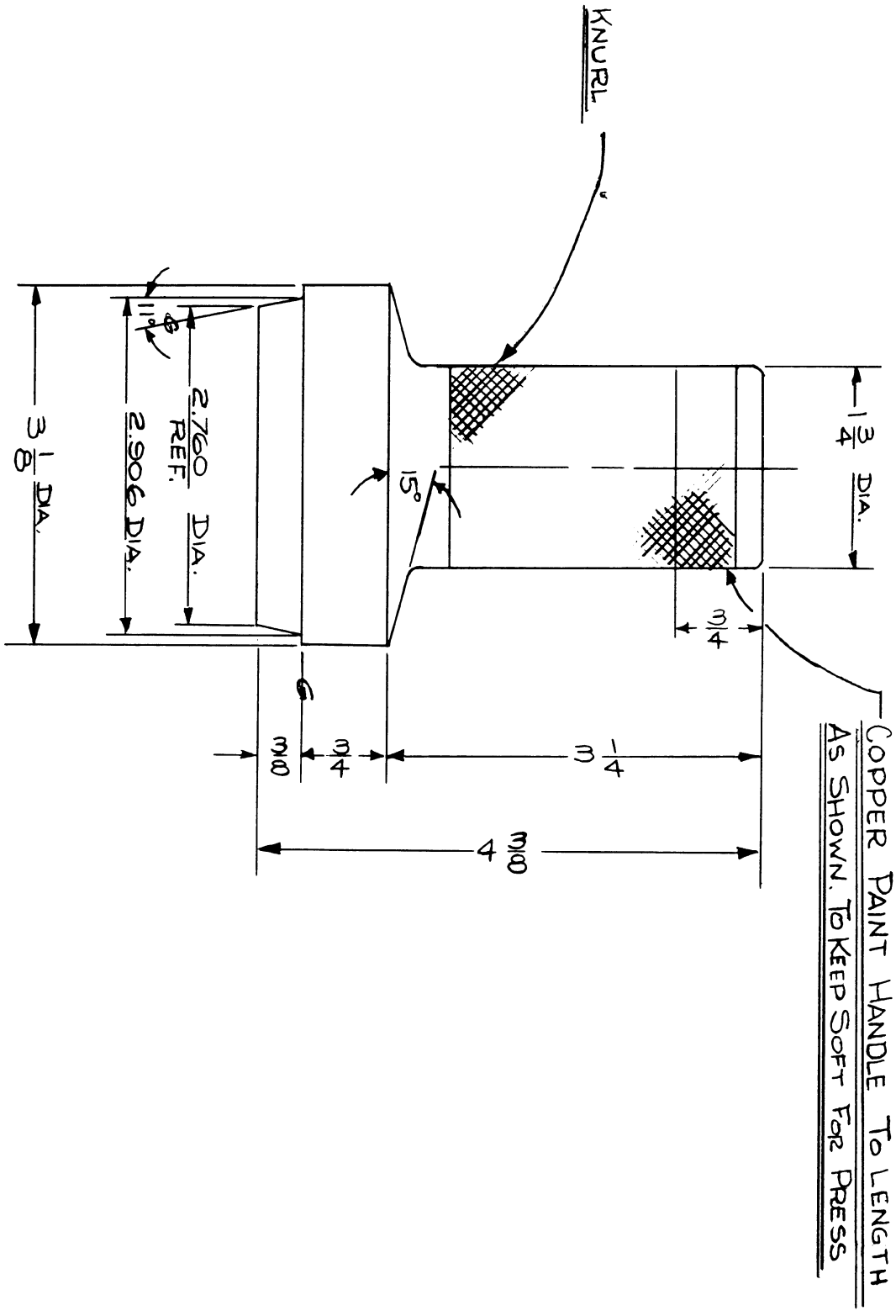
4) TOOL NO. T-144581
   SEAL PRESSING FIXTURE for SEAL(1B)

5) TOOL NO. T-152878
   SEAL SLEAVE PRESSING FIXTURE for SEAL SLEAVE(10)



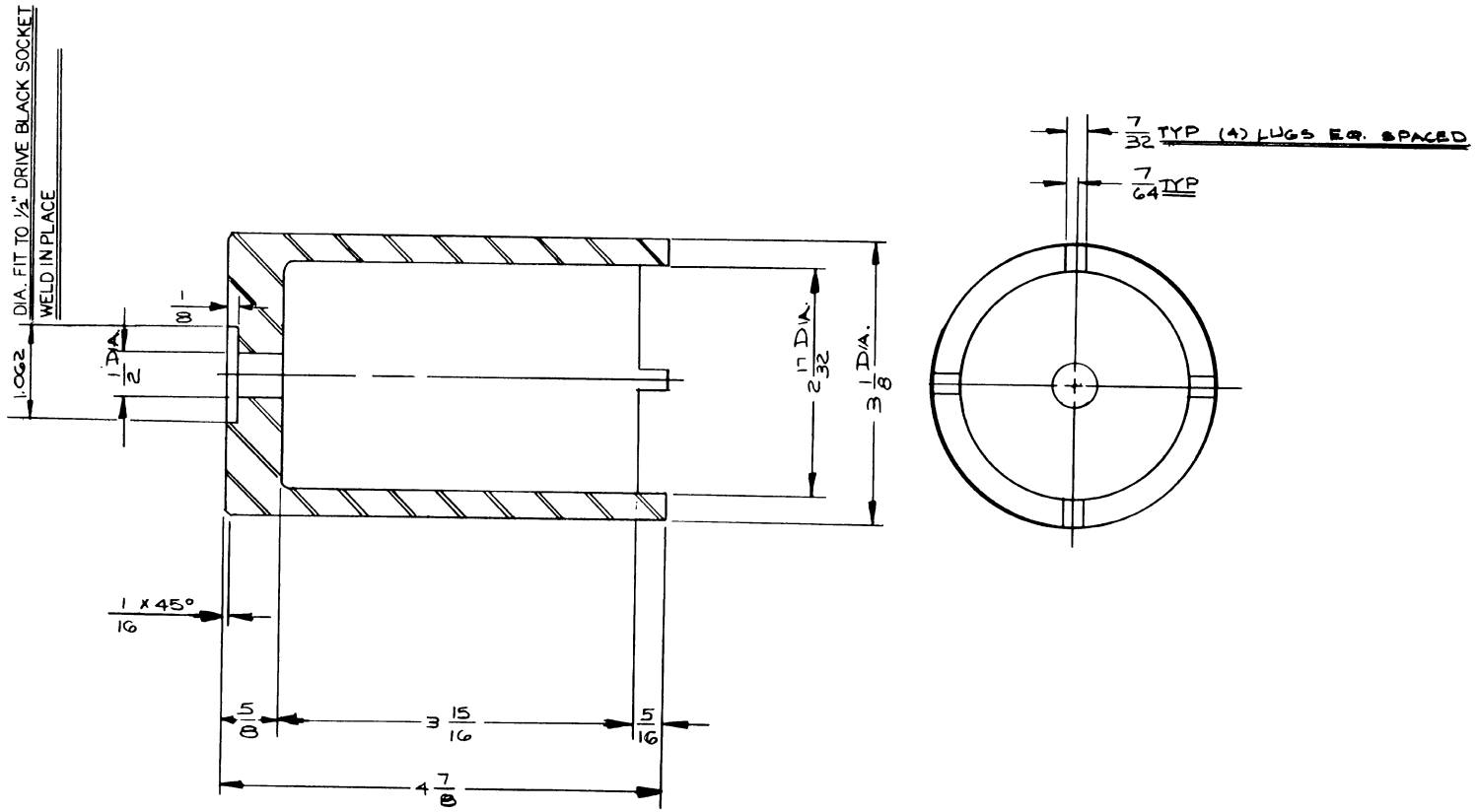
TOOL NO. T-148242
BEARING CONE PRESSING FIXTURE for CONE(1D)

SCALE: 3/4



TOOL NO. T-139353
BEARING CUP PRESSING FIXTURE for CUP(1C)

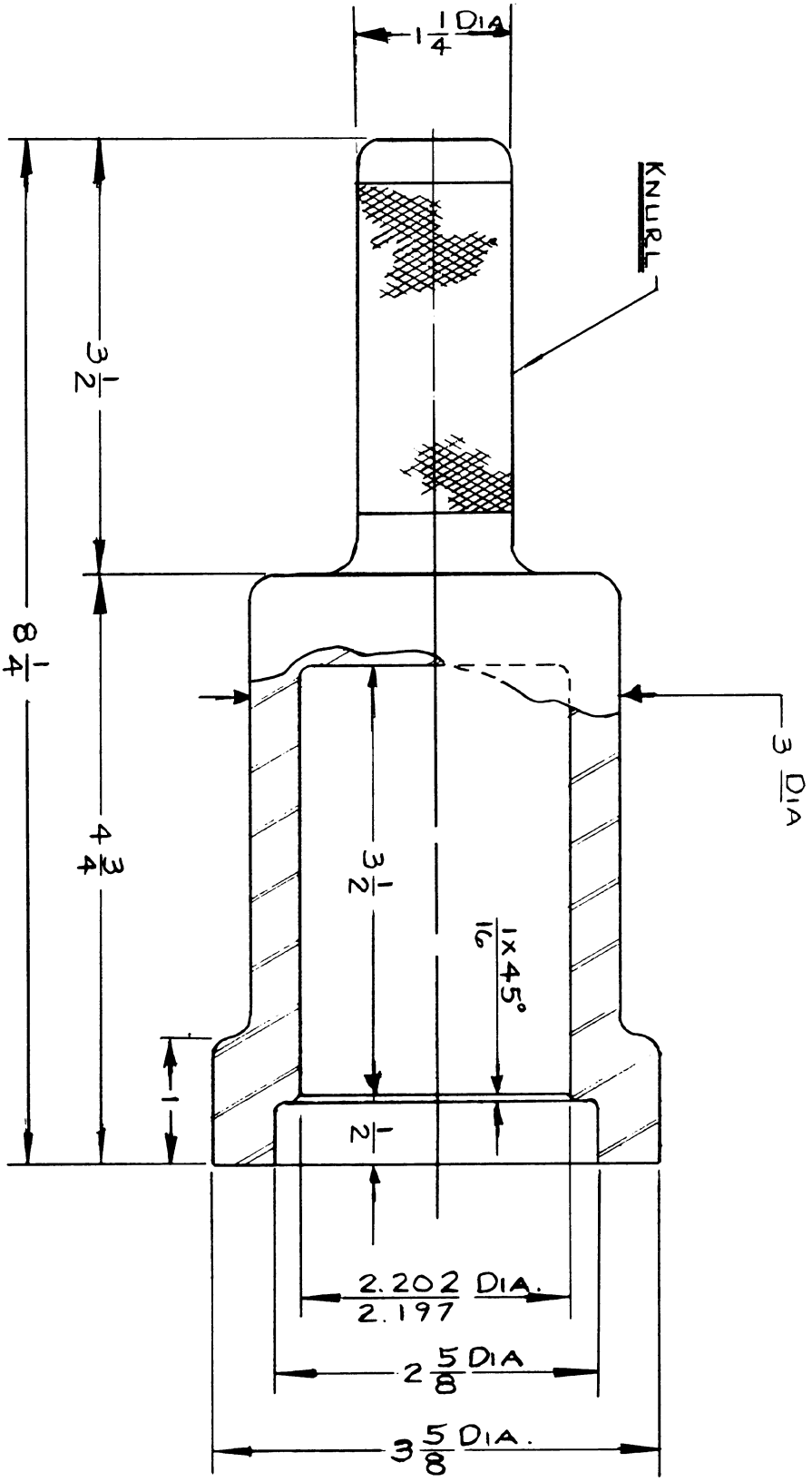
SCALE: 3/4



TOOL NO. T-152999
LOCKNUT WRENCH for LOCKNUT(1E)

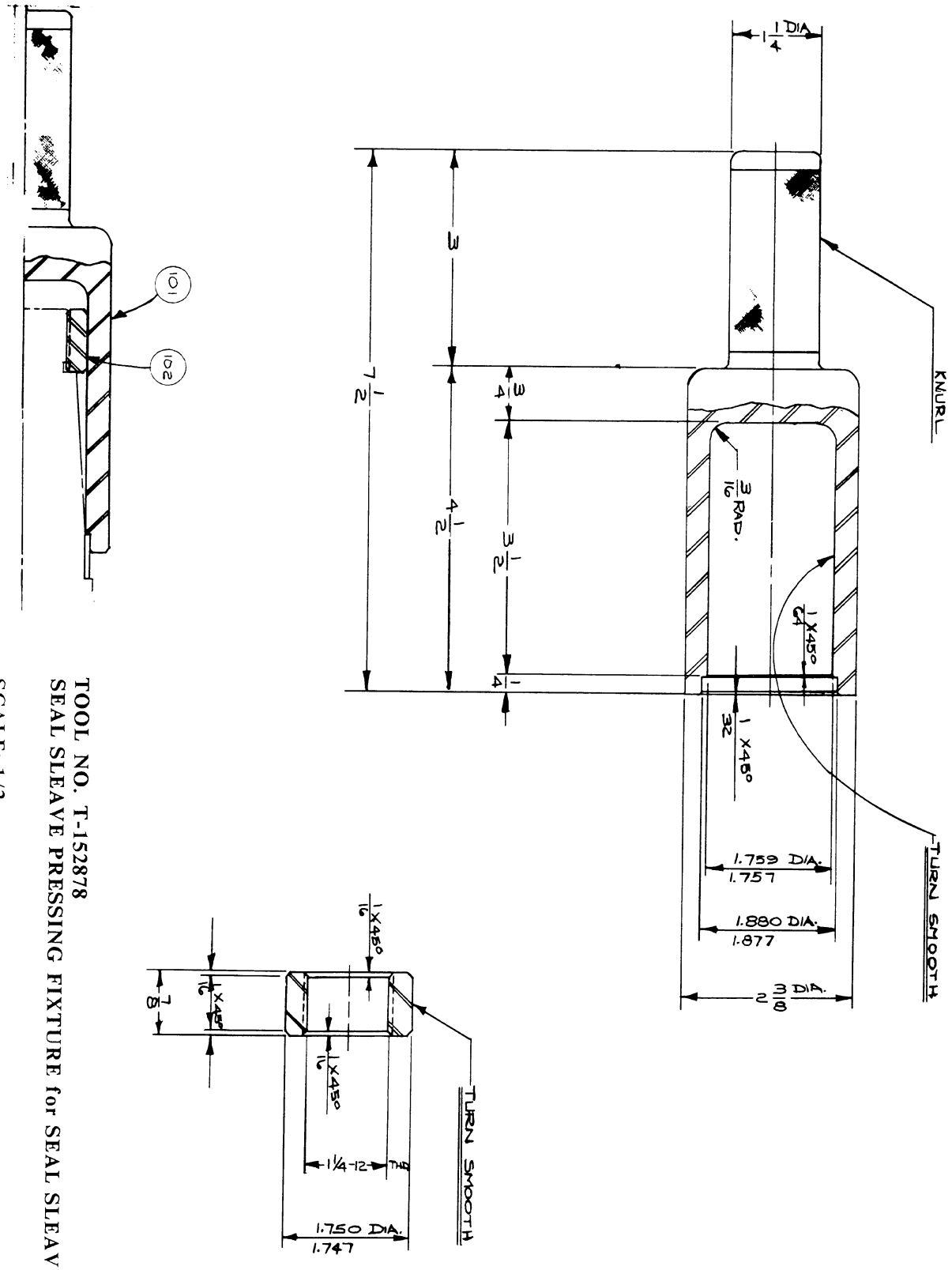
USE A 1/2" DRIVE BLACK SOCKET

SCALE: 1/2



TOOL NO. T-144581
SEAL PRESSING FIXTURE for SEAL(1B)

SCALE: 3/4



TOOL NO. T-152878
SEAL SLEAVE PRESSING FIXTURE for SEAL SLEAVE(10)

SCALE: 1/2

PARTS LIST

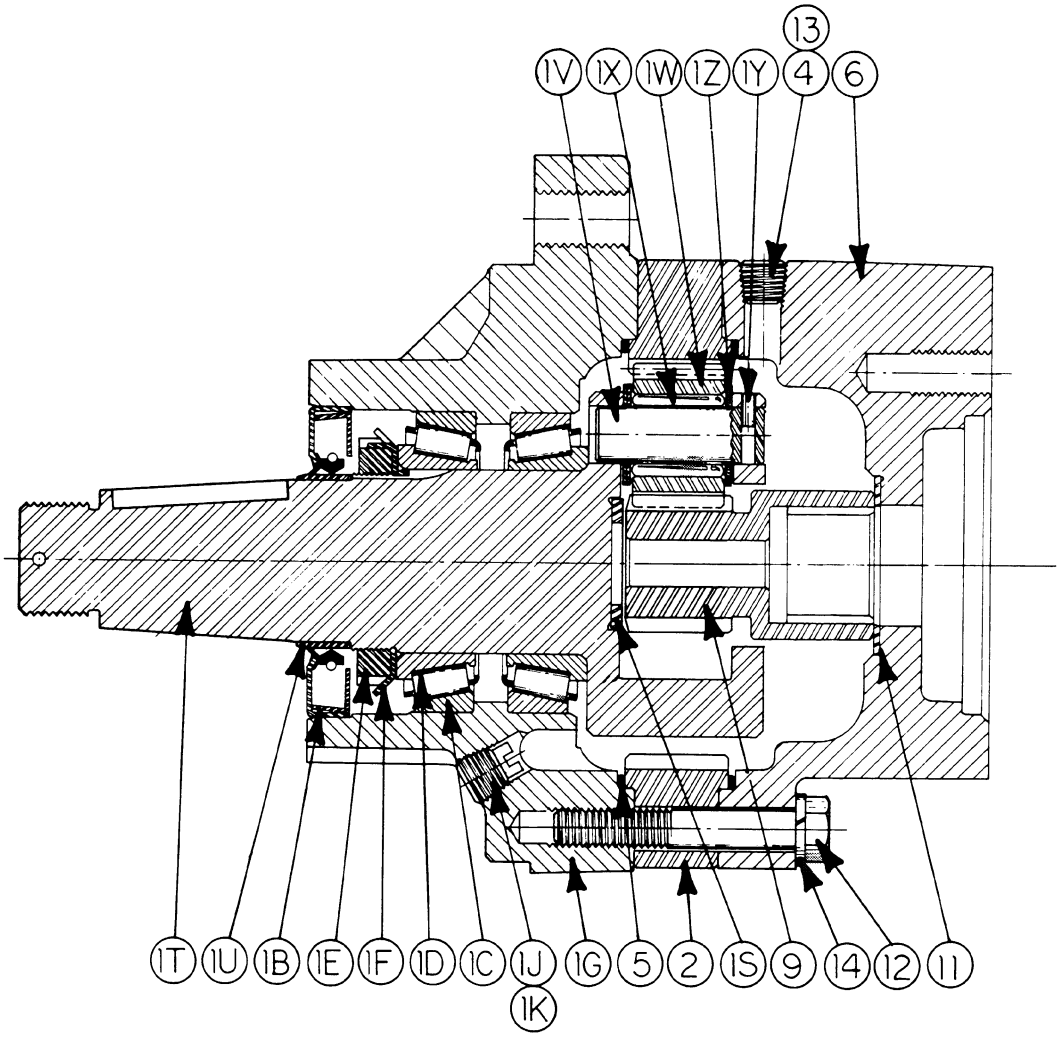
ITEM	QUANTITY	DESCRIPTION
1	1	hub-shaft sub-assembly
1B	1	seal
1C	2	bearing cup
1D	2	bearing cone
1E	1	locknut
1F	1	lockwasher
1G	1	hub
1K	3	magnetic pipe plug
1R	1	output shaft sub-assembly
1S	1	thrust washer
1T	1	output shaft/carrier
1V	3	planet shaft
1W	3	planet gear
1X	57	needle roller
1Y	3	spring pin
1Z	12	thrust washer

ADDITIONAL PARTS FOR UNITS WITHOUT A BRAKE

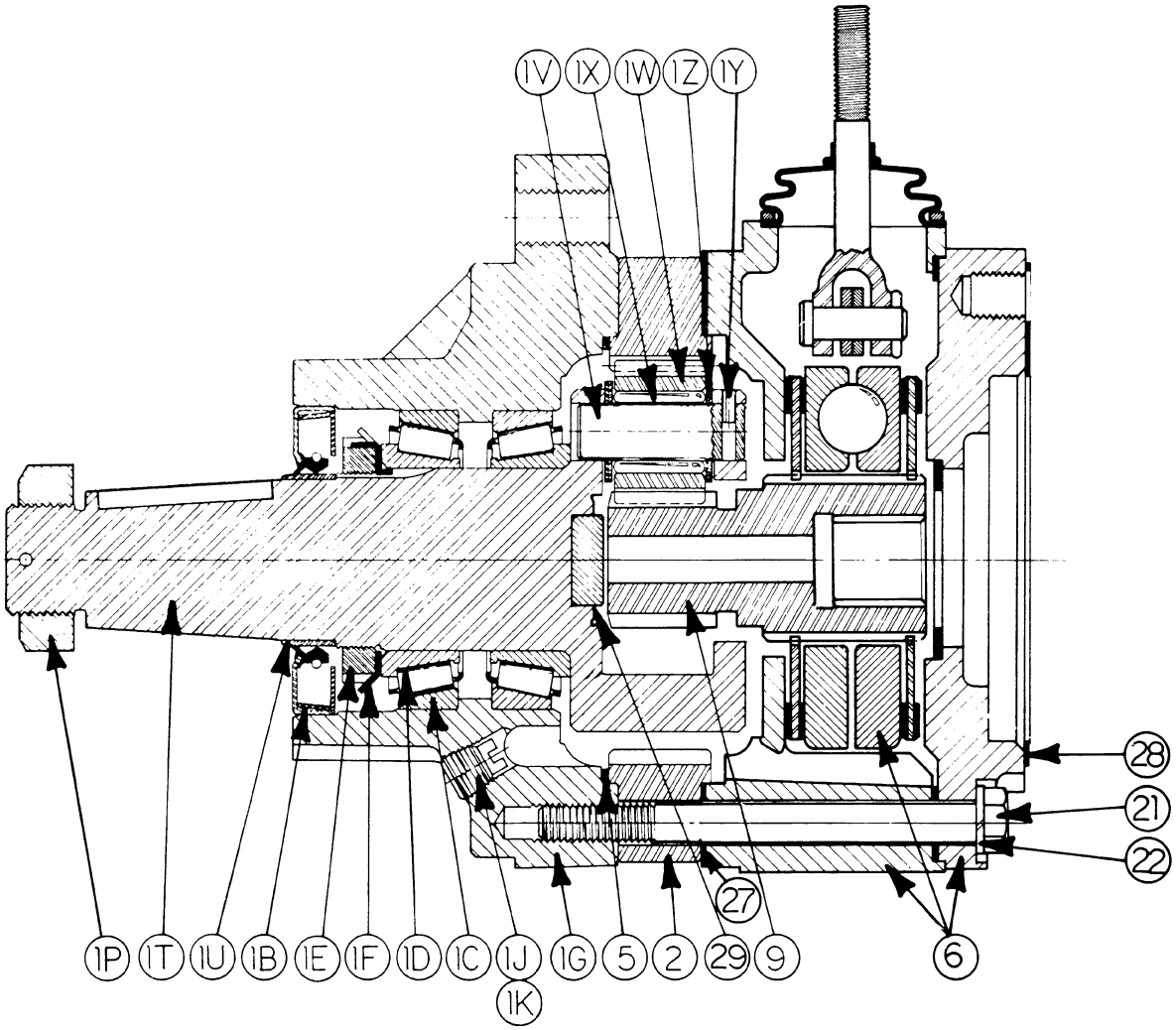
2	1	ring gear
4	4	pipe plug
5	2	"O" ring
6	1	cover
9	1	input gear
11	1	thrust washer
12	6	bolt
14	6	lock washer
24	1	ID plate
25	4	drive screw
26	2	dowel pin

ADDITIONAL PARTS FOR UNITS WITH A BRAKE

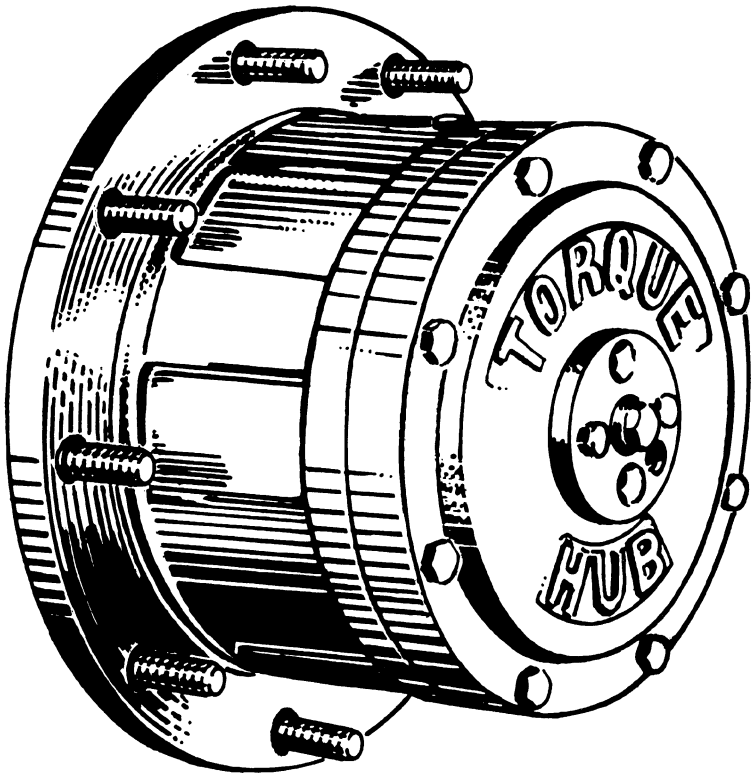
2	1	ring gear
5	1	"O" ring
6	1	brake
9	1	input gear
21	5	bolt
22	5	lock washer
24	1	ID plate
25	4	drive screw
26	2	dowel pin
27	1	gasket
29	1	thrust spacer



CROSS-SECTIONAL VIEW of SO7A WITHOUT BRAKE



CROSS-SECTIONAL VIEW of S07A WITH BRAKE



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WSM

WORKSHOP MANUAL
KUBOTA DIESEL ENGINES
D650-B/D750-B/D850-B
DH850-B/D950-B

MANUEL D'ATELIER
MOTEURS DIESEL KUBOTA
D650-B/D750-B/D850-B
DH850-B/D950-B

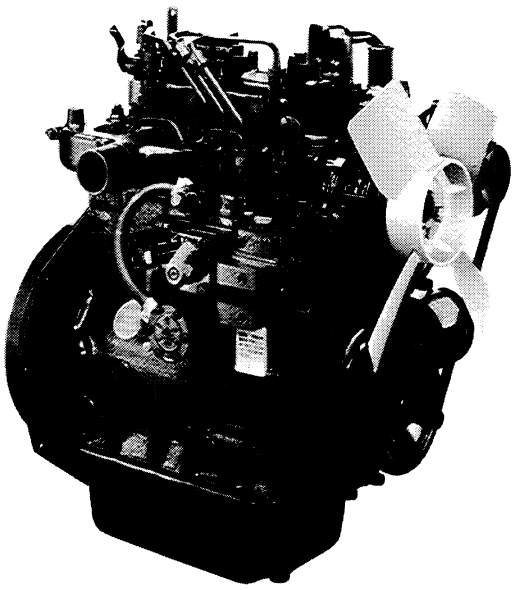
WERKSTATTANLEITUNG
KUBOTA DIESELMOTOREN
D650-B/D750-B/D850-B
DH850-B/D950-B

KUBOTA

INTRODUCTION

This Workshop Manual provides general description and comprehensive information for servicing Kubota D650-B, D750-B, D850-B, DH850-B, D950-B diesel engines. It consists of five sections as following:

- Section I: "General" covers specifications, performance curves, dimensions, preventive maintenance and so on.
- Section II : "Construction and Function" covers the newest information on the features, functions and constructions of these Kubota engines.
- Section III and IV: "Disassembly and Servicing of Engine" and "Disassembly and Servicing of Electrical System" cover disassembling and reassembling procedures, checking and servicing instructions. In addition, troubleshooting charts with reference pages are provided at the beginning of each section, which helps you to find out the cause of malfunctions easily.
- Section V: "Service Directions" covers all reference values and allowable limits for servicing.



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INTRODUCTION

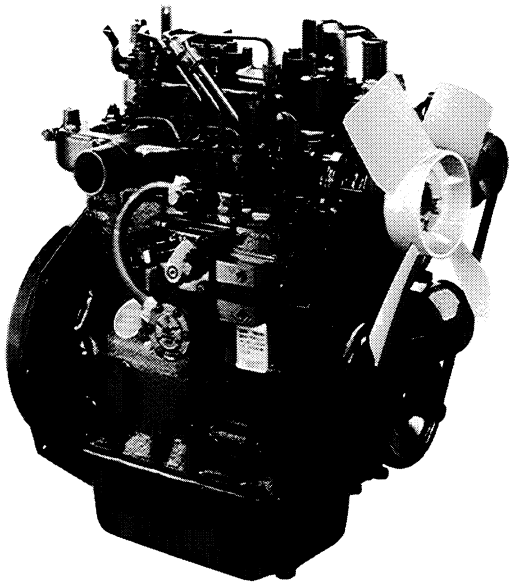
Le présent manuel d'atelier fournit la description générale et tous les renseignements pour l'entretien des moteurs diesel Kubota D650-B, D750-B, D850-B, DH850-B, D950-B. Il se divise en 5 parties:

- Section I: "Généralités". Elle traite des spécifications, des courbes de rendement, des dimensions, des examens périodiques, etc.

- Section II: "Agencement et Fonctionnement". Elle donne les renseignements les plus récents concernant les caractéristiques, les fonctions et l'agencement de ces moteurs.

- Section III et IV: "Démontage et Entretien du moteur" et "Démontage et Entretien du système électrique", présentent les opérations de démontage et de remontage, les instructions pour l'entretien et les vérifications. En outre, un tableau de dépannage avec référence aux pages est fourni au début de chaque partie, pour vous aider à trouver aisément la cause d'un ennui.

- Section V: "Mode d'entretien". Y figurent toutes les valeurs de référence et les tolérances nécessaires pour l'entretien.



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EINLEITUNG

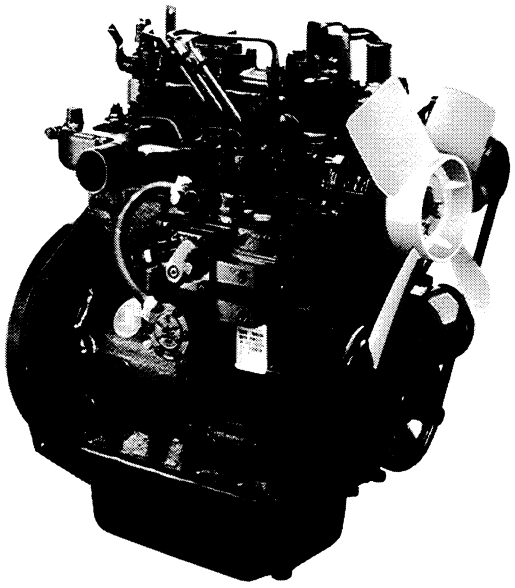
Diese Werkstattanleitung bietet eine allgemeine Beschreibung und umfangreiche Informationen für die Wartung der Kubota Dieselmotoren D650B, D750-B, D850-B, DH850-B, D950-B. Diese Anleitung besteht aus den folgenden fünf Teilen.

- Abschnitt I: "Allgemeines." Dieser Abschnitt befaßt sich mit technischen Daten, Leistungskurvenangaben, Abmessungen, regelmäßige Inspektionen, und so weiter.

- Abschnitt II: "Konstruktion und Funktion." In diesem Abschnitt werden neuste Informationen über die Eigenschaften, Funktionen und Konstruktionsweise der vorliegenden Kubota Dieselmotoren gegeben.

- Abschnitt III und IV: "Ausbau und Wartung des Motors" und "Ausbau und Wartung des elektrischen Systems". In diesen Abschnitten werden Anweisungen für das Zerlegen, Überprüfen und Warten sowie Zusammensetzen der Motoren gegeben. Darüberhinaus findet man in diesen Abschnitten eine Fehlersuchtabelle am Anfang eines jeden Abschnitts, wodurch die Ursache von eventuell auftretenden Störungen leicht unter Angabe der betreffenden Seitennummer aufgefunden werden kann.

- Abschnitt V: "Wartungsanweisungen." Hier werden alle für die Wartung wichtigen Referenzdaten und Grenzwerte aufgeführt.



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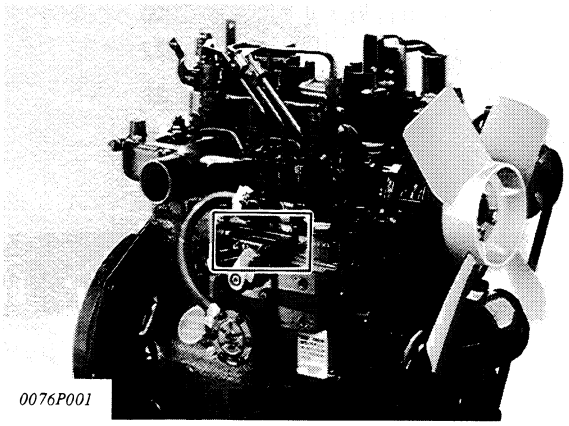
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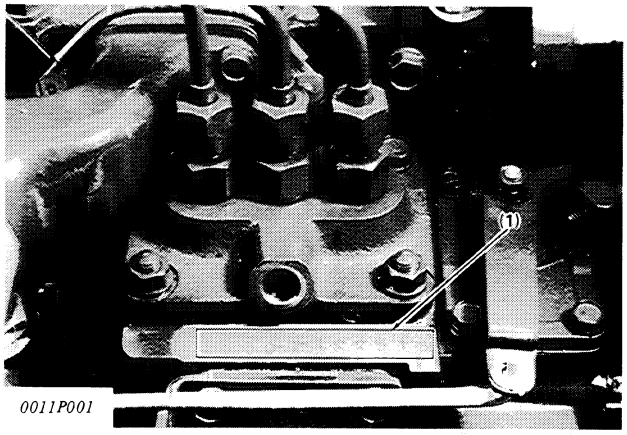
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1. ENGINE IDENTIFICATION



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When you inquire of the maker about this engine, be sure to confirm the serial number of your engine.



0011P001

(1) Serial number

1. IDENTIFICATION DU MOTEUR

Joindre à toute demande de renseignements adressée au fabricant le numéro de série de votre moteur.

(1) Numéro de série

1. MOTORENIDENTIFIKATION

Bei Erkundigungen über den vorliegenden Motor beim Hersteller muß darauf geachtet werden, daß die Seriennummer Ihres Motors festgestellt, und entsprechend im Schriftverkehr angegeben wird.

(1) Seriennummer

2. SPECIFICATIONS

1	**Model**		**D650-B**	**D750-B**
2	Type		Vertical, water-cooled 4-cycle diesel engine	
3	Number of Cylinders		3	
4	Bore and Stroke		64 x 70 mm · 2.52 x 2.76 in.	68 x 70 mm · 2.68 x 2.76 in.
5	Total Displacement		675cm^3 · 41.2 cu. in.	762cm^3 · 46.5 cu. in.
6	Brake H. P.	DIN 6270-NA	8.5kW/3000rpm · 11.5ps/3000rpm	9.6kW/3000rpm · 13.0ps/3000rpm
		DIN 6270-NB	9.2kW/3000rpm · 12.5ps/3000rpm	10.7kW/3000rpm · 14.5ps/3000rpm
		DIN 70020-NF	10.3kW/3000rpm · 14.0ps/3000rpm	11.8kW/3000rpm · 16.0ps/3000rpm
		SAE Gross H. P.	11.2kW/3000rpm · 15.0HP/3000rpm	12.7kW/3000rpm · 17.0HP/3000rpm
		SAE Intermittent H. P.	9.7kW/3000rpm · 13.0HP/3000rpm	11.2kW/3000rpm · 15.0HP/3000rpm
		SAE Cont. H. P.	8.6kW/3000rpm · 11.5HP/3000rpm	9.7kW/3000rpm · 13.0HP/3000rpm
7	Maximum Bare Speed		3200rpm	
8	Minimum Bare Speed		800 rpm	
9	Maximum torque		36.5Nm, 3.72kgf·m, 26.9ft-lbs/1800rpm	42.2Nm, 4.30kgf·m, 31.1ft-lbs/1800rpm
10	Combustion Chamber		Spherical Type	
11	Fuel Injection Pump (Model)		Bosch Type K Mini Pump (NP-PFR3KD50/2NP4)	
12	Plunger Bore		5mm · 0.197in.	
13	Governor		Centrifugal Ball Mechanical Governor	
14	Injection Nozzle Type (Model)		"Throttle" Type (ND-DN12 SD12)	
15	Injection Timing		25° before Top Dead Center	
16	Injection Pressure		13.7MPa · 140kgf/cm^2 · 1990psi	
17	Compression Ratio		22	
18	Lubricating System		Forced Lubrication by Rotor-type Pump	
19	Lubricating Oil Filter		Full Flow Paper Filter (Cartridge type)	
20	Oil Pressure Adjustment		Ball type valve	
21	Lubricating Oil Capacity		4.6 ℓ 1.22 U.S. gals 1.01 Imp. gals	
22	Cooling System		Pressurized Radiator, Forced Circulation (with pump)	
23	Starting System		Electric Starting with Cell Starter	
24	Battery		12V, 45AH, equivalent	
25	Starting Support Device		By Glow Plug in Combustion Chamber	
26	Dynamo for Charging		12V, 150W	
27	Fuel		Disel Fuel No. 2-D (ASTM D975)	
28	Weight (Dry)		810N · 82.6kg · 182 lbs	805N·82.1 kg · 181 lbs
29	Injection Order		1 – 2 – 3	
30	Direction of Rotation		Counterclockwise (viewed from flywheel side)	
31	Application		General Power Source	

D850-B	DH850-B	D950-B
Vertical, water-cooled 4-cycle diesel engine		
3		
72 x 70mm · 2.83 x 2.76 in.		75 x 70mm · 2.95 x 2.76in.
855cm^3 · 52.2 cu. in.		927cm^3 · 56.6 cu. in.
11.4kW/3000rpm · 15.5ps/3000rpm	12.9kW/3600rpm · 17.5ps/3600rpm	12.5kW/3000rpm · 17.0ps/3000rpm
12.5kw/3000rpm · 17.0ps/3000rpm	14.7kW/3600rpm · 20.0ps/3600rpm	13.6kW/3000rpm · 18.5ps/3000rpm
14.0kW/3000rpm · 19.0ps/3000rpm	16.2kW/3500rpm · 22.0ps/3600rpm	15.1kW/3000rpm · 20.5ps/3000rpm
14.9kW/3000rpm · 20.0HP/3000rpm	17.2kw/3600rpm · 23.0HP/3600rpm	16.0kW/3000rpm · 21.5HP/3000rpm
13.4kW/3000rpm · 18.0HP/3000rpm	15.7kW/3600rpm · 21.0HP/3600rpm	14.5kW/3000rpm · 19.5HP/3000rpm
11.6kW/3000rpm · 15.5HP/3000rpm	13.1kW/3600rpm · 17.5HP/3600rpm	12.7kW/3000rpm · 17.0HP/3000rpm
3200rpm	3780rpm	3200rpm
800 rpm		
50.6Nm, 5.16kgf·m, 37.3ft-lbs/1800rpm	49.9Nm, 5.09kgf·m, 36.8ft-lbs/1800rpm	55.6Nm, 5.67kgf·m, 41.0ft-lbs/1800rpm
Spherical Type		
Bosh Type K Mini Pump (NP-PFR3KD50/2NP4)		
5mm · 0.197in.		
Centrifugal Ball Mechanical Governor		
"Throttle" Type (ND-DN12 SD12)		
25° before Top Dead Center		
13.7MPa · 140kgf/cm^2 · 1990 psi		
22		
Forced Lubrication by Rotor-type Pump		
Full Flow Paper Filter (Cartridge type)		
Ball type valve		
4.6 ℓ 1.22 U.S. gals 1.01 Imp. gals	3.7ℓ 0.98 U.S. gals 0.81 Imp. gals	4.6ℓ 1.22 U.S. gals 1.01 Imp. gals
Pressurized Radiator, Forced Circulation (with pump)		
Electric Starting with Cell Starter		
12V, 45AH, equivalent		
By Glow Plug in Combustion Chamber		
12V, 150W		
Diesel Fuel No. 2-D (ASTM D975)		
810N · 82.6kg · 182 lbs		814N · 83.1kg · 183 lbs
1 – 2 – 3		
Counterclockwise (viewed from flywheel side)		
General Power Source		

2. SPECIFICATIONS

1	**Modèle**		**D650-B**	**D750-B**
2	Type		Vertical, refroidissement hydraulique avec moteur diesel à 4 temps	
3	Nombre de cylindres		3	
4	Alésage et course		64 x 70mm	68 x 70mm
5	Taux de capacité		675cc	762cc
6	Chevaux-Vapeur (Par Frein)	DIN 6270-NA	8,5kW/3000tr/mn · 11,5ps/3000tr/mn	9,6kW/3000tr/mn ·13,0ps/3000tr/mn
		DIN 6270-NB	9,2kW/3000tr/mn · 12,5ps/3000tr/mn	10,7kW/3000tr/mn · 14,5ps/3000tr/mn
		DIN 70020-NF	10,3kW/3000tr/mn · 14,0ps/3000tr/mn	11,8kW/3000tr/mn · 16,0ps/3000tr/mn
		SAE Indiqué C.V.	11,2kW/3000tr/mn · 15,0HP/3000tr/mn	12,7kW/3000tr/mn · 17,0HP/3000tr/mn
		SAE Intermittent C.V.	9,7kW/3000tr/mn · 13,0HP/3000tr/mn	11,2kW/3000tr/mn · 15,0HP/3000tr/mn
		SAE Continu C.V.	8,6kW/3000tr/mn · 11,5HP/3000tr/mn	9,7kW/3000tr/mn · 13,0HP/3000tr/mn
7	Maximum vitesse déchargé		3200tr/mn	
8	Minimum vitesse déchargé		800tr/mn	
9	Maximum couple		36,5Nm·3,72kgf·m/1800tr/mn	42,2Nm·4,30kgf·m/1800tr/mn
10	Chambre de combustion		Chambre Sphérique	
11	Pompe à huile (Modèle)		Mini-pompe K de Bosch (NP-PFR3KD50/2NP4)	
12	Alésage du piston		5 mm	
13	Régulateur		Régulateur à boules	
14	Injecteur		ND-DN12 SD12,type "régulateur"	
15	Temps d'injection		25° avant le point mort haut	
16	Pression d'injection		13,7MPa · 140kgf/cm^2	
17	Rapport de compression		22	
18	Système de lubrification		Graissage sous pression par pompe de type rotor	
19	Filtre à huile de graissage		Filtre de papier à écoulement total (type cartouche)	
20	Réglage de la pression d'huile		Soupape à boulet	
21	Contenance en huile de graissage		4,6 ℓ	
22	Refroidissement		Radiateur presseur, Circulation forcée (Avec pompe à eau)	
23	Démarrage		Démarreur électrique	
24	Batterie		12V, 45AH, équivalent	
25	Dispositif auxiliaire de démarrage		Par bougie incandescente dans la chambre de combustion	
26	Dynamo		12V, 150W	
27	Essence		Gas-oil No. 2-D (ASTM D975)	
28	Poids (sec)		810N · 82,6kg	805N·82,1kg
29	Séquence d'injection		1 – 2 – 3	
30	Sens de rotation		En sens inverse des aiguilles d'une montre (vu du volant moteur)	
31	Application		Source de force motrice générale	

D850-B	DH850-B	D950-B
Vertical, refroidissement hydraulique avec moteur diesel à 4 temps		
3		
72 x 70mm		75 x 70mm
855cc		927cc
11,4kW/3000tr/mn · 15,5ps/3000tr/mn	12,9kW/3600tr/mn, 17,5ps/3600tr/mn	12,5kW/3000tr/mn, 17,0ps/3000tr/mn
12,5kW/3000tr/mn · 17,0ps/3000tr/mn	14,7kW/3600tr/mn, 20,0ps/3600tr/mn	13,6kW/3000tr/mn, 18,5ps/3000tr/mn
14,0kW/3000tr/mn· 19,0ps/3000tr/mn	16,2kW/3600tr/mn, 22,0ps/3600tr/mn	15,1kW/3000tr/mn, 20,5ps/3000tr/mn
14,9kW/3000tr/mn · 20,0HP/3000tr/mn	17,2kW/3600tr/mn, 23,0HP/3600tr/mn	16,0kW/3000tr/mn, 21,5HP/3000tr/mn
13,4kW/3000tr/mn · 18,0HP/3000tr/mn	15,7kW/3600tr/mn, 21,0HP/3600tr/mn	14,5kW/3000tr/mn, 19,5HP/3000tr/mn
11,6kW/3000tr/mn · 15,5HP/3000tr/mn	13,1kW3600tr/mn, 17,5HP/3600tr/mn	12,7kW/3000tr/mn, 17,0HP/3000tr/mn
3200tr/mn	3780tr/mn	3200tr/mn
800tr/mn		
50,6Nm·5,16kgf·m /1800tr/mn	49,9Nm·5,09kgf·m/1800tr/mn	55,6Nm·5,67kgf·m/1800tr/mn
Chambre Sphérique		
Mini-pompe K de Bosch (NP-PFR3KD50/2NP4)		
5mm		
Régulateur à boules		
ND-DN 12 SD12, type "régulateur"		
25° avant le point mort haut		
13,7MPa · 140kgf/cm^2		
22		
Graissage sous pression par pompe de type rotor		
Filtre de papier à écoulement total (type cartouche)		
Soupape à boulet		
4,6 ℓ	3,7 ℓ	4,6 ℓ
Radiateur presseur, Circulation forcée (Avec pompe à eau)		
Démarreur électrique		
12V, 45AH, équivalent		
Par bougie incandescente dans la chambre de combustion		
12V, 150W		
Gas-oil No. 2-D (ASTM D975)		
810N · 82,6kg		814N · 83,1kg
1 – 2 – 3		
En sens inverse des aiguilles d'une montre (vu du volant moteur)		
Source de force motrice générale		

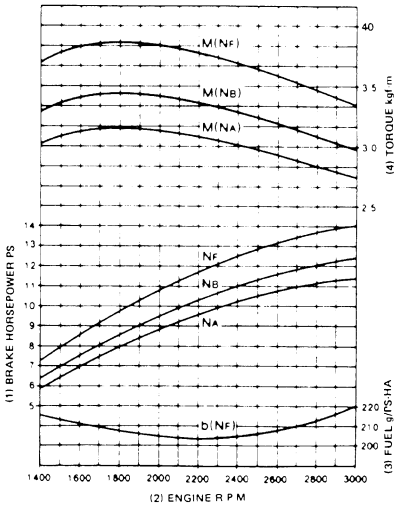
2. SPEZIFIKATIONEN

1	**Modell**		**D650-B**	**D750-B**
2	Typ		Vertikaler, Wasser-gekühlter 4-Takt Dieselmotor	
3	Zylinderzahl		3	
	Bohrung und Hub		64 x 70mm	68 x 70mm
5	Hubraum		675cm^3	762cm^3
6	Bremsleistung PS	DIN 6270-NA	8,5kW/3000Upm · 11,5ps/3000Upm	9,6kW/3000Upm · 13,0ps/3000Upm
		DIN 6270-NB	9,2kW/3000Upm · 12,5ps/3000Upm	10,7kW/3000Upm · 14,5ps/3000Upm
		DIN 70020-NF	10,3kW/3000Upm · 14,0ps/3000Upm	11,8kW/3000Upm · 16,0ps/3000Upm
		SAE Total PS	11,2kW/3000Upm · 15,0HP/3000Upm	12,7kW/3000Upm · 17,0HP/3000Upm
		SAE Interm. PS	9,7kW/3000Upm · 13,0HP/3000Upm	11,2kW/3000Upm · 15,0HP/3000Upm
		SAE Anhalt PS	8,6kW/3000Upm · 11,5HP/3000Upm	9,7kW/3000Upm · 13,0HP/3000Upm
7	Maximale Durchlaufgeschwindigkeit		3200Upm	
8	Minimale Leerlaufdrehzahl		800Upm	
9	Maximaler Drehmomentwert		36,5Nm · 3,72kp·m/1800Upm	42,2Nm · 4,30kp·m/1800Upm
10	Verbrennungskammer		Kugelförmiger Typ	
11	Kraftstoff-Einspritzpumpe		Kleinpumpe, Bosch K-Typ (NP-PFR3KD50/2NP4)	
12	Druckkolbenhub		5mm	
13	Steuerung		Zentrifugaler mechanischer Ballregulator	
14	Einspritzdüse		Drosseltyp (ND-DN12 SD12)	
15	Einspritzeinstellzeit		25° vor dem Hochpunkt	
16	Einspritzdruck		13,7MPa · 140kp/cm^2	
17	Verdichtungsverhältnis		22	
18	Schmierungssystem		Zwangsschmierung durch Rotortyp Pumpe	
19	Schmierungsölfilter		Vollflußpapierfilter (Patronen-Typ)	
20	Öldruckeinstellung		Kugelventiltyp	
21	Schmierungsölkapazität		4,6 ℓ	
22	Kühlsystem		Druckkühler, Vorgesehene Regulation (mit Wasserpumpe)	
23	Anlassersystem		Elektrischer Start mit Zellenanlasser	
24	Batterie		12V, 45AH, gleich	
25	Anlasserunterstützungsvorrichtung		Durch Glühkerze in der Verbrennungskammer	
26	Lichtmaschine zum Aufladen		12V, 150W	
27	Kraftstoff		Dieselkraftstoff Nr. 2-D (ASTM D975)	
28	Gewicht		810N · 82,6kg	805N · 82,1kg
29	Zündfolge		1 – 2 – 3	
30	Drehrichtung		Zähle gegen den Uhrzeigersinn vom Schwungrad aus	
31	Anwendung		Grundkraftquelle	

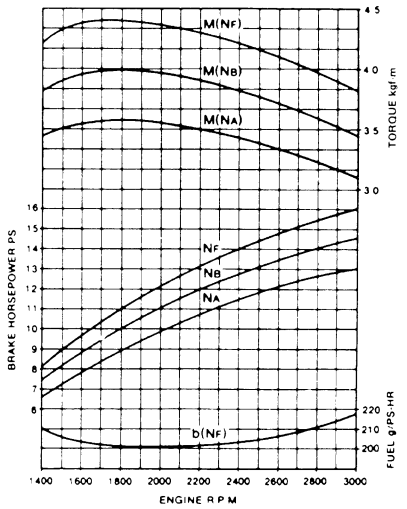
D850-B	DH850-B	D950-B
Vertikaler, Wasser-gekühlter 4-Takt Dieselmotor		
3		
72 x 70mm		75 x 70mm
855cm^3		927cm^3
11,4kW/3000Upm · 15,5ps/3000Upm	12,9kW/3600Upm · 17,5ps/3600Upm	12,5kW/3000Upm · 17,0ps/3000Upm
12,5kW/3000Upm · 17,0ps/3000Upm	14,7kW/3600Upm · 20,0ps/3600Upm	13,6kW/3000Upm · 18,5ps/3000Upm
14,0kW/3000Upm · 19,0ps/3000Upm	16,2kW/3600Upm · 22,0ps/3600Upm	15,1kW/3000Upm · 20,5ps/3000Upm
14,9kW/3000Upm · 20,0HP/3000Upm	17,2kW/3600Upm · 23,0HP/3600Upm	16,0kW/3000Upm · 21,5HP/3000Upm
13,4kW/3000Upm · 18,0HP/3000Upm	15,7kW/3600Upm · 21,0HP/3600Upm	14,5kW/3000Upm · 19,5HP/3000Upm
11,6kW/3000Upm · 15,5HP/3000Upm	13,1kW/3600Upm · 17,5HP/3600Upm	12,7kW/3000Upm · 17,0HP/3000Upm
3200Upm	3780Upm	3200Upm
800Upm		
50,6Nm · 5,16kp·m/1800Upm	49,9Nm · 5,09kp·m/1800Upm	55,6Nm · 5,67kp·m/1800Upm
Kugelförmiger Typ		
Kleinpumpe, Bosch K-Typ (NP-PFR3KD50/2NP4)		
5 mm		
Zentrifugaler mechanischer Ballregulator		
Drosseltyp (ND-DN12 SD12)		
25° vor dem Hochpunkt		
13,7MPa · 140kp/cm^2		
22		
Zwangsschmierung durch Rotortyp Pumpe		
Vollflußpapierfilter (Patronen-Typ)		
Kugelventiltyp		
4,6 ℓ	3,7 ℓ	4,6 ℓ
Druckkühler, Vorgesehene Regulation (mit Wasserpumpe)		
Elektrischer Start mit Zellenanlasser		
12V, 45AH, gleich		
Durch Glühkerze in der Verbrennungskammer		
12V, 150W		
Dieselkraftstoff Nr. 2-D (ASTM D975)		
810N · 82,6kg		814N · 83,1kg
1 – 2 – 3		
Zähle gegen den Uhrzeigersinn vom Schwungrad aus		
Grundkraftquelle		

3. PERFORMANCE CURVES

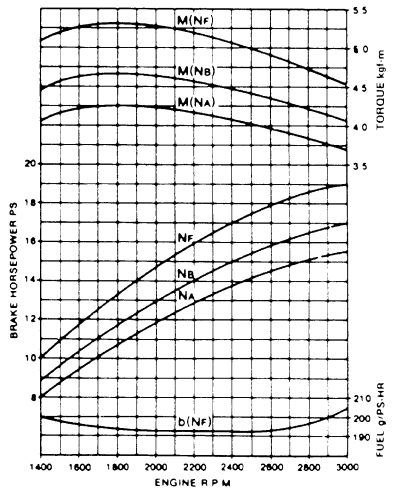
■ D650-B



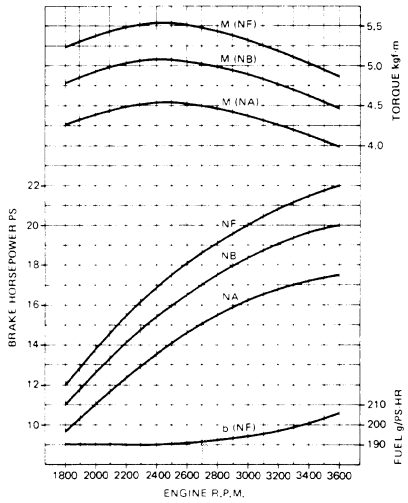
■ D750-B



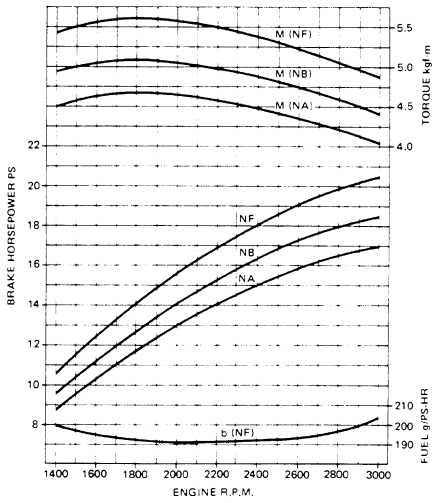
■ D850-B



■ DH850-B



■ D950-B



Note:
Each performance curves, obtained in accordance with DIN 6270 and DIN 70020, are corrected to 760mmHg, and 20°C, 60% humidity.

(1) Brake horsepower
(2) Engine rpm
(3) Fuel
(4) Torque

Notice:
Les courbes de performance présentées ici ont été établies en conformité avec DIN 6270 et DIN 70020, et corrigées à 760mmHg, et 20°C, humidité 60%.

(1) Puissance au frein
(2) Tr/min
(3) Combustible
(4) Couple

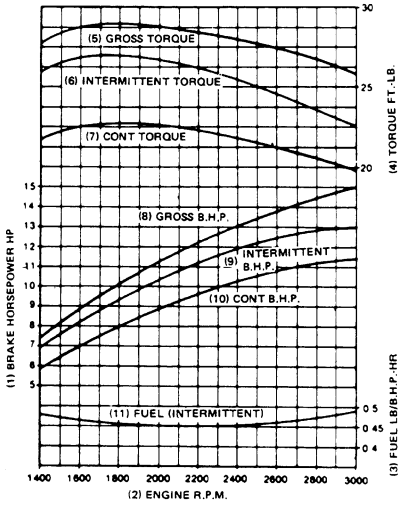
Anmerkung:
Jede Leistungskurve aufgestellt in Übereinstimmung nach DIN 6270 und DIN 70020, wurde abgestimmt auf 760mmHg und 20°C, sowie 60% Luftfeuchtigkeit.

(1) Bremspferdekraft
(2) Motordrehzahl
(3) Brennstoff
(4) Drehkraft

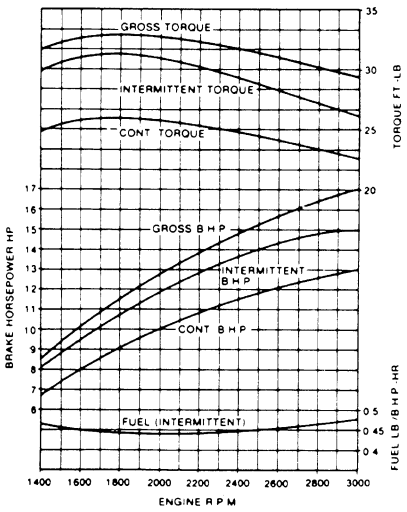
3. COURBES DE PERFORMANCE

3. LEITUNGSKURVEN

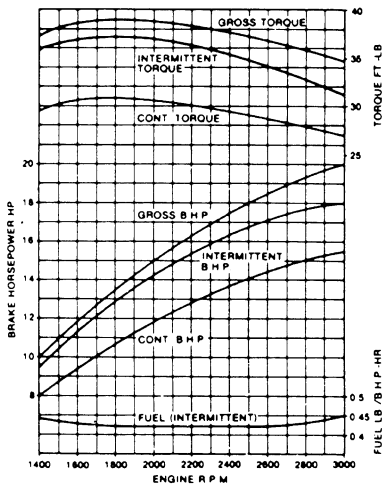
■ D650-B



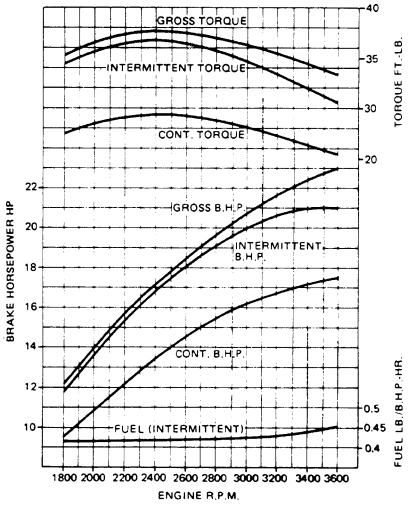
■ D750-B



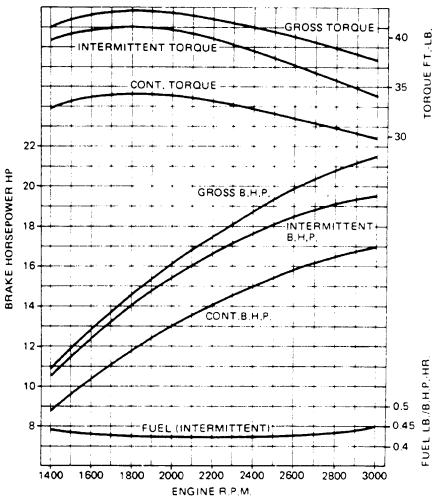
■ D850-B



■ DH850-B



■ D950-B



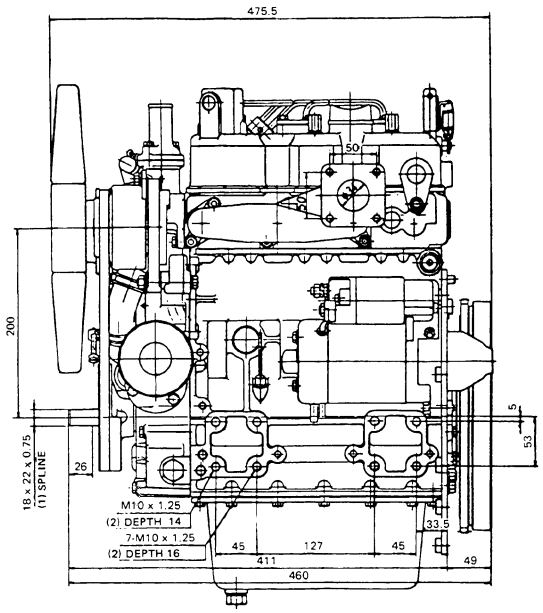
Note:
Each performance curves, obtained in accordance with SAE J1816b, are corrected to 760mmHg, and 20°C, 60% humidity

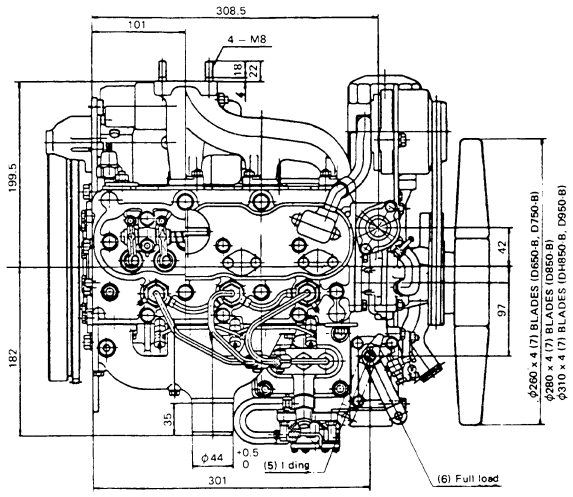
Notice:
Les courbes de performance présentés ici ont été établies en conformittant avec SAE J816b, et corrigées à 760mmHg, et 20°C, humidité 60%.

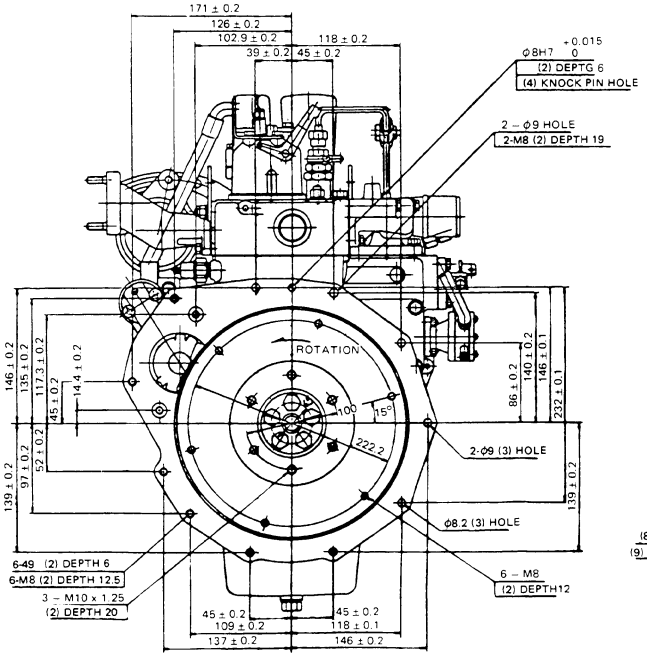
Anmerkung:
Jede Leistungskurve autgestellt in Übereinstimmung nach SAE J816b, wurde abgestimmt auf 760mmHg und 20°C, aowie 60% Luftfeuchtigkeit.

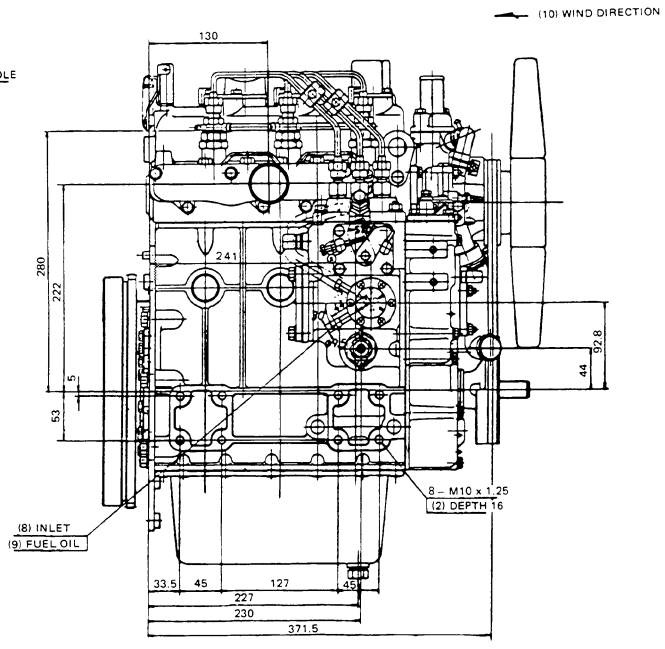
(1) Brake horsepower	**(1) Puissance au frein**	**(1) Bremspferdekraft**
(2) Engine rpm	**(2) Tr/min du moteur**	**(2) Motordrehzahl**
(3) Fuel	**(3) Combustible**	**(3) Brennstoff**
(4) Torque	**(4) Couple**	**(4) Drehkraft**
(5) Gross torque	**(5) Couple brut**	**(5) Bruttodrehkraft**
(6) Intermittent torque	**(6) Couple intermittent**	**(6) Pulsierende Drehkraft**
(7) Cont torque	**(7) Couple continu**	**(7) Dauerdrehmoment**
(8) Gross B H P	**(8) Puissance au frein brute**	**(8) Brutto-Bremspferdekraft**
(9) Intermittent BHP	**(9) Puissance au frein intermittente**	**(9) Pulsierende Bremspferdekraft**
(10) Cont BHP	**(10) Puissance au continue**	**(10) Dauernde Bremspferdekraft**
(11) Fuel (intermittent)	**(11) Combustible (intermittent)**	**(11) Brennstoff (Pulsierend)**

4. DIMENSIONS



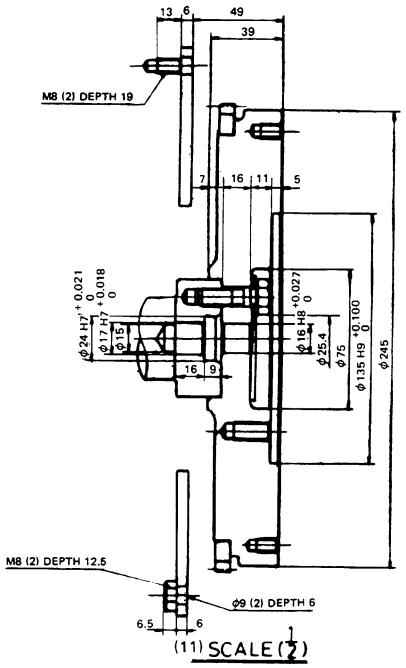


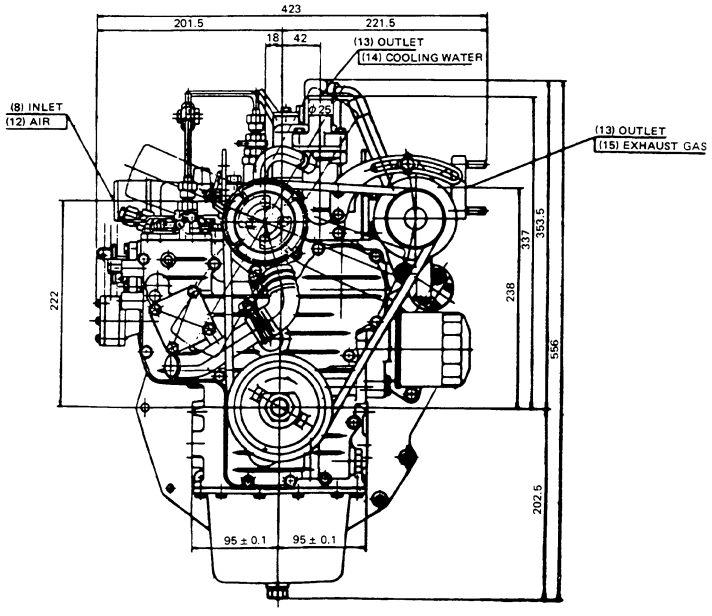




4. DIMENSIONS

4. ABMESSUNGEN





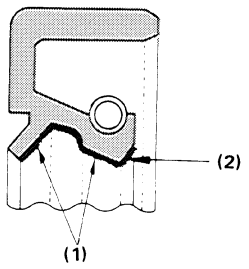
(1) Spline
(2) Depth
(3) Hole
(4) Knock pin hole
(5) Idling
(6) Full load
(7) Blades
(8) Inlet
(9) Fuel oil
(10) Wind direction
(11) Scale
(12) Air
(13) Outlet
(14) Cooling water
(15) Exhaust

(1) Rainure
(2) Profondeur
(3) Trou
(4) Trou de goupille
(5) Ralenti
(6) Maximum
(7) Ailes
(8) Admission
(9) Carburant
(10) Direction du vent
(11) Echelle
(12) Ain
(13) Emission
(14) Eau réfrigerante
(15) Echappement

(1) Federnute
(2) Tiefe
(3) Loch
(4) Klopfenloch
(5) Leerlauf
(6) Volllast
(7) Flügel
(8) Einlaß
(9) Treiböl
(10) Windrichtung
(11) Maßstab
(12) Luft
(13) Ablauf
(14) Kühlwasser
(15) Auslaß

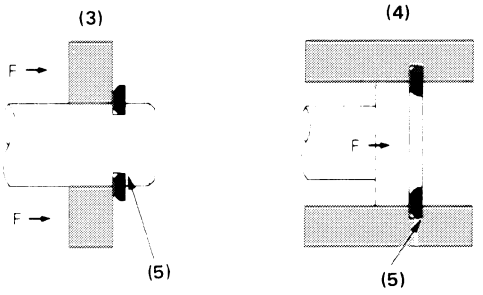
5. GENERAL WARNINGS

[A] Applying grease to oil seal



C023F066

[B] Direction of installing circlips



C039F083

1) When disassembling, arrange each part on a clean place. Do not mix them up. Replace bolts and nuts where they were.
2) When servicing voltaged places or connecting instruments to electrical equipment, first disconnect battery negative terminal.
3) If special tools are needed for repairing, use KUBOTA-supplied tools.
4) Replace gaskets or O-rings with new ones when disassembling, and apply grease on the O-ring and the oil seal when reassembling.
5) When exchanging parts, use KUBOTA-genuine parts to maintain engine performance and safety.
6) To prevent oil and water leakage, apply non-drying adhesive to the gaskets according to this manual before reassembling.
7) When hoisting up the engine, use the hook provided on the cylider head.
8) When installing external circlips or internal circlips, direct corner end to the non-loosening direction.

(1) Inside of lip
(2) Grease
(3) External circlip
(4) Internal circlip
(5) Direct the corner end to the direction subject to force.

5. RECOMMANDATIONS GENERALES

1) Au démontage, placer chaque élément dans un endroit propre. Ne pas les mélanger. Replacer boulons et écrous où ils étaient.
2) Lors de l'entretien de pièces sous tension ou de l'emploi de dispositifs électriques, débrancher d'abord le fil négatif de la batterie.
3) S'il faut utiliser des outils spéciaux pour la réparation, utiliser les outils KUBOTA prévus.
4) Au démontage, remplacer par des neufs les joints et joints toriques et appliquer de la graisse sur le joint torique et le joint d'huile, au remontage.
5) Lors du changement de pièces, utiliser les pièces KUBOTA prévues, pour maintenir le rendement du moteur et par mesure de sécurité.
6) Pour empêcher les fuites d'huile et d'eau, appliquer un joint liquide aux garnitures désignées, avant de remonter.
7) Au moment de soulever le moteur, utiliser le crochet fixé sur la culasse.
8) Au moment de fixer les anneaux fendus d'arbre er de trou, fixer le coin carré du côté supportant la force.

[A] Graissage du joint d'huile
(1) Intérieur du bord
(2) Graisse
[B] Direction d'installation des anneaux fendus
(3) Anneau d'arbre
(4) Anneau de trou
(5) Orienter le coin du côté où s'applique la force.

5. ALLGEMEINE VORSICHTSMASSNAHMEN

1) Beim Zerlegen des Motors die einzelnen abgenommenen Teile an einen sauberen Platz legen. Die Teile dürfen nicht durcheinandergebracht werden. Die Bolzen, Schrauben und Muttern wieder an ihrem ursprünglichen Platz anbringen.
2) Bei Wartungsarbeiten an Teilen, die unter Spannung stehen, oder bei Verwendung von elektrischen Geräten, vor den Wartungsarbeiten zuerst das negative Kabel abnehmen bzw.
3) Falls Spezialwerkzeuge für die Reparatur- oder Wartungsarbeiten erforderlich sein sollten, unbedingt KUBOTA-Spezialwerkzeuge verwenden.
4) Beim Zerlegen von Kolben usw, die Dichtungen und O-Ringe auswechseln und die O-Ringe und Öldichtungen beim Zusammensetzen entsprechend einölen.
5) Beim Auswechseln von Maschinenteilen des Motors sollten unbedingt nur KUBOTA-Originalteile verwendet werden, um die Leistungsfähigkeit und Sicherheit des Motors zu gewährleisten.
6) Um Öl- und Wasserdurchsickerungen zu verhindern, müssen Flüssigkeitsdichtungen an den entsprechenden Dichtungen angebracht werden.
7) Beim Anheben des Motors nur den Hebehaken, der am Zylinderkopf angebracht ist, benutzen.
8) Beim Einsetzen der Achsenklammern oder Lochklammern muß das Eckenende in die nichtlösende Richtung gebracht werden.

[A] Eine Schmierungs-Ölabdichtung auftragen:
(1) Innenrand
(2) Schmierung
[B] Richtung des Einsetzens der Klammern:
(3) Achsenklammer
(4) Lochklammer
(5) Das Eckenende gegen die Kraftaufnahmerichtung bringen.

6. BOLT TORQUES

As a lot of bolts and nuts in the engine are of special shape, be careful to tighten them correctly using a torque wrench. When tightening, follow this method:
First tighten all the bolts 50% of the regular torque, then tighten them fully.

6-1 TIGHTENING BOLTS OF IMPORTANT PARTS

■ Marked bolts must be tightened after applying oil.

		D650-B D750-B	D850-B DH850-B D950-B
▪ Head bolts and nuts		39.2 to 44.1Nm 4.0 to 4.5kgf·m 28.9 to 32.5ft·lbs	64.7 to 69.6Nm 6.6 to 7.1kgf·m 47.7 to 51.4ft·lbs
▪ Bearing case bolts 1		19.6 to 23.5Nm 2.0 to 2.4kgf·m 14.5 to 17.4ft·lbs	
▪ Bearing case bolts 2		29.4 to 34.3Nm 3.0 to 3.5kgf·m 21.7 to 25.3ft·lbs	
▪ Flywheel bolts		53.9 to 58.8Nm 5.5 to 6.0kgf·m 39.8 to 43.4ft·lbs	
▪ Connecting rod bolts		26.5 to 30.4Nm 2.7 to 3.1kgf·m 19.5 to 22.4ft·lbs	
▪ Rocker arm bracket studs		16.7 to 20.6Nm 1.7 to 2.1kgf·m 12.3 to 15.2ft·lbs	
▪ Idle gear shaft bolts		9.806 to 11.28Nm 1.00 to 1.15kgf·m 7.233 to 8.318ft·lbs	
Glow plugs (No need to apply oil)		19.6 to 24.5Nm 2.0 to 2.5kgf·m 14.5 to 18.1ft·lbs	
Drain plugs		39.2 to 49.0Nm 4.0 to 4.5kgf·m 28.9 to 36.2ft·lbs	
Nozzle holders		29.4 to 49.0Nm 3.0 to 5.0kgf·m 21.7 to 36.2ft·lbs	
Oil switch	Bis	1.37 to 1.96Nm 0.14 to 0.20kgf·m 10.1 to 14.5ft·lbs	
	Taper screw	14.7 to 19.6Nm 1.5 to 2.0kgf·m 10.8 to 14.5ft·lbs	
Fuel limit lock nut		27.5 to 34.3Nm 2.8 to 3.5kgf·m 20.3 to 25.3ft·lbs	
Fuel limit cap nut		24.5 to 29.4Nm 2.5 to 3.0kgf·m 18.1 to 21.7ft·lbs	
Injection pipes		14.7 to 25.5Nm 1.5 to 2.6kgf·m 10.8 to 18.8ft·lbs	
▪ Crankshaft nut		137 to 157Nm 14 to 16kgf·m 101 to 116ft·lbs	
Air vent screw (on injection pump)		13.7 to 17.6Nm 1.4 to 1.8kgf·m 10.1 to 13.0ft·lbs	

6. COUPLES DE SERRAGE

Certains boulons et écrous du moteur ayant une forme particulière, prendre soin de les serrer correctement avec une clé dynamométrique. Au moment de serrer, procéder comme suit:
Serrer d'abord tous les boulons à 50% du couple normal puis complètement.

6-1 SERRAGE DES BOULONS DE PIECES IMPORTANTES

■ Les boulons marqués doivent être serrés application d'huile.

		D650-B D750-B	D850-B DH850-B D950-B
▪ Boulons à tête et écrous		39,2 à 44,1Nm 4,0 à 4,5kgf·m	64,7 à 69,6Nm 6,6 à 7,1kgf·m
▪ Boulons de boîte à palier 1		19,6 à 23,5Nm 2,0 à 2,4kgf·m	
▪ Boulons de boîte à palier 2		29,4 à 34,3Nm 3,0 à 3,5kgf·m	
▪ Boulons de volant		53,9 à 58,8Nm 5,5 à 6,0kgf·m	
▪ Boulons de bielle		26,5 à 30,4Nm 2,7 à 3,1kgf·m	
▪ Goujons de support de culbuteur		16,7 à 20,6Nm 1,7 à 2,1kgf·m	
▪ Boulons de l'arbre de transmission intermédiaire		9,806 à 11,28Nm 1,00 à 1,15kgf·m	
Bougies incandescentes (nul besoin d'huile)		19,6 à 24,5Nm 2,0 à 2,5kgf·m	
Bouchons de purge		39,2 à 49,0Nm 4,0 à 4,5kgf·m	
Porte-injecteurs		29,4 à 49,0Nm 3,0 à 5,0kgf·m	
Interrupteur à l'huile	Bis	1,37 à 1,96Nm 0,14 à 0,20kgf·m	
	Vis conique	14,7 à 19,6Nm 1,5 à 2,0kgf·m	
Contre-écrou de limite de combustible		27,5 à 34,3Nm 2,8 à 3,5kgf·m	
Ecrou à chape de limite de combustible		24,5 à 29,4Nm 2,5 à 3.0kgf·m	
Tuyaux d'injection		14,7 à 25,5Nm 1,5 à 2,6kgf·m	
▪ Ecrou de vilebrequin		137 à 157Nm 14 à 16kgf·m	
Ecrou de purge d'air (sur pompe d'injection)		13,7 à 17,6Nm 1,4 à 1,8kgf·m	

6. BOLZENDREHMOMENTWERTE

Da viele Bolzen und Muttern dieses Motors von einer besonderen Form sind, muß darauf geachtet werden, daß diese richtig mit einem Drehmomentschlüssel festgezogen werden. Beim Festziehen wie folgt vorgehen:
Zuerst alle Bolzen auf 50% des Gesamtdrehmomentwertes festziehen und danach richtig anziehen.

6-1 FESTZIEHEN DER BEFESTIGUNGS-BOLZEN WICHTIGER TEILE

■ Bolzen müssen nach entsprechendem Einölen festgezogen werden.

		D650-B, D750-B	D850-B DH850-B D950-B
▪ Kopfbolzen und Muttern		39,2 bis 44,1Nm 4,0 bis 4,5kp·m	64,7 bis 69,6Nm 6,6 bis 7,1kp·m
▪ Lagerungsgehäusebolzen 1		19,6 bis 23,5Nm 2,0 bis 2,4kp·m	
▪ Lagerungsgehäusebolzen 2		29,4 bis 34,3Nm 3,0 bis 3,5kp·m	
▪ Schwungscheibenbolzen		53,9 bis 58,8Nm 5,5 bis 6,0kp·m	
▪ Pleuelstangenbolzen		26,5 bis 30,4Nm 2,7 bis 3,1kp·m	
▪ Kipphebelmontagestutzen		16,7 bis 20,6Nm 1,7 bis 2,1kp·m	
▪ Zwischenradachsenbolzen		9,806 bis 11,28Nm 1,0 bis 1,15kp·m	
Glühkerzen (Brauchen nicht geölt zu werden)		19,6 bis 24,5Nm 2,0 bis 2,5kp·m	
Ablaufsstöpsel		39,2 bis 49,0Nm 4,0 bis 4,5kp· m	
Düsenhalter		29,4 bis 49,0Nm 3,0 bis 5,0kp· m	
Ölschalter	Schraube	1,37 bis 1,96Nm 0,14 bis 0,20kp·m	
	Kegelkopf-schraube	14,7 bis 19,6Nm 1,5 bis 2,0kp·m	
Treibstoffbegrenzungs-verriegelungsschraube		27,5 bis 34,3Nm 2,8 bis 3,5kp·m	
Treibstoffbegrenzungs-kappenmutter		24,5 bis 29,4Nm 2,5 bis 3,0kp·m	
Einspritzrohre		14,7 bis 25,5Nm 1,5 bis 2,6kp·m	
▪ Kurbelwellenmutter		137 bis 157Nm 14 bis 16kp·m	
Lufteinströmschraube (an der Einspritzpumpe)		13,7 bis 17,6Nm 1,4 bis 1,8kp·m	

6-2 OTHER BOLT TORQUES

6-2 AUTRES COUPLES POUR BOULONS

6-2 ANDERE BOLZEN-DREHMOMENT WERTE

Material Grade / Grade de matière / Materialgütegrad — Nominal Dia. / Dia. nominal / Nom. Durchmesser	Standard Bolt Boulon standardisé Standardschrauben	Special Bolt Boulon spécial Spezialschrauben	Special Bolt Boulon spécial Spezialschrauben
	SS41, S20C	S43C, S48C (Refined) S43C, S48C (Raffiné) S43C, S48C (Nachbearbeitet)	SCr435, SCM435 (Refined) SCr435, SCM435 (Raffiné) SCr435,SCM435 (Nachbearbeitet)
M 6	7.8 – 9.3 Nm 0.80 – 0.95 kgf·m (kp·m) 5.8 – 6.9 ft-lbs	9.8 – 11.3 Nm 1.00 – 1.15 kgf·m (kp·m) 7.2 – 8.3 ft-lbs	12.3 – 14.2 Nm 1.25 – 1.45 kgf·m (kp·m) 9.0 – 10.5 ft-lbs
M 8	17.7 – 20.6 Nm 1.80 – 2.10 kgf·m (kp·m) 13.0 – 15.2 ft-lbs	23.5 – 27.5 Nm 2.40 – 2.80 kgf·m (kp·m) 17.4 – 20.3 ft-lbs	29.4 – 34.3 Nm 3.00 – 3.50 kgf·m (kp·m) 21.7 – 25.3 ft-lbs
M10	39.2 – 45.1 Nm 4.00 – 4.60 kgf·m (kp·m) 28.9 – 33.3 ft-lbs	48.0 – 55.9 Nm 4.90 – 5.70 kgf·m (kp·m) 35.4 – 41.2 ft-lbs	60.8 – 70.6 Nm 6.20 – 7.20 kgf·m (kp·m) 44.8 – 52.1 ft-lbs
M12	62.8 – 72.6 Nm 6.40 – 7.40 kgf·m (kp·m) 46.3 – 53.5 ft-lbs	77.5 – 90.2 Nm 7.90 – 9.20 kgf·m (kp·m) 57.1 – 66.5 ft-lbs	103.0 – 117.7 Nm 10.50 – 12.00 kgf·m (kp·m) 75.9 – 86.8 ft-lbs
M14	107.9 – 125.5 Nm 11.00 – 12.80 kgf·m (kp·m) 79.6 – 92.6 ft-lbs	123.6 – 147.1 Nm 12.60 – 15.00 kgf·m (kp·m) 91.1 – 108.5 ft-lbs	166.7 – 196.1 Nm 17.00 – 20.00 kgf·m (kp·m) 123.0 – 144.7 ft-lbs
M16	166.7 – 191.2 Nm 17.00 – 19.50 kgf·m (kp·m) 123.0 – 141.0 ft-lbs	196.1 – 225.5 Nm 20.00 – 23.00 kgf·m (kp·m) 144.7 – 166.4 ft-lbs	259.9 – 304.0 Nm 26.50 – 31.00 kgf·m (kp·m) 191.7 – 224.2 ft-lbs
M18	245.2 – 284.4 Nm 25.00 – 29.00 kgf·m (kp·m) 180.0 – 209.8 ft-lbs	274.6 – 318.7 Nm 28.00 – 32.50 kgf·m (kp·m) 202.2 – 235.1 ft-lbs	343.2 – 402.0 Nm 35.00 – 41.00 kgf·m (kp·m) 253.2 – 296.5 ft-lbs
M20	333.4 – 392.2 Nm 34.00 – 40.00 kgf·m (kp·m) 245.9 – 389.3 ft-lbs	367.7 – 431.5 Nm 37.50 – 44.00 kgf·m (kp·m) 271.2 – 318.2 ft-lbs	490.3 – 568.7 Nm 50.00 – 58.00 kgf·m (kp·m) 361.6 – 419.5 ft-lbs

Bolt material grades are shown by numbers punched on the bolt heads. Prior to tightening, be sure to check out the numbers as shown below:

Punched Number	Bolt Material Grade
None	Standard Bolts SS41, S20C
7	Special Bolts S43C, S48C (Refined)
9	Special Bolts SCM435, SCr435 (Refined)

Le grade de matière des boulons est indiqué par le numéro marqué sur la tête de boulon. Pour le couple de serrage, vérifiez le numéro comme suit:

Numéro marqué	Grade de matière des boulons
Nul	Boulon standardisé SS41, S20C
7	Boulon spécial S43C, S48C (Raffiné)
9	Boulon spécial SCM435, SCr435 (Raffiné)

Gütegrade der Schrauben sind durch Einstanzungen auf dem Schraubenkopf ersichtlich. Vor dem Anziehen der Schrauben, bitte die Nummern überprüfen, wie nachstehend gezeigt:

Eingestanzte Nummer	Gütegrad Schraubenmaterial
Keine	Standardschrauben SS41, S20C
7	Spezialschrauben S43C, S48C(Nachbearbeitet)
9	Spezialschrauben SCM435, SCr435 (Nachbearbeitet)

7. PREVENTIVE MAINTENANCE

7-1 SERVICE INTERVAL

To maintain long-lasting and save engine performance, make it a rule to carry out regular inspections; following the table.

No.	Item	Interval of Service													Ref. Page
		35hr.	50hr.	100hr.	150hr.	200hr.	250hr.	300hr.	350hr.	400hr.	450hr.	500hr.	one year	two years	
1	Changing lubrication oil	○		○	○ (175hr.)		○	○ (325hr.)		○	○ (475hr.)				26
2	Changing oil filter cartridge				○			○			○				26
3	Changing fuel filter cartridge									○					28
4	Cleaning air cleaner element			○		○		○		○		○			30
5	Changing air cleaner element												○		30
6	Checking screw tightness on hydraulic pipe, fuel pipe and fuel flow pipe		○	○	○	○	○	○	○	○	○	○			
7	Checking for tightness on radiatior hoses				○			○			○				
8	Changing fuel pipes and fuel return pipes													○	32
9	Changing radiator hoses													○	32
10	Washing inside of radiator											○			32
11	Checking fan belt tension					○				○					192
12	Opening pressure of radiator cap												every 6 months		190
13	Valve clearance												○		160
14	Nozzle opening pressure												○		162
15	Compression pressure												○		150
16	Injection timing												○		168

⚠ CAUTION :

- **When changing or inspecting, be sure to level and stop the engine.**

7. ENTRETIEN PREVENTIF

7-1 INTERVALLE DE SERVICE

Pour conserver son rendement au moteur et assurer une marche en toute sécurité, prendre l'habitude d'effectuer une inspection régulière, conformément au tableau.

No.	Article	Intervalle de service													Page de référence
		35 heures	50 heures	100 heures	150 heures	200 heures	250 heures	300 heures	350 heures	400 heures	450 heures	500 heures	un an	deux ans	
1	Changement du lubrifiant	○		○	○ (175heures)		○	○ (325heures)		○	○ (475heures)				26
2	Changement de la cartouche de filtre à huile				○			○			○				26
3	Changement de l'élément de filtre à combustible									○					28
4	Nettoyage de l'élément d'épurateur d'air			○		○		○		○		○			30
5	Changement de l'élément d'épurateur d'air												○		30
6	Vérification du serrage des écrous sur le tuyau hydraulique, le tuyau de combustible et le tuyau de trop-plein de combustible		○	○	○	○	○	○	○	○	○	○			
7	Vérification du serrage des colliers sur les tuyaux du radiateur				○			○			○				
8	Changement des tuyaux de combustible et des tuyaux de retour de combustible													○	32
9	Changement des tuyaux d'eau													○	32
10	Lavage de l'intérieur du radiateur											○			32
11	Vérification de la tension de la courroie de ventilateur					○				○					192
12	Pression d'ouverture du bouchon du radiateur												Tous les 6 mois		190
13	Jeu aux queues des soupapes												○		160
14	Pression d'ouverture de l'injecteur												○		162
15	Pression de compression												○		150
16	Réglage de l'injection												○		168

⚠ PRECAUTION :

- **Ne jamais oublier de mettre le moteur à niveau et de l'arrêter avant de procéder à un changement où à une inspection.**

7. REGELMÄSSIGE WARTUNGEN

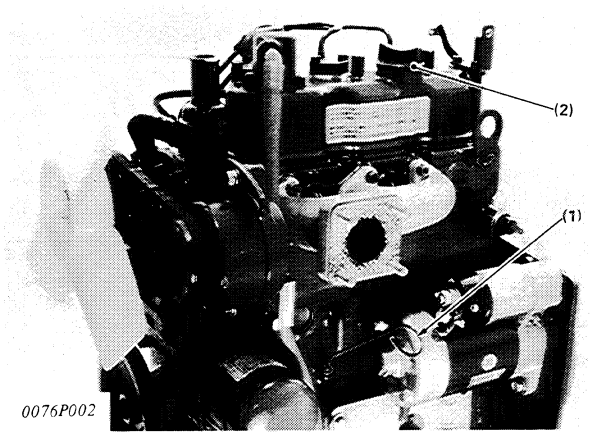
7-1 WARTUNGSZEITSPANNEN

Um die Motorenfunktionen aufrechtzuerhalten und eine lange Betriebsspanne des Motors zu gewährleisten, müssen die regelmäßigen Überprüfungen gemäß der untenstehenden Tabelle ausgeführt werden.

No.	Wartungsposten	Service-Zeitspanne													Referenz-seite
		35 Std.	50 Std.	100 Std.	150 Std.	200 Std.	250 Std.	300 Std.	350 Std.	400 Std.	450 Std.	500 Std.	Ein Jahr	Zwei Jahre	
1	Auswechseln des Schmierungsöls	○		○	○ (175Std.)		○	○ (325Std.)		○	○ (475Std.)				26
2	Auswechseln der Ölfilter-Patrone				○			○			○				26
3	Auswechseln des Treibstoff-Filterelements									○					28
4	Reinigung des Luftreinigungselementes			○		○		○		○		○			30
5	Auswechseln des Luftreinigungselementes												○		30
6	Überprüfen der Schraubenfestigkeit der hydraulischen Rohre, Treibstoffrohr und Treibstoffüberflußrohr.		○	○	○	○	○	○	○	○	○	○			
7	Überprüfen der Bandfestigkeit des Radiatorenschlauches				○			○			○				
8	Auswechseln der Treibstoffrohre und Treibstoffrückführungs-rohre.													○	32
9	Auswechseln der Wasserrohre													○	32
10	Auswaschen des Radiators											○			32
11	Überprüfung der Festigkeit des Ventilatorenriemens					○				○					192
12	Öffnungsdruck der Radiaotrenkappe												Alle 6 Monate		190
13	Ventilabstände												○		160
14	Düsenöffnungsdruck												○		162
15	Kompressionsdruck												○		150
16	Injektionstaktsteuerung												○		168

⚠ ACHTUNG :

- **Bei Auswechslungs- oder Überprüfungsarbeiten muß der Motor unbedingt ausgeschaltet und ausgerichtet werden.**



0076P002

7-2 POINTS OF INSPECTION AND CHANGING

(1) Engine Lubricating Oil

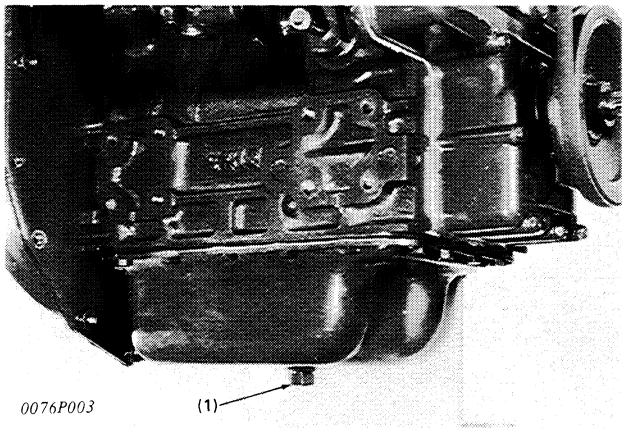
KUBOTA Genuine Oil (for diesel engines) or CC/CD class oils defined by API. It should be as follows according to temperature.

25°C (77°F) above	SAE 30 or 10W-30
0°C to 25°C (32°F to 77°F)	SAE 20 or 10W-30
0°C (32°F) below	SAE 10W or 10W-30

(2) Checking Engine Oil Level

Level the engine, stop for 5 minutes or more and remove the dip stick. Read the engine oil level on the dip stick. If the oil level is below the lower mark on the dip stick, add sufficient KUBOTA Genuine Engine Oil or its equivalent of the proper viscosity to bring the level to the upper mark.

(1) Dip stick
(2) Oil filler plug

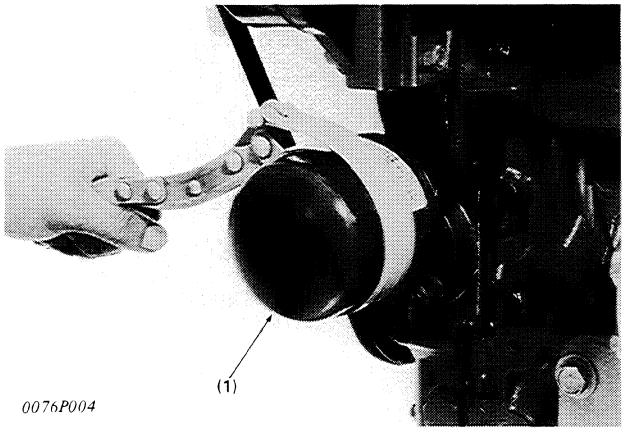


0076P003

(3) Changing Engine Oil

Drain the oil while the engine is still warm, by removing the drain plug on the oil pan and oil filler plug, so that the oil may completely drain.
Do not mix different brands of oil. If a different brand of oil should be employed, drain out the existing oil no matter how new it may be and then replace it. Do the same when using oil of a different viscosity.

(1) Oil drain plug



0076P004

(4) Changing Engine Oil Filter Cartridge

1) Remove the oil filter cartridge with a filter wrench.
2) Apply a slight coat of oil to the rubber gasket on the new cartridge.
3) Screw the new cartridge in by hand.
   Over-tightening may cause deformation of rubber gasket.
4) After cartridge has been replaced, engine oil normally decreases a little. Check that the engine oil does not leak through the seal and be sure to read the oil level. Then, add engine oil up to the prescribed level.

(1) Oil filter cartridge

7-2 POINTS A INSPECTER ET CHANGER

(1) Huile de lubrification du moteur

Huile KUBOTA Genuine (pour moteurs diesel) ou huiles CC/CD selon la classification API.
Selon la température:

25°et plus	SAE 30 ou 10W-30
0°C à 25°C	SAE 20 ou 10W-30
Au-dessous de 0°C	SAE 10W ou 10W-30

(2) Vérification du niveau d'huile

Mettre le moteur à niveau. Attendre cinq minutes au moins, après l'arrêt du moteur pour retirer la jauge et vérifier le niveau d'huile. Si celui-ci est à l'encoche inférieure, ajouter la quantité nécessaire d'Huile KUBOTA Genuine ou un équivalent dont la viscosité est adéquate, pour faire monter le niveau à l'encoche supérieure.

(1) Jauge
(2) Bouchon de remplissage pour l'huile

(3) Vidange de l'huile moteur

Evacuer l'huile pendant que le moteur est encore chaud, en retirant le bouchon de vidange du carter à huile et celui du remplissage pour l'huile afin que l'huile puisse bien s'écouler. Ne pas mélanger différentes marques d'huile. Si une autre huile doit être utilisée, retirer l'huile existante, même neuve, et la remplacer. Faire de même pour une huile dont la viscosité est différente.

(1) Bouchon de vidange d'huile

(4) Remplacement de la cartouche de filtre à huile moteur

1) Retirer la cartouche avec une clé.
2) Appliquer une fine couche d'huile à la garniture de gomme sur la nouvelle cartouche.
3) Visser à la main la cartouche. Un serrage trop fort peut provoquer une déformation de la garniture de caoutchouc.
4) Après le remplacement de la cartouche, l'huile doit normalement baisser un peu. Vérifier si le moteur ne fuit pas par le joint; vérifier le niveau d'huile. Ensuite, ajouter de l'huile jusqu'au niveau conseillé.

(1) Cartouche de filtre à huile moteur

7-2 ALLGEMEINE BEMERKUNGEN ZUM ÜBERPRÜFEN UND AUSWECHSELN

(1) Motorenschmierungsöl

Als Motorenschmierungsöl sollte KUBOTA-Originalöl (für Dieselmotoren) oder CC/CD-Öle, die von API angegeben werden, verwendet werden. Entsprechend den Temperaturen sollten die folgenden Motorenöle verwendet werden.

Über 25°C	SAE 30 oder 10W-30
0°C bis 25°C	SAE 20 oder 10W-30
Unter 0°C	SAE 10W oder 10W-30

(2) Überprüfung des Ölstands

Bei horizontaler Lage des Motors nach einer Abschaltzeit von wenigstens 5 Minuten, den Öleintauchstab herausziehen und den Ölstand auf dem Eintauchstab ablesen. Falls der Ölstand bei dieser Überprüfung unter der unteren Markierung des Eintauchstabes sein sollte, muß die entsprechende Menge von KUBOTA-Originalöl oder entsprechendes Öl mit den gleichen Eigenschaften bis zur oberen Markierung des Eintauchstabes nachgefüllt werden.

(1) Eintauchstab
(2) Einfüllstöpsel

(3) Auswechseln des Motorenöls

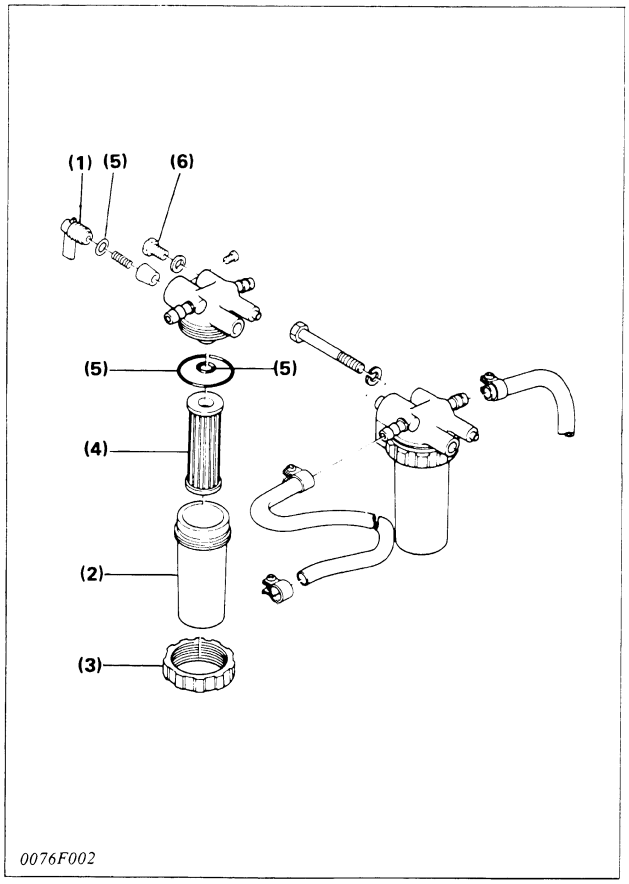
Das Öl noch im warmen Zustand des Motors ablaufen lassen. Hierfür den Ablaßstöpsel sowie den Stöpsel an der Ölwanne und den Einfüllstöpsel öffnen, so daß das Öl vollständig ablaufen kann.
Niemals verschiedene Ölsorten miteinander vermischen. Falls eine andere Ölsorte verwendet werden soll, muß zuerst das noch im Motor verbliebene Öl vollständig abgelassen werden, auch wenn dieses noch neu sein sollte, um dann die neue Ölsorte einfüllen zu können. Der gleiche Vorgang muß auch beim Auswechseln von Öl mit verschiedenen Schmierungseigenschaften vorgenommen werden.

(1) Ablaßstöpsel

(4) Auswechseln der Ölfilter-Patrone

1) Die Ölfilter-Patrone mit einem Filterschlüssel entfernen.
2) Eine leichte Ölbeschichtung an der Gummidichtung der neuen Patrone anbringen.
3) Die neue Patrone mit der Hand einschrauben. Übermäßiges Festziehen könnte eine Verformung der Gummiabdichtung hervorrufen.
4) Nach dem Auswechseln der Ölfilter-Patrone verringert sich das Motorenöl etwas. Überprüfen, ob das Motorenöl nicht durch die Abdichtungen aussickern kann, wobei auch der Ölstand selbst abgelesen werden muß. Danach entsprechend Motorenöl zum vorgeschriebenen Pegelstand einfüllen.

(1) Ölfilter-Patrone



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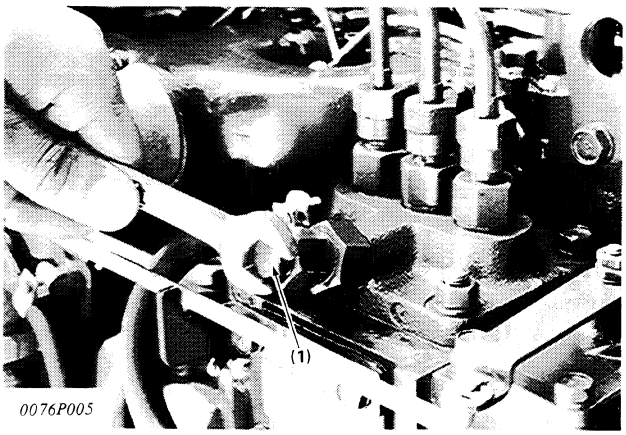
(1) Cock lever
(2) Filter cup
(3) Retaining ring
(4) Element
(5) O ring
(6) Air vent screw

(5) Inspection of Fuel Filter (not included in the basic engine)

Water and foreign matter in fuel are accumulated in the filter. Periodically clean it and exchange the filter element.

1) Close the fuel filter cock.
2) Loosen the retaining ring on the filter cup and clean the filter cup and element in light oil.

When assembling, prevent dust entering and vent air from the fuel system.



0076P005

(1) Air vent screw

(6) Venting the Fuel System

Air must be vented when:

- The fuel filter and piping are removed.
- The fuel tank becomes completely empty.
- The engine has not been used for an extended time.

Venting procedure is as follows:

1) Fill the fuel tank with fuel, and open the fuel cock.
2) Twist off the air vent screw at the top of the filter by turning it twice.
3) When bubbles disappear from fuel coming out of the plug, twist it back on.
4) Open the air vent plug on the fuel injection pump.
5) Pull the engine stop lever back completely to stop the engine, and run the starter for about 10 seconds.
6) Close the air vent plug when air bubbles disappear from the fuel flowing out.

(Important)

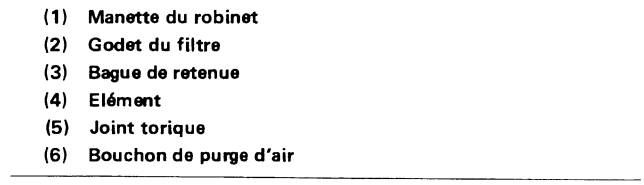
- **Do not perform venting when the engine is hot.**

(5) Inspection du filtre à combustible (non inclus dans le moteur de base)

Il est nécessaire, en raison de l'accumulation, dans ce filtre, d'eau et d'autres substances étrangères se trouvant dans le combustible, de le nettoyer périodiquement et d'en changer l'élément.

1) Fermer le robinet du filtre à combustible.
2) Desserrer la bague de retenue qui se trouve sur le godet du filtre. Nettoyer le godet et l'élément dans un bain d'huile fluide.

Au moment de l'assemblage, faire attention à ce que la poussière et l'air en provenance de la purge d'air du circuit d'alimentation en combustible ne viennent pas les contaminer.



(1) Manette du robinet
(2) Godet du filtre
(3) Bague de retenue
(4) Elément
(5) Joint torique
(6) Bouchon de purge d'air

(6) Purge d'air du circuit d'alimentation en combustible

Il faut procéder à une purge d'air lorsque:

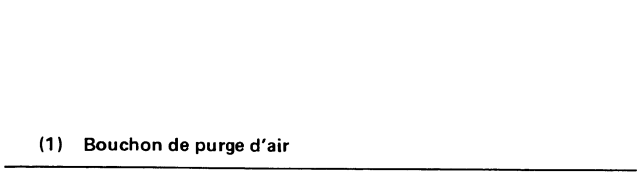
- Le filtre à combustible et la tuyauterie sont retirés.
- Le réservoir à combustible se vide complètement.
- Le moteur n'a pas fonctionné pendant une période prolongée.

La purge s'effectue comme suit:

1) Remplir de combustible le réservoir à combustible et ouvrir le robinet de combustible.
2) Desserrer la vis de purge d'air, sur le dessus du filtre, en la tournant deux fois.
3) La revisser lorsque les bulles d'air cessent de se former dans le combustible s'écoulant du bouchon.
4) Ouvrir le bouchon de purge d'air de la pompe d'injection de combustible.
5) Tirer à fond le levier d'arrêt du moteur afin de le stopper et actionner le démarreur pendant 10 secondes environ.
6) Fermer le bouchon de purge d'air lorsque l'écoulement de combustible est exempt de toute bulle.

(Important)

- **Ne pas procéder à la purge d'air si le moteur est chaud.**



(1) Bouchon de purge d'air

(5) Überprüfung des Treibstoff-filters (Im Basismodell nicht enthalten)

Wasser und andere Fremdstoffe werden im Filter angesammelt. Deshalb muß der Filter periodisch gereinigt und das Filterelement periodisch ausgewechselt werden.

1) Den Treibstoff-Filterhahn schließen.
2) Den Halterungsring an der Filterschale lösen und die Kappe und das Element in leichtem Öl reinigen.

Beim Wiedereinsetzen, diese Teile vor Verschmutzungen durch Staub und Ventilationsluft des Treibstoffsystems schützen.



(1) Hahnhebel
(2) Filterschale
(3) Halterungsring
(4) Element
(5) O-Ring
(6) Luftventilationsstöpsel

(6) Entlüftung des Treibstoffsystems

Das Treibstoffsystem muß entlüftet werden, wenn:

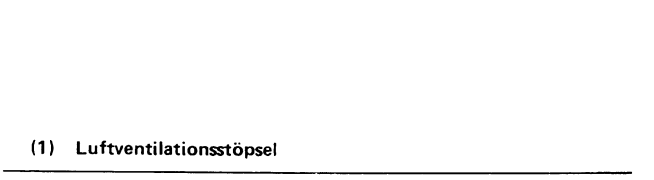
- Der Treibstoff-Filter und die Rohre entfernt wurden.
- Der Treibstofftank völlig entleert wurde.
- Der Motor für eine längere Zeit nicht benutzt worden ist.

Der Entlüftungsvorgang wird wie folgt ausgeführt:

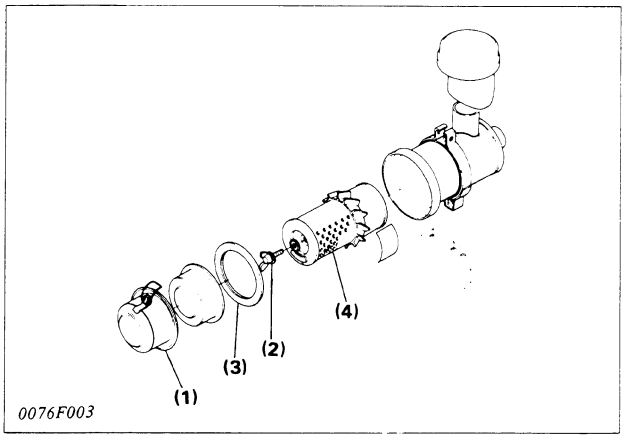
1) Treibstoff in den Tank einfüllen und den Treibstoffhahn entsprechend öffnen.
2) Die Entlüftungsschraube auf der Oberseite des Filters durch zweimaliges Drehen abdrehen.
3) Wenn der aus dem Stöpsel kommende Treibstoff keine weitere Blasenbildung mehr hat, kann die Entlüftungsschraube wieder aufgedreht werden.
4) Den Luftstöpsel der Treibstoffeinspritzpumpe öffnen.
5) Den Motorenunterbrechungshebel vollständig nach hinten ziehen, um den Motor zu unterbrechen. Dann den Starter für ungefähr 10 Sekunden betätigen.
6) Wenn die Luftblasen des herausströmenden Treibstoffes verschwinden, den Luftstöpsel wieder schließen.

(Wichtig)

- **Den Entlüftungsvorgang niemals bei heißem Motor ausführen.**



(1) Luftventilationsstöpsel



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0011P077

(7) Cleaning of Air Cleaner (not included in the basic engine)

The air cleaner is one of the most important parts and has a direct influence on the engine output. Periodically clean it and exchange air cleaner element.

- **Cleaning of air cleaner cover**

1) Do not allow dust to cover more than half of the inner space of the air cleaner cover.
2) Mount the air cleaner cover with the mark "TOP ↑" up.

- **Cleaning of air cleaner element**

1) Remove the air cleaner cover and wing bolt.
2) Lifting the air cleaner element slightly, take out it.
3) Remove dust by shaking the element or blowing compressed air into the element. (Air pressure must be less than 686kPa (7kg/cm^2 100psi).)
   Do not blow air on the outside of the element.

- **Removal of stains by carbon or oil**

1) Immerse the dirty element in the solution of KUBOTA's genuine element cleaning agent (Agent of 15g (33 lbs) to water of 1ℓ (0.88Imp·qts, 1.06 U.S. qts)) for about 15 minutes and then wash it splashingly.
2) Wash the element carefully in clean water. The water pressure must be less than 27.5kPa (2.8kgf/cm^2, 39.8psi).
3) Swish water from the element and put it in a well-ventilated place for natural seasoning. When time is short, use an electric fan or drier. Do not apply heat from the drier directly to the element.
4) After drying the element well, check for damage inside the element by using a light.
5) When exchanging the element, also replace the packing.

(Note)

- **The element is of dry type. Do not use oil on it.**

(1) Air cleaner cover
(2) Wing bolt
(3) Cover gasket
(4) Air cleaner element

(7) Nettoyage de l'épurateur d'air (non inclus dans le moteur de base)

L'épurateur d'air est une pièce essentielle, qui joue un rôle important dans le rendement du moteur. Nettoyer et changer périodiquement l'élément de cet épurateur.

■ **Nettoyage du capot de l'épurateur d'air**

1) Ne pas laisser la poussière remplir plus de la moitié de l'intérieur de ce capot.
2) Monter le capot de façon à ce que l'indication "TOP ↑" (HAUT) se trouve sur le dessus.

■ **Nettoyage de l'élément d'épurateur d'air**

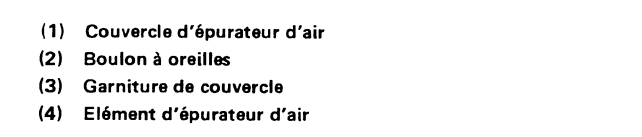
1) Retirer le capot de l'épurateur d'air ainsi que le boulon à oreilles.
2) Soulever légèrement l'élément afin de le sortir.
3) Secouer l'élément ou le faire passer par un jet d'air pour en retirer la poussière. (La pression d'air doit être inférieure à 686kPa (7kg/cm^2).)
   Ne pas souffler d'air sur la partie extérieure de l'élément.

■ **Enlèvement de taches faites par du charbon ou de l'huile**

1) Plonger l'élément souillé dans une solution à base d'agent détersif authentique pour éléments, de marque KUBOTA (15g d'agent pour un litre d'eau) et l'y laisser 15 minutes environ avant de le rincer à grande eau.
2) Bien nettoyer l'élément à l'eau pure. La pression d'eau doit être inférieure à 27,5kPa (2,8kgf/cm^2).
3) Secouer l'élément pour l'égoutter et le laisser sécher ensuite dans un endroit bien aéré. Se servir d'un ventilateur ou d'un séchoir électrique si on est à court de temps. Ne pas appliquer directement la chaleur du séchoir sur l'élément.
4) Après séchage complet de l'élément, se servir d'une lampe de poche pour vérifier si l'intérieur de l'élément n'a pas été détérioré.
5) Refaire aussi la garniture lorsque l'on change l'élément.

(Remarque)

- **Cet élément est du type à sec. Ne pas y appliquer d'huile.**



(1) Couvercle d'épurateur d'air
(2) Boulon à oreilles
(3) Garniture de couvercle
(4) Elément d'épurateur d'air

(7) Reinigung des Luftreinigers (Im Basismodell nicht enthalten)

Der Luftreiniger stellt einen der wichtigsten Teile des Motorenbetriebs dar, und übt direkten Einfluß auf die Motorenleistung aus. Dieser Luftreiniger muß periodisch gereinigt werden und das Luftreinigungselement in periodischen Abständen ausgewechselt werden.

■ **Reinigung der Luftreinigungsabdeckung**

1) Staub darf nicht mehr als die Hälfte des Innenraums der Luftreinigungsabdeckung einnehmen.
2) Die Abdeckung des Luftreinigers mit der "TOP ↑"-Bezeichnung nach oben zeigend montieren.

■ **Reinigung des Reinigungselementes (Luftfilter)**

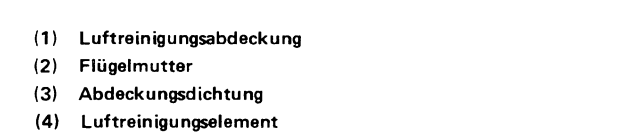
1) Die Luftreinigungsabdeckung und die Flügelschraube entfernen.
2) Das Luftreinigungselement durch leichtes Anheben herausnehmen.
3) Den angesammelten Staub durch Schütteln oder Durchblasen mit Druckluft entsprechend entfernen. (Der Luftdruck für die Reinigung muß unter 686kPa (7kp/cm^2) verbleiben.) Die Druckluft nicht auf die Außenseite des Elementes blasen.

■ **Entfernung von Kohle- oder Ölverschmutzungen**

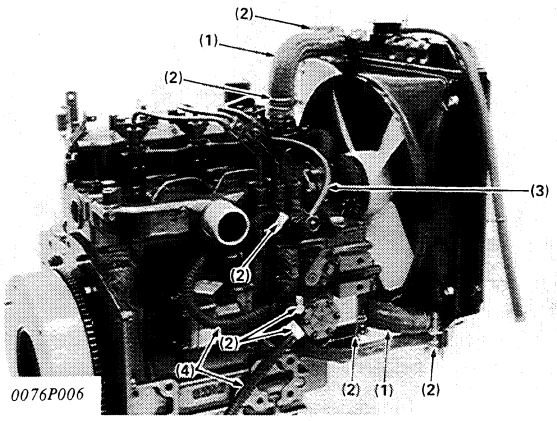
1) Das verschmutzte Element in eine KUBOTA Originalreinigungslösung eintauchen, (Das Mischverhältnis beträgt 15 gr. Reinigungsmittel auf einen Liter Wasser.) in dieser Lösung für ungefähr 15 Minuten eingetaucht lassen und dann durch Spritzen auswaschen.
2) Das Element dann vorsichtig in Frischwasser abspülen. Der Wasserdruck darf 27,5kPa (2,8kp/cm^2) nicht übersteigen.
3) Das Wasser dann vom Element abtropfen lassen und dieses dann an einem gut durchlüfteten Platz entsprechend trocknen lassen. Ist nicht genug Zeit für eine natürliche Trocknung vorhanden, kann ein elektrischer Ventilator oder Trockner verwendet werden. Die Hitze einer Trocknungsvorrichtung darf jedoch nicht direkt dem Element zugeleitet werden.
4) Nach vollständigem Trocknen des Elementes, dieses unter Verwendung einer Lichtquelle auf Innenbeschädigungen untersuchen.
5) Beim Auswechseln des Elementes sollte auch die Dichtung ausgewechselt werden.

(Anmerkung)

- **Dieses Element ist ein Trockenelementtyp. Niemals Öl gebrauchen.**



(1) Luftreinigungsabdeckung
(2) Flügelmutter
(3) Abdeckungsdichtung
(4) Luftreinigungselement



0076P006

(8) Changing Pipes

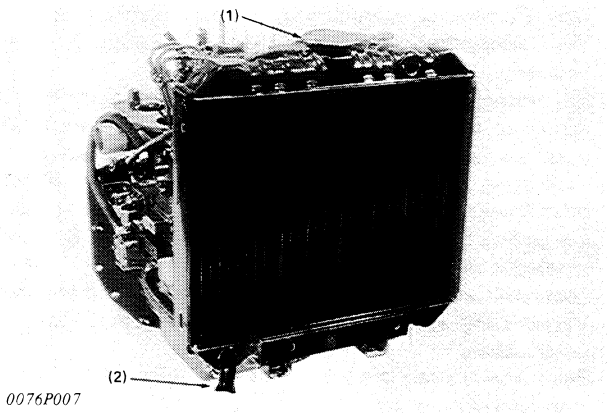
Rubber pipes (fuel pipes, hoses, etc.) have short lives whether they are used or not. Change them and the tightening bands for new ones every 2 years or when they are damaged.

1) Be careful that pipes, hoses and tightening bands are not loosened or damaged.
2) When changing the pipes, vent air from the fuel system.

⚠ CAUTION :

- **When changing, be careful not to let dust enter pipes or injection pump.**
  Dust may be the cause of irregular action in injection pump or injection nozzle.

(1) Water pipe
(2) Tightening band
(3) Fuel return pipe
(4) Fuel pipe



0076P007

(9) Changing Coolant (Radiator is not included in the basic engine)

1) Open drain cock and radiator cap to drain all the water.
2) Wash the inside of the radiator with tap water.

■ **Treatment of Anti-freeze**

When temperatures fall below 0°C (32°F), never fail to mix anti-freeze with the cooling tap water. As the ratios between them are different according to the manufacturer and temperature, follow the instructions of each firm.

⚠ CAUTION :

- **Never open radiator cap while engine is running or soon after it stops. Hot water sometimes shoots out if the radiator cap is opened while the engine is hot.**

(1) Radiator cap
(2) Drain cock

(8) Changement des tuyaux

Les tuyaux en caoutchouc (tuyaux de carburant, boyaux, etc.) sont de durée limitée, qu'ils aient servi ou non. Les remplacer, ainsi que les colliers de serrage, tous les deux ans ou lorsqu'ils sont abîmés.

1) Faire attention à ce que les tuyaux, boyaux et colliers de serrage ne soient pas lâches ou en mauvais état.
2) Purger l'air du circuit d'alimentation en carburant lorsqu'on change les tuyaux.

⚠ PRECAUTION :

- **Faire attention à ne pas laisser de poussière pénétrer dans les tuyaux ou la pompe à injection durant le changement. La poussière peut, en effet, entraver le fonctionnement de la pompe à injection et du gicleur.**

(1) Tuyau d'eau
(2) Collier de serrage
(3) Tuyau de retour de combustible
(4) Tuyau de combustible

(9) Changement du réfrigérant (le radiateur n'est pas inclus dans le moteur de base.)

1) Ouvrir le robinet purgeur et le bouchon du radiateur afin de purger toute l'eau.
2) Laver l'intérieur du radiateur à l'eau du robinet.

■ **Traitement par antigel**

Lorsqu'il fait moins de 0°C (32°F), ne jamais oublier de mélanger de l'antigel à l'eau de refroidissement du robinet. Du fait que les proportions varient en fonction du fabricant et de la température, suivre les instructions données par chaque fabricant.

⚠ PRECAUTION :

- **Ne jamais ouvrir le bouchon du radiateur lorsque le moteur est en marche ou vient de s'arrêter, car des gerbes d'eau pourraient jaillir subitement, du fait que le moteur est chaud.**

[A] Changement du réfrigérant
(1) Bouchon du radiateur.
(2) Robinet purgeur

(8) Auswechseln der Rohre

Gummirohre (Treibstoffrohre, Schläuche usw.) sind Verschleißteile, die unabhängig von der Benutzung verbraucht werden. Diese Teile und die Befestigungsbänder alle zwei Jahre, oder bei Beschädigungen auswechseln.

1) Darauf achten, daß die Rohre, Schläuche und Befestigungsbänder nicht gelöst oder beschädigt werden.
2) Beim Auswechseln von Röhren muß auch das Treibstoffsystem entlüftet werden.

⚠ ACHTUNG :

- **Beim Auswechseln der Rohre muß darauf geachtet werden, daß kein Staub oder andere Fremdstoffe in die Rohre eintreten können.**
  Staubverschmutzungen können zu irregulären Aktionen der Einspritzpumpe und Einspritzdüse führen.

(1) Wasserrohr
(2) Befestigungsband
(3) Treibstoffrückführungsrohr
(4) Treibstoffrohr

(9) Auswechseln des Kühlmittels (Der Radiator ist im Basismodell nicht enthalten.)

1) Den Ablaufhahn und die Radiatorenkappe öffnen, um den gesamten Wasserinhalt auslaufen zu lassen.
2) Den Radiatorinnenraum mit Leitungswasser gut auswaschen.

■ **Frostschutzbehandlung**

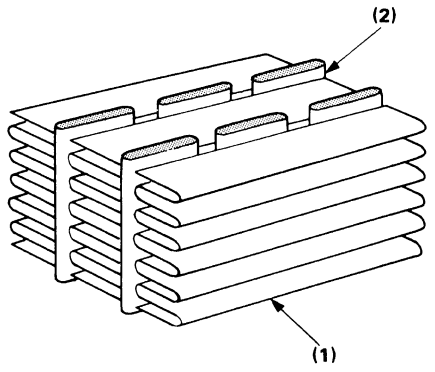
Wenn die Außentemperatur unter einen Wert von 0°C (32°F) abfällt, muß unbedingt ein Frostschutzmittel mit dem Kühlwasser vermischt werden. Da das Mischungsverhältnis zwischen dem Frostschutzmittel und Kühlwasser gemäß den Wetterbedingungen und Herstellervorschriften verschieden ist, sollte gemäß den Anweisungen des Herstellers des Frostschutzmittels vorgegangen werden.

⚠ ACHTUNG :

- **Die Radiatorenkappe niemals bei laufendem Motor oder kurz nach der Laufunterbrechung öffnen. Heißes Wasser kann manchmal aus dem Radiator herausspritzen, wenn dieser im heißen Zustand des Motors geöffnet wird.**

[A] Auswechseln des Kühlmittels
(1) Radiatorenkappe
(2) Ablaufhahn

[A] Cleaning radiator core



0076F014

(10) Cleaning Radiator Core

When dust enters between fins and tubes, wash out with tap water under pressure.

(Important)

- **Never use a screw driver, etc., when cleaning. It may damage the special tubes or cause the radiator to lose its function.**

(1) Fin
(2) Tube

(10) Nettoyage du faisceau du radiateur

Laver à l'eau du robinet sous pression la poussière qui s'accumule entre les ailettes et les tubes.

(Important)

- **Ne jamais se servir d'objets durs, tels que tournevis et autres outils du même genre durant le nettoyage, car ils pourraient abîmer les tubes ou détériorer le radiateur.**

[A] Nettoyage du faisceau du radiateur
(1) Ailette
(2) Tube

(10) Reinigung des Radiatorenkerns

Bei Staubansammlung zwischen den Rippen und Rohren, diese mit Druckleitungswasser entsprechend auswaschen.

(Wichtig)

- **Niemals einen Schraubenzieher oder andere harte Gegenstände zur Reinigung verwenden. Die Feinrohre können dadurch Beschädigungen erleiden, die zum Funktionsverlust des Radiators führen können.**

[A] Reinigung des Radiatorenkerns
(1) Rippe
(2) Rohre

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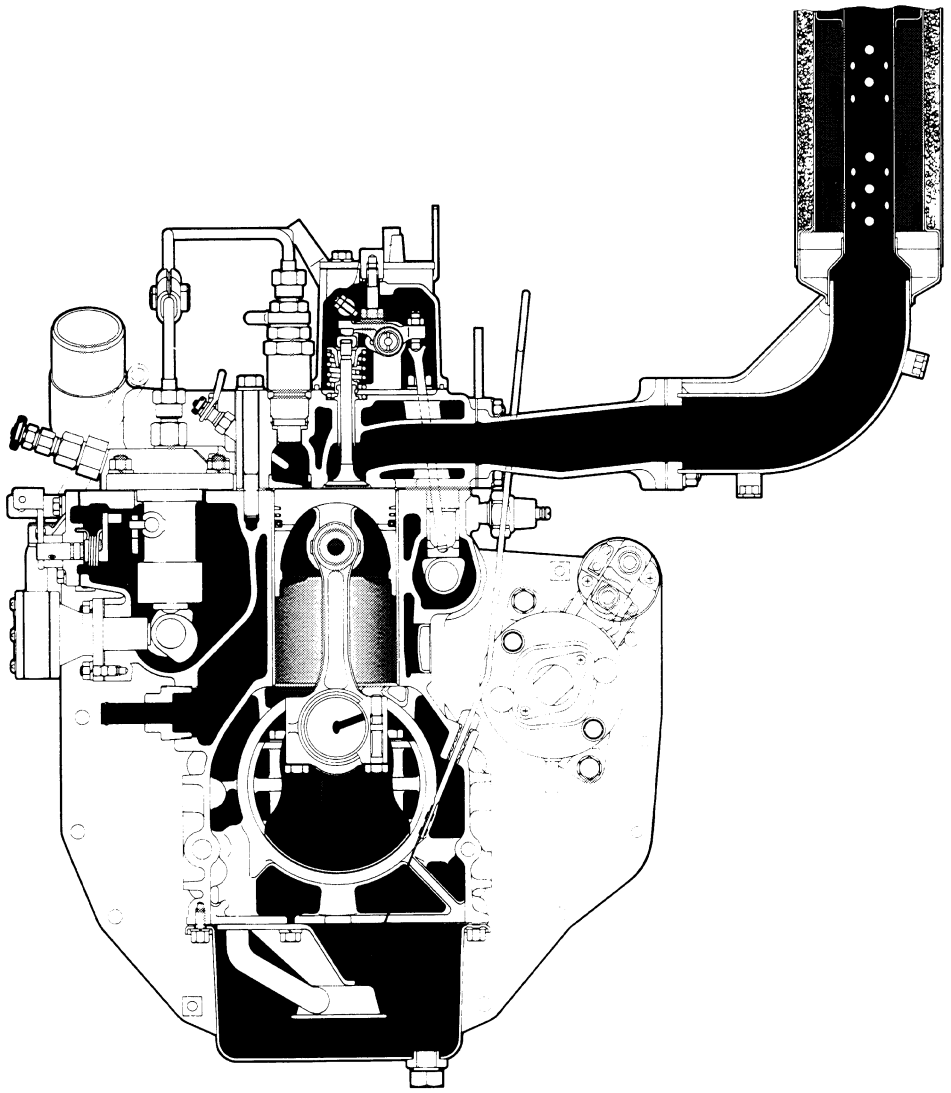
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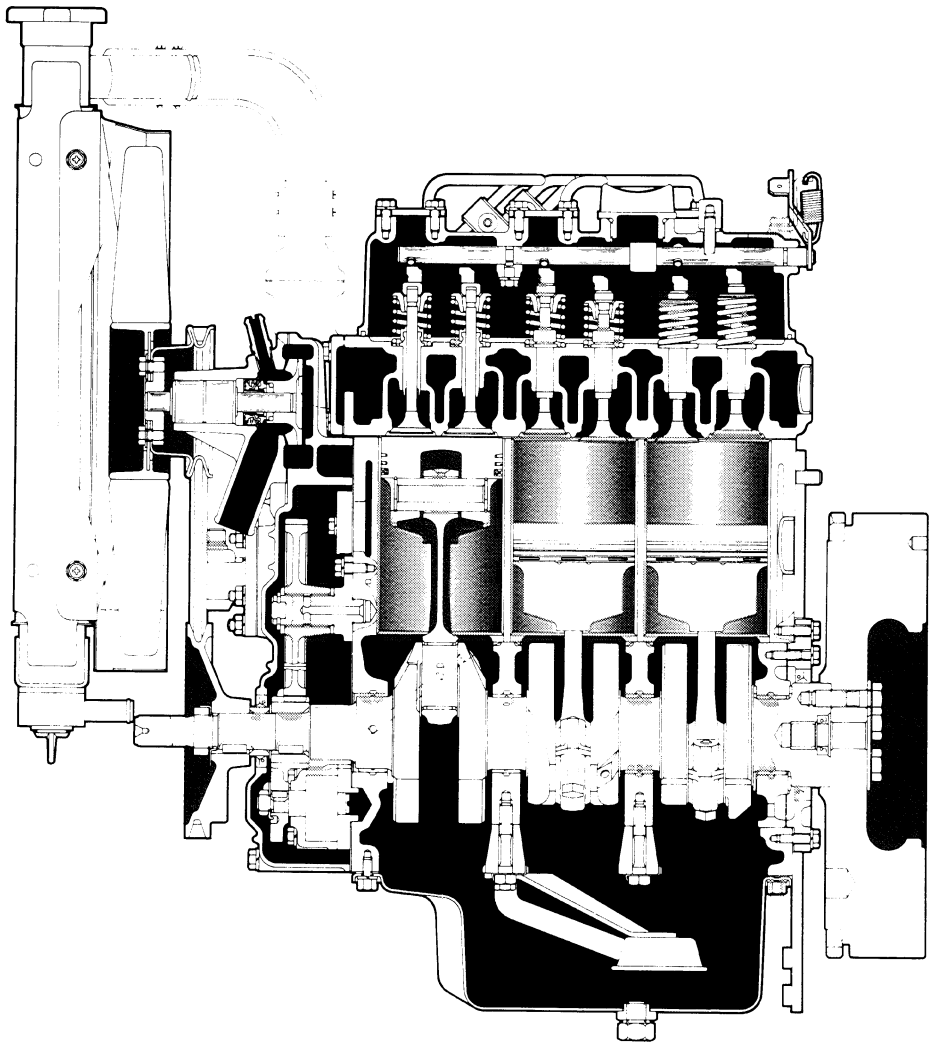
The D650-B, D750-B, D850-B, DH850-B, D950-B are vertical, water-cooled, 4-cycle diesel engines. They are incorporated KUBOTA's foremost technologies. With KUBOTA's spherical combustion chamber, well-known Bosch K type injection pump and well-balanced designs, they feature greater power, low fuel consumption, little vibration and quiet operation.



0076F004

Les moteurs D650-B, D750-B, D850-B, DH850-B et D950-B sont des moteurs Diesel à quatre temps, à refroidissement vertical par eau. Ils sont le produit des techniques les plus avancées de KUBOTA: une chambre de combustion à cuve de turbulence sphérique, modèle exclusif de KUBOTA, la célèbre pompe d'injection K de Bosch, une conception d'ensemble bien équilibrée-caractéristiques qui assurent puissance accrue, consommation moindre de combustible, vibration réduite au minimum et allure silencieuse.

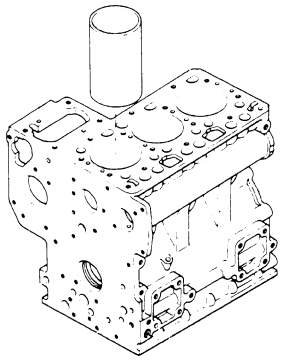
Die Motorenmodelle D650-B, D750-B, D850-B, DH850-B und D950-B sind wassergekühlte, Viertakt-Vertikaldieselmotoren die nach dem neuesten technologischem Stand des Hauses KUBOTA konstruiert wurden. Durch die von KUBOTA entwickelte Kugelbrennkammer, die bekannte Bosch-Einspritzpumpe des K-Typs und die ausgewogene Gesamtkonstruktion werden größere Maschinenleistung, geringerer Kraftstoffverbrauch, geringe Vibration und geringere Betriebsgeräusche gewährleistet.



0076F005

1. ENGINE

[A] Tunnel cylinder block

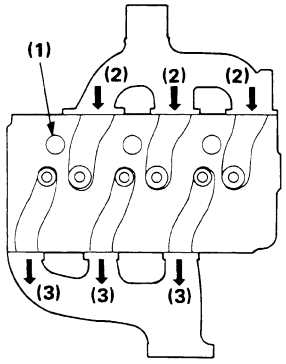


0011F012

1-1 CYLINDER BLOCK

The engine features a high durability tunnel-type cylinder in which the crank bearing part is constructed body. Furthermore, dry-type cylinder liners, being pressure-fitted into cylinders, allow effective cooling, less distortion, higher wear-resistance qualities and each cylinder having its own chamber helps to minimize noise.

[A] Cross-flow type cylinder head

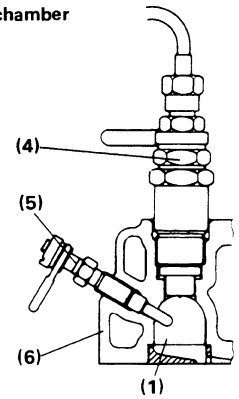


0076F006

1-2 CYLINDER HEAD

The cross-flow type inlet/exhaust ports in this engine have their openings at both sides of the cylinder head. Because overlaps of inlet/exhaust ports are smaller than in ports of other types which have openings one side, the suction air can be protected from being heated and expanded by heated exhaust air. The cool, high density suction air has a high voluminous efficiency and raises the power of the engine. Furthermore, distortion of the cylinder head by heated exhaust air is reduced because suction ports are arranged alternately. The combustion chamber is of KUBOTA's exclusive spherical combustion chamber type. Suction air is whirled to be mixed effectively with fuel, prompting combustion and reducing fuel consumption.
In the combustion chamber are installed throttle type injection nozzle and rapid heating sheathed type glow plug. This glow plug assures easier than ever engine starts even at −15°C (5°F).

[B] Combustion chamber



0011F013

(1) Combustion chamber
(2) Suction
(3) Exhaust
(4) Nozzle assembly
(5) Glow plug
(6) Cylinder head

1. MOTEUR

1-1 BLOC-CYLINDRES

Le moteur est caractérisé par un cylindre type tunnel, de haute longévité, dans lequel le palier-manivelle est une pièce monobloc. L'ajustage des chemises sèches aux cylindres étant, de plus, effectué sous pression, il s'ensuit: refroidissement efficace, déformation moindre, plus haute résistance à l'usure et allure plus silencieuse du fait que chaque cylindre est muni de sa propre chambre.

[A] Bloc-cylindres type tunnel

1-2 CULASSE

Les orifices d'admission/échappement type à circulation opposée sont placés des deux côtés de la culasse. Du fait que les orifices d'admission/échappement n'interfèrent pas, ainsi que cela peut se produire dans le cas où les orifices sont d'un seul côté, l'air d'aspiration ne risque pas d'être chauffé et dilaté par l'air chaud d'échappement. L'air d'admission, étant froid et de densité élevée, présente une grande efficacité volumétrique, ce qui augmente la puissance du moteur.
Du fait que les orifices d'admission sont disposés en alternance, il s'ensuit aussi une déformation moindre de la culasse par l'air chaud d'échappement.
La chambre de combustion à cuve de turbulence sphérique est un modèle exclusif de KUBOTA. On fait tourbillonner l'air d'admission afin de le mélanger plus efficacement avec le combustible, ce qui a pour effet d'accélérer la combustion et de réduire la consommation de combustible.
L'injecteur à régulateur et la bougie incandescente sous gaine à échauffement rapide se trouvent dans la chambre de combustion. Cette bougie incandescente assure, même à $-15^{\circ}C$ ($5^{\circ}F$) un démarrage aisé du moteur.

[A] Cylindre à circulation opposée
[B] Chambre de combustion

(1) Chambre de combustion	(4) Injecteur
(2) Admission	(5) Bougie incandescente
(3) Echappement	(6) Culasse

1. MOTOR

1-1 ZYLINDERBLOCK

Der Motor beinhaltet einen verschleißfesten Zylinderblock des Tunneltyps, bei dem die Lagerungsteile der Kurbelwelle in das Hauptgehäuse eingearbeitet sind. Darüberhinaus erlauben die druckeingepaßten Trockentyplaufbuchsen eine effektivere Kühlung, weniger Verziehung und eine höhere Verschleißfestigkeit. Die Tatsache, daß jeder Zylinder seine eigene Kammer besitzt, fördert die Geräuschsminimalisierung.

[A] Tunnelzylinderblock

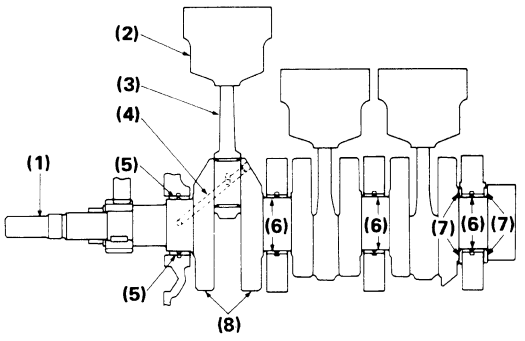
1-2 ZYLINDERKOPF

Die Kreuzflußtyp-Ansaug-/Ausstoßöffnungen dieses Motors haben ihre Öffnungen an beiden Seiten des Zylinderkopfes. Dadurch, daß die die Überlappung der Ansaug-/Ausstoßöffnungen gegenüber anderen Typen, die die Öffnungen auf einer Seite haben, Kleiner ist, kann die Ansaugluft vor Erhitzungen und Ausdehnungen durch erhitzte Ausstoßluft geschützt werden. Durch diese kühle, hochverdichtete Ansaugluft kann eine hohe Effektivität erreicht und die Leistung des Motors gesteigert werden.
Darüberhinaus wird die Verziehung des Zylinderkopfes durch erhitzte Ausstoßluft weitgehendst reduziert, da die Ansaugöffnungen in abwechselnder Reihenfolge angeordnet sind.
Als Verbrennungskammer wird KUBOTAs Eigenerzeugung einer Rundverbrennungskammer benutzt. Die Ansaugluft wird hier auf effektive Weise mit dem Treibstoff vermischt, wodurch die Verbrennung erleichtert und der Treibstoffverbrauch verringert werden kann.
In diese Verbrennungskammer ist die Einspritzdüse des Drosseltyps und die schnellerhitzende Glühkerze des Abschirmtyps eingesetzt. Durch diese Glühkerze wird ein leichtes Anlassen des Motors selbst bei Temperaturen von $-15^{\circ}C$ ($5^{\circ}F$) ermöglicht.

[A] Kreuzflußtypenzylinder
[B] Verbrennungskammer

(1) Verbrennungskammer	(4) Düseneinheit
(2) Ansaugung	(5) Glühkerze
(3) Ausstoß	(6) Zylinderkopf

[A] Crankshaft



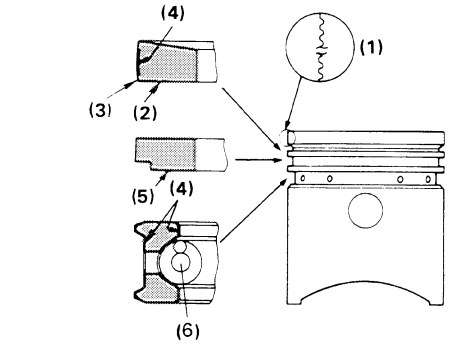
0076F007

1-3 CRANKSHAFT

The crankshaft is driven by the pistons and connecting rods, and translates its reciprocating movement into a circular movement. It also drives the oil pump, camshaft and fuel camshaft. Six counterweights are integrated into one unit to minimize bearing wear and lubricating oil temperature rise.
Crankshaft journals, crankpins and oil seal sliding section are induction-hardened to raise wear resistance quality.
Crankshaft journals are supported by the main bearing cases in which bearing is used.
Crankshaft bearing 1 at the front end is a wind type bushing and the three bearings 2 behind are split type bushings.
Side bearings 1, 2 of split type are mounted on both sides of the main bearing case 1 at the flywheel side.
Crankshaft bearings and side bearings are plated with special alloy to raise wear resistance quality.

(1) Crankshaft
(2) Piston
(3) Connecting rod
(4) Oil passage
(5) Crankshaft bearing 1
(6) Crankshaft bearing 2
(7) Side bearing
(8) Counterweight

[A] Pistons and piston rings



0075F011

1-4 PISTON AND PISTON RINGS

Piston circumference has a special elliptic shape in consideration of expansion due to explosion heat. Piston head is flat-formed. Furthermore, ribs are provided between the piston head and top ring to reduce distortion and to help heat radiation (only D850-B, DH850-B, D950-B).
Piston is made of special aluminum alloy of low thermal expansion and high temperature resistance.
Top ring is of key stone type which can stand against heavy load, and the sliding surface to the cylinder wall is shaped into barrel face which is well fitted to the wall and plated with hard chrome.
Second ring is of under-cut type which is effective to prevent oil rising.
Oil ring is effective to scrape oil because it is closely fitted to the cylinder wall by coil expander and the upper and lower ends of its sliding surface are cut diagonally to raise fare pressure to the cylinder walls.
A part of scraped oil is forced into the inside of piston through oil escape holes of rings and piston. The oil ring is plated with hard chrome to increase wear resistance quality.

(1) Rib
(2) Top ring
(3) Barrel face
(4) Hard chrome plating
(5) Second ring
(6) Coil expander ring

1-3 VILEBREQUIN

Le vilebrequin, mû par les pistons et les bielles, transforme le mouvement alternatif en un mouvement circulaire. Il actionne aussi la pompe à huile, l'arbre à cames et l'arbre de distribution du combustible. Le groupement de six contrepoids en un seul bloc permet de réduire l'usure du palier et empêche aussi que la température du lubrifiant ne s'élève.

Les portées du vilebrequin, les manetons et la section coulissante du disque de retenue d'huile ont été trempés par induction afin d'accroître leur résistance à l'usure.

Les portées du vilebrequin sont supportées par le corps du palier principal qui fait bloc avec ce palier.

Palier-manivelle 1: à l'extrémité se trouvent une coquille de coussinet et trois coussinets métalliques 2, derrière se trouvent des coussinets fendus. Des paliers latéraux 1 et 2, de type en deux pièces, ont été montés des deux côtés du corps du palier principal 1 côté volant.

Les coussinets de palier et les coussinets latéraux sont recouverts par galvanoplastie d'un alliage spécial qui les rend plus résistants à l'usure.

(1) Vilebrequin
(2) Piston
(3) Bielle
(4) Trou de graissage
(5) Palier-vilebrequin 1
(6) Palier-vilebrequin 2
(7) Palier latéral
(8) Contrepoids

1-4 PISTONS ET SEGMENTS DE PISTON

La circonférence du piston est de forme elliptique en raison de la dilatation engendrée par la chaleur d'explosion. La tête du piston est plate. Une nervure a été aussi prévue entre la tête du piston et le segment supérieur afin de réduire la déformation et d'aider le rayonnement de la chaleur (sur les modèles D850-B, DH850-B et D950-B seulement). Le piston est en alliage spécial d'aluminium présentant une faible dilatation thermique et une résistance élevée à l'amplitude thermique. Le segment supérieur type clé de voûte peut supporter de lourdes charges, et on a donné à la portion glissant vers la paroi du cylindre une forme en berceau qui lui permet de bien épouser la paroi. Il a été chromé avec un chrome dur.

Le second segment est de type coupé à recouvrement, ce qui empêche l'huile de monter.

Le segment racleur est efficace du fait qu'il est ajusté de près à la paroi du cylindre à l'aide d'un joint compensateur à spirale et que les extrémités supérieure et inférieure de son aire de glissement ont été taillées en diagonale afin d'élever la pression d'huile en cours de fonctionnement.

Une partie de l'huile raclée est forcée dans le piston par les trous d'échappée d'huile des segments et du piston. Le segment racleur est chromé au chrome dur afin de lui assurer une plus haute résistance à l'usure.

(1) Nervure
(2) Segment supérieur
(3) Face en berceau
(4) Chromage dur
(5) Second segment
(6) Anneau de dilatation du serpentin

1-3 KURBELWELLE

Die Kurbelwelle wird durch die Kolben und Pleuelstangen angetrieben, um deren gegenseitige Bewegung in eine Drehbewegung umzusetzen.

Durch die Kurbelwelle werden auch gleichzeitig die Ölpumpe, die Nockenwelle und die Treibstoffnockenwelle betrieben. Um Lagerungsverschleiß und Temperaturanstieg des Schmierungsöls zu minimalisieren, wurden sechs Gegengewichte in diese Einheit integriert.

Um die Verschleißfestigkeit der Kurbelwellenenden, der Kurbelstifte und der Schiebeteile der Ölabdichtungen zu erhöhen, wurden diese Teile besonders induktionsgehärtet.

Die Kurbelwellenenden werden durch die Hauptlagerung mit Lagerungsmetall unterstützt.

Die Kurbelwellenlagerung 1 besitzt am Ende eine Windtypenschale und die hinteren drei Lagerungen 2 sind gespaltene Lagerungsschalen.

Die Seitenlagerungen 1, 2 vom Spalttyp sind auf der Schwungscheibenseite auf beiden Seiten des Hauptlagerungsgehäuses 1 angebracht.

Die Lagerungen der Kurbelwelle und die Seitenlagerungen sind mit einer speziellen Legierung überzogen, um deren Verschleißfestigkeit weiterhin zu erhöhen.

(1) Kurbelwelle
(2) Kolben
(3) Pleuelstange
(4) Öldurchfluß
(5) Kurbelwellenlagerung 1
(6) Kurbelwellenlagerung 2
(7) Seitenlagerung
(8) Gegengewicht

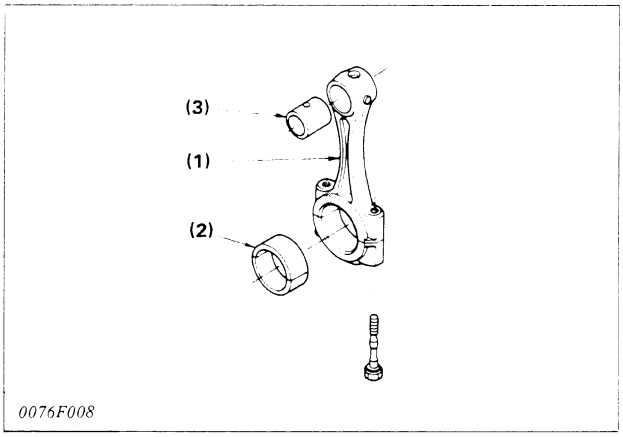
1-4 KOLBEN UND KOLBENRINGE

Der Kolbenumfang wurde auf eine spezielle elliptische Form ausgelegt, um Ausdehnungen durch die Verbrennungshitze entgegenzuwirken. Der Kolbenkopf besitzt eine Flachfläche. Darüberhinaus wurde zur Verringerung von Verziehungen und um die Wärmeausstrahlung zu kontrollieren, eine Rippe zwischen dem Zylinderkopf und der Kolbennabe eingerichtet. (Nur bei den Modellen D850-B, DH850-B, D950-B) Die Kolben selbst sind aus einer speziellen Aluminiumlegierung, um eine geringe Temperaturausdehnung und hole Temperaturwiderstandsfähigkeit zu gewährleisten. Als Oberring wird der Key-stone-Typ verwendet, der starken Belastungen standhält. Die Bewegungsfläche der Zylinderwand ist auf eine Faßfläche ausgelegt, die gut an die Wand angepaßt und mit Hartchrom beschichtet ist. Der Zweitring ist vom Unterschneidungstyp, der für die Verhinderung des Ölanstiegs sorgt.

Der Ölring dient zum effektiven Abschaben des Öls, da dieser dicht zur Zylinderwand durch den Spulenausdehner eingesetzt ist und dessen obere und untere Enden der Bewegungsflächen diagonal geschnitten sind, um den Druck an den Zylinder wänden zu erhöhen.

Ein Teil des abgeschabten Öls wird durch die Ölentweichungslöcher der Ringe und Kolben zwangsweise zurück in den Kolben geleitet. Um die Verschleißfestigkeit des Ölrings zu erhöhen, ist dieser mit Hartchrom beschichtet.

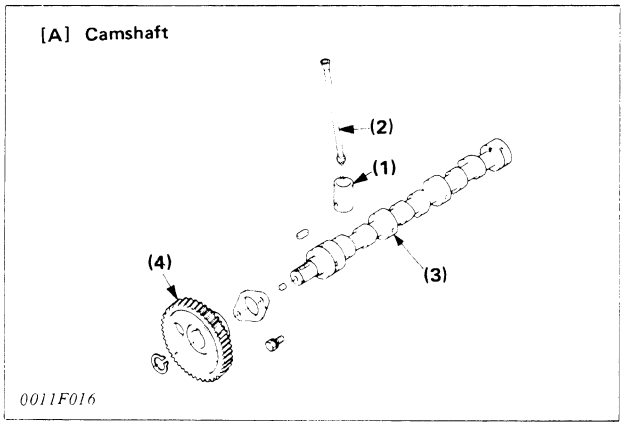
(1) Rippe
(2) Oberring
(3) Laufbuchsenfläche
(4) Hartchrombeschichtung
(5) Zweitring
(6) Spulenausdehnungsring



1-5 CONNECTING RODS

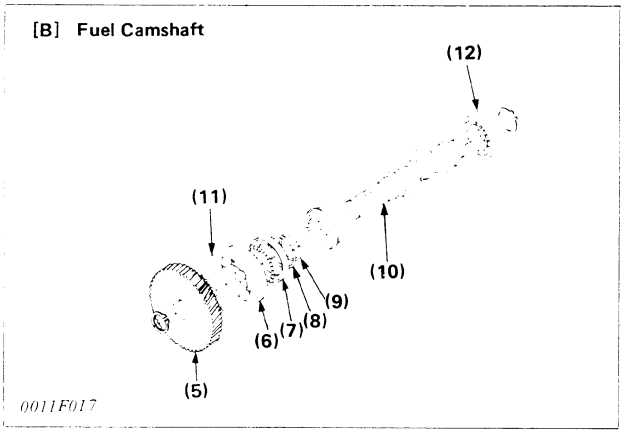
Connecting rod is used to connect the piston with the crankshaft. The big end of the connecting rod has crankpin bearings (split type) and the small end has a bushing (Solid type).

(1) Connecting rod
(2) Crankpin bearing
(3) Bushing



1-6 CAMSHAFT AND FUEL CAMSHAFT

The camshaft is made of special cast iron and the journal and cam sections are chilled to resist wear. The journal sections are force-lubricated. The fuel camshaft controls the reciprocating movement of the injection pump, and is equipped with a ball to control the governor. Fuel camshaft is made of carbon steel and cam sections are quenched and tempered to provide greater wear resistance.



(1) Tappet
(2) Push rod
(3) Camshaft
(4) Camshaft gear
(5) Injection pump gear
(6) Governor sleeve
(7) Governor ball case
(8) Circlip
(9) Circlip
(10) Fuel camshaft
(11) Ball
(12) Ball bearing

1-5 BIELLE

La bielle sert à relier le piston au vilebrequin. La tête de bielle est munie de douilles de maneton (type fendu) tandis que le pied est muni d'un coussinet (type coquille).

(1) Bielle
(2) Douille de maneton
(3) Coussinet

1-6 ARBRE A CAMES ET ARBRE DE DISTRIBUTION A CAME

L'arbre à cames est en fonte spéciale, tandis que le tourillon et les cames ont été trempés en coquille pour résister à l'usure. La section du tourillon est graissée sous pression. L'arbre de distribution à came contrôle le mouvement alternatif de la pompe d'injection et est muni d'une boule contrôlant le régulateur. L'arbre de distribution à came est en acier au carbone, tandis que les pieces de la came ont subi trempe et revenu pour lui assurer une plus grande résistance à l'usure.

[A] Arbre à cames
(1) Poussoir
(2) Tige-poussoir
(3) Arbre à cames
(4) Distribution de l'arbre à cames
[B] Arbre de distribution à came
(5) Garniture de la pompe d'injection
(6) Manchon de régulateur
(7) Cuvette de la boule du régulateur
(8) Attache circulaire
(9) Attache circulaire
(10) Arbre de distribution à came
(11) Boule
(12) Coussinet de boule

1-5 PLEUELSTANGEN

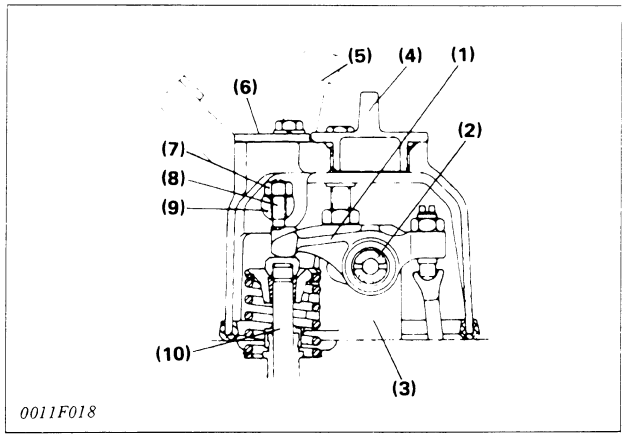
Pleuelstangen werden als Verbindungsstäbe zwischen den Kolben und der Kurbelwelle benötigt. Das größere Ende der Pleuelstange ist mit einer Kurbelstiftlagerung (gespaltener Typ) ausgestattet, während das kleinere Ende mit einer Buchse (Wind-Typ) ausgestattet ist.

(1) Pleuelstange
(2) Kurbelstiftlagerung
(3) Buchse

1-6 NOCKENWELLE UND TREIBSTOFFNOCKENWELLE

Die Nockenwelle ist aus einem speziellen Gußeisen gefertigt, wobei die Nockensektionen und Endteile für die Verbesserung der Verschleißfestigkeit entsprechend abgeschreckt wurden. Die Endsektionen sind zwangsgeschmiert. Durch die Treibstoffnockenwelle werden die Gegenbewegungen der Einspritzpumpe kontrolliert, wobei diese Vorrichtung mit Kugeln für die Steuerung der Geschwindigkeitsreglungsvorrichtung ausgestattet ist. Die Treibstoffnockenwelle besteht aus Kohlestahl und die Nockensektionen sind gehärtet und abgeschreckt, um eine erhöhte Verschleißfestigkeit zu gewährleisten.

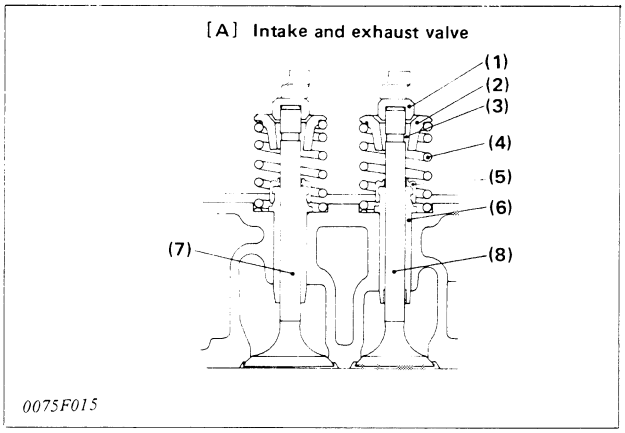
[A] Nockenwelle
(1) Nocke
(2) Druckstab
(3) Nockenwelle
(4) Nockenwellenzahnrad
[B] Treibstoffnockenwelle
(5) Einspritzpumpenzahnrad
(6) Drehzahlenreglermanchette
(7) Drehzahlenreglerkugelgehäuse
(8) Umfangsklammer
(9) Umfangsklammer
(10) Treibstoffnockenwelle
(11) Kugel
(12) Kugelgehäuse



1-7 ROCKER ARM ASSEMBLY

The rocker arm assembly includes the rocker arms, rocker arm brackets and rocker arm shaft and converts the reciprocating movement of the push rods to an open/close movement of the inlet and exhaust valves. Valve control timing must be adjusted with screws on the rocker arms. Lubrication oil is pressurized through the bracket to the rocker arm shaft so that the rocker arm bearings and the entire system are lubricated sufficiently.

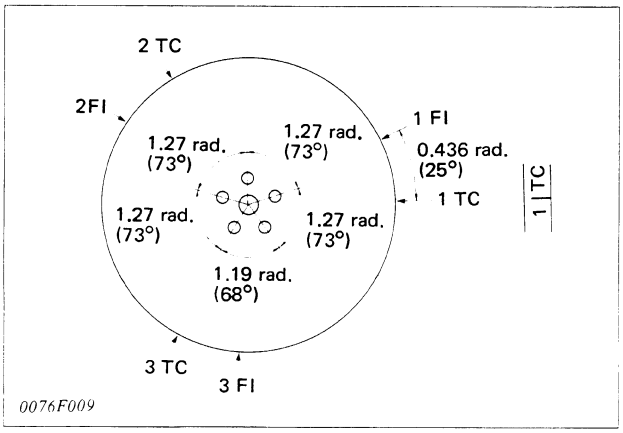
(1) Rocker arm
(2) Rocker arm shaft
(3) Rocker arm bracket
(4) Oil filer plug
(5) Decompression lever
(6) Decompression window cover
(7) Decompression nut
(8) Decompression bolt
(9) Decompression shaft
(10) Valve



1-8 INLET AND EXHAUST VALVES

The inlet and exhaust valves and their guides are different from each other. Other parts, such as valve springs, valve spring retainers, valve spring collets, valve stem seals, and valve caps are the same for both the inlet and exhaust valves. All contact or sliding parts are quenched and tempered to resist wear.

(1) Valve cap
(2) Valve spring Retainer
(3) Valve spring Collets
(4) Valve spring
(5) Valve stem seal
(6) Valve guide
(7) Inlet valve
(8) Exhaust valve



1-9 FLYWHEEL

Flywheel is connected with the crankshaft. Storing explosive force by each cylinder as the force of inertia, the flywheel functions to rotate the crankshaft smoothly.
On the circumference of the flywheel are stamped marks for fuel injection timing and top dead center. The flywheel and crankshaft can be fixed to each other at a certain point according to the arrangement of flywheel mounting bolt hole.

1 TC . . . Mark for top dead center of 1st piston
1 FI . . . Mark for fuel injection of 1st piston

1-7 BLOC DE CULBUTEUR

Le bloc de culbuteur comprend le culbuteur, le support et l'arbre du culbuteur. Il transforme le mouvement alternatif des tiges-poussoirs en un mouvement d'ouverture et de fermeture des soupapes d'admission et d'échappement. On doit régler le calage des soupapes à l'aide des vis se trouvant sur le culbuteur. L'huile de graissage, mise sour pression, passe par le support pour arriver à l'arbre du culbuteur qui joue le rôle d'axe, assurant ainsi la lubrification correcte des coussinets du culbuteur et de l'ensemble du système.

(1) Culbuteur
(2) Arbre de culbuteur
(3) Support de culbuteur
(4) Ajusteur d'huile
(5) Levier de décompression
(6) Couvercle de regard de la décompression
(7) Ecrou de décompression
(8) Boulon de décompression
(9) Arbre de décompression
(10) Soupape

1-8 SOUPAPES D'ADMISSION ET D'ECHAPPEMENT

Les soupapes d'admission et d'échappement, de même que leurs guides, ne sont pas pareilles. D'autres pièces, telles que les ressorts de soupape, les étriers de ressort de soupape, les bagues de ressort de soupape, les joints de queue de soupape et les capuchons de soupape, sont identiques pour les soupapes d'admission et d'échappement. Toutes les surfaces de contact et les aires de glissement ont subi trempe et revenu afin d'être plus résistantes à l'usure.

(1) Capuchon de soupape
(2) Etrier de ressort de soupape
(3) Bague de ressort de soupape
(4) Ressort de soupape
(5) Joint de queue de soupape
(6) Guide de soupape
(7) Soupape d'admission
(8) Soupape d'échappement

1-9 VOLANT

Le volant est relié au vilebrequin. Par l'emmagasinage de la force d'explosion de chaque cylindre sous forme de force d'inertie, le volant fait tourner le vilebrequin sans à-coups.
Des repères estampés se trouvent sur la circonférence du combustible volant, indiquant la distribution d'injection de combustible et le haut de course. Il est possible d'attacher, à un certain point, le volant au vilebrequin, en fonction de la position du trou de boulon de montage du volant.

1|TC . . . Indique haut de course du premier piston
1|FI . . . Indique injection de combustible du premier piston

1-7 KIPPARMEINHEIT

Die Kipparmeinheit umfaßt die Kipparme, die Kipparmmontagestücke und die Kipparmachse, wodurch die Gegenbewegung der Druckstäbe in eine Öffnungs- und Schließ bewegung der Einlaß- und Ausstoßventile umgesetzt wird. Der Steuerungstakt der Ventile muß mit der Einstellschraube an den Kipparmen entsprechend eingestellt werden. Das Schmierungsöl wird unter Druck gesetzt durch die Montagestücke der Kipparmachse, um eine genügende Schmierung der Kipparmlagerungen und des gesamten Systems zu gewährleisten.

(1) Kipparm
(2) Kipparmachse
(3) Kipparmmontagestück
(4) Ölfilterstöpsel
(5) Dekompressionshebel
(6) Dekompressionsfensterabdeckung
(7) Dekompressionsmutter
(8) Dekompressionsbolzen
(9) Dekompressionsachse
(10) Ventil

1-8 EINLAß- UND AUSSTOßVENTILE

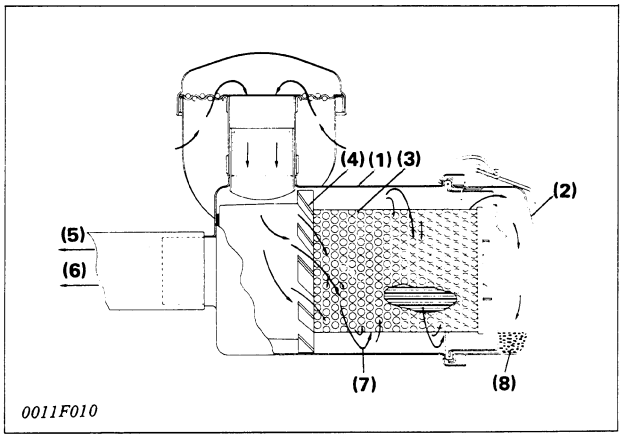
Die Einlaß- und Ausstoßventile sowie deren Führungen unterscheiden sich voneinander. Andere Teile wie die Ventilspiralen, Ventilspiralenhalterungen, Ventilspiralenmanchetten, Ventilstababdichtungen und Ventilkappen sind für die Einlaß- und Ausstoßventile gleich ausgelegt. Bei den Ventilen sind alle Kontakt- oder Bewegungsteile entsprechend gehärtet und abgeschreckt, um die Verschleißfestigkeit zu erhöhen.

(1) Ventilkappe
(2) Ventilspiralenhalter
(3) Ventilspiralenmanchette
(4) Ventilspirale
(5) Ventilstababdichtung
(6) Ventilführung
(7) Einlaßventil
(8) Ausstoßventil

1-9 SCHWUNGSCHEIBE

Die Schwungscheibe steht in direkter Verbindung mit der Kurbelwelle. Durch Speicherung des Verbennungsstoßes durch jeden Zylinder, dient die Schwungscheibe zur Glättung der Kurbelwellendrehung.
Auf der Umfangsfläche der Schwungscheibe sind Markierung en zue Bezeichnung des oberen Totpunktes und für die Taktgebung der Treibstoffeinspritzung angebracht. Die Schwungscheibe und die Kurbelwelle können in Übereinstimmung mit der Anordnung des Schwungscheibenbolzenloches miteinander nur an einer bestimmten Aufsetzstelle verbunden werden.

1|TC . . . Markierung für Oberer Totpunkt des ersten Kolbens
1|FI . . . Markierung für Treibstoffeinsprizung des ersten Kolbens

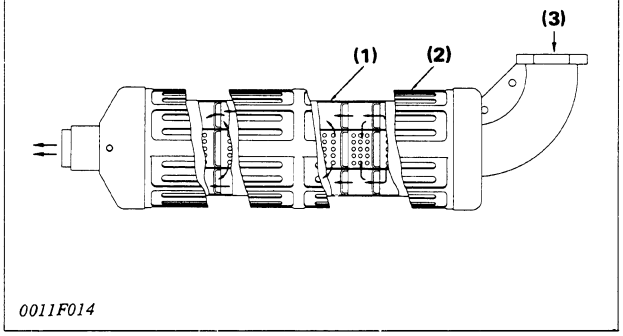


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1-10 AIR CLEANER (not included in the basic engine)

The air cleaner is a dry-cyclone type for easy maintenance. Air is purified as follows:
Air is drawn through the element's fins at high speed and flows around the inner surface of body. As a result, heavier dust particles circulate around the circumference and enter the holes in the air cleaner's cover where they accumulate. Minute dust, while circulating in the air flow, is absorbed in the element to prevent it from entering the engine.

(1) Body
(2) Cover
(3) Element
(4) Fin
(5) To cylinder
(6) Clean air
(7) Flow of dust
(8) Build-up of dust



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1-11 MUFFLER (not included in the basic engine)

The cylinder exhausts gas at high temperature and high pressure, which passes around different baffles in the muffler and then through many small holes which decrease pressure further, absorb heat and lower exhaust noise and temperature. To protect against fire and burns, a cover surrounds the outside of the muffler.

(1) Body
(2) Cover
(3) From cylinder

1-10 EPURATEUR D'AIR (non inclus dans le moteur de base)

L'épurateur d'air de type cyclone à sec est d'entretien facile. L'air est purifié comme suit:
L'air est aspiré à grande vitesse par les ailettes de l'élément et circule autour de la surface intérieure du corps. Il en résulte que les particules de poussière, qui sont les plus lourdes, tournent autour de la périphérie et pénètrent par les trous dans le capot de l'épurateur, où elles s'y accumulent. La poussière fine est absorbée par l'élément, ce qui l'empêche de pénétrer dans le moteur.

(1) Corps
(2) Capot
(3) Elément
(4) Ailette
(5) Vers le cylindre
(6) Air pur
(7) Circulation de poussière
(8) Accumulation de poussière

1-11 SILENCIEUX (non inclus dans le moteur de base)

Le cylindre refoule des gaz dont la température et la pression sont élevées. Ces gaz circulent à travers les chicanes du silencieux et passent ensuite par de nombreux petits orifices, ce qui a pour effet de réduire encore plus la pression, d'absorber la chaleur, d'étouffer le bruit et d'abaisser la température. Une couverture extérieure entoure le silencieux afin de prévenir tout risque d'incendie ou de brûlures.

(1) Corps
(2) Couverture
(3) En provenance du cylindre

1-10 LUFTREINIGER (Im Basismodell nicht enthalten)

Der Luftreiniger besteht aus einem Cyclone-Trockentyp, um einfache Wartung zu gewährleisten.
Die Luft wird auf folgende Weise gereinigt:
Die Luft wird mit hoher Geschwindigkeit durch die Rippen des Elementes eingesaugt und fließt dann um die Innenfläche des Luftreinigungsgehäuse. Resultierend hiervon können schwerere Staubteilchen um die Wandumfänge des Gehäuses zirkulieren, um in die Löcher des Luftreinigungsabdeckungsgehäuses einzutreten und hier gesammelt zu werden.
Kleinere Staubteilchen des Luftstroms werden im Element selbst aufgefangen, um am Weiterlaufen in das Innere des Motors gehindert zu werden.

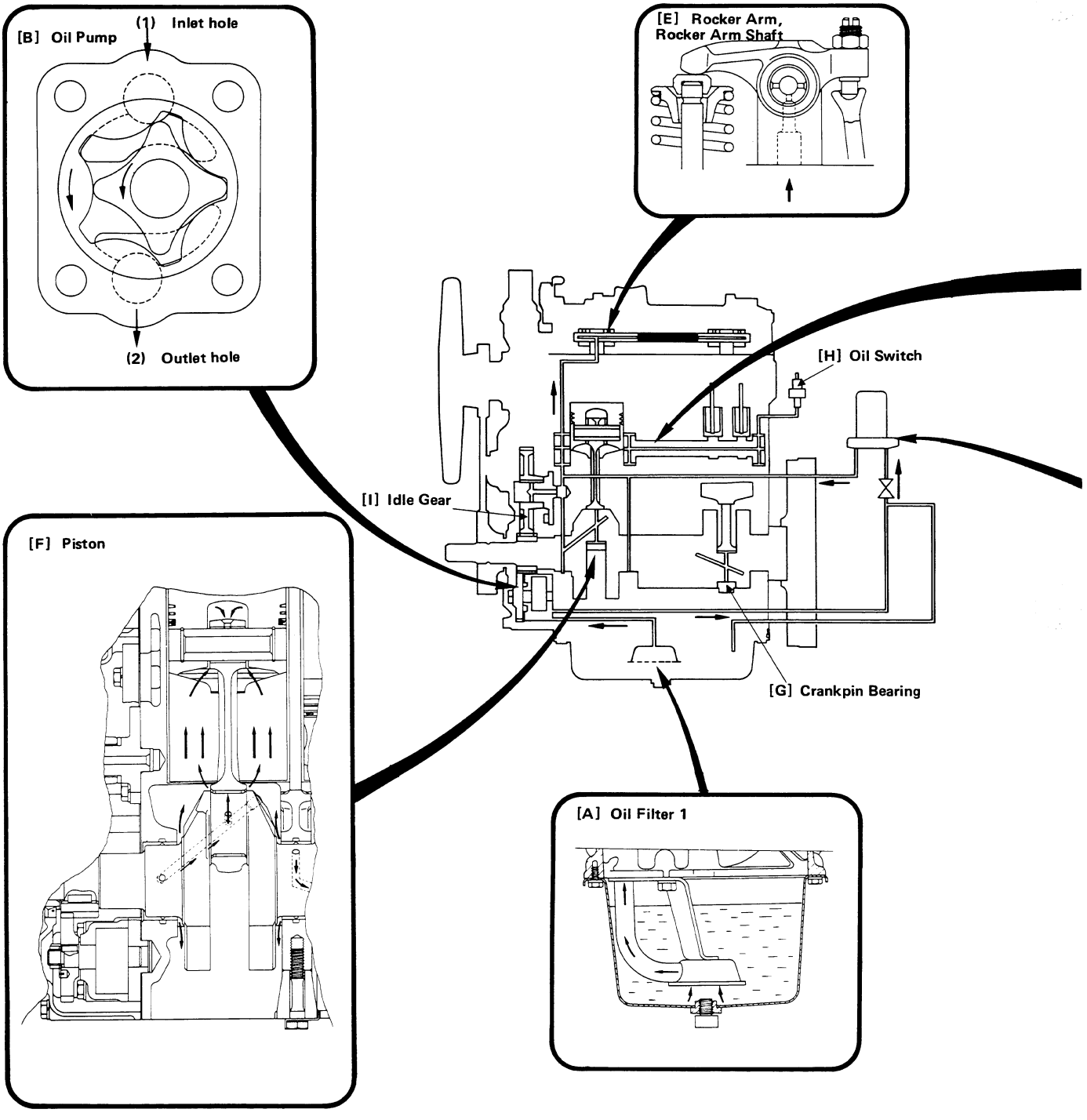
(1) Gehäuse
(2) Abdeckung
(3) Element
(4) Rippe
(5) Zum Zylinder
(6) Saubere Luft
(7) Flußrichtung des Staubs
(8) Ablagerung des angesammelten Staubs

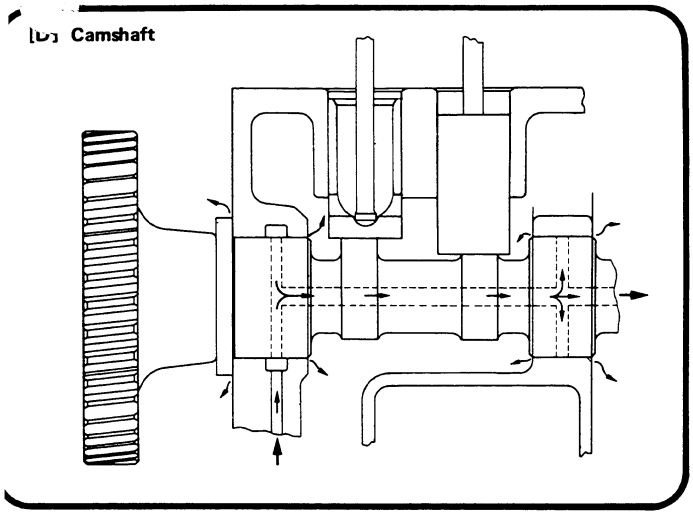
1-11 AUSPUFFTOPF (Im Basismodell nicht enthalten)

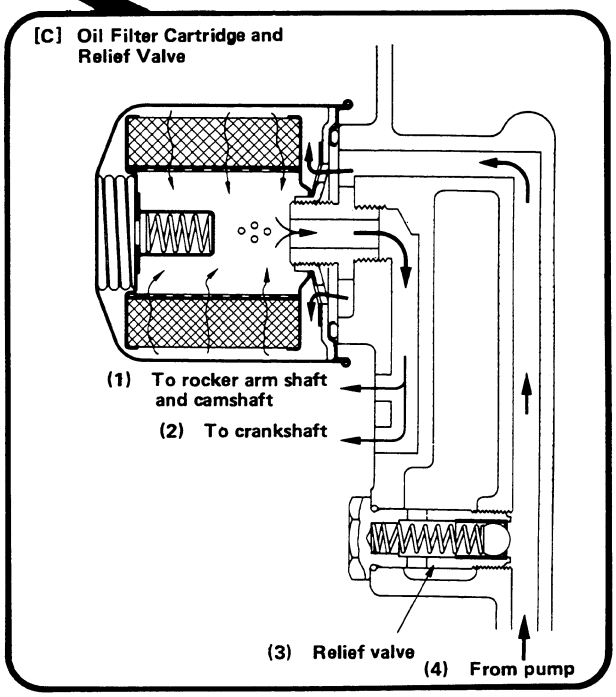
Vom Zylinder werden heiße Gase unter Hochdruck ausgestoßen, die im Auspufftopf über verschiedene Ablenkbleche zur Verringerung des Drucks geleitet werden, um dann durch eine große Anzahl kleiner Löcher geleitet zu werden, durch die die Hitze des Auspuffgases weiterhin verringert wird und die Auspuffgeräusche gleichfalls verringert werden. Die Außenseite des Auspufftopfes ist mit einer Schutzabdeckung versehen, um Brände oder Verbrennungen zu verhindern.

(1) Gehäuse
(2) Abdeckung
(3) Vom Zylinder

2. LUBRICATION SYSTEM





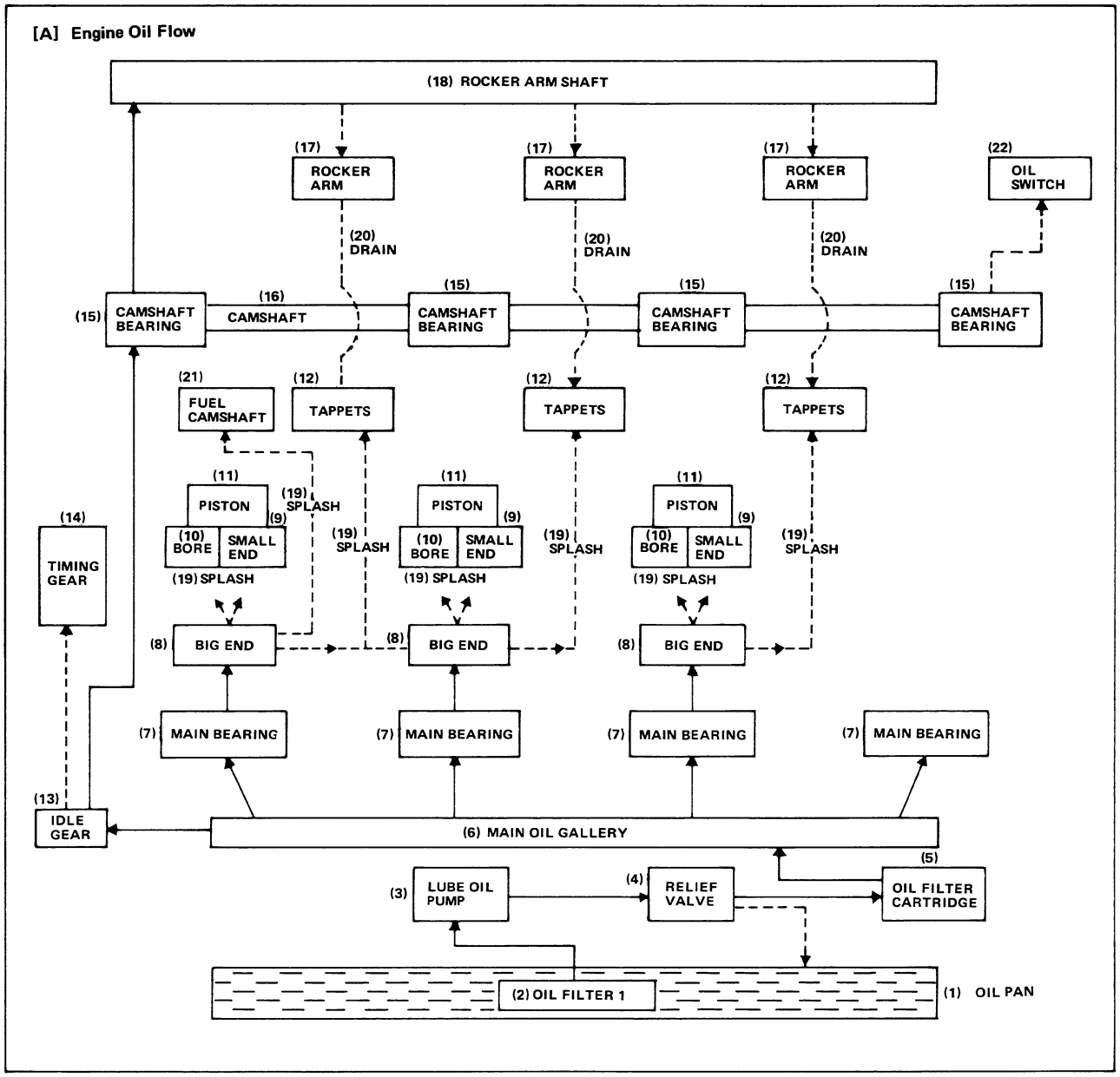


2. SYSTEME DE LUBRIFICATION

[A] Filtre à huile 1
[B] Pompe à huile
  (1) Arrivée d'huile
  (2) Sortie d'huile
[C] Cartouche du filtre à huile et soupape de sûreté
  (1) Vers l'arbre du culbuteur et l'arbre à cames
  (2) Vers le vilebrequin
  (3) Soupape de sûreté
  (4) En provenance de la pompe
[D] Arbre à cames
[E] Culbuteur, Arbre de culbuteur
[F] Piston
[G] Interrupteur à bain d'huile
[H] Piston
[I] Pignon fou

2. SCHMIERUNGSSYSTEM

[A] Ölfilter 1
[B] Ölpumpe
  (1) Einlaßöffnung
  (2) Ausstoßöffnung
[C] Ölfilter-Patrone und Umgehungsventil
  (1) Zur Kipparmachse und Kurbelwelle
  (2) Zur Kurbelwelle
  (3) Umgehungsventil
  (4) Von der Pumpe
[D] Nockenwelle
[E] Kipparm, Kipparmachse
[F] Kolben
[G] Ölschalter
[H] Kolben
[I] Zwischenzahnrad



This engine lubrication system consists of oil filter 1 (strainer), oil pump, relief valve, oil filter cartridge and oil switch. The oil pump suctions lubrication oil from the oil pan through oil filter 1, and the oil flows down to the filter cartridge, where it is further filtered. Then the oil is forced to crankshaft, connecting rods, idle gear, camshaft and rocker arm shaft to lubricate each part. Some part of oil, splashed by the crankshaft or leaking and dropping from gaps of each part, lubricates these parts: pistons, cylinders, small ends of connecting rods, tappets, pushrods, inlet and exhaust valves and timing gears.

[A] Système de lubrification

(1) Bac d'huile
(2) Filtre à huile
(3) Pompe à huile
(4) Soupape de sûreté
(5) Cartouche de filtre à huile
(6) Galerie principale pour l'huile
(7) Palier principal
(8) Tête
(9) Pied de bielle
(10) Trou de palier
(11) Piston
(12) Mentonnet
(13) Pignon intermédiaire
(14) Engrenage de distribution
(15) Palier d'arbre à cames
(16) Arbre à cames
(17) Culbuteur
(18) Arbre de culbuteur
(19) Barbotage
(20) Purge
(21) Arbre de distribution à came
(22) Interrupteur à l'huile

Ce système du lubrification moteur consiste dans le filtre à huile 1, une pompe à huile, une soupape de sûreté, une cartouche de filtre à huile et un interrupteur à l'huile. La pompe aspire l'huile du bac d'huile par le filtre à huile 1 et celle-ci s'écoule dans la cartouche où elle est ensuite filtrée. Puis, l'huile est envoyée sous pression au vilebrequin, à la bielle, au pignon fou, à l'arbre à came et à l'arbre de culbuteur, pour lubrifier chacun d'entre eux.

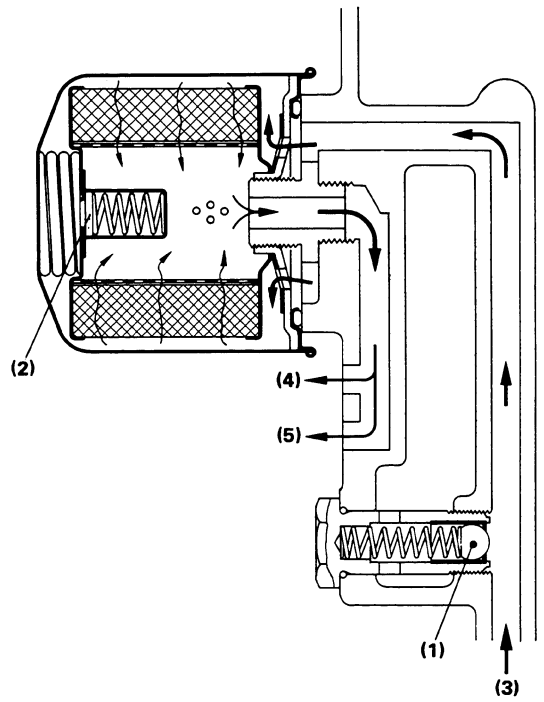
Une partie de l'huile, qui s'est échappée du vilebrequin ou qui fuit par les interstices des pièces, lubrifie les pistons, les cylindres, les, pieds de bielle, les popussoirs les tiges de poussée, les soupapes d'admission et d'échappement et l'engrenage de distribution.

[A] Schmierungssystem

(1) Ölwanne
(2) Ölfilter
(3) Schmierungsölpumpe
(4) Ablaufventil
(5) Schmierungsölfilter-Patrone
(6) Hauptölleitung
(7) Hauptlagerung
(8) Größeres Ende
(9) Kleineres Ende
(10) Bohrung
(11) Kolben
(12) Nocken
(13) Leerlaufgetriebe
(14) Taktgetriebe
(15) Nockenwellenlagerung
(16) Nockenwelle
(17) Kipphebel
(18) Kipphebelachse
(19) Einspritzen
(20) Ablauf
(21) Treibstoffnocken-welle
(22) Ölschalter

Das Schmierungssystem dieses Motors besteht aus dem Ölfilter 1 (Sieb), einer Ölpumpe, einem Ablaufventil, Ölfilter-Patrone und einem entsprechenden Ölschalter. Die Ölpumpe saugt das Öl durch den Ölfilter 1 von der Ölwanne an, wonach es durch die Ölfilter-Patrone geleitet wird, um weiter gefiltert zu werden. Dann wird das Öl zur Kurbelwelle, Pleuelstange, Leerlaufgetriebe, Nockenwelle und Kipphebelachse geleitet, um jedes Teil zu schmieren, Ein Teil des Schmierungsöls, welches durch die Kurbelwelle hochgespritzt wird oder aus den Rillen der Einzelteile aussickert und heruntertropft, ölt die Kolben, Zylinder, das kleinere Ende der Kolbenstange, Nocken, Druckstab, Einlauf- und Ausstoßventil sowie das Taktgebergetriebe.

[A] Relief valve and by-pass valve



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2-1 RELIEF VALVE

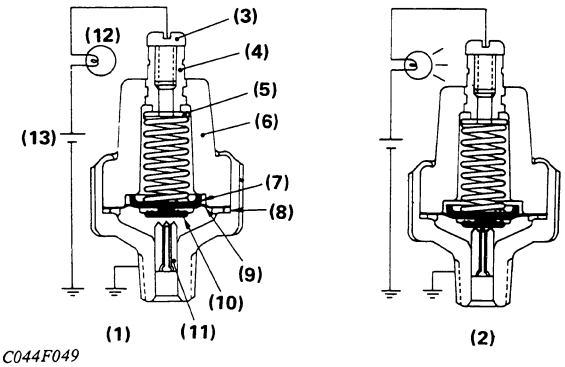
Relief valve prevents damage to the lubrication system due to high oil pressure. Control range of the relief valve is 196 to 441KPa (2.0 to 4.5kgf/cm^2, 28 to 64psi). When oil pressure exceeds the upper limit, the ball is pushed back by high pressure oil and the oil escapes.

2-2 BY-PASS VALVE

Oil filter cartridge has a by-pass valve inside, to prevent the lack of lubrication oil in the engine, if the oil filter element is clogged. When the pressure difference before filtering and after is more than 98.1kPa (1.0kgf/cm^2, 14.2psi), the by-pass valve opens and lets the oil pass to each part of engine without passing through the filter.

(1) Relief valve
(2) By-pass valve
(3) From pump
(4) To rocker arm shaft and camshaft
(5) To crankshaft

[A] Oil switch



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2-3 OIL SWITCH

Oil switch is provided on the way for the oil pressure. If the oil pressure is proper, it is switched off, if oil pressure falls below 49.0kPa (0.5kgf/cm^2, 7.1psi), the oil warning lamp etc. will light, warning the operater. In this case, stop the engine immediately and check the cause of the pressure drop.

(1) When oil pressure is proper
(2) When oil pressure falls
(3) Screw
(4) Terminal
(5) Spring plate
(6) Insulator
(7) Spring retainer
(8) Rubber packing
(9) Oil seat
(10) Contact rivet
(11) Contact
(12) Lamp
(13) Battery

2-1 SOUPAPE DE SURETE

Cette soupape de sûreté sert à empêcher le système de lubrification d'être endommagé par l'huile se trouvant à haute pression. La gamme de contrôle de cette soupape va de 196 à 441kPa (2,0 à 4,5kgf/cm^2).
Lorsque la pression dépasse la limite supérieure, la boule se trouve repoussée par l'huile sous pression, provoquant ainsi un échappement d'huile.

2-2 SOUPAPE DE DERIVATION

La cartouche du filtre à huile est munie, à l'intérieur, d'une soupape de dérivation, afin d'empêcher le moteur de souffrir d'un manque de lubrification au cas où l'élément se trouverait encrassé. Lorsque la différence de pression entre préfiltrage et post-filtrage dépasse 98,1kPa (1,0kgf/cm^2), la soupape de dérivation s'ouvre et permet à l'huile de couler vers chaque partie du moteur sans avoir à passer par le filtre.

[A] Soupape de sûreté et soupape de dérivation
- **(1) Soupape de sûreté**
- **(2) Soupape de dérivation**
- **(3) En provenance de la pompe**
- **(4) Vers l'arbre du culbuteur et le vilebrequin**
- **(5) Vers le vilebrequin**

2-3 INTERRUPTEUR A L'HUILE

L'interrupteur à l'huile permet de détecter les baisses de pression de l'huile: fermé en pression normale, si la pression descend au dessous de 49,0kPa (0,5kgf/cm^2), une lampe témoin s'allume qui alerte l'opérateur. Dans ce cas, arrêter immédiatement le moteur et chercher la cause de la chute de pression.

[A] Interrupteur à l'huile
- **(1) Lorsque la pression d'huile est correcte**
- **(2) Lorsque la pression d'huile diminue**
- **(3) Vis**
- **(4) Prise**
- **(5) Lame de ressort**
- **(6) Insulateur**
- **(7) Etrier de ressort**
- **(8) Garniture en caoutchouc**
- **(9) Logement pour l'huile**
- **(10) Rivet de contact**
- **(11) Contact**
- **(12) Lampe**
- **(13) Batterie**

2-1 ABLAUFVENTIL

Das Ablaufventil dient zur Verhinderung von Beschädigungen des Schmierungssystems, die durch zu hohen Öldruck auftreten könnten. Der Kontrollbereich des Ablaufsventils ist 196 bis 441kPa (2,0 bis 4,5kp/cm^2).
Wenn der Öldruck den oberen Grenzwert übersteigen sollte, wird die Kugel durch das Hochdrucköl zurückgestoßen, wodurch das Öl entsprechend entweichen kann.

2-2 UMGEHUNGSVENTIL

Die Ölfilter-Patrone ist mit einem Umgehungsventil ausgerüstet, durch die der Ölfluß des Schmierungsöls selbst bei einer Verstopfung des Filters aufrecht gehalten werden kann. Bei einem Druckunterschied von mehr als 98,1kPa (1,0kp/cm^2) vor und hinter dem Filter, wird das Umgehungsventil geöffnet, um das Öl ohne Filterdurchlauf in die betreffenden Teile des Motors zu leiten.

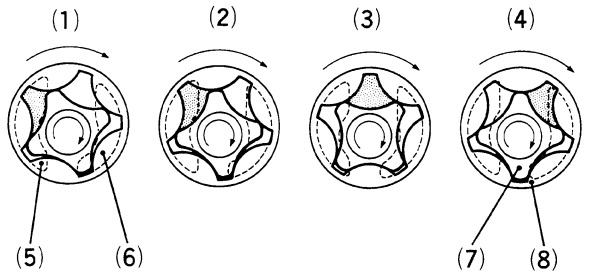
[A] Ablaufventil und Umgehungsventil
- **(1) Ablaufventil**
- **(2) Umgehungsventil**
- **(3) Von der Pumpe**
- **(4) Zur Kipparmachse und Kurbelwelle**
- **(5) Zur Kurbelwelle**

2-3 ÖLSCHALTER

Ein Öldruckschalter ist für die Überwachung des Öldrucks vorgesehen. Bei normalem Öldruck bleibt dieser Schalter ausgeschaltet, während bei einem, unter einen Druckwert von 49,0kPa (0,5 kp/cm^2) abfallenden Öldruckwert, dieser Schalter eingeschaltet wird und die Öldruckwarnlampe usw. dadurch aufleuchten kann, um den Bediener des Motors vor einem zu geringen Ölstand zu warnen. Beim Aufleuchten dieser Öldruckwarnlampe muß der Motor sofort ausgeschaltet werden, um die Ursache des Druckabfalls ermitteln zu können.

[A] Ölschalter
- **(1) Bei normalem Öldruck**
- **(2) Bei Abfall des Öldrucks**
- **(3) Schraube**
- **(4) Anschluß**
- **(5) Federdruckpunkt**
- **(6) Isoliermittel**
- **(7) Federsitz**
- **(8) Gummidichtung**
- **(9) Ölabdichtung**
- **(10) Kontaktniete**
- **(11) Kontakt**
- **(12) Lampe**
- **(13) Batterie**

[A] Rotor-type pump in operation



0321F007

2-4 OIL PUMP

The oil pump is of rotor type and works smoothly and noiselessly. An inner and outer rotor turn inside a housing. In operation, the inner rotor is driven inside the outer rotor. The inner rotor has one less lobe than the outer rotor, so that only one lobe is in full engagement with the outor rotor at any one time. This allows the other lobes to slide over the outer lobes, making a seal to prevent back-up of oil.
As the lobes slide up and over the lobes on the outor rotor, oil is drawn in. As the lobes fall into the ring's cavities, oil is squeezed out.

(1) Draw in 1
(2) Draw in 2
(3) Draw in 3
(4) Squeeze out
(5) Inlet
(6) Outlet
(7) Inner rotor
(8) Outer rotor

2-4 POMPE A HUILE

Il s'agit d'une pompe à rotor, caractérisée par un fonctionnement doux et silencieux.
Un rotor intérieur et un rotor extérieur tournent dans un carter. Le rotor intérieur compte, durant le pompage, un pétale de moins que le rotor extérieur, de sorte qu'il n'y a toujours qu'un seul pétale engrené sur le rotor extérieur. Ceci permet aux autres pétales de glisser sur les pétales extérieurs, créant ainsi un joint hermétique qui empêche l'huile de s'accumuler. L'huile est aspirée au fur et à mesure que les pétales glissent, de bas en haut, sur les pétales du rotor extérieur et elle est extraite au fur et à mesure que les pétales tombent dans les alvéoles de la bague.

[A] Pompe à rotor en action

(1) Admission 1
(2) Admission 2
(3) Admission 3
(4) Décharge
(5) Arrivée
(6) Sortie
(7) Rotor intérieur
(8) Rotor extérieur

2-4 ÖLPUMPE

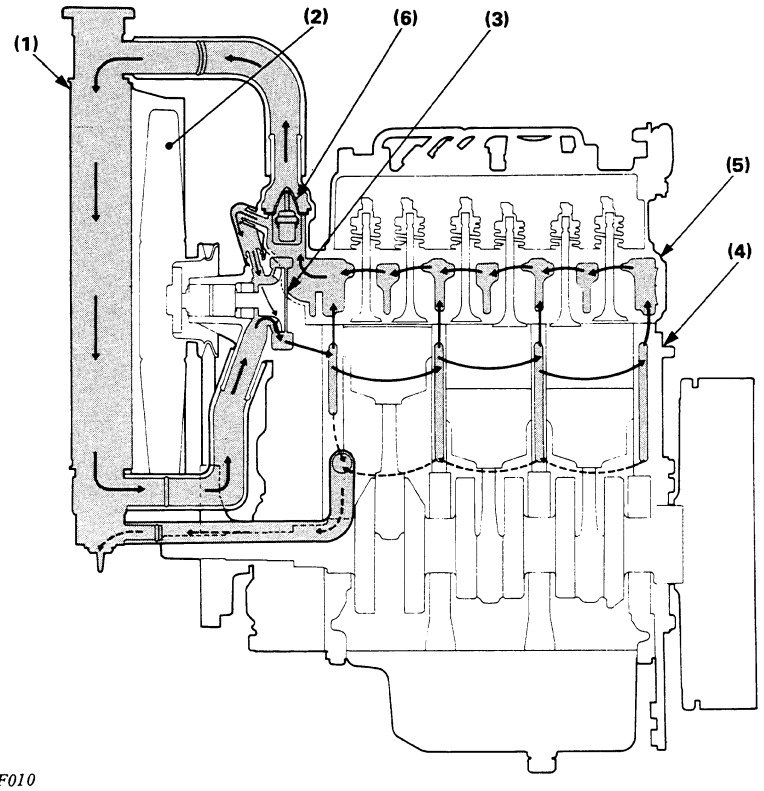
Die Ölpumpe ist von einem Rotorentyp, der glatt und geräuschlos arbeitet.
Innerhalb des Gehäuses drehen sich ein Innen- und Außenrotor.
Bei Betrieb bewegt sich der Innenrotor innenhalb des Außenrotors. Der Innenrotor hat einen Flügel weniger als der Außenrotor, so daß zu jeder gegebenen Zeit nur ein Flügel mit dem Außenring volle Eingreifung hat. Dadurch wird den anderen Flügeln erlaubt, über die Außenflügel geschoben zu werden, wodurch eine Abdichtung gegen den Rückfluß von Öl geschaffer wird.
Beim Aufschieben der Flügel über die Flügel des Außenrings wird das Öl eingesaugt, während es ausgestoßen wird, wenn die Flügel in die Aussparungen des Rings einfallen.

[A] Betrieb der Rotorentypenpumpe

(1) Einlaß 1
(2) Einlaß 2
(3) Einlaß 3
(4) Ausstoß
(5) Einlaß
(6) Ausstoß
(7) Innenrotor
(8) Außenrotor

3. COOLING SYSTEM

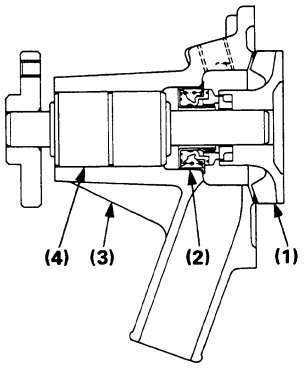
[A] Cooling System



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The cooling system consists of a radiator (not included in the basic engine), centrifugal water pump, suction fan and thermostat.
The water is cooled through the radiator core, and the fan set behind the radiator pulls cooling air through the core to improve cooling.
The pump sucks the cooled water, forces it into the cylinder block and draws out the hot water. Then the cooling is repeated. Furthermore, to control temperature of water, a thermostat is provided on the way. When the thermostat opens, the water moves directly to radiator, but when it closes, the water moves toward the water pump through the by-pass between thermostat and water pump. The opening temperature of thermostat is about 82°C (180°F).

(1) Radiator
(2) Suction fan
(3) Water pump
(4) Cylinder block
(5) Cylinder head
(6) Thermostat



0076F011

3-1 WATER PUMP

35 ℓ /min. (7.7 Imp.gals/min, 9.2 U.S. gals/min) of water is forced into the crank case and cylinder head to cool them. The impeller, of backward type, is bent as far as possible from the center, in the opposite direction to rotation. The bearing unit prevents cooling water from entering by a special mechanical seal.

(1) Water pump impeller
(2) Mechanical seal
(3) Water pump body
(4) Bearing unit

3. SYSTEME DE REFROIDISSEMENT

Le système de refroidissement se compose d'un radiateur (non inclus dans le moteur de base), d'une pompe centrifuge à eau, d'un ventilateur aspirant et d'un thermostat.
L'écoulement d'eau est refroidi en passant par le faisceau du radiateur, tandis que le ventilateur, monté derrière le radiateur, crée, par aspiration, un appel d'air de refroidissement dans le faisceau du radiateur, ce qui rend l'opération encore plus efficace. La pompe aspire l'eau refroidie et la refoule dans le bloc-cylindres, d'où elle retire l'eau chaude qui va subir à son tour le même processus de refroidissement. Un thermostat sert, de plus, à régler la température de l'eau. Lorsqu'il s'ouvre, l'eau s'écoule directement vers le radiateur et lorsqu'il se ferme, elle s'écoule vers la pompe à eau en passant par le conduit de dérivation, situé entre le thermostat et la pompe à eau. La température d'ouverture du thermostat est d'environ 82°C (180°F).

[A] Système de refroidissement
- **(1) Radiateur**
- **(2) Ventilateur aspirant**
- **(3) Pompe à eau**
- **(4) Bloc-cylindres**
- **(5) Culasse**
- **(6) Thermostat**

3-1 POMPE A EAU

L'eau, à raison de 35 ℓ/min est refoulée dans le carter du moteur et la culasse, en vue de les refroidir. La turbine à mouvement rétrograde est infléchie, aussi loin que possible du centre, dans le sens opposé à la rotation.
Un dispositif mécanique d'étanchéité empêche l'eau de refroidissement de s'écouler dans la portée.

- **(1) Turbine de la pompe à eau**
- **(2) Dispositif mécanique d'étanchéité**
- **(3) Corps de la pompe à eau**
- **(4) Portée**

3. KÜHLUNGSSYSTEM

Das Kühlungssystem (im Basismodell nicht enthalten) besteht aus einem Radiator, einer Zentrifugalwasserpumpe, eimem Saugventilator und einem Thermostat. Durch den Radiatorenkern wird das Wasser gekühlt und der hinter dem Radiator angebrachte Ventilator verbessert den Kühlungseffekt durch das Ansaugen von Kühlungsluft durch den Kern des Ventilators.
Die Pumpe saugt das gekühlte Wasser in den Zylinderblock und saugt das heiße wasser entsprechend ab, wonach der Kühlungsvorgang wiederholt wird. Um darüberhinaus die Temperatur des Wassers kontrollieren zu können, ist ein Thermostat eingebaut. Bei geöffneter Stellung des Thermostats kann das Wasser direkt in den Radiator gelangen, wird jedoch in geschlossener Stellung über die Umgehung zwischen dem Thermostat und der Wasserpumpe zur Wasserpumpe geleitet. Die Öffnungstemperatur des Thermostates ist etwa 82°C (180°F).

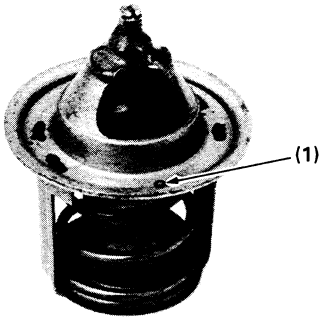
[A] Kühlungssystem
- **(1) Radiator**
- **(2) Saugventilator**
- **(3) Wasserpumpe**
- **(4) Zylinderblock**
- **(5) Zylinderkopf**
- **(6) Thermostat**

3-1 WASSERPUMPE

Für die Kühlung des Kurbelgehäuses und des Zylinderkopfes wird ein Wasserfluß von 35 ℓ/min in den Motor gedrückt. As Rückwärtstypenflügelrad wurde weitgehendst von der Mitte der Rückwärtsdrehung weggebogen. Durch eine spezielle mechanische Abdichtungsvorrichtung wird das Eintreten von Kühlwasser in die Lagerungsteile verhindert.

- **(1) Wasserpumpenflügelrad**
- **(2) Mechanische Abdichtung**
- **(3) Wasserpumpengehäuse**
- **(4) Lagerung**

3-2 THERMOSTAT



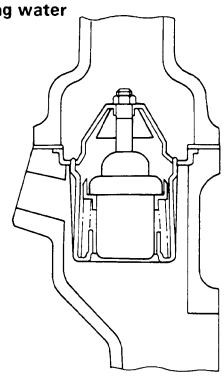
0076P008

The thermostat maintains the cooling water at correct temperature. KUBOTA's engine uses wax pellet type thermostat. Wax is enclosed in the pellet. The wax is solid at low temperatures, but turns liquid at high temperatures, expands and opens the valve.

a) At low temperatures (lower than 82°C (180°F)).
As the thermostat is closed, cooling water circulates in the engine through water return pipe without running to the radiator. Air in the water jacket in the engine escapes to the radiator side through leak hole of the thermostat.

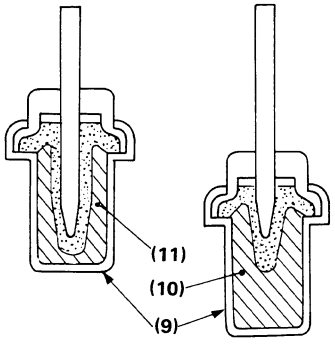
b) At high temperatures (higher than 82°C (180°F)).
When the temperature of cooling water exceeds 82°C (180°F), wax in the pellet turns liquid and expands. Because the spindle is fixed, the pellet is lowered, the valve is separated from the sheet, and then cooling water is sent to the radiator.

[A] Flow of cooling water



0076F012

[B] Temperature sensor of wax pellet type thermostat



0076F013

(1) Leak hole
(2) Water cover
(3) Spindle
(4) Pellet
(5) Valve
(6) Sheet
(7) To radiator
(8) To engine
(9) Pellet
(10) Wax (liquid)
(11) Wax (solid)

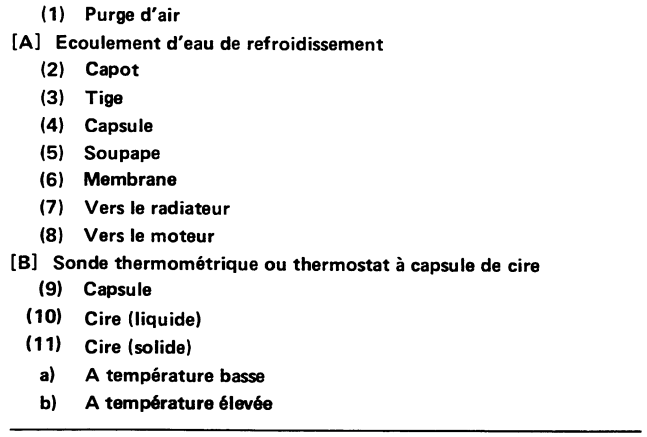
a) At low temperature
b) At high temperature

3-2 THERMOSTAT

Le thermostat sert à commander automatiquement la température du moteur. Le moteur KUBOTA est muni d'un thermostat à capsule de cire. La cire, qui se trouve dans la capsule, est à l'état solide lorsque la température est basse, mais se liquéfie lorsque la température s'élève et, par sa dilatation, entraîne l'ouverture de la soupape.

a) A température basse (inférieure à 82°C (180°F))
Le thermostat étant fermé, l'eau de refroidissement s'écoule dans le moteur par le tuyau de retour d'eau, sans passer par le radiateur. L'air se trouvant dans la chemise d'eau du moteur s'échappe du côté du radiateur par la purge d'air du thermostat.

b) A température élevée (supérieure à 82°C (180°F))
Lorsque la température de l'eau de refroidissement dépasse 82°C (180°F), la cire contenue dans la capsule se liquéfie et se dilate. La tige étant fixe, la capsule descend, ce qui sépare la soupape de sa membrane et envoie l'eau de refroidissement au radiateur.



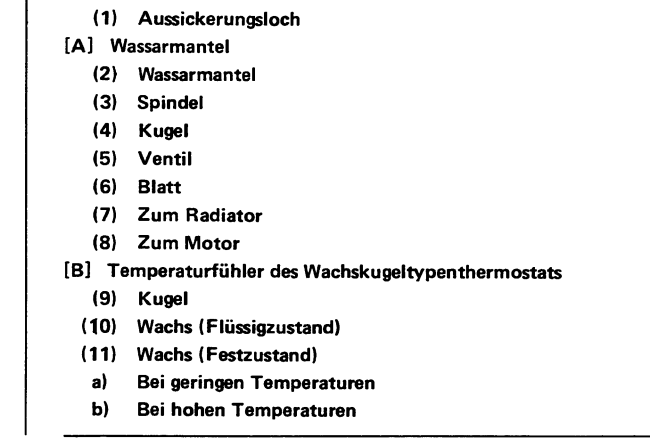
(1) Purge d'air
[A] Ecoulement d'eau de refroidissement
(2) Capot
(3) Tige
(4) Capsule
(5) Soupape
(6) Membrane
(7) Vers le radiateur
(8) Vers le moteur
[B] Sonde thermométrique ou thermostat à capsule de cire
(9) Capsule
(10) Cire (liquide)
(11) Cire (solide)
a) A température basse
b) A température élevée

3-2 THERMOSTAT

Durch den Thermostat wird eine automatische Kontrolle der Betriebstemperatur des Motors ermöglicht. In dem vorliegenden KUBOTA Motor wird ein Thermostat des Wachskugeltyps verwendet. Bei geringen Temperaturen befindet sich die Wachsmasse in einem Festzustand, wird jedoch bei hohen Temperaturen verflüssigt, wodurch die Masse ausgedehnt und das Ventil geöffnet wird.

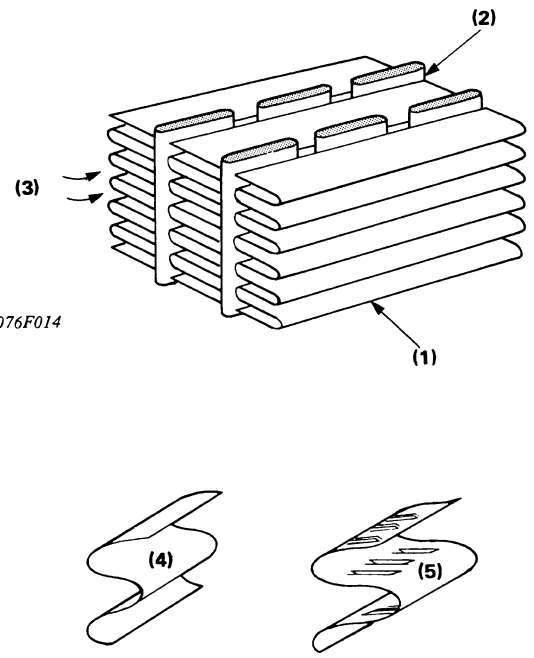
a) Bei geringen Temperaturen (Geringer als 82°C (180°F))
Da der Thermostat bei dieser Temperaur geschlossen ist, zirkuliert das Kühlwasser im Motor durch die Zirkulationsrohre ohne in den Radiator zur Kühlung geleitet zu werden. Die Luft im Wassermantel kann dann zur Radiatorenseite durch das Aussickerungsloch des Thermostaten entweichen.

b) Bei hohen Temperaturen (Höher als 82°C (180°F))
Wenn die Temperatur des Kühlwassers einen Wert von 82°C (180°F) übersteigt, wird das Wachs der Kugel verflüssigt und dehnt sich entsprechend aus. Da die Spindel unbeweglich ist, wird die Kugel verringert, wodurch das Ventil vom Blatt getrennt wird und das Kühlwasser dann zum Radiator geleitet wird.



(1) Aussickerungsloch
[A] Wassarmantel
(2) Wassarmantel
(3) Spindel
(4) Kugel
(5) Ventil
(6) Blatt
(7) Zum Radiator
(8) Zum Motor
[B] Temperaturfühler des Wachskugeltypenthermostats
(9) Kugel
(10) Wachs (Flüssigzustand)
(11) Wachs (Festzustand)
a) Bei geringen Temperaturen
b) Bei hohen Temperaturen

[A] Type of radiator core



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3-3 RADIATOR (not included in the basic engine)

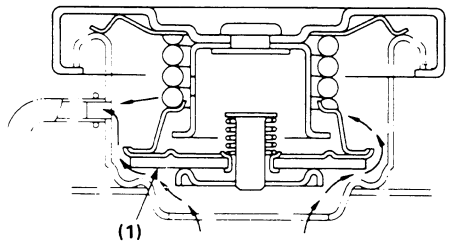
Radiator core consists of water carrying tubes and fins making a right angle with the tubes. Heat of hot water in the tubes is radiated from the tube walls and fins. KUBOTA's engine uses corrugated fin type core which has a light weight and high heat transfer rate. Clogging is minimized by the louverless fins.

Specifications for radiator

Type of core		Louverless corrugated fin
Dimensions of core	Width	382mm (15.04 in.)
	Height	300mm (11.81 in.)
	Thickness	32mm (1.26 in.)
Radiation area		3.6m^2 (40cu. feet)
Radiating capacity		14300kcal/h

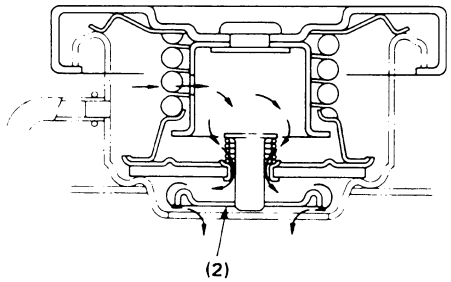
(1) Fin
(2) Tube
(3) Cooling air
(4) Louverless corrugated fin
(5) Louvered corrugated fin

[A] Radiator cap (upper specified pressure)
When pressure in the radiator exceeds the specified pressure



0011F033

[B] Radiator cap (lower specified pressure)
When pressure in the radiator falls below the specified pressure



0011F034

3-4 RADIATOR CAP (not included in the basic engine)

The radiator cap is a pressure type, which opens the pressure valve to reduce internal pressure when internal pressure is increased beyond a certain point due to increase in water temperature. The normal valve actuating pressure of the radiator cap is 88kPa (0.9kgf/cm^2, 13 psi).
When water temperature is reduced (and its volume is reduced) pressure in the radiator becomes negative, and the vacuum valve opens and introduces air into the radiator to prevent distortion of the radiator.

(1) Pressure valve
(2) Vacuum valve

3-3 RADIATEUR (non inclus dans le moteur de base)

Le faisceau du radiateur se compose du tuyau d'eau et de l'ailette qui forme un angle droit avec ce tuyau. La chaleur de l'eau qui se trouve dans le tuyau se dégage par la paroi du tuyau et par l'ailette. Le moteur KUBOTA emploie un faisceau de type à ailette ondulée, presentant légèreté et taux élevé de transmission de chaleur. L'encrassement est fort réduit du fait que l'ailette n'est pas orientée.

Clauses techniques du radiateur

Type de faisceau		Ailette ondulée non orientée
Dimensions du faisceau	Largeur	382mm
	Hauteur	300mm
	Epaisseur	32mm
Zone de rayonnement thermique		3,6m^2
Pouvoir rayonnant		14300kcal/h

[A] Type de faisceau du radiateur
- **(1) Ailette**
- **(2) Tuyau**
- **(3) Air de refroidissement**
- **(4) Ailette ondulée non orientée**
- **(5) Ailette ondulée non orientée**

3-4 BOUCHON DU RADIATEUR (non inclus dans le moteur de base)

Il s'agit d'un bouchon à pression, qui ouvre la soupape de pression afin de réduire la pression intérieure lorsque celle-ci dépasse un certain point en raison de l'élévation de la température de l'eau. La pression normale de commande de la soupape du bouchon du radiateur est de 88kPa (0,9kgf/cm^2). La pression à l'intérieur du radiateur devient négative lorsque la température de l'eau est abaissée (et que son volume est réduit); la soupape fonctionnant par dépression s'ouvre alors, ce qui a pour effet d'introduire de l'air dans le radiateur afin d'empêcher que celui-ci ne subisse de déformation.

[A] Bouchon du radiateur (limite supérieure de la pression prévue)
Lorsque la pression à l'intérieur du radiateur dépasse la pression prescrite

(1) Clapet de pression

[B] Bouchon du radiateur (limite inférieure de la pression prévue)
Lorsque la pression à l'intérieur du radiateur diminue jusqu'à devenir inférieure à la pression prescrite.

(2) Clapet de dépression

3-3 RADIATOR (Im Basismodell nicht enthalten)

Der Radiatorenkern besteht aus Wasserrohren und Rippen, die diesem im rechten Winkel zugeordnet sind. Die Hitze des heißen Wassers im Rohr wird von der Rohrwand und den Rippen abgestrahlt. In KUBOTA Motoren wird ein Wellenrippentypenkern verwendet, der sich durch geringes Gewicht und eine hohe Wärmeaustauschrate auszeichnet. Durch die Rippen ohne Schlitze werden Verstopfungen weitgehendst unterbunden.

Spezifikation des Radiators

Kerntyp		Wellenrippen
Kernabmessungen	Breite	382mm
	Höhe	300mm
	Stärke	32mm
Abstrahlbereich		3,6m^2
Abstrahlkapazität		14300kKal/h

[A] Radiatorenkerntyp
- **(1) Rippe**
- **(2) Rohr**
- **(3) Kühlungsluft**
- **(4) Wellenrippen Ohne Schlitze**
- **(5) Wellenrippen Mit Schlitze**

3-4 RADIATORENKAPPE (Im Basismodell nicht enthalten)

Die Radiatorenkappe dieses Modelles ist ein Drucktyp, der bei einem übermäßigen Anstieg des Radiatoreninnendrucks durch erhöhte Wassertemperatur das Druckventil entsprechend öffnet, um den Innendruck auszugleichen. Der normale Ventilaktivierungsdruck der Radiatorenkape beträgt 88kPa (0,9kp/cm^2). Bei einem Absinken der Wassertemperatur (und reduzierter Wassermenge) wird der Radiatorendruck negativ, wodurch das Vakuumventil geöffnet wird. Durch dieses Öffnen kann Luft in den Radiator einströmen, wodurch dieser vor Verformungen geschützt wird.

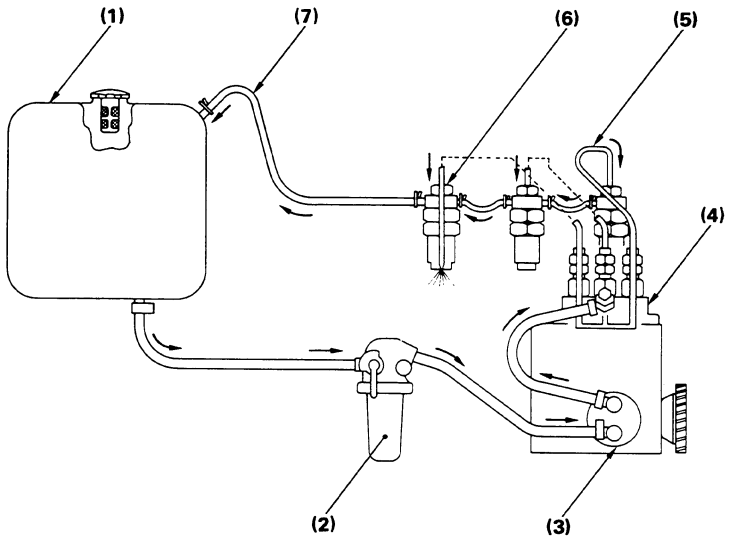
[A] Radiatorenkappe (Maximaldruck)
Wenn der Radiatorendruck den vorgeschriebenen Wert übersteigt.

(1) Druckventil

[B] Radiatorenkappe (Minimaldruck)
Wenn der Radiatorendruck unter den vorgeschriebenen Druckwert abfällt.

(2) Vakuumventil

[A] Fuel System

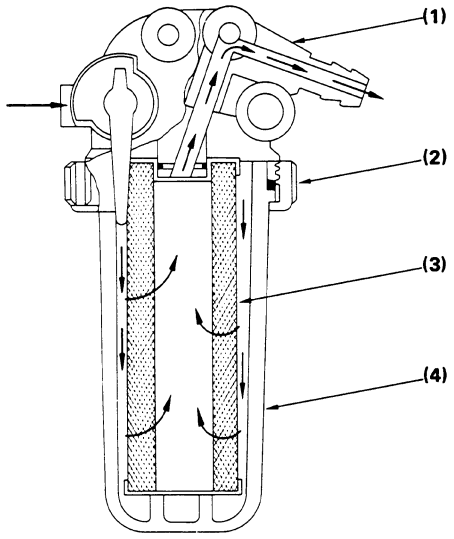


0011F035

While the engine is running, fuel is fed from the fuel tank (optional part) through the fuel filter to the fuel pump, which feeds fuel to the injection pump. The injection pump then feeds the fuel through the injection pipes, to the nozzles which inject fuel to the cylinders for combustion. Any fuel leaking from nozzles is collected in the fuel overflow pipes which drain into the tank.

(1) Fuel tank
(2) Fuel filter
(3) Fuel pump
(4) Injection pump
(5) Injection pipe
(6) Injection nozzle
(7) Fuel overflow pipe

[A] Fuel Filter



0011F036

4-1 FUEL FILTER

A fuel filter is used to prevent dirty fuel from reaching the injection pump and injection nozzles. The filter element will require occasional replacement to maintain an adequate flow of fuel to the injection pump. The frequency of this service will vary according to the cleanliness of available fuel and the care used in storage.

Fuel pumped by the fuel pump from the fuel tank is filtered by the fuel filter between the tank and pump to eliminate foreign matter and protect injection pump and nozzles. When fuel enters the filter, it passes through the filter element's circumference toward the center for filtering. The maximum filtrated granular size of this element is 48 μm (0.048 mm, 0.0019 in.), and general size is from 10 to 20 μm (0.01 to 0.02mm, 0.0004 to 0.0008 in.).

(1) Cock body
(2) Retaining ring
(3) Element
(4) Filter cup

4. SYSTEME D'ALIMENTATION EN COMBUSTIBLE

L'alimentation en combustible, lorsque le moteur est en marche, se fait comme suit: du réservoir à combustible (facultatif), via le filtre à combustible, jusqu'à la pompe à injection, d'où il passe dans la pompe d'injection pour arriver, par le tuyau d'injection, jusqu'aux injecteurs qui l'alimentent dans le cylindre en vue de la combustion. Tout combustible s'échappant des injecteurs est recueilli par le tuyau de trop-plein qui le retourne au réservoir.

[A] Système d'alimentation en combustible
- **(1) Réservoir à combustible**
- **(2) Filtre à combustible**
- **(3) Pompe à combustible**
- **(4) Pompe d'injection**
- **(5) Tuyau d'injection**
- **(6) Injecteur**
- **(7) Tuyau de trop-plein de combustible**

4-1 FILTRE A COMBUSTIBLE

Le filtre à combustible sert à empêcher le combustible souillé d'atteindre la pompe d'injection et les injecteurs. Il faudra remplacer, de temps en temps, l'élément de ce filtre afin que l'écoulement du combustible vers la pompe d'injection ne soit pas entravé, la fréquence de cette opération varie en fonction de la propreté du combustible employé et du soin avec lequel il a été entreposé.
Le filtrage du combustible en provenance du réservoir se fait entre ce dernier et la pompe à combustible afin d'éviter d'endommager la pompe d'injection et l'injecteur.
Le combustible circule d'abord le long de la périphérie de l'élément du filtre avant d'arriver au centre, où il sera filtré.
Le calibre maximum de passage des mailles de cet élément est de 48 μm (0,048 mm) et en général de 10 à 20 μm (0,01 à 0,02 mm).

[A] Filtre à combustible
- **(1) Boisseau de robinet**
- **(2) Bague de retenue**
- **(3) Elément**
- **(4) Godet de filtre**

4. TREIBSTOFFSYSTEM

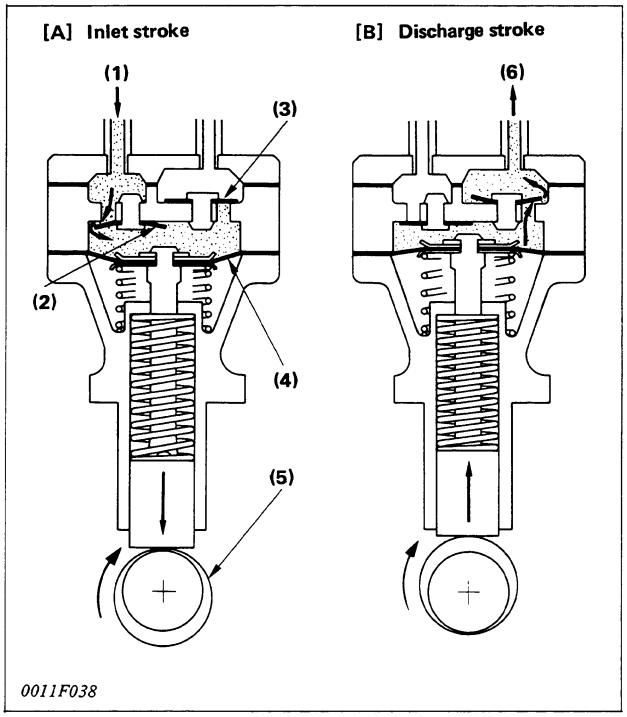
Im Laufzustand des Motors wird der Treibstoff vom Treibstofftank (Zusatzteil) über den Treibstoff-Filter zur Treibstoffpumpe geleitet, die diesen der Einspritzpumpe zuleitet. Die Einspritzpumpe leitet dann den Treibstoff durch das Einspritzrohr der Einspritzdüse zu, die den Treibstoff in den Zylinder zur Verbrennung einspritzt. Jegliche Treibstoffaussickerungen von der Düse werden von dem Treibstoffüberlaufrohr aufgefangen und in den Tank zurückgeleitet.

[A] Treibstoffsystem
- **(1) Treibstofftank**
- **(2) Treibstoff-Filter**
- **(3) Treibstoffpumpe**
- **(4) Einspritzpumpe**
- **(5) Einspritzrohr**
- **(6) Einspritzdüse**
- **(7) Treibstoffüberlaufrohr**

4-1 TREIBSTOFF-FILTER

Der Treibstoff-Filter verhindert, daß schmutziger Treibstoff die Einspritzpumpe und -düsen erreicht. Das Filterelement dieses Treibstoff-Filters muß gelegentlich ausgewechselt werden, um einen genügenden Fluß von Treibstoff zur Einspritzpumpe aufrecht zu erhalten. Die Häufigkeit dieses Auswechselns hängt vom Reinheitsgrad des erhältlichen Treibstoffes und der Vorsicht bei der Lagerung von Treibstoff ab.
Der von der Treibstoffpumpe vom Treibstofftank angesaugte Treibstoff wird durch den Treibstoff-Filter auf dem Weg zwischen dem Tank und der Pumpe entsprechend gefiltert, um Fremdstoffe zu eliminieren und die Einspritzpumpe sowie die Düse vor Beschädigungen zu schützen.
Der in den Filter eintretende Treibstoff läuft durch den Außenumfang des Filterelementes gegen die Mitte, um entsprechend gefiltert zu werden.
Die maximale Filterkorngröße dieses Elementes beträgt 48 μm (0,048 mm), wogegen die normale Größe von 10 bis 20 μm (0,01 bis 0,02 mm) beträgt.

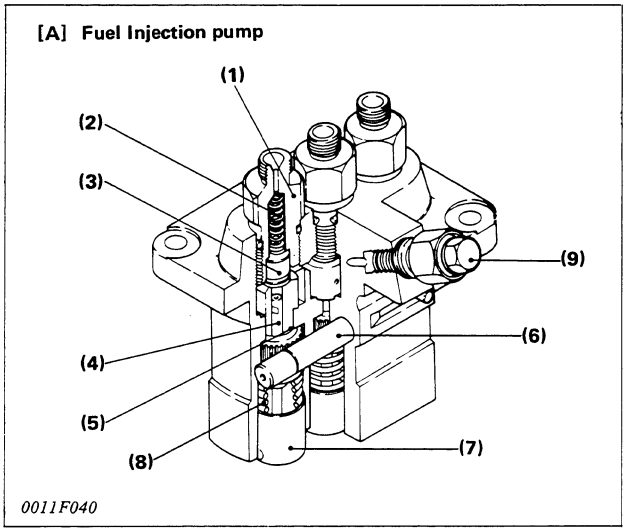
[A] Treibstoff-Filter
- **(1) Hahngehäuse**
- **(2) Haiterungsring**
- **(3) Element**
- **(4) Filterkappe**



4-2 FUEL PUMP

Filtered fuel is forcibly sucked from the tank by the fuel pump and fed under pressure to the injection pump. Inlet and discharge pressures are produced by a vertical movement of the diaphragm which is caused by the special cam (for pump) of the fuel camshaft. Fuel is suctioned on the downward stroke, and discharged on the upward stroke. A system of two valves allows fuel to flow in only one direction.

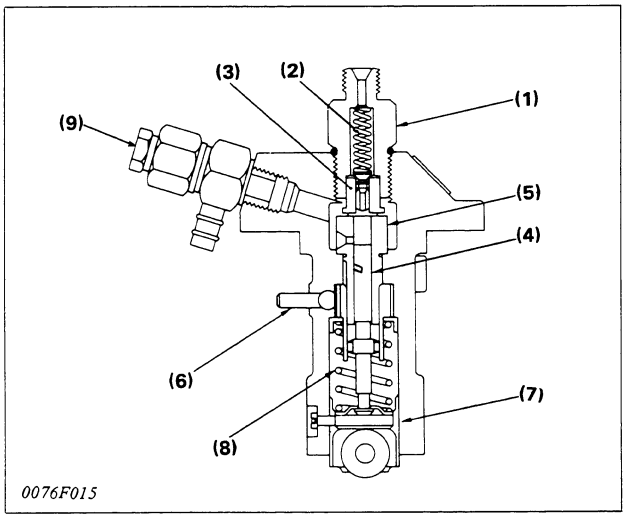
(1) From fuel filter
(2) Inlet valve
(3) Outlet valve
(4) Diaphragm
(5) Fuel camshaft
(6) To Injection pump



4-3 FUEL INJECTION PUMP

The well-known Bosch K type mini pump is provided, it features high injection quality even at low engine speed. The fuel injection pump plunger is reciprocated by the fuel camshaft which is driven by the crankshaft through a system of timing gears. Fuel camshaft rpm is 1/2 of camshaft rpm.

(1) Delivery valve holder
(2) Delivery valve spring
(3) Delivery valve
(4) Plunger } Pump element
(5) Cylinder }
(6) Control rack
(7) Tappet
(8) Plunger spring
(9) Air vent screw



4-2 POMPE A COMBUSTIBLE

Le combustible filtré est refoulé sous pression par la pompe à combustible dans la pompe d'injection. Les pressions d'admission et de refoulement sont établies par un mouvement vertical du diaphragme, provoqué par la came spéciale (pour pompe) de l'arbre de distribution à came. Le combustible est aspiré lors de la course descendante du piston. Un système composé de deux soupapes ne permet l'écoulement du combustible que dans un seul sens.

[A] Course aspirante
- (1) En provenance du filtre à combustible
- (2) Soupape d'admission
- (3) Soupape d'échappement
- (4) Diaphragme
- (5) Arbre de distribution à came

[B] Course refoulante
- (6) Vers la pompe d'injection

4-3 POMPE D'INJECTION DE COMBUSTIBLE

Emploi de la célèbre mini-pompe K de Bosch, caractérisée par son efficacité d'injection même lorsque le moteur tourne à petite vitesse. La course du piston de la pompe d'injection est transmise par l'arbre de distribution à came qui est, lui-même, commandé par le vilebrequin, grâce à un système d'engrenages. Le nombre de tours par minute de l'arbre de distribution à came est la moitié de celui de l'arbre à cames.

[A] Pompe d'injection de combustible
- (1) Porte-valve de la soupape de refoulement
- (2) Ressort de la soupape de refoulement
- (3) Soupape de refoulement
- (4) Piston, (5) Cylindre } élément de la pompe
- (6) Crémaillère de commande
- (7) Taquet
- (8) Ressort du piston
- (9) Vis de purge d'air

4-2 TREIBSTOFFPUMPE

Der gefilterte Treibstoff wird zwangsweise vom Treibstofftank durch das Ansaugen der Treibstoffpumpe unter Druck der Einspritzpumpe zugeleitet. Die Einlaß- und Ausstoßdrücke werden durch die Vertikalbewegung der Membrane erzeugt, die durch eine Spezialnocke (für die Pumpe) der Treibstoffnockenwelle erzeugt wird. Der Treibstoff wird bei Herunterbewegung eingesaugt. Ein Ventilsysten mit zwei Ventilen erlaubt dem Treibstoff nur in eine Richtung zu fließen.

[A] Einlaßtakt
- (1) Vom Treibstoff-Filter
- (2) Einlaßventil
- (3) Auslaßventil
- (4) Membrane
- (5) Treibstoff-Nockenwelle

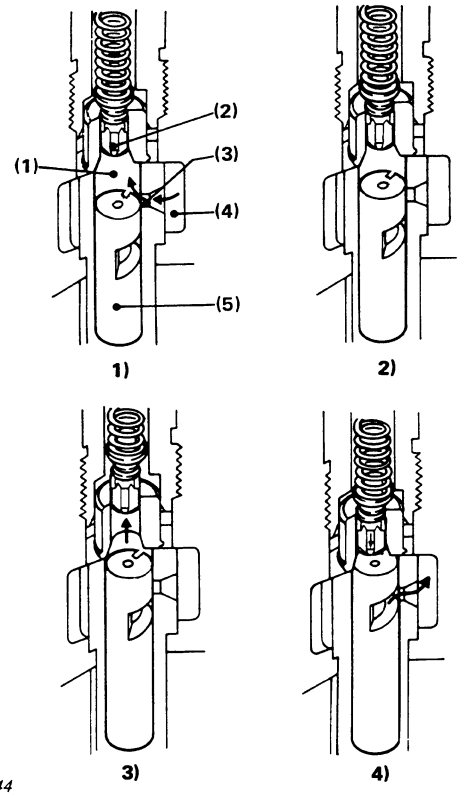
[B] Ausstoßtakt
- (6) Zur Einspritzpumpe

4-3 TREIBSTOFFEINSPRITZPUMPE

Als Einspritzpumpe wird die weitgehendst bekannte Bosch Minipumpe des Typs K verwendet. Diese Pumpe bietet selbst bei geringen Drehgeschwindigkeiten des Motors eine hohe Einspritzqualität. Der Kolben der Treibstoff-Einspritzpumpe wird von der Treibstoffnockenwelle gegenbewegt, welche ihrerseits durch ein Zahnradsystem von der Kurbelwelle bewegt wird.
Die Umdrehungsgeschwindigkeit der Treibstoffnockenwelle beträgt 1/2 der Nockenwellenumdrehung.

[A] Treibstoffeinspritzpumpe
- (1) Zuleitungsventilhalter
- (2) Zuleitungsventilspirale
- (3) Zuleitungsventil
- (4) Kolben, (5) Zylinder } Pumpen element
- (6) Kontrollgestell
- (7) Nocken
- (8) Kolbenspirale
- (9) Luftventilationsspirale

[A] Pressure-feed Start to Completion



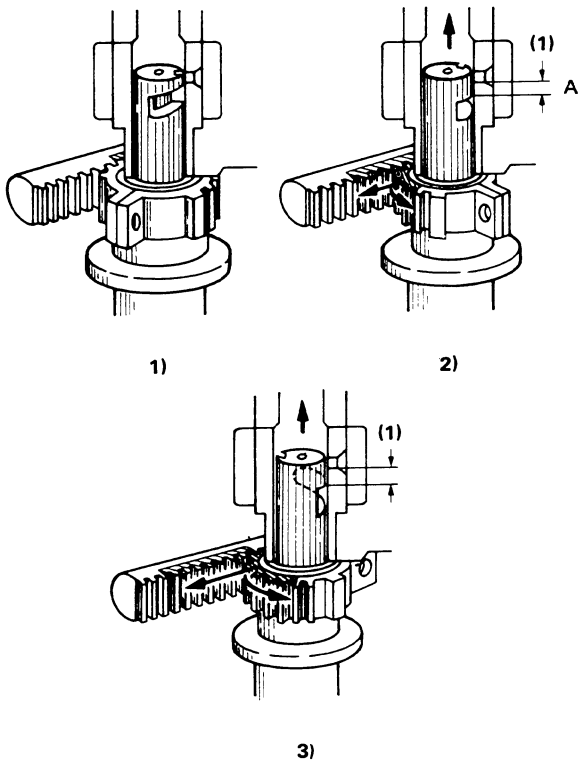
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■ **Fuel Pressure-feed**

1) Bottom dead center of plunger
   At bottom dead center, fuel enters the delivery chamber through the fuel chamber and the feed hole. (Fuel chamber is always kept full by the fuel pump.)
2) Pressure-feed start
3) Pressure-feed process
   Plunger is pushed up by camshaft to close the feed hole, and fuel pressurization starts. As the plunger moves up, pressure increases, and delivery valve is opened. Then fuel is pressure-fed through the injection pipe and nozzle into the combustion chamber.
4) Completion of pressure-feed
   When plunger moves further up, the control groove and feed hole meet. Pressurized fuel in the delivery chamber is returned through the plunger's center hole, control groove, and feed hole to the fuel chamber. Then pressure falls and pressure-feed is completed.

(1) Delivery chamber
(2) Delivery valve
(3) Feed hole
(4) Fuel chamber
(5) Plunger

[A] Injection Control



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■ **Injection Control**

1) Injection "zero"
   The feed hole meets the control groove before it is closed by the plunger top. Therefore, fuel is not pressurized, and is not injected even if the plunger moves up.
2) Injection "medium"
   When the plunger is rotated a certain amount in the direction of the arrow by the control rack, stroke A is effective until the feed hole meets the control groove and fuel is injected as the stroke amount.
3) Injection "maximum"
   When the plunger is rotated by the control rack to the maximum amount (in the direction of the arrow), effective stroke reaches maximum and maximum injection is provided.

(1) Effective stroke

■ Alimentation sous pression en combustible

1) Fond de course du piston
   Le combustible entre, lorsque le piston est à fond de course, dans la chambre de refoulement en passant par la chambre à combustible et le trou de remplissage (la chambre à combustible, que la pompe à combustible alimente, est toujours pleine).
2) Début de l'alimentation sous pression
3) Processus de l'alimentation sous pression
   L'arbre de distribution pousse le piston vers le haut, ce qui ferme le trou de remplissage et amorce la mise sous pression du combustible. La pression s'accroît, à mesure que le piston s'élève, jusqu'à provoquer l'ouverture de la soupape de refoulement. Le combustible est alors alimenté dans la chambre à combustion en passant par le tuyau d'injection et l'injecteur.
4) Fin de l'alimentation sous pression
   La rainure de contrôle, en raison de l'élévation du piston, arrive au niveau du trou de remplissage. Le combustible sous pression, se trouvant dans la chambre de refoulement, est retourné dans la chambre à combustible en passant par le trou au centre du piston, la rainure de contrôle et le trou de remplissage. La pression diminue, marquant la fin du processus.

[A] Processus de l'alimentation sous pression
- **(1) Chambre de refoulement**
- **(2) Soupape de refoulement**
- **(3) Trou de remplissage**
- **(4) Chambre à combustible**
- **(5) Piston**

■ Commande de l'injection

1) Injection "zéro"
   Le trou de remplissage arrive au niveau de la rainure de contrôle avant d'être bouché par le haut du piston. Le combustible n'est donc pas sous pression et ne peut, par suite, être injecté même si le piston s'élève.
2) Injection "moyenne"
   Lorsque la crémaillère de commande fait tourner le piston, jusqu'à un certain point, dans le sens de la flèche, la course A du piston est efficace jusqu'à ce que le trou de remplissage arrive au niveau de la rainure de contrôle et que le combustible soit injecté en fonction du nombre de coups de piston.
3) Injection "maximale"
   Lorsque la crémaillère de commande fait tourner le piston au maximum (dans le sens de la flèche), la course efficace du piston atteint son maximum et, en conséquence, l'injection aussi.

[A] Commande de l'injection
- **(1) Course efficace du piston**

■ Treibstoffdruckzuleitung

1) Absolute untere Mittelstellung des Kolbens
   In der absoluten unteren Mittelstellung des Kolbens gelangt der Treibstoff durch die Treibstoffkammer und die Zuleitungsöffnung in die Zuleitungskammer. (Die Treibstoffkammer wird immer von der Treibstoffpumpe voll mit Treibstoff gehalten.
2) Beginn der Druckzuführung
3) Druckzuführungsvorgang
   Der Kolben wird durch die Nockenwelle hochgedrückt, um das Zuleitungsloch zu verschließen, wodurch der Verdichtungsvorgang beginnt. Durch die Hochbewegung des Kolbens erhöht sich der Druck bis dieser das Zuleitungsventil öffnet. Der Treibstoff kann dann durch das Einspritzrohr und die Düse in die Verbrennungskammer eingespritzt werden.
4) Beendigung der Druckzuführung
   Wenn der Kolben dann weiterhin hochbewegt wird, treffen die Kontrollrille und das Zuleitungsloch aufeinander, wodurch der unter Druck gesetzte Treibstoff in der Zuleitungskammer über das Mittelloch des Kolbens, die Kontrollrille und Zuführungsloch zur Treibstoffkammer zurückgeleitet werden kann. Der Druck fällt dann ab, wodurch der Vorgang der Druckzuführung beendet ist.

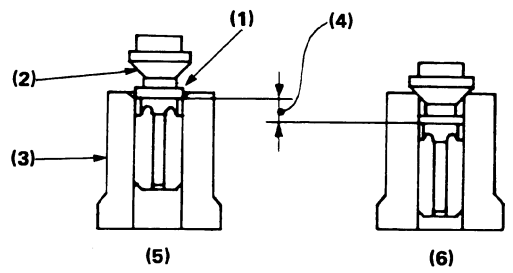
[A] Beginn bis Beendigung der Druckzuleitung
- **(1) Zuleitungskammer**
- **(2) Zuleitungsventil**
- **(3) Zeleitungsloch**
- **(4) Treibstoffkammer**
- **(5) Kolben**

■ Einspritzkontrolle

1) Einspritzung "Null"
   Das Zuleitungsloch und die Kontrollrille treffen vor Verschluß durch die Kolbenoberseite aufeinander. Dadurch wird selbst bei Hochbewegung des Kolbens, der Treibstoff nicht unter Druck gesetzt und gleicherweise nicht eingespritzt.
2) Einspritzung "Mittel"
   Wenn der Kolben durch das Kontrollgestell etwas in Pfeilrichtung gedreht wird, wird der Stoßabstand (A) effektiv bis das Zuleitungsloch und die Kontrollrille aufeinandertreffen. Die Einspritzung wird dann entsprechend dem effektiven Stoßabstand vorgenommen.
3) Einspritzung "Maximum"
   Wenn der Kolben durch das Kontrollgestell auf die Maximalstellung gedreht wird (Pfeilrichtung gemäß Abb. 56), erreicht der Effektivstoß seine Maximalstellung, wodurch maximale Einspritzung vorgenommen wird.

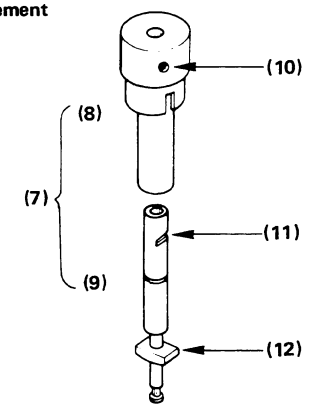
[A] Einspritzkontrolle
- **(1) Effektiver Stoß**

[A] Delivery Valve



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[B] Pump Element



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■ **Delivery Valve**

The delivery valve is composed of the valve and the valve seat. It performs two functions:

(1) Reverse flow prevention
If the circuit between the delivery chamber and the nozzle is always closed, a time lag will occur between pressure-feed start of valve element and start of nozzle injection. This, in turn, will prevent injection from stopping properly until after completion of pressurefeed.
To eliminate this time lag, the valve lowers on completion of pressure-feed and the relief valve contacts the valve seat, and breaks the circuit between the injection pipe and plunger.

(2) Fuel dribbling prevention
After the relief valve contacts delivery valve seat, this valve lowers a little. Since the relief valve breaks the circuit, pressure in the injection pipe is reduced as the valve lowers, preventing fuel dribbling from the nozzle.

■ **Pump Element**

The pump element is composed of a cylinder and a plunger. Their contact surfaces are precision finished to provide a high injection pressure even at low speeds. The cylindrical surface of the plunger has slanted grooves, which are called control grooves, and a connecting hole for plunger head.

■ **Control Rack**

This is connected directly to the governor fork in the engine body. It is connected with the plunger by pinion to change injection volume.

■ **Tappet**

The tappet converts rotating movement of the camshaft into a reciprocating movement to drive plunger. A roller is used where it contacts the cam to reduce friction.

(1) Relief valve
(2) Seat
(3) Delivery valve seat
(4) Pressure decrease because of increase in this volume
(5) End of pressure-feed and start of sucking back
(6) End of sucking back

(7) Pump element
(8) Cylinder
(9) Plunger
(10) Feed hole
(11) Control groove
(12) Driving face

■ **Soupape de refoulement**

La soupape de refoulement se compose de la soupape et du siège de soupape. Elle remplit deux fonctions:

(1) Empêcher l'écoulement en sens contraire
Si le circuit entre la chambre de refoulement et l'injecteur reste toujours fermé, un retard se produira entre le début de l'alimentation sous pression de l'injecteur et le début de l'injection propre et, de même, l'injection ne cessera vraiment qu'après l'arrêt total de l'alimentation sous pression. La soupape, en vue d'éliminer ce retard, s'abaisse à l'arrêt de l'alimentation sous pression. La soupape de sûreté vient alors en contact avec le siège de cette soupape, ce qui a pour effet de couper le circuit entre le tuyau d'injection et le piston.

(2) Prévention d'égouttage de combustible
La soupape de refoulement s'abaisse un peu lorsque son siège est en contact avec la soupape de sûreté. Etant donné que cette dernière a coupé le circuit, la pression à l'intérieur du tuyau d'injection diminue au fur et à mesure que la soupape s'abaisse, ce qui empêche l'injecteur de goutter.

■ **Pièces constituantes de la pompe**

Elles se composent d'un cylindre et d'un piston. Leurs surfaces de contact ont reçu une finition de précision afin d'assurer une haute pression d'injection, même à petite vitesse. La surface cylindrique du piston présente une rainure en biais, dénommée rainure de contrôle, et un logement pour la tête du piston.

■ **Crémaillère de commande**

Elle est reliée directement à la fourchette du régulateur se trouvant dans le corps du moteur. Elle est reliée au piston par un pignon, ce qui lui permet de régler le volume de l'injection.

■ **Mentonnet**

Il convertit le mouvement rotatif de l'arbre de distribution en un mouvement alternatif destiné à entraîner le piston. Un galet, placé au point en contact avec la came, sert à réduire le frottement.

[A] Soupape de refoulement
(1) Soupape de sûreté
(2) Siège
(3) Siège de la soupape de refoulement
(4) Diminution de pression en raison de l'augmentation du volume
(5) Arrêt de l'alimentation sous pression et début de l'aspiration en sens contraire
(6) Arrêt de l'aspiration en sens contraire

[B] Pièces constituantes de la pompe
(7) Pièces constituantes de la pompe
(8) Cylindre
(9) Piston
(10) Trou de remplissage
(11) Rainure de contrôle
(12) Face d'entraînement

■ **Zuleitungsventil**

Das Zuleitungsventil besteht aus dem Ventil und dem Ventilsitz. Zwei Funktionen werden von diesem Ventil ausgeführt:

(1) Rückflußverhinderung
Wenn der Kreislauf zwischen der Zuleitungskammer und der Düse immer geschlossen bleibt, kann eine Zeitverzögerung zwischen dem Beginn der Druckzuführung des Ventilelementes und dem Beginn der Düseneinspritzung auftreten. Durch diese Zeitverzögerung wird jedoch verhindert, daß der Einspritzvorgang auf richtige Weise unterbrochen werden kann bis zur Beendigung der Druckzuleitung.
Um diese Zeitverzögerung zu eliminieren, wird das Ventil bei Beendigung der Druckzuführung heruntergebewegt, wodurch das Ablaufventil auf die Kontaktfläche des Ventilsitzes gebracht wird und der Kreislauf zwischen dem Einspritzrohr und dem Kolben unterbrochen wird.

(2) Tropfenverhinderung
Nachdem das Ablaufventil den Zuleitungsventilsitz berührt hat, wird dieses Ventil etwas heruntergebewegt. Da das Ablaufventil nun den Kreislauf unterbricht, wird der Druck im Einspritzrohr reduziert, wodurch Treibstoffabtropfungen von der Düse verhindert werden.

■ **Pumpenelement**

Das Pumpenelement ist aus einem Zylinder und einem Kolben zusammengesetzt. Die Kontaktflächen dieser Teile sind präzisionsbearbeitet, um selbst bei geringen Drehgeschwindigkeiten einen hohen Einspritzdruck zu erzeugen. Die zylinderförmige Oberfläche des Kolbens ist mit einer schrägen Rille versehen, die als Kontrollrille bezeichnet wird. Sie besitzt ein Verbindungsloch für den Kolbenkopf.

■ **Kontrollgestell**

Diese Kontrollvorrichtung besitzt eine direkte Verbindung zur Gabel des Drehzahlenreglers im Motorengehäuse. Durch ein Ritzel wird eine Verbindung mit dem Kolben hergestellt, durch die eine Veränderung der Einspritzmenge herbeigeführt werden kann.

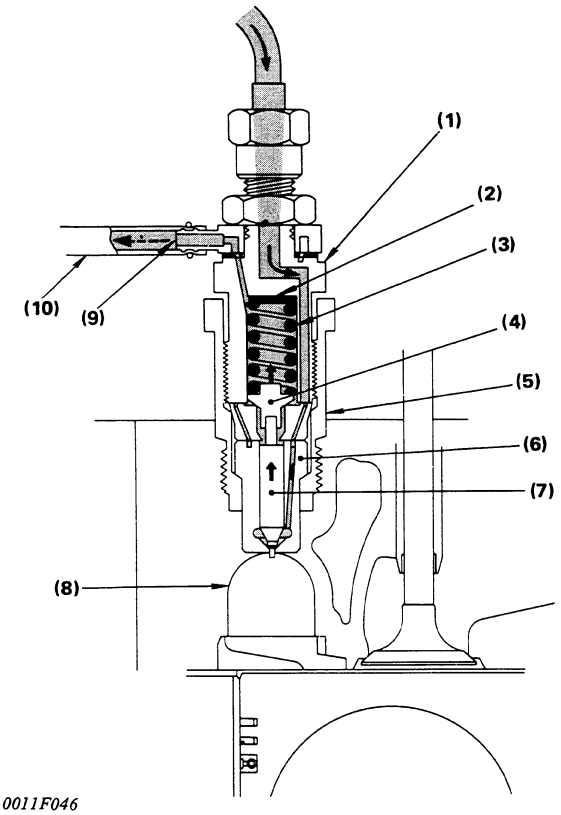
■ **Nocken**

Die Nocken verwandeln die Drehbewegung der Nockenwelle in eine Stoßbewegung zum Antrieb zur Bewegung des Kolbens. Um Reibungen zu verringern, wird auf den Kontaktflächen der Nocken eine Rolle verwendet.

[A] Zuleitungsventil
(1) Ablaufventil
(2) Sitz
(3) Zuleitungsventilsitz
(4) Der Druck erhöht sich durch diese Volumenveränderung
(5) Ende der Druckzuleitung und Beginn der Rücksaugung
(6) Ende der Rücksaugung

[B] Pumpenelement
(7) Pumpenelement
(8) Zylinder
(9) Kolben
(10) Zuleitungsloch
(11) Kontrollrille
(12) Treibfläche

[A] Injection nozzle



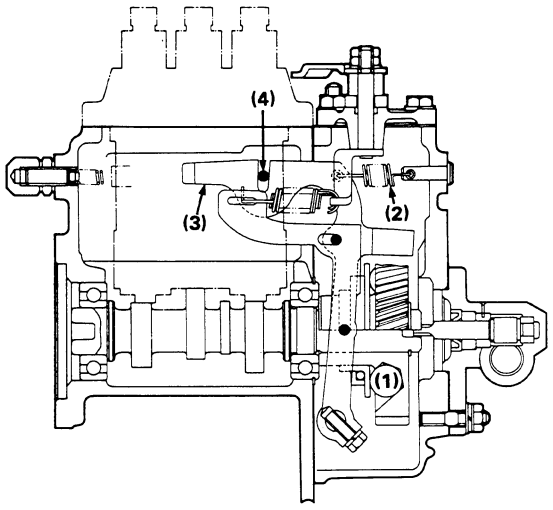
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4-4 INJECTION NOZZLE

This nozzle is throttle-type. Fuel fed from the pump is pressurized to push the needle valve up and the fuel is then injected. The needle valve is pressed by the nozzle spring through the push rod. Fuel overflow is passed from nozzle holder center through the fuel overflow nipple and the fuel overflow pipe to the fuel tank. The injection pressure is provided 13.7 to 14.7MPa (140 to 150kgf/cm^2, 1991 to 2133 psi). Injection pressure can be controlled by inserting shims between nozzle holder body and adjusting washers. The pressure increases approx. 981kPa (10kgf/cm^2, 142psi) when inserted a 0.1mm (0.0039in.) shim. Injection nozzle is also precision finished as is the injection pump, treat it carefully and protect from water and dust.

(1) Nozzle holder body
(2) Adjusting washer
(3) Nozzle spring
(4) Push rod
(5) Retaining nut
(6) Nozzle body
(7) Needle valve
(8) Combustion chamber
(9) Fuel overflow nipple
(10) Fuel overflow pipe

[A] At start



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4-5 GOVERNOR

With centrifugal ball weight system, this mechanical governor works in the whole range of speeds. It keeps the engine speed and controls the engine output.

■ At start

When the engine is started, more fuel is required than in running. At starting, fork lever 1 is pulled rightward by starter spring because ball weights have no centrifugal force. Control rack moves to a position for overlimit discharging of fuel to assure easy starting.

(1) Ball weights
(2) Start spring
(3) Fork lever 1
(4) Control rack

4-4 INJECTEUR

L'injecteur est muni d'un obturateur. Le combustible amené par la pompe est comprimé, soulève le pointeau et est injecté. Le pointeau est enfoncé par le ressort d'injecteur au moyen de la tige-poussoir. Le trop-plein passe du centre du porte-injecteur, par le raccord de trop-plein et le tuyau de trop-plein dans le réservoir. La pression d'injection est de 13,7 à 14,7Mpa (140 à 150kgf/cm^2). Cette pression peut être commandée en insérant des cales entre le corps du porte-injecteur et la rondelle d'ajustement. La pression augmente d'environ 980,6kPa (10kgf/cm^2) avec une cale de 0,1mm. L'injecteur est de la même finition précise que la pompe: il convient de l'entretenir et de le preserver de l'eau et de la poussière.

[A] Injecteur
(1) Porte-injecteur
(2) Rondelle de réglage
(3) Ressort d'injecteur
(4) Tige de poussoir
(5) Ecrou de retenue
(6) Injecteur
(7) Clapet d'injecteur
(8) Chambre de combustion
(9) Orifice de trop-plein
(10) Tuyau de trop-plein

4-5 REGULATEUR

Il s'agit d'un régulateur à force centrifuge (exercée par le poids d'une boule), fonctionnant sur toute la gamme des vitesses. Il sert à maintenir la vitesse du moteur et à en contrôler le rendement.

■ **Au démarrage**

La consommation de combustible au démarrage est plus élevée que pendant la marche. Le ressort du démarreur pousse le levier à fourchette 1 vers la droite, du fait que la boule n'exerce pas de force centrifuge. La crémaillère de commande se met en position d'injection supra-limite de combustible, afin d'assurer un démarrage aisé.

[A] Au démarrage
(1) Poids de la boule
(2) Ressort de démarrage
(3) Levier à fourchette 1
(4) Crémaillère de commande

4-4 EINSPRITZDÜSE

Es handelt sich hier um eine Düse des Drosseltyps. Der in der Pumpe unter Druck gesetzte Treibstoff kann das Nadelventil hochdrücken, wodurch der Treibstoff dann eingespritzt werden kann. Das Nadelventil wird durch den Druckstab von der Düsenfeder gedrückt. Ein Treibstoffüberfluß wird über die Mitte des Düsenhalters durch den Überflußnippel zurück in der Treibstofftank geleitet. Der vorgesehene Einspritzdruck beträgt 13,7 bis 14,7 MPa (140 bis 150 kp/cm^2). Der Einspritzdruck kann durch das Einsetzen von Einpaßstücken zwischen dem Düsenhalter und den Einstellunterlegscheiben eingestellt werden. Der Druck nimmt ungefähr 980,6 kPa (10 kp/cm^2) zu, wenn ein 0,1mm Einpaßstück eingesetzt wird. Die Einspritzdüse ist auf gleiche Weise wie die Pumpe selbst, ein Präzisionsinstrument und muß daher vorsichtig behandelt und vor Staub und Wasser geschützt werden.

[A] Einspritzdüse
(1) Düsenhalterteil
(2) Einstellscheibe
(3) Düsenfeder
(4) Druckstab
(5) Überwurfmutter
(6) Düsenteil
(7) Nadelventil
(8) Brennkammer
(9) Überflußnippel
(10) Überflußnippel

4-5 REGLER

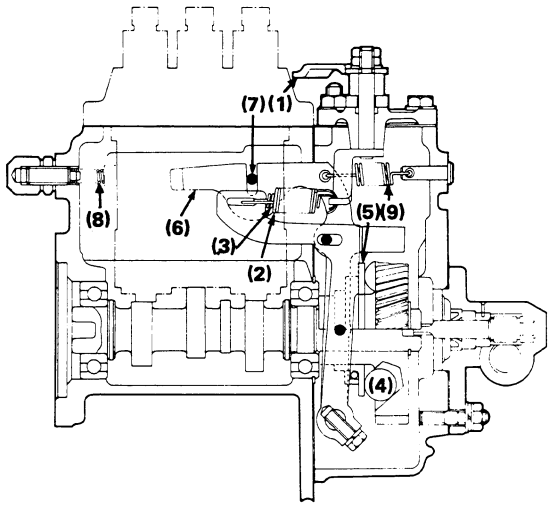
Dieser Drehzahlenregler des Zentrifugalkugelsystems regelt die Drehzahlen des Motors über den gesamten Drehzahlenbereich und kontrolliert die Ausgangsleistung des Motors.

■ **Beim Motorenanlauf**

Beim Anlauf eines Motors wird mehr Treibstoff benötigt als zur Aufrechterhaltung eines Betriebslaufs. Der Gabelhebel (1) wird beim Anlauf des Motors durch die Starterspirale nach rechts gedrückt, da die Kugelgewichte in diesem Zustand keine Zentrifugalkraft besitzen. Dadurch kann das Kontrollgestell auf eine Stellung bewegt werden, bei der übermäßiger Treibstoffausstoß für einen einfachen Anlaufvorgang ermöglicht wird.

[A] Beim Motorenanlauf
(1) Kugelgewicht
(2) Anlaufspirale
(3) Gabelhebel 1
(4) Kontrollgestell

[B] At idling



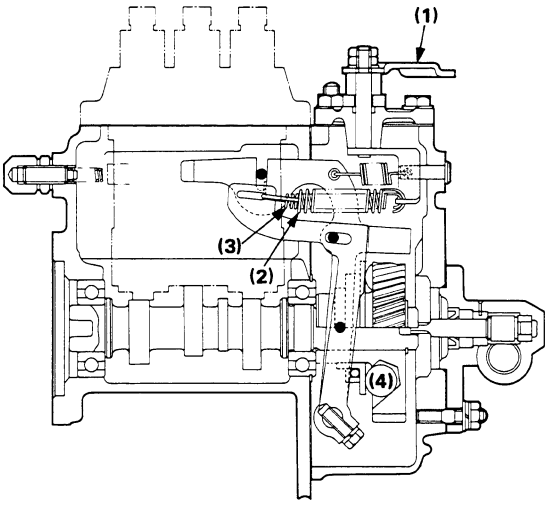
0076F017

(1) Speed control lever
(2) Governor spring 1
(3) Governor spring 2
(4) Ball weight
(5) Governor sleeve
(6) Fork lever 1
(7) Control rack
(8) Idling limit spring
(9) Start spring

■ At idling

When speed control lever is set at idling position after the engine is started, high speed governor spring 1 does not work at all and also low speed governor spring 2 does only a little action. Therefore, governor sleeve is pushed leftward by a centrifugal force of ball weights. Fork lever 1 and control rack are moved leftward by the sleeve and then idling limit spring is compressed by control rack. As a result, the control rack is kept at a position where a centrifugal force of ball weights and forces start spring, governor spring 2 and idling limit spring are balanced, providing stable idling.

[C] At middel/high speed running



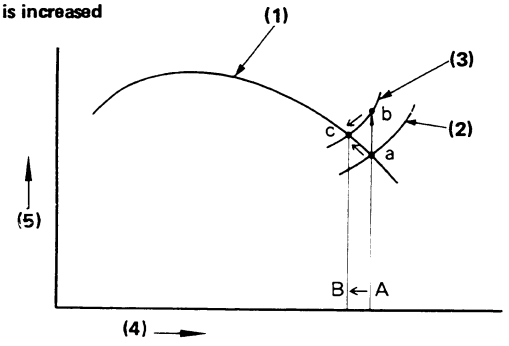
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■ At middle/high speed running

The engine speed is controlled when the tension of governor springs 1 and 2, which are pulled speed control lever, and the centrifugal force of ball weights are balanced. When the speed is reduced (A → B) with load increased (a → b), the centrifugal force of ball weights becomes smaller than the tension of governor springs 1 and 2. As a result, the control rack is moved rightward and fuel injection amount is increased to produce an engine torque required for the load. (a → c)

(1) Speed control lever
(2) Governor spring 1
(3) Governor spring 2
(4) Ball weights

[D] When load is increased



C042F067

(1) Engine toque curve
(2) Small load torque curve
(3) Large load torque curve
(4) Engine R.P.M
(5) Torque

■ Au ralenti

Lorsque, après le démarrage du moteur, le levier de contrôle de la vitesse est passé en position de ralenti, le ressort 1 de grande vitesse du régulateur ne fonctionne pas du tout, tandis que le ressort de petite vitesse du régulateur n'a que peu d'effet. Le manchon de régulateur se trouve poussé vers la gauche par la force centrifuge exercée par les boules. Il déplace donc aussi vers la gauche le levier 1 à fourchette et la crémaillère de commande. Cette dernière bande alors le ressort de vitesse limite au ralenti. Il s'ensuit que la crémaillère de commande est maintenue dans une position où la force centrifuge exercée par les boules et les forces représentées par le ressort de démarrage, le ressort 2 du régulateur et le ressort de vitesse limite au ralenti s'équilibrent pour assurer une marche stable au ralenti.

[B] Au ralenti
- **(1) Levier de contrôle de la vitesse**
- **(2) Ressort 1 du régulateur**
- **(3) Ressort 2 du régulateur**
- **(4) Poids de la boule**
- **(5) Manchon de régulateur**
- **(6) Levier à fourchette 1**
- **(7) Crémaillère de commande**
- **(8) Ressort de vitesse limite au ralenti**
- **(9) Ressort de démarrage**

■ A moyenne/grande vitesse

La vitesse du moteur est stabilisée lorsque la tension des ressorts 1 et 2 du régulateur, réglée par le levier de contrôle de la vitesse, s'équilibre avec la force centrifuge exercée par les boules.
La force centrifuge exercée par la boule devient inférieure à la tension des ressorts 1 et 2 du régulateur lorsque la vitesse est réduite (A → B) en même temps que la charge est accrue (a → b). Il s'ensuit que la crémaillère de commande se déplace vers la droite et que le volume de combustible à injecter est accru en fonction du couple de charge requis. (a → c)

[C] A moyenne/grande vitesse
- **(1) Levier de contrôle de la vitesse**
- **(2) Ressort 1 du régulateur**
- **(3) Ressort 2 du régulateur**
- **(4) Poids des boules**

[D] En charge accrue
- **(1) Diagramme du couple moteur**
- **(2) Diagramme du couple en charge réduite**
- **(3) Diagramme du couple en charge élevée**
- **(4) Vitesse de rotation tr/min.**
- **(5) Couple**

■ Im Leerlauf

Wenn der Drehzahlenreglungshebel nach Anlauf des Motors auf die Leerlaufstellung gebracht wird, bleibt die Hochgeschwindigkeitsreglerspirale 1 inaktiv und die Niedrigreglerspirale wird nur etwas aktiviert. Dadurch wird die Drehzahlenreglermanchette durch die Zentrifugalkraft der Kugelgewichte nach links gedrückt. Der Gabelhebel 1 und das Kontrollgestell werden dann durch die Manchette nach links gedrückt, wodurch die Leerlaufbegrenzungsspirale durch das Kontrollgestell zusammengedrückt wird. Resultierend daraus wird das Kontrollgestell in einer Stellung gehalten, bei der die Kräfte der Kugelgewichte, der Anlaufspirale, der Drehzahlenreglerspirale 2 und der Leerlaufbegrenzungsspirale gegeneinander ausgeglichen sind, um einen glatten Leerlauf zu gewährleisten.

[B] Bei Leerlauf
- **(1) Geschwindigkeitsreglerhebel**
- **(2) Drehzahlenreglerspirale 1**
- **(3) Drehzahlenreglerspirale 2**
- **(4) Kugelgewicht**
- **(5) Drehzahlenreglermanchette**
- **(6) Gabelhebel 1**
- **(7) Kontrollgestell**
- **(8) Leerlaufbegrenzungsspirale**
- **(9) Starterspirale**

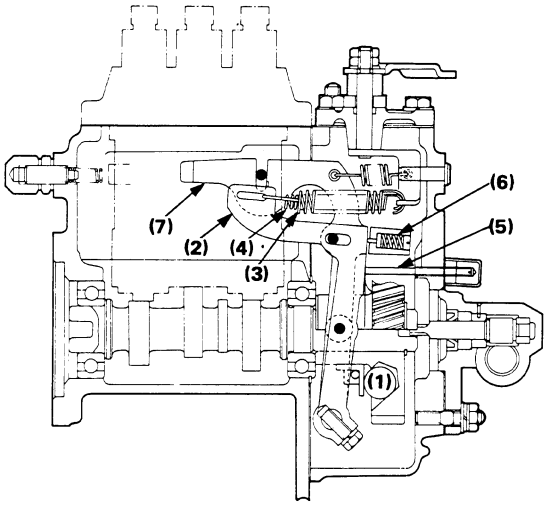
■ Bei Mittel-/Hochgeschwindigkeitslauf

Die Drehzahl des Motorenlaufs wird konstant gehalten, wenn der Zug der Drehzahlenreglerspirale 1 und 2, die vom Drehzahlenreglerhebel gezogen werden, und die Zentrifugalkraft der Kugelgewichte ausgeglichen ist. Wenn die Drehzahl des Motorenlauf (A → B) durch Lastvergrößerung (a → b) reduziert wird, wird die Zentrifugalkraft der Kugelgewichte geringer als der Zug der Drehzahlenreglerspiralen 1 und 2. Dadurch, wird das Kontrollgestell nach rechts bewegt, wodurch die Einspritzmenge des Treibstoffs erhöht wird, um entsprechend, der Belastung entsprechenden, Drehmoment des Motors zu erzeugen. (a → c)

[C] Bei Mittel-/Hochgeschwindigkeitslauf
- **(1) Geschwindigkeitsreglerhebel**
- **(2) Drehzahlenreglerspirale 1**
- **(3) Drehzahlenreglerspirale 2**
- **(4) Kugelgewicht**

[D] Bei erhöhter Belastung
- **(1) Motoren-Drehmomentkurve**
- **(2) Drehmomentkurve bei geringer Belastung**
- **(3) Drehmomentkurve bei hoher Belastung**
- **(4) Motor Upm**
- **(5) Torsionskraft**

[E] At high speed running with overload



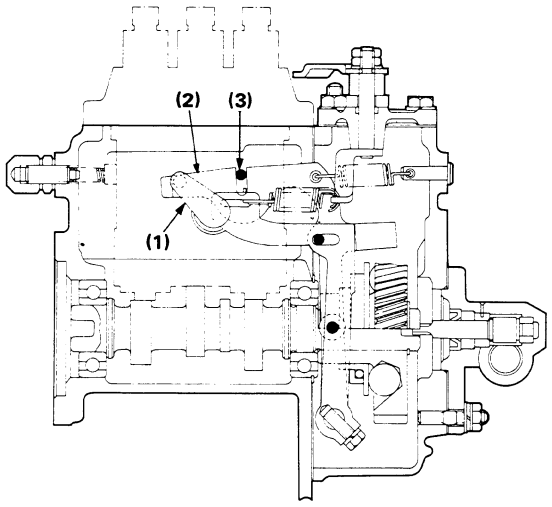
0076F018

(1) Ball weight
(2) Fork lever 2
(3) Governor spring 1
(4) Governor spring 2
(5) Maximum output limit bolt
(6) Spring
(7) Fork lever 1

■ At high speed running with overload

When an overload is applied to the engine running at a high speed, the centrifugal force of ball weights become small as the speed is reduced, and fork lever 2 is pulled rightward by governor springs 1 and 2, increasing fuel injection. Fork lever 2 becomes ineffective to increase fuel injection when it is stopped by maximum output limit bolt. After that when the force of spring becomes larger than the centrifugal force of ball weights, fork lever 1 moves rightward to increase fuel injection, driving the engine continuously with a high torque.

[F] To stop engine



0076F019

■ To stop engine

When stop lever is moved to "STOP" position, fork lever is moved leftward and then control rack is moved to the non-injection position, stopping the engine.

(1) Stop lever
(2) Fork lever 1
(3) Control rack

■ **A grande vitesse en surcharge**

Si une surcharge est appliquée au moteur tournant à grande vitesse, la force centrifuge exercée par les boules diminue en fonction de la réduction de la vitesse. Les ressorts 1 et 2 du régulateur tirent alors le levier 2 à fourchette vers la droite, ce qui augmente le volume de combustible injecté. Le levier à fourchette 2 ne peut plus servir à augmenter le volume d'injection, lorsqu'il est arrêté par le boulon de limite de puissance maximale.
La force du ressort devient, ensuite, supérieure à la force centrifuge exercée par la boule et le levier à fourchette 1 se déplace vers la droite, augmentant ainsi le volume à injecter, ce qui a pour effet de faire tourner constamment le moteur en fonction d'un couple élevé.

[E] A grande vitesse en surcharge
- **(1) Poids de la boule**
- **(2) Levier à fourchette 2**
- **(3) Ressort 1 du régulateur**
- **(4) Ressort 2 du régulateur**
- **(5) Boulon de limite de puissance maximale**
- **(6) Ressort**
- **(7) Levier à fourchette 1**

■ **Pour arrêter le moteur**

Lorsque le levier d'arrêt est mis en position "ARRET" (STOP), le levier à fourchette se déplace vers la gauche, la crémaillère de commande se met en position "non-injection", ce qui arrête le moteur.

[F] Pour arrêter le moteur
- **(1) Levier d'arrêt**
- **(2) Levier à fourchette 1**
- **(3) Crémaillère de commande**

■ **Bei Hochgeschwindigkeitslauf mit Überlastung**

Wenn bei Hochgeschwindigkeitslauf des Motors eine Überlastung auftritt, verringert sich die Zentrifugalkraft der Kugelgewichte durch die verringerte Umdrehungszahl des Motors, wodurch der Gabelhebel 2 durch die Drehzahlreglerspiralen 1 und 2 nach rechts gezogen wird, um die Treibstoffeinspritzung zu erhöhen.
Wenn der Gabelhebel 2 durch den Begrenzungsbolzen des Maximalleistungsausganges gestoppt wird, wird dieser ineffektiv, um eine weitere Erhöhung der Treibstoffeinspritzung zu unterbinden.
Wenn danach die Zugkraft der Spirale größer als die Zentrifugalkraft der Kugelgewichte wird, wird der Gabelhebel 1 nach rechts bewegt, um die Treibstoffeinspritzung zu erhöhen, wobei der Motor fortlaufend mit einem hohen Drehmoment getrieben werden kann.

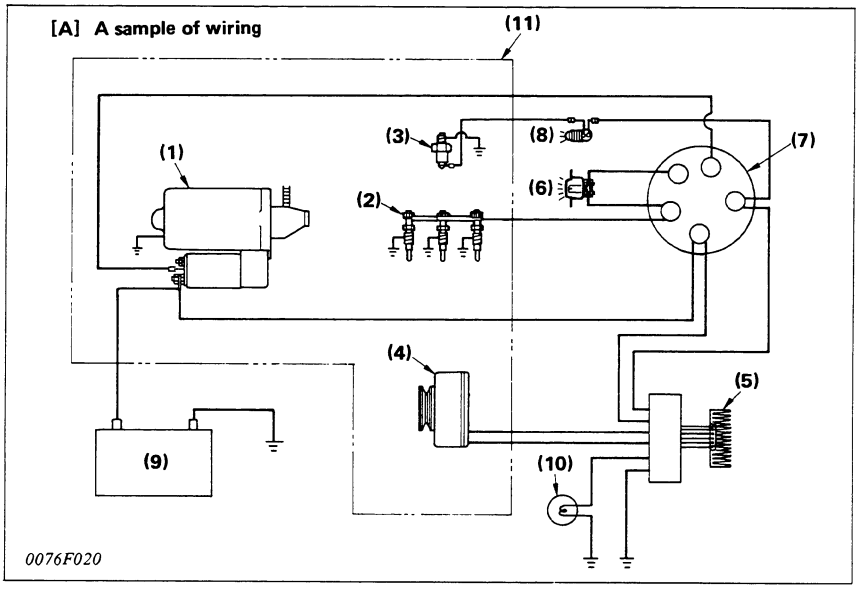
[E] Bei hohen Drehzahlen mit Überlastung
- **(1) Kugelgewicht**
- **(2) Gabelhebel 2**
- **(3) Drehzahlenreglerspirale 1**
- **(4) Drehzahlenreglerspirale 2**
- **(5) Begrenzungsbolzen für maximalen Ausgang**
- **(6) Spirale**
- **(7) Gabelhebel 1**

■ **Anhalten des Motors**

Wenn der Stopphebel auf die "STOPP (STOP)"-Stellung gebracht wird, wird der Gabelhebel nach links bewegt, wobei das Kontrollgestell auf die Nichteinspritzposition (Einspritzung "Null") gebracht wird und somit der Motorenlauf unterbrochen werden kann.

[F] Beim Anhalten des Motors
- **(1) Stopphebel**
- **(2) Gabelhebel 1**
- **(3) Kontrollgestell**

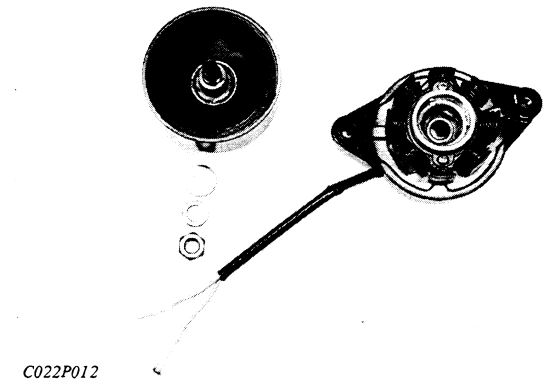
5. ELECTRICAL SYSTEM



The electrical system of the engine comprises two units; starting unit consisting of starter, glow plug, etc., and charging unit consisting of alternator, regulator, etc.
Optional parts such as main switch and glow plug indicator are also available.

(1) Starter
(2) Glow plug
(3) Oil switch
(4) Alternator
(5) Regulator
(6) Glow plug indicator
(7) Key switch
(8) Oil lamp
(9) Battery
(10) Charge lamp
(11) Engine

(6) (7) (8) (9) (10) not included in the basic engine

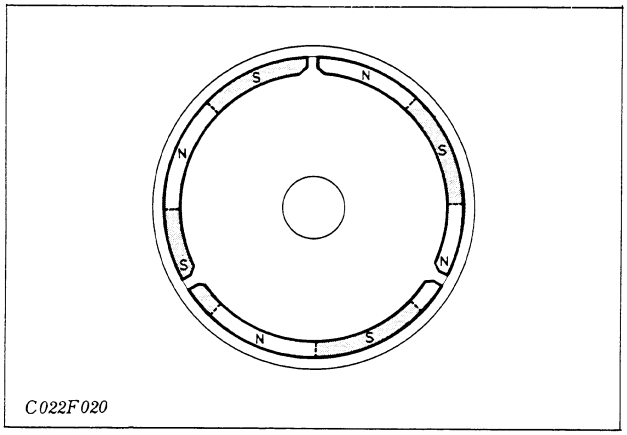

C022P012

5-1 CHARGING SYSTEM

The charging system of this engine uses alternator and regulator which has functions of rectification and voltage regulation.

(1) Alternator

This alternator (Code No.: 15531-64011) is an 8-8 pole rotating magnet type alternator.
It is simple in construction, consisting of a stator and rotor. The rotor is made up of eight permanent magnet pole pieces assembled on a shaft and rotates on the center of the stator around which eight electro-magnetic coils are provided for. Alternator produces higher voltage in slow speed rotation, compared with DC generator, and charges electric current to the battery during engine idling. Accordingly, there is no fear of bettery failure.



C022F020

Rotation direction	Clockwise (as seen from pulley side)
Speed in normal use	1600 to 5600rpm
Allowable maximum speed	1200rpm
Charging performance	Over 14A at 5200rpm, 14A
Charge starting speed	Over 1800rpm
Battery to be used	12V, 45AH
Regulator to be used	Code No.: 15533-64601

5. SYSTEME D'APPAREILLAGE ELECTRIQUE

Le système d'appareillage électrique du moteur comprend deux sections: celle du démarrage, formée par le démarreur, la bougie incandescente, etc. et celle de la charge, formée par un alternateur, un régulateur, etc. Les dispositifs facultatifs tels qu'interrupteur général, indicateur d'incandescence de la lampe et autres, sont aussi mis à la disposition du client.

[A] Exemple de cablage

(1) Démarreur
(2) Bougie incandescente
(3) Interrupteur à l'huile
(4) Alternateur
(5) Régulateur
(6) Indicateur d'incandescence de la lampe
(7) Interrupteur à clé
(8) Lampe d'huile
(9) Batterie
(10) Lampe de charge
(11) Moteur

non inclus dans le moteur de base

5-1 SYSTEME DE CHARGE

Le système de charge de ce moteur est formé par un alternateur et un régulateur dont le rôle est de redresser et de régler la tension.

(1) Alternateur

Cet alternateur (N° de code: 15531-64011) est une génératrice à 8-8 pôles type aimant rotatif.
De conception simple, elle se compose d'un enduit fixe et d'un rotor, ce dernier étant constitué par huit pôles à aimant permanent, montés sur un axe de rotation, fixé au centre de l'induit fixe, lequel est entouré par huit bobines d'électro-aimant. L'alternateur, lorsqu'il tourne à petite vitesse, produit une tension supérieure à celle que produirait une génératrice à courant continu, et charge la batterie lorsque le moteur tourne au ralenti. Ainsi n'y a-t-il aucun risque de panne de batterie.

Sens de la rotation	Vers la droite (vue de la poulie)
Vitesse de régime	1600 à 5600 tr/mn
Vitesse limite admissible	1200 tr/mn
Performance de charge	Plus de 14A à 5200 tr/mn 14A
Vitesse de début de charge	Plus de 1800 tr/mn
Batterie à utiliser	12V, 45A
Régulateur à utiliser	N° de code: 15533-64601

5. ELEKTRISCHES SYSTEM

Das elektrische System dieses Motors besteht aus zwei Einheiten: Die Startereinheit, die aus dem Starter, Glühkerze usw. zusammengesetzt ist, und die Aufladeeinheit, die aus einem Wechselstromdynamo, dem Regulator und anderen erforderlichen Teilen besteht.
Darüberhinaus sind zusätzliche Teile wie ein Hauptschalter oder eine Glühkerzen-Betriebsanzeige als Zusatzteile erhältlich.

[A] Verdrahtungsbeispiel

(1) Starter
(2) Glühkerze
(3) Ölschalter
(4) Wechselstromdynamo
(5) Regulator
(6) Glühkerzen-Betriebsanzeige
(7) Schlüsselschalter
(8) Öllampe
(9) Batterie
(10) Aufladelampe
(11) Motor

Im Basismodell nicht enthalten.

5-1 AUFLADUNGSSYSTEM

Im Aufladungssystem dieses Motors findet ein Wechselstromdynamo und ein Regulator zur Erzeugung, Gleichrichtung und Spannungsregulation der erforderlichen Betriebs- und Ladespannungen Verwendung.

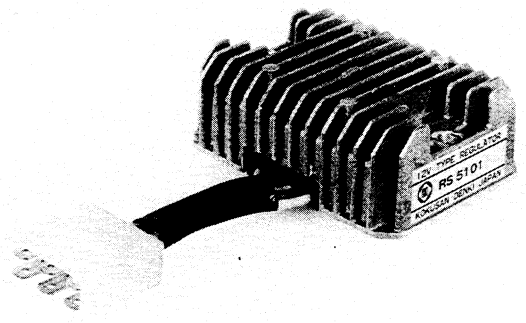
(1) Wechselstromdynamo

Dieser Wechselstromdynamo (Kodenummer: 15531-64011) ist ein 8-8-poliger Drehmagnetentypgenerator. Dieser Generator besteht aus einer einfachen Konstruktion eines Stators und Rotors. Der Rotor besteht aus acht Dauermagneten, die auf die Achse des Rotors aufgesetzt sind, und dreht sich im Stator, der mit acht Magnetspulen ausgerüstet ist. Im Vergleich zu einem Gleichstromgenerator erzeugt ein Wechselstromgenerator selbst bei geringen Drehzahlen des Motors höhere Spannungen, wodurch ein Aufladen der Batterie auch bei Leerlauf des Motors erfolgen kann. Die Möglichkeit von Batteriestörungen wird durch diese Anordnung deshalb weitgehendst ausgeschaltet.

Drehrichtung	Rechtsdrehung (Von der Riemenscheibe her gesehen)
Drehzahlen bei Normalbetrieb	1600 bis 5600 Upm
Erlaubte Höchstdrehzahlen	1200 Upm
Ladeleistung	Über 14A bei 5200 Upm, 14A
Ladeeinsetzdrehzahlen	Über 1800 Upm
Zu verwendende Batterie	12V, 45AH
Zu verwendender Regulator	Kodenummer: 15533-64601

(2) Regulator (not included in the basic engine)

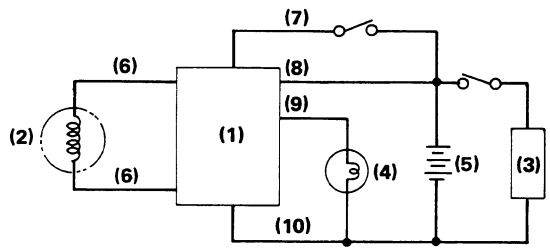
The regulator performs rectification and voltage regulation. The regulator converts AC into DC which flows through the power consuming circuits and the battery, and also charges the battery. If however, the battery voltage exceeds a certain level. The DC current is cut off from the charging circuit to prevent overcharging.



0076P009

Model	RS5101
Part No.	15533-64601
Weight	Approx. 250g
Regulated voltage	14 to 15V
Battery to be used	12V
Charge indication lamp	12V, 3.4W
Alternator to be used	Under 70V of peak value of no-load voltage Under 16A of output current

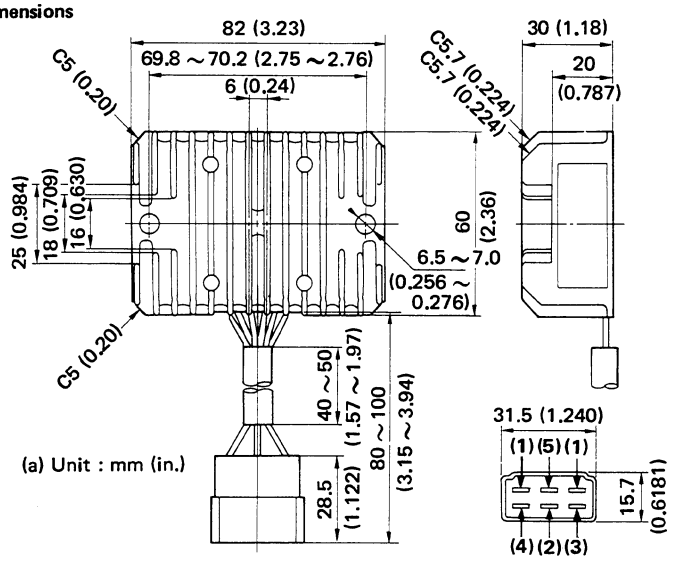
[A] General wiring diagram



0076F021

(1) Regulator
(2) Alternator
(3) Load
(4) Charge lamp
(5) Battery
(6) Blue lead wire
(7) Yellow lead wire
(8) Red lead wire
(9) Green lead wire
(10) Black lead wire

[B] Dimensions



0076F022

■ Features

1) This small-sized regulator can control large output current because charging current is supplied and stopped by thyristor (Series system).
2) Built-in AC diode generation detecting circuit permits a charge indication lamp (12V, 3.4W) to be easily connected.
3) Protection diode protects regulator when battery is wrongly connected.

(1) Blue lead wire
(2) Yellow lead wire
(3) Red lead wire
(4) Green lead wire
(5) Black lead wire

(2) Régulateur (non inclus dans le moteur de base)

Ce régulateur sert à rectifier et à régler la tension. Il convertit le courant alternatif en courant continu, dont le flux passe par les circuits d'utilisation et par la batterie d'accumulateurs qu'il charge donc aussi. Afin d'éviter toute surcharge, le courant continu est coupé du circuit de charge si la tension de la batterie dépasse un certain niveau.

Modèle	RS5101
N° de pièce	15533-64601
Poids	250 g environ
Tension nominale	de 14 à 15V
Batterie à utiliser	12V
Lampe de charge	12V, 3,4W
Alternateur à utiliser	En dessous d'une valeur de crete de tension à vide de 70V En dessous d'un courant de sortie de 16A

[A] Diagramme général de connexion

(1) Régulateur
(2) Alternateur
(3) Charge
(4) Lampe de charge
(5) Batterie
(6) Câble bleu
(7) Câble jaune
(8) Câble rouge
(9) Câble vert
(10) Câble noir

■ Caractéristiques

(1) Ce régulateur, bien que petit, peut contrôler un courant de sortie intense, du fait qu'un thyristor (système en série) fournit et coupe le courant de charge.
(2) Un circuit intégré de détection par diode c.a. de production d'énergie électrique permet le raccordement aisé d'une lampe de charge (12V, 3,4W).
(3) Une diode a pour rôle de protéger le régulateur au cas où le raccordement de la batterie serait incorrect.

[B] Dimensions

(1) Conducteur bleu
(2) Conducteur jaune
(3) Conducteur rouge
(4) Conducteur vert
(5) Conducteur noir

(2) Regulator (Im Basismodell nicht enthalten)

Durch den Regulator werden Spannungsgleichrichtungsbetrieb und Spannungsregulation (Stabilisation) vorgenommen. Der Regulator verwandelt zuerst den Wechselstrom des Generators in einen, in den elektrischen Kreisen zu verwendenden Gleichstrom um, durch den auch die Batterie aufgeladen werden kann. Bei Übersteigen der Batteriespannung eines bestimmten Spannungswertes wird die Gleichstromzuleitung zur Batterie vom Ladekreis unterbrochen, um Überladung der Batterie zu verhindern.

Modell	RS5101
Teilnummer	15533-64601
Gewicht	Ungefähr 250 gr.
Regulierter Spannungsbereich	14 bis 15V
Zu verwendende Batterie	12 V
Aufladeanzeigelampe	12V, 3,4W
Zu verwendender Wechselstromdynamo	Unter 70V des Spitzenwertes der unbelasteten Spannung Unter 16A des Ausgangsstroms

[A] Allgemeiner Verdrahtungsplan

(1) Regulator
(2) Wechselstromdynamo
(3) Belastung
(4) Aufladelampe
(5) Batterie
(6) Blauer Zuleitungsdraht
(7) Gelber Zuleitungsdraht
(8) Roter Zuleitungsdraht
(9) Grüner Zuleitungsdraht
(10) Schwarzer Zuleitungsdraht

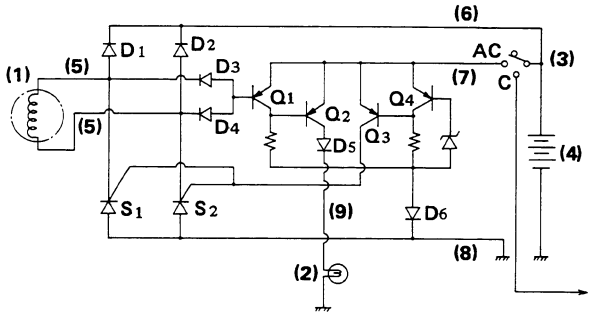
■ Eigenschaften

(1) Durch diesen, auf geringe Größe ausgelegten Regulator können hohe Ausgangsströme geregelt werden, da der Ladestrom von einem Thyristor zugeleitet und unterbrochen wird (Serientyp).
(2) Ein eingebauter Wechselstromerzeugungs-Diodendetektionskreis erlaubt einfachen Anschluß einer Ladeanzeigelampe (12V, 3,4W).
(3) Eine Schutzdiode schützt den Regulator bei falschen Anschlüssen der Batterie.

[B] Abmessungen

(1) Blauer Zuleitungsdraht
(2) Gelber Zuleitungsdraht
(3) Roter Zuleitungsdraht
(4) Grüner Zuleitungsdraht
(5) Schwarzer Zuleitungsdraht

[A] Basic circuit



0076F023

(3) Charging mechanism

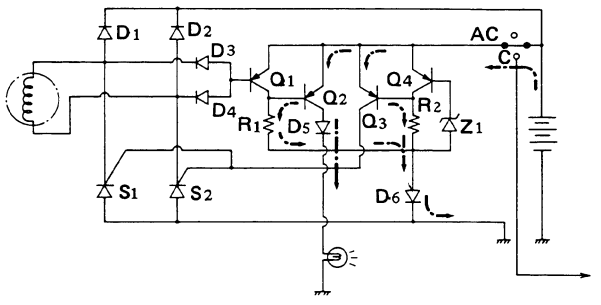
The charging mechanism is described in four sections:
1) When key switch is ON
2) At starting
3) In charging
4) Over-charge protection

(1) GEN: Magnet type AC generator
(2) LAMP: Charge indication lamp (not included in the basic engine)
(3) KEY SW: Key switch (not included in the basic engine)
(4) BATT: Battery (not included in the basic engine)
(5) Blue: GEN connecting terminal
(6) Red: BATT + connecting terminal
(7) Yellow: BATT voltage test terminal
(8) Black: BATT − connecting terminal
(9) Green: LAMP connecting terminal
S_1, S_2: Output control/rectification thyristor (SCR)
D_1, D_2: Output rectifying diode
D_3, D_4: GEN generation detecting diode
D_5, D_6: Protection diode for wrong connecting of BATT
Z_1: BATT terminal voltage setting diode
Q_1: GEN generation detecting transistor
Q_2: LAMP on/off transistor
Q_3: Gate current control transistor
Q_4: BATT voltage detecting transistor

Inner connecting of key switch contacts

Position \ Terminal	BATT	AC	C
0			
1	○——	——○	
2	○——	——○	——○

[B] Fig. 1 Fonction du circuit



0076F024

1) When Key Switch is "ON"

When the engine is at standstill with key switch set at position 1, the circuit functions to light LAMP, as shown in Fig. 1. With key switch at position 1, current flows to base of Q_2 through the route of BATT--→ emitter/base of Q_2--→ R_1--→ D_6--→ BATT and collector of Q_2 is then turned on. As a result, currunt also flows to LAMP though the route of BATT--→ emitter/collector of Q_2--→ D_5--→ LAMP--→ BATT lighting LAMP to indicate that charging is not carried out. At this time, though current flows to base of Q_3 through the route of BATT--→ emitter/base of Q_3--→ R_2--→ D_6--→ BATT, collector of Q_3 has no current because GEN is sationary.

(3) Processus de charge

La description de ce processus se fait en quatre parties:
1) Lorsque l'interrupteur à clé est en position CONTACT (ON)
2) Au démarrage
3) Durant la charge
4) Protection contre les surcharges

(1) GEN: Génératrice à c.a., type aimant
(2) LAMP: Lampe de charge (non incluse dans le moteur de base)
(3) KEY SW: Interrupteur à clé (non inclus dans le moteur de base)
(4) BATT: Batterie (non incluse dans le moteur de base)
(5) Bleu: Borne de raccordement GEN
(6) Rouge: Borne de raccordement BATT
(7) Jaune: Borne d'essai de tension BATT +
(8) Noir: Borne de raccordement BATT —
(9) Vert: Borne de raccordement LAMP
S_1, S_2 : Thyristor de contrôle/redressement de la puissance de sortie
D_1, D_2 : Diode redressement de la puissance de sortie
D_3, D_4 : Diode détectrice de production d'énergie GEN
D_5, D_6 : Diode de protection contre raccordement incorrect de BATT
Z_1 : Diode de réglage de la tension à la borne BATT
Q_1 : Transistor détecteur de production d'énergie GEN
Q_2 : Transistor de contact/coupure LAMP
Q_3 : Transistor de contrôle de courant grille
Q_4 : Transistor détecteur de tension BATT

Connexion intérieure des contacts de l'interrupteur à clé

Borne / Position	BATT	AC	C
0			
1	○——	——○	
2	○——	——○	——○

[A] Circuit de base

(1) Lorsque l'interrupteur à clé est en position "CONTACT" (ON)

Lorsque le moteur est au repos et que l'interrupteur à clé est mis en position 1, le circuit, ainsi que l'indique la Fig. 1, provoque l'allumage de LAMP. L'interrupteur à clé se trouvant en position 1, le flux de courant arrive à la base de Q_2 en suivant le parcours: BATT--→ émetteur/base de Q_2--→ R_1--→ D_6--→ BATT, le collecteur de Q_2 établit alors le contact. Il en résulte que le flux de courant arrive à LAMP en suivant le parcours: BATT--→ émetteur/collecteur de Q_2--→ D_5--→ LAMP--→ BATT, ce qui allume LAMP pour indiquer que la charge ne s'opère pas. Mais, bien que le flux de courant arrive à la base de Q_3 en suivant le parcours: BATT --→ émetteur/base de Q_3--→ R_2--→ D_6--→ BATT, le collecteur n'établit pas le courant, du fait que GEN est au repos.

[B] Fig. 1, Fonction of circuit

(3) Aufladememechanismus

Der Aufladememechanismus wird in vier Bereiche unterteilt:
1) Beim Einschalten des Schlüsselschalters
2) Beim Starten des Motors
3) Beim Aufladen der Batterie
4) Überladungsschutz

(1) GEN: Magnettyp-Wechselstromgenerator
(2) LAMP: Ladeanzeigelampe (Im Basismodell nicht enthalten)
(3) KEY SW: Schlüsselschalter (Im Basismodell nicht enthalten)
(4) BATT: Batterie (Im Basismodell nicht enthalten)
(5) Blau: GEN-Anschlußklemme
(6) Rot: BATT + Anschluß
(7) Gelb: BATT-Spannungsprüfanschluß
(8) Schwarz: BATT — Anschluß
(9) Grün: LAMP-Anschlußklemme
S_1, S_2: Ausgangsreglung/Gleichrichtungs-Thyristor (SCR)
D_1, D_2: Ausgangsgleichrichtungsdiode
D_3, D_4: GEN-Erzeugungsdetektionsdiode
D_5, D_6: Schutzdiode für falschen Batterieanschluß
Z_1: BATT-Anschluß-Spannungsstelldiode
Q_1: GEN-Erzeugungsdetektionstransistor
Q_2: LAMP Ein/Aus-Transistor
Q_3: Gate-Stomreglungstransistor
Q_4: BATT-Spannungsdetektionstransistor

Innenanschlüsse der Schlüsselschalterkontakte

Anschluß / Position	BATT	AC	C
0			
1	○——	——○	
2	○——	——○	——○

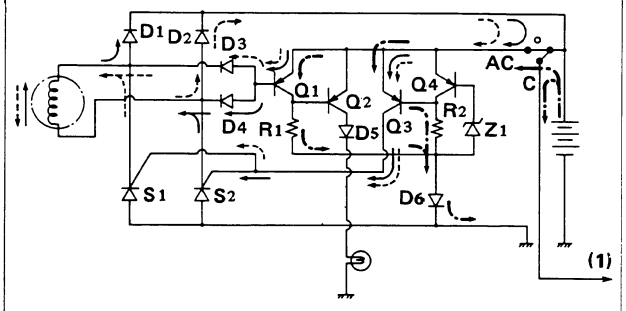
[A] Basiskreis

(1) Beim Einschalten des Schlüsselschalters

Wenn der Schlüsselschalter bei nichtlaufendem Motor auf die Stellung 1 gestellt wird, funktioniert der Kreis zur Betreibung der Lampe (LAMP) gemäß der Abbildung 1. In Stellung 1 des Schlüsselschalters kann der Strom in die Basis des Transistors Q_2 über BATT -Emitter/Basis von Q_2--→ R_1--→ D_6--→ BATT laufen, wodurch der Kollektor des Q_2 eingeschaltet wird. Resultierend hiervon kann nun ein Strom über den Kreislauf BATT--→ Emitter/Kollektor von Q_2--→ D_5--→ LAMP--→ BATT fließen, wodurch die Lampe eingeschaltet wird und anzeigt, daß der Ladevorgang nicht ausgeführt wird. Zur gleichen Zeit kann nun ein Strom in die Basis des Transistors Q_3 über BATT--→ Emitter/Basis des Q_3--→ R_2--→ D_6--→ BATT fließen, jedoch liefert der Kollektor von Q_3 keinen Strom, da der GENERATOR unbewegt bleibt.

[B] Abbildung 1, Funktion des Kreises

[C] Fig. 2, Function of circuit



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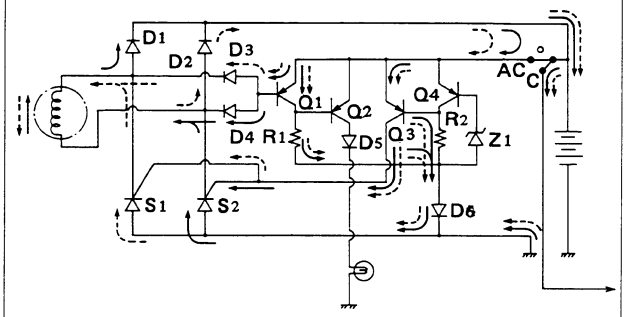
2) At Starting

When key switch is turned to position 2, coil of starter relay is energized and starter starts engine. GEN also starts generation for charging and LAMP is turned off.

In detail, with GEN starting, current flows to base of Q_1 through the route of GEN⟶ D_1⟶ emitter/base of Q_1⟶ D_4⟶ GEN, or GEN⟶ D_2⟶ emitter/base of Q_1⟶ D_3⟶ GEN, and therefore current also flows through Q_1, short-circuiting emitter and base of Q_2. As a result, base current of Q_2 is interrupted, Q_2 is turned off and accordingly current to LAMP is also interrupted.

(1) To relay coil of starter

[D] Fig. 3, Function of circuit



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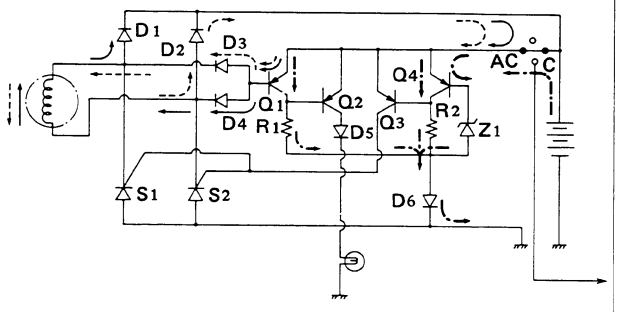
3) In Charging

Becuase BATT terminal voltage just after engine start is lower than setting value (14 to 15V), or lower than zener level of Z_1, current is not supplied to base of Q_4 and Q_4 is off, as shown in Fig. 2. Q_3 is on with base current which flows through the route of BATT⟶ emitter/base of Q_3⟶ R_2 ⟶ D_6⟶ BATT, and gate current is supplied to S_1 or S_2 through the route of GEN⟶ D_1⟶ emitter/collector of Q_3⟶ gate/cathode of S_2⟶ GEN, or GEN⟶ D_2⟶ emitter/collector of Q_3⟶ gate/cathode of S_1⟶ GEN. When engine speed is increased so that GEN generation voltage becomes higher than BATT terminal voltage, S_1 or S_2 is turned on and, as shown in Fig. 3, charge current is supplied to BATT through the route of GEN⟶ D_1⟶ BATT⟶ anode/cathode of S_2⟶ GEN, or GEN⟶ D_2⟶ BATT⟶ anode/cathode of S_1 ⟶ GEN.

After S_1 or S_2 is turned on, collector current of Q_1 and base current of Q_3 are supplied by GEN, not BATT.

When key switch is returned to position 1 after engine is started, BATT is charged, if BATT terminal voltage is lower than the setting value, or zener level of Z_1.

[E] Fig. 4, Function of circuit



0076F027

4) Over-Charge Protection

When BATT terminal voltage is higher than the setting value or zener level of Z_1, BATT is not charged by the function of circuit as shown in Fig. 4. That is, Q_4 is on with base current which flows through the route of BATT⟶ emitter/base of Q_4⟶ Z_1⟶ D_6⟶ BATT, shortcircuiting emitter and base of Q_3. Therefore, Q_3 is off with no base current and gate current is not supplied to S_1 and S_2. Consequently S_1 and S_2 are off and BATT is not charged.

2) Au démarrage

Lorsqu'on tourne l'interrupteur à clé en position 2, la bobine du relais de démarrage est excitée, ce qui entraîne le démarrage du moteur. GEN se met aussi à produire de l'énergie destinée à la charge et LAMP s'éteint.
Soit, en détail, GEN étant en action, le flux de courant arrive à la base de Q_1 en suivant le parcours: GEN⟶ D_1⟶émetteur/base de Q_1⟶D_4⟶GEN, ou le parcours: GEN⟶ D_2⟶émetteur/base de Q_1⟶ D_3⟶ GEN; il s'ensuit que le flux de courant passe aussi par Q_1, ce qui court-circuite l'émetteur et la base de Q_2. Il en résulte que le courant à la base de Q_2 est coupé, Q_2 est donc mis hors circuit, coupant ainsi le courant à LAMP.

[C] Fig. 2 Fonction du circuit
(1) Vers la bobine de relais du démarreur

3) Durant la charge

Etant donné que, tout de suite après le démarrage du moteur, la tension à la borne BATT est inférieure à la valeur nominale (14 à 15V) ou même inférieure à Z_1 sur l'échelle Zener, le courant, ainsi que l'illustre la Fig. 2, ne passe pas à la base de Q_4, ce qui met ce dernier hors circuit. Q_3 est mis en circuit par le flux de courant qui suit le parcours: BATT⟶ émetteur/base de Q_3⟶ R_2⟶ D_6⟶ BATT, S_1 ou S_2 reçoit un courant grille qui a suivi le parcours: GEN⟶D_1⟶émetteur/collecteur de Q_3⟶ grille/cathode de S_2⟶ GEN ou le parcours: GEN⟶ D_2⟶ émetteur/collecteur de Q_3⟶grille/cathode de S_1⟶ GEN. Lorsque la vitesse du moteur s'accroît au point que la tension de service de GEN devient supérieure à la tension à la borne BATT, S_1 ou S_2 est mis en circuit et, ainsi que le montre la Fig. 3, le courant de charge est fourni à BATT, en fonction du parcours: GEN⟶ D_1⟶ BATT⟶ anode/cathode de S_2⟶ GEN, ou du parcours: GEN ⟶ D_2⟶B ATT⟶ anode/cathode de S_1⟶ GEN.
Après la mise en circuit de S_1 ou de S_2, GEN et non pas BATT fournit le courant au collecteur de Q_1 et à la base de Q_3.
Si, après le démarrage du moteur, l'interrupteur à clé est remis en position 1, BATT se charge si la tension à la borne BATT est inférieure à la valeur nominale ou à Z_1 sur l'échelle Zener.

[D] Fig. 3 Fonction du circuit

4) Protection contre les surcharges

Lorsque la tension à la borne BATT est supérieure à la valeur nominale ou à Z_1 sur l'échelle Zener, BATT, ainsi que l'illustre la Fig. 4, ne se charge pas en fonction du circuit. A savoir, Q_4 est en circuit grâce au courant arrivé à sa base en suivant le parcours: BATT⟶ émetteur/base de Q_4⟶ Z_1⟶ D_6⟶ BATT, et qui a court-circuité l'émetteur et la base de Q_3. Il s'ensuit que Q_3, privé de courant à la base, est hors circuit et que S_1 et S_2 ne reçoivent pas de courant grille. S_1 et S_2 sont donc hors circuit et BATT ne se charge pas.

[E] Fig. 4 Fonction du circuit

2) Beim Starten des Motors

Wenn der Schlüsselschalter auf die Position 2 gedreht wird, wird die Spule des Starterrelais unter Stom gesetzt und der Anlassvorgang durch den Starter eingeleitet. Der GENERATOR beginnt dann auch mit der Erzeugung von Ladeströmen, wodurch die LAMPE ausgeschaltet wird. Einzeln ausgedrückt, fließt beim Anlauf des GENERATORS ein Strom über GEN⟶ D_1⟶ Emitter/Basis des Q_1⟶ D_4⟶ GEN oder über GEN⟶ D_2⟶Emitter basis des Q_1⟶D_3⟶ GEN in die Basis des Q_1 wodurch der Emitter und die Basis des Q_2 überbrückt werden können. Resultierend davon wird der Basisstrom von Q_2 unterbrochen, Q_2 ausgeschaltet und auf diese Weise wird die LAMPE unterbrochen.

[C] Abbildung 2, Funktion des Kreises
Zur Relaisspule des Starters

3) Beim Aufladen der Batterie

Da die Anschlußspannung der BATTERIE unmittelbar nach dem Anlassen des Motors geringer als der Einstellwert (14 bis 15V) oder geringer als der Zenerpegel von Z_1 ist, wird der Basis des Q_4 kein Basisstrom zugeleitet, wodurch dieser Transistor im ausgeschalteten Zustand verbleibt. (Siehe Abbildung 2.) Der Transistor Q_3 ist nun eingeschaltet und dessen Basisstrom fließt über BATT⟶ Emitter/Basis des Q_3 ⟶ R_2⟶ D_6⟶ BATT, und gleicherweise wird der Gate-Strom über GEN⟶ D_1⟶ Emitter/Kollektor des Q_3⟶ Gate/Kathode des S_2⟶ GEN oder GEN⟶ D_2⟶ Emitter/Kollektor des Q_3⟶ Gate/Kathode des S_1⟶ GEN den S_1 oder S_2 zugeleitet. Wenn nun die Drehzahl des Motors ansteigt, sodaß die Spannung des GENERATORS höher als die BATTERIE -Klemmenspannung gelangt, werden S_1 oder S_2 gemäß der Abbildung 3 eingeschaltet, wodurch über GEN⟶ D_1⟶ BATT⟶ Anode/Kathode des S_2⟶ GEN oder GEN⟶ D_2⟶ BATT⟶ Anode/Kathode des S_1⟶ GEN, der Ladestrom entsprechend der Batterie zugeleitet wird.
Nachdem S_1 oder S_2 eingeschaltet wurden, wird der Kollektorstrom des Q_1 und der Basisstrom des Q_3 vom GENERATOR und nicht mehr von der Batterie zugeleitet. Wenn der Schlüsselschalter nun nach dem Anlassen des Motors auf die Stellung 1 zurückgebracht wird, wird die Batterie aufgeladen, wenn die Batteriespannung unter den eingestellten Spannungswert oder den Zenerpegel von Z_1 absinkt.

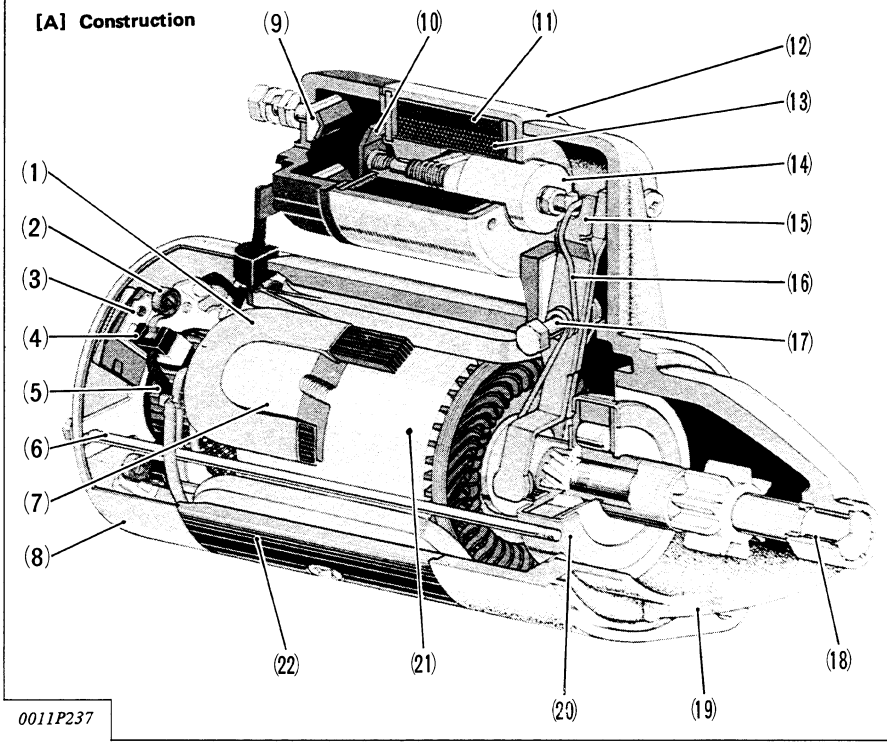
[D] Abbildung 3, Funktion des Kreises

4) Überladungsschutz

Durch die Schutzfunktion des Kreises der Abbildung 4 wird die Batterie nicht aufgeladen, wenn die Batteriespannung über dem Einstellungs- oder dem Zenerwert der Z_1 liegt. In diesem Zustand ist der Transistor Q_4 eingeschaltet, dessen Basisstrom über BATT⟶ Emitter/Basis des Q_4⟶ Z_1⟶ D_6⟶ BATT fließt, wodurch der Emitter und die Basis des Q_3 kurzgeschlossen werden. Durch diesen Vorgang wird Q_3 ausgeschaltet, wodurch Basis- und Gate-Ströme nicht den S_1 und S_2 zugeleitet werden können. S_1 und S_2 sind dann im ausgeschalteten Zustand und ein Ladevorgang wird nicht ausgeführt.

[E] Abbildung 4, Funktion des Kreises

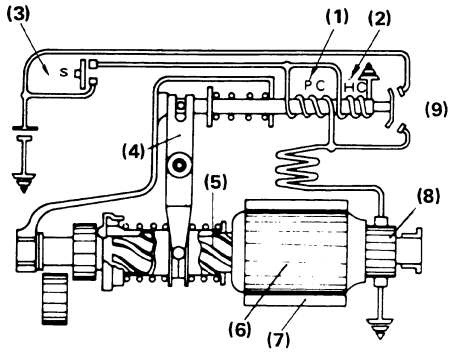
[A] Construction



0011P237

(1) Field coil
(2) Brush spring
(3) Brush holder
(4) Brush
(5) Commutator
(6) Through bolt
(7) Pole core
(8) End frame
(9) Contact bolt
(10) Contact plate
(11) Holding coil
(12) Magnet switch
(13) Pull-in coil
(14) Moving core
(15) Drive lever
(16) Drive spring
(17) Lever set bolt
(18) Bearing
(19) Drive side housing
(20) Overrunning clutch
(21) Armature
(22) Yoke

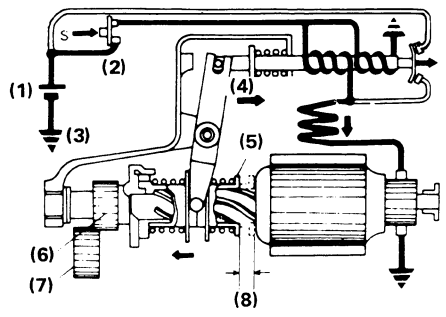
[B] Starter circuit



0011F173

(1) PC : Pull-in Coil
(2) HC : Holding Coil
(3) S : Switch
(4) Drive lever clutch
(5) Screw spline
(6) Armature
(7) Pole core
(8) Commutator
(9) Contact plate

[A] When key switch is on



0011F174

5-2 CRANKING SYSTEM

(1) Starter

The magnet-switch type starter is composed of two main sections. The first section converts battery current into mechanical rotation to turn the engine crankshaft. It is composed of the field coil, armature, brush, commutator, pinion, overrunning clutch, etc. The second section allows the pinion and flywheel to engage together and current to flow through the motor section. It is composed of the pull-in coil, holding coil plunger, drive lever, contact plate, etc.

■ When key switch is on:

When the key switch is turned on, a current flows from the battery through the pull-in coil in the magnet switch section to the holding coil, energizing the plunger to pull it in.
At this time, the pinion moves by the drive lever to engage with the ring gear.

(1) Battery
(2) Starter switch
(3) Ground
(4) Return spring
(5) Spline tube
(6) Pinion
(7) Ring gear
(8) Operated by lever

5-2 SYSTEME DE LANCEMENT DU MOTEUR

(1) Starter

Le Starter à interrupteur magnétique se compose de deux parties principales: la première transforme le courant de la batterie en une rotation mécanique qui entraîne le vilebrequin moteur. Elle consiste en une bobine d'excitation, un induit, un balai, un commutateur, un pignon, une armature, un embrayage, etc. La seconde fait s'engrener pignon et volant et fait passer le courant par le moteur. Elle consiste en un levier de commande, une plaque de contact, d'un enroulement de maintien, d'un enroulement de traction, etc.

[A] Agencement

(1)	Bobine d'excitation	(12)	Interrupteur magnétique
(2)	Ressort de balai	(13)	Enroulement de traction
(3)	Porte-balais	(14)	Noyau mobile
(4)	Balais	(15)	Levier de commande
(5)	Commutateur	(16)	Ressort de commande
(6)	Passant	(17)	Boulon fixant le levier
(7)	Noyau magnétique	(18)	Palier
(8)	Cadre de bout	(19)	Logement côté entraînement
(9)	Boulon contact	(20)	Embrayage de survoltage
(10)	Contact	(21)	Armature
(11)	Enroulement de maintien	(22)	Chape

[B] Circuit starter

(1) PC: Enroulement de traction
(2) HC: Enroulement de maintien
(3) S: Interrupteur
(4) Levier de commande
(5) Clavette à vis
(6) Armature
(7) Induit
(8) Commutateur
(9) Contacts

■ **Quand le contact est mis**

Quand on ouvre, un courant s'écoule, par l'enroulement de traction, de la batterie à l'enroulement de maintien, amenant le plongeur à le tirer.
A ce moment, le pignon est engagé, par le levier de commande, sur la couronne dentée.

[A] Quand le contact est mis

(1)	Batterie	(5)	Tube clavette
(2)	Démarrage	(6)	Pignon
(3)	Masse	(7)	Couronne dentée
(4)	Ressort de rappel	(8)	Commande par levier

5-2 KURBELSYSTEM

(1) Starter

Dieser Starter des Magnetschaltertyps ist aus den folgenden zwei Hauptsektionen zusammengesetzt: In der ersten Sektion wird die Batteriekraft in eine mechanische Bewegung zur Drehung der Kurbelwelle des Motors umgesetzt. Dieses Teil besteht aus der Feldspule, Anker, Bürste, Kommutator, Ritzel, Überlaufskupplung usw. Die zweite Sektion ermöglicht ein Zusammentreffen des Ritzels und der Schwungscheibe und die Stromzuleitung zum Motorenteil. Dieses Teil besteht aus der Einzugsspule, Haltespule, Tauchspulenkolben, Treibhebel, Kontaktplatte usw.

[A] Konstruktion

(1)	Feldspule	(12)	Magnetschalter
(2)	Bürstenfeder	(13)	Einzugsspule
(3)	Bürstenhalter	(14)	Bewegungsrern
(4)	Bürste	(15)	Treibhebel
(5)	Kommutator	(16)	Treibspirale
(6)	Durchgangsschraube	(17)	Hebeleinstellbolzen
(7)	Polkern	(18)	Lagerung
(8)	Endrahmen	(19)	Treibseitengehäuse
(9)	Kontaktbolzen	(20)	Überlaufskupplung
(10)	Kontaktplatte	(21)	Anker
(11)	Haltespule	(22)	Joch

[B] Starterkreis

(1) PC : Einzugsspule
(2) HC: Haltespule
(3) S: Schalter
(4) Treibhebelkupplung
(5) Schraubenrille
(6) Anker
(7) Polkern
(8) Kommutator
(9) Kontaktplatte

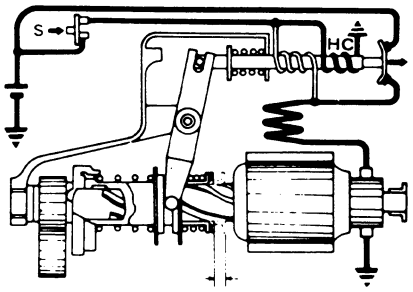
■ **Beim Einschalten des Schalters:**

Wenn der Schalter eingeschaltet wird, fließt ein Strom durch die Anzugsspule von der Batterie zur Magnetschaltersektion der Haltespule, wodurch der Tauchspulenkolben eingezogen werden kann.
Zu dieser Zeit wird auch das Ritzelgetriebe durch den Treibhebel gegen das Ringgetriebe (Ringzahnrad) gedrückt.

[A] Beim Einschalten des Schalters

(1)	Batterie	(5)	Rillenrohr
(2)	Starterschalter	(6)	Ritzel
(3)	Masse	(7)	Ringgetriebe
(4)	Rückführspirale	(8)	Durch den Hebel bewegt

[A] When contact plate is closed

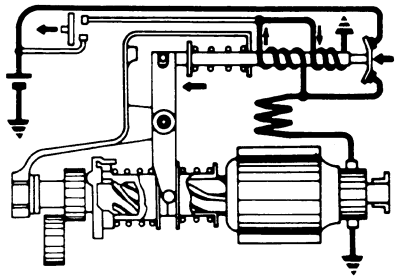


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■ **When contact plate is closed:**

When the contact plate is closed, a large current flows through the motor section to generate a large mechanical power which turns the engine crankshaft.
At this time, the pinion is moved forward by the screw spline for more contact.
Since the pull-in coil ends are short-circuited by the contact plate, the plunger is held only by the force of the holding coil.

[A] When key switch is released

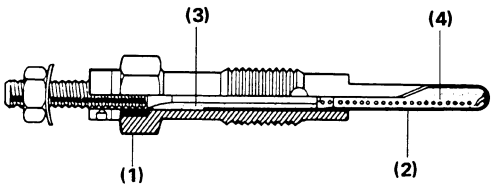


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■ **When key switch is released:**

When the key switch is released, a current flows instantaneously through the pull-in coil in the opposite direction as shown in Fig. Therefore, the forces of the holding coil and pull-in coil are balanced. As a result, the plunger is returned by the return spring. Simultaneously, the pinion is disengaged from the ring gear, the contact plate is disconnected, and the starter is promptly stopped by the armature brake.

[A] Construction of bar glow plug



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(2) Glow Plugs

Glow plugs are used for each pre-combustion chamber of the cylinder head to make starting easier. The glow plugs are quick-heating type, which make starting easier with short pre-heating time.

(1) Housing
(2) Metal tube
(3) Insulating powder
(4) Heat coil

■ **Plaque de contact fermée**

Quand la plaque est fermée, un fort courant s'écoule par la section moteur pour produire une grande force mécanique qui fait tourner le vilebrequin moteur.
A ce moment, le pignon est avancé par la clavette à vis pour plus de contact.
Les extrémités d'enroulement étant court-circuitées par le plot, le piston est maintenu par la force du seul enroulement de maintien.

[A] Plaque de contact fermée

■ **Quand l'interrupteur est relâché**

Quand on relâche la clé de contact, un courant s'écoule instantanément par l'enroulement de traction dans le sens opposé, cf fig. D'où équilibre des forces des deux enroulements et retour du piston, ramené par le ressort. Simultanément, le pignon est déclenché de la couronne dentée, le plot est déconnecté et le starter est rapidement arrêté par le frein d'armature.

[A] Quand l'interrupteur est relâché

(2) Bougies incandescentes

Des bougies incandescentes sont utilisées pour chaque chambre de précombustion de la culasse, pour faciliter le démarrage. Les bougie incandescentes sont de type à échauffement rapide, qui facilite le démarrage grâce à un court préchauffement.

[A] Agencement de la bougie incandescente à lame
- **(1) Chambre**
- **(2) Tube en métal**
- **(3) Poudre isolante**
- **(4) Bobine de chauffage**

■ **Wenn die Kontaktplatte geschlossen wird:**

Wenn die Kontaktplatte geschlossen wird, kann ein hoher Strom durch die Motorensektion fließen, um eine entsprechend starke Kraft zur Drehung der Kurbelwelle des Motors zu erzeugen.
Zu diesem Zeitpunkt wird das Ritzelgetriebe durch die Schraubenrille vorwärtsbewegt, um mehr Kontakt zu erlangen. Da die Enden der Einzugsspule durch die Kontaktplatte kurzgeschlossen werden, wird der Tauchspulenkolben nur von der Kraft der Haltespule gehalten.

[A] Wenn die Kontaktplatte geschlossen wird

■ **Wenn der Schlüsselschalter losgelassen wird**

Wenn der Schlüsselschalter losgelassen wird, kann ein Strom augenblicklich in die Gegenrichtung durch die Einzugsspule fließen, wie in der Abbildung gezeigt wird. Durch diese Vorrichtung sind die Kräfte der Einzugs- und Haltespulen ausgeglichen, wodurch der Tauchspulenkolben durch die Rückführspirale zurückgeführt werden kann. Gleichzeitig wird auch das Ritzelgetriebe vom Ringzahnrad gelöst, wonach der Starter von der Ankerbremse sofort angehalten wird.

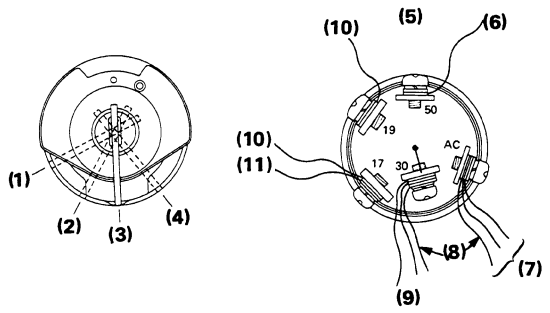
[A] Wenn der Schlüsselschalter losgelassen wird

(2) Glühkerzen

Glühkerzen werden für jede Vorkammer vom Zylinderkopf gebraucht, um das Anlassen zu erleichtern.
Diese Glühkerzen bestehen aus einem Schnellheiztyp, welcher einfaches Starten ohen lange Vorwärmzeiten ermöglicht.

[A] Konstruktion der Stabglühkerze
- **(1) Gehäuse**
- **(2) Metallrohr**
- **(3) Isolierpulver**
- **(4) Hitzespule**

[A] Key Position: OFF



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5-3 KEY SWITCH (not included in the basic engine)

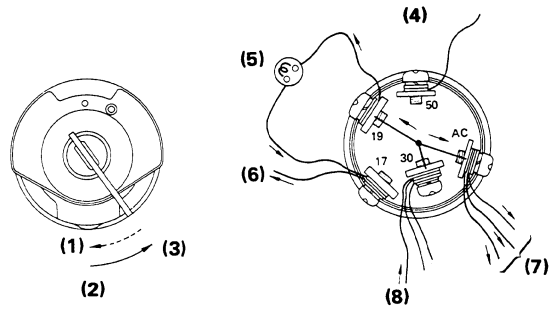
Power is supplied to the circuits from the battery when the engine stops and from the dynamo when the engine rotates, depending on the position of key switch.

■ **Key position: OFF**

When key switch is at OFF, battery terminal No. 30 is not connected with any other terminals.

(1) Start Position
(2) ON Position
(3) OFF Position
(4) Preheating Position
(5) Rear
(6) To Starter
(7) To accessories such as oil pressure lamp, head lamp, etc.
(8) To regulator
(9) From Battery
(10) To Glow Plug Lamp
(11) To Glow Plugs

[B] Key Position: PREHEAT



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■ **Key position: PREHEAT**

When key switch is at PREHEAT, battery terminal No. 30 is connected with terminal No. 19 and with terminal AC. As terminal No. 19 is connected with terminal No. 17 through glow plugs indicator (not included in the basic engine), glow plugs and glow plug indicator are heated.
When key switch is released free after heating glow plugs, it is returned automatically to OFF position.

(1) Automatic Return
(2) OFF Position
(3) Preheating Position
(4) Rear
(5) Glow Plug Lamp
(6) To Glow Plugs
(7) To Accesories
(8) From Battery

5-3 INTERRUPTEUR A CLE (non inclus dans le moteur de base)

La batterie fournit l'énergie aux circuits lorsque le moteur s'arrête et la dynamo lorsque le moteur tourne, ceci en fonction de la position de l'interrupteur à clé.

■ Position de la clé: COUPE (OFF)

Si l'interrupteur à clé est en position "COUPE", la borne N° 30 de la batterie n'est connectée à aucune autre borne.

[A] Position de la clé: "coupé"

(1) Position "démarrage"
(2) Position "contact"
(3) Position "coupé"
(4) Position "préchauffage"
(5) Arrière
(6) Vers le démarreur
(7) Vers accessoires tels qu' indicateur de pression d'huile, phare, etc.
(8) Vers régulateur
(9) Venant de la batterie
(10) Vers indicateur d'incandescence de la bougie
(11) Vers bougie incandescente

■ Position de la clé: PRECHAUFFAGE (PREHEAT)

Lorsque l'interrupteur à clé est en position "PRECHAUFFAGE", la borne N°30 de la batterie est raccordée à la borne N°19 et à la borne c.a.. Du fait que la borne N°19 est raccordée à la borne N°17 grâce à l'indicateur d'incandescence de la bougie (non inclus dans le moteur de base), les bougies incandescentes et les indicateurs chauffent. Lorsque, après le chauffage de cette bougie, l'interrupteur à clé est déclenché, il retourne automatiquement en position "COUPE".

[B] Position de la clé: "préchauffage"

(1) Retour automatique
(2) Position "coupé"
(3) Position "préchauffage"
(4) Arrière
(5) Indicateur d'incandescence de la bougie
(6) Vers bougie incandescente
(7) Vers accessoires
(8) Venant de la batterie

5-3 SCHLÜSSELSCHALTER (Im Basismodell nicht enthalten)

Abhängig von der Stellung des Schlüsselschalters werden die Kreise bei laufendem Motor vom Dynamo und bei angehaltenem Motor von der Batterie mit Strom versorgt.

■ Schlüsselstellung: OFF

In der "OFF"-Stellung des Schlüsselschalters ist der Batterieanschluß Nr. 30 mit keinem anderen Anschluß verbunden.

[A] Schlüsselstellung OFF

(1) START-Stellung
(2) ON-Stellung
(3) OFF-Stellung
(4) PREHEAT-Stellung
(5) Rückansicht
(6) Zum Starter
(7) Zu Zusatzteilen wie Öldrucklampe, Kopflampe usw.
(8) Zum Regulator
(9) Von der Batterie
(10) Zur Glühkerzenlampe
(11) Zu den Glühkerzen

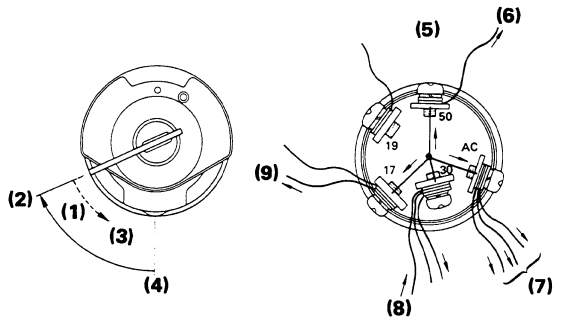
■ Schlüsselstellung: PREHEAT (Vorwärmung)

In der "PREHEAT"-Stellung des Schlüsselschalters ist der Batterieanschluß Nr. 30 mit den Anschlüssen Nr. 19 und AC in Verbindung. Da nun der Anschluß Nr. 19 über den Glühkerzenanzeiger (Im Basismodell nicht enthalten) mit dem Anschluß Nr. 17 verbunden wird, werden die Glühkerzen erhitzt und die Anzeiger leuchten auf. Nach dem Erhitzungsvorgang werden die Schalter automatisch auf die "OFF"-Stellung zurückgestellt.

[B] Schalterstellung PREHEAT

(1) Automatische Rückführung
(2) OFF-Stellung
(3) PREHEAT-Stellung
(4) Rückansicht
(5) Glühkerzenlampe
(6) Zu den Glühkerzen
(7) Zu den Zusatzteilen
(8) Von der Batterie

[C] Key Position: START



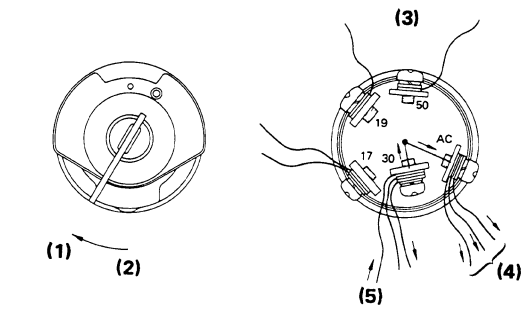
0011F171

■ **Key position: START**

When key switch is at START, battery terminal No. 30 is connected with terminals No. 50, No. 17 and AC, and starter is actuated. At the same time, glow plugs are heated, but indicator is not heated.
When key switch is released free after engine is started, key swtich is returned automatically to ON position.

(1) Automatic return
(2) Start Position
(3) ON Position
(4) OFF Position
(5) Rear
(6) To Starter
(7) To Accesories
(8) From Battery
(9) To Glow Plugs

[D] Key Position; ON



0011F172

■ **Key position: ON**

Battery terminal No. 30 is connected only with terminal AC, and starter is stopped.

Rated current of each terminal
No. 17 and No. 19 . . . . . 30A
No. 50 . . . . . 12A
AC 10A

(1) ON Position
(2) OFF Position
(3) Rear
(4) To Accesories
(5) From Battery

■ Position de la clé: DEMARRAGE (START)

Si l'interrupteur à clé se trouve en position "DEMARRAGE", la borne N°30 de la batterie est connectée aux bornes N°50, N° 17 et c.a., le démarreur entre alors en action. Les bougies incandescentes se trouvent chauffées en même temps, mais non pas l'indicateur. Lorsque, après démarrage du moteur, l'interrupteur à clé est déclenché, il se met automatiquement en position "CONTACT" (ON).

[C] Position de la clé: "démarrage"

(1) Retour automatique
(2) Position "démarrage"
(3) Position "contact"
(4) Position "coupé"
(5) Arrière
(6) Vers le démarreur
(7) Vers accessoires
(8) Venant de la batterie
(9) Vers bougie incandescente

■ Position de la clé: CONTACT (ON)

La borne N°30 de la batterie n'est connectée qu'à la borne c.a., ce qui entraîne l'arrêt du démarreur.

Courant nominal de chaque borne

N°17 et N°19	30A
N°50	12A
c.a.	10A

[D] Position de la clé: "contact"

(1) Position "contact"
(2) Position "coupé"
(3) Arrière
(4) Vers accessoires
(5) Venant de la batterie

■ Schlüsselstellung: START

Wenn der Schlüsselschalter auf die "START"-Stellung gebracht wird, wird der Batterieanschluß Nr. 30 mit den Anschlüssen Nr. 50, 17 und AC in Verbindung gebracht, wodurch der Starter aktiviert wird. Gleichzeitig werden die Glühkerzen erhitzt, jedoch leuchtet bei diesem Vorgang die Glühkerzenanzeigelampe nicht auf.
Wenn der Schlüsselschalter nach dem Anlassen des Motors losgelassen wird, wird der Schlüsselschalter automatisch auf die ON-Stellung gebracht.

[C] Schalterstellung: START

(1) Automatische Rückführung
(2) START-Stellung
(3) ON-Stellung
(4) OFF-Stellung
(5) Rückansicht
(6) Zum Starter
(7) Zu Zusatzteilen
(8) Von der Batterie
(9) Zu den Glühkerzen

■ Schlüsselstellung: ON

Der Batterieanschluß Nr. 30 wird nur nach Unterbrechung des Starterbetriebs mit dem AC-Anschluß in Verbindung gebracht.

Nennstrom jedes Anschlusses

Nr. 18 und Nr. 19	30A
Nr. 50	12A
AC	10A

[D] Schlüsselstellung ON

(1) ON-Stellung
(2) OFF-Stellung
(3) Rückansicht
(4) Zu Zusatzteilen
(5) Von der Batterie

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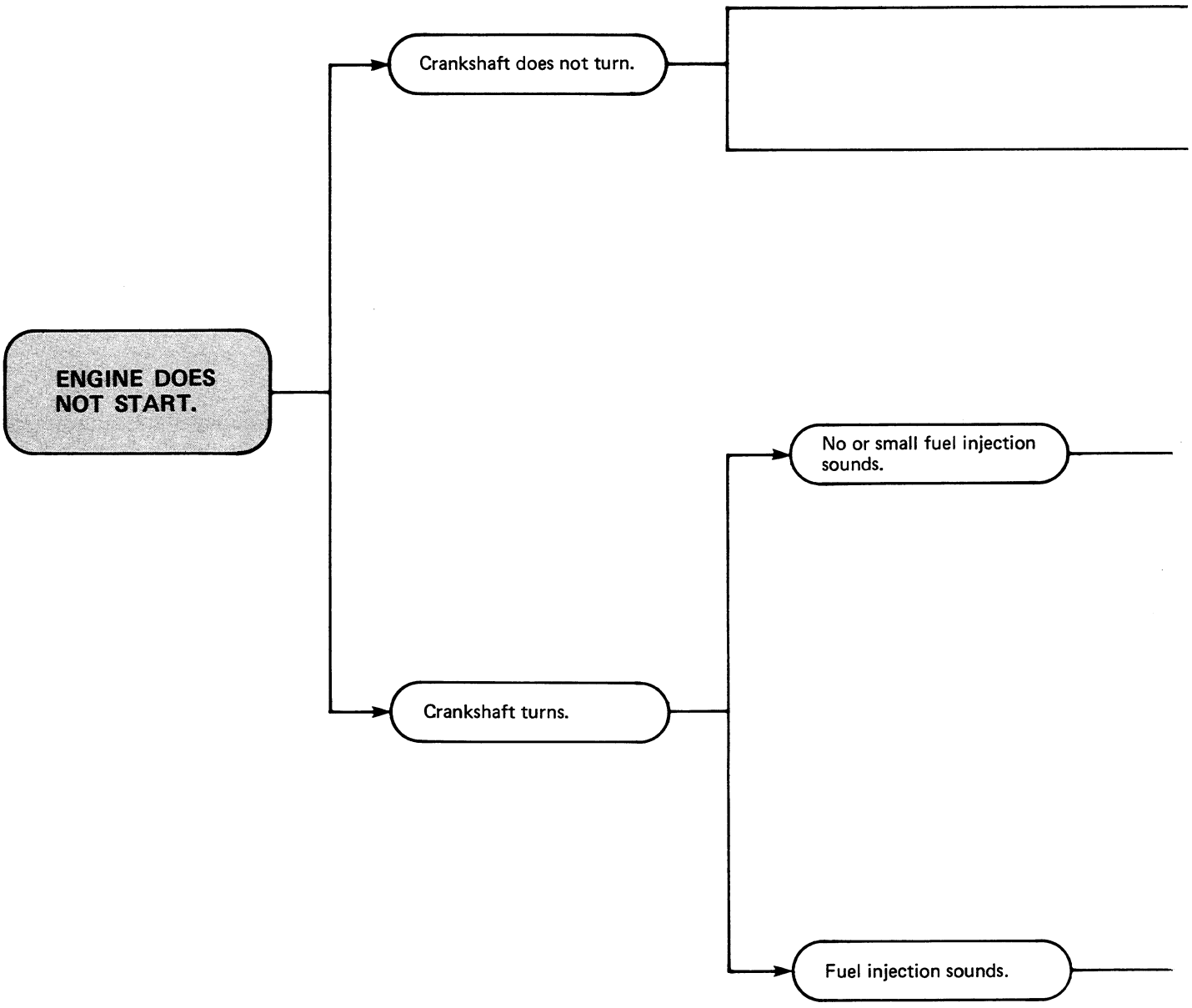
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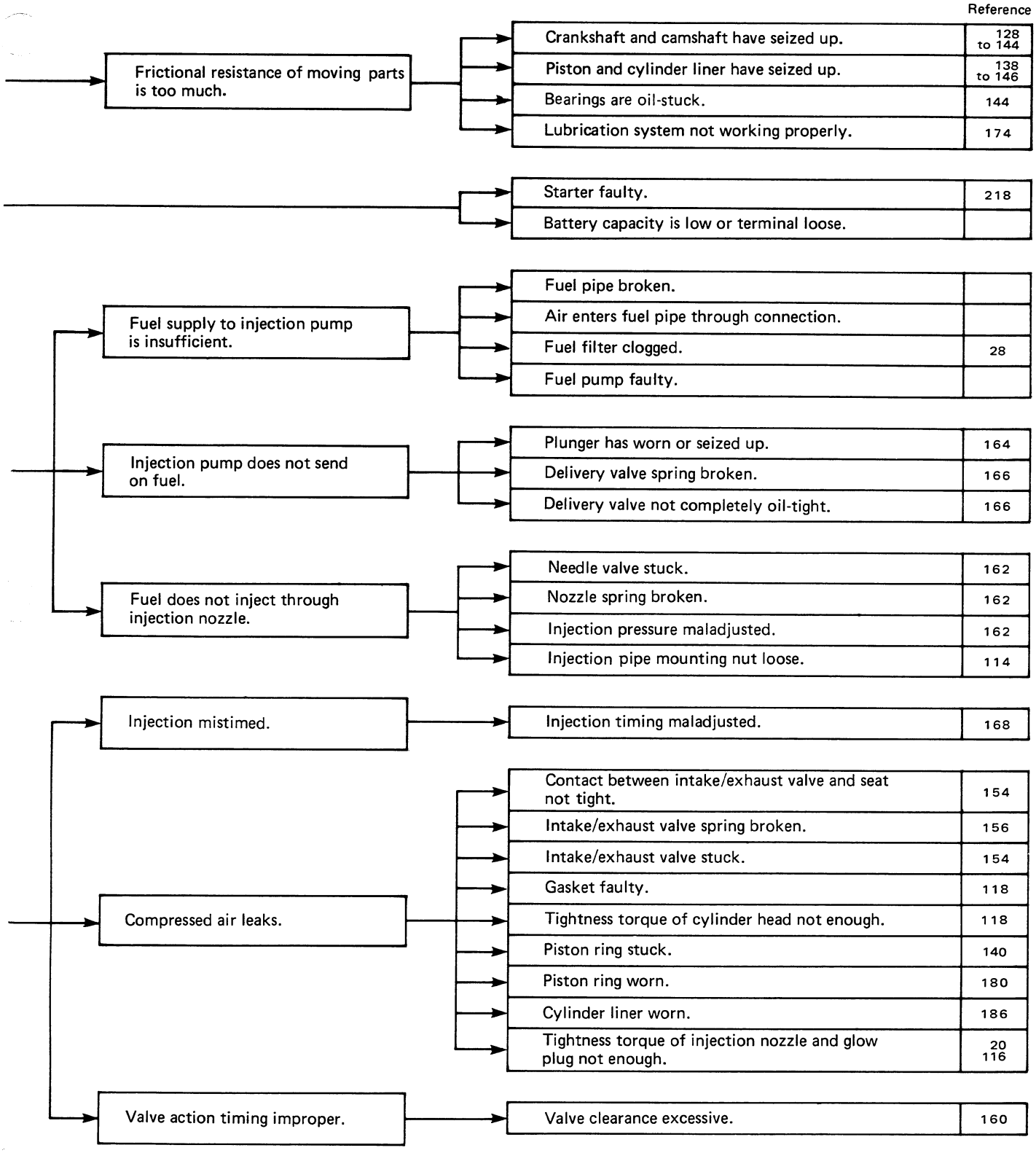
AUSBAU UND WARTUNG DES MOTORS

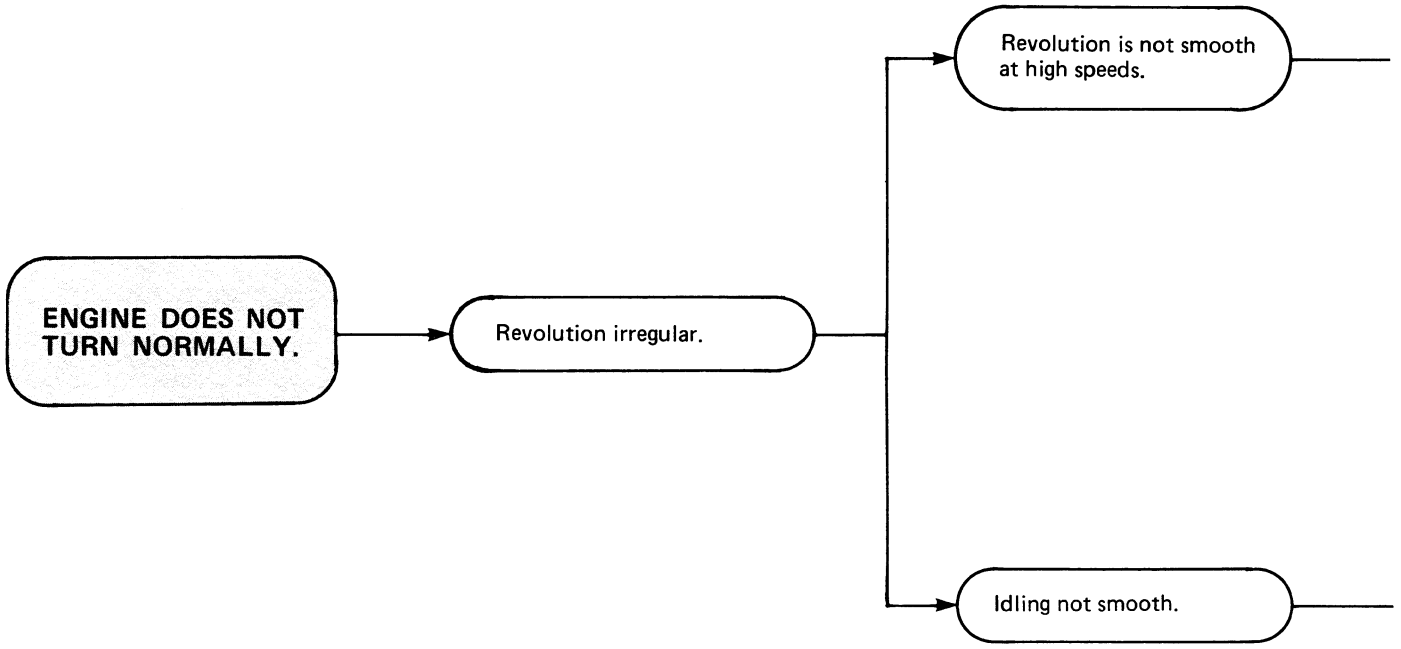
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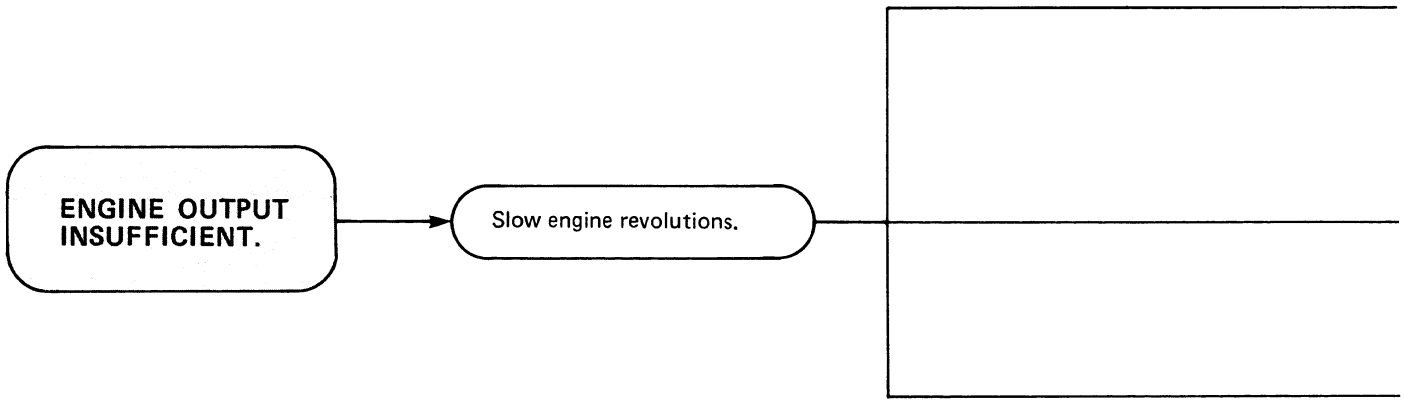
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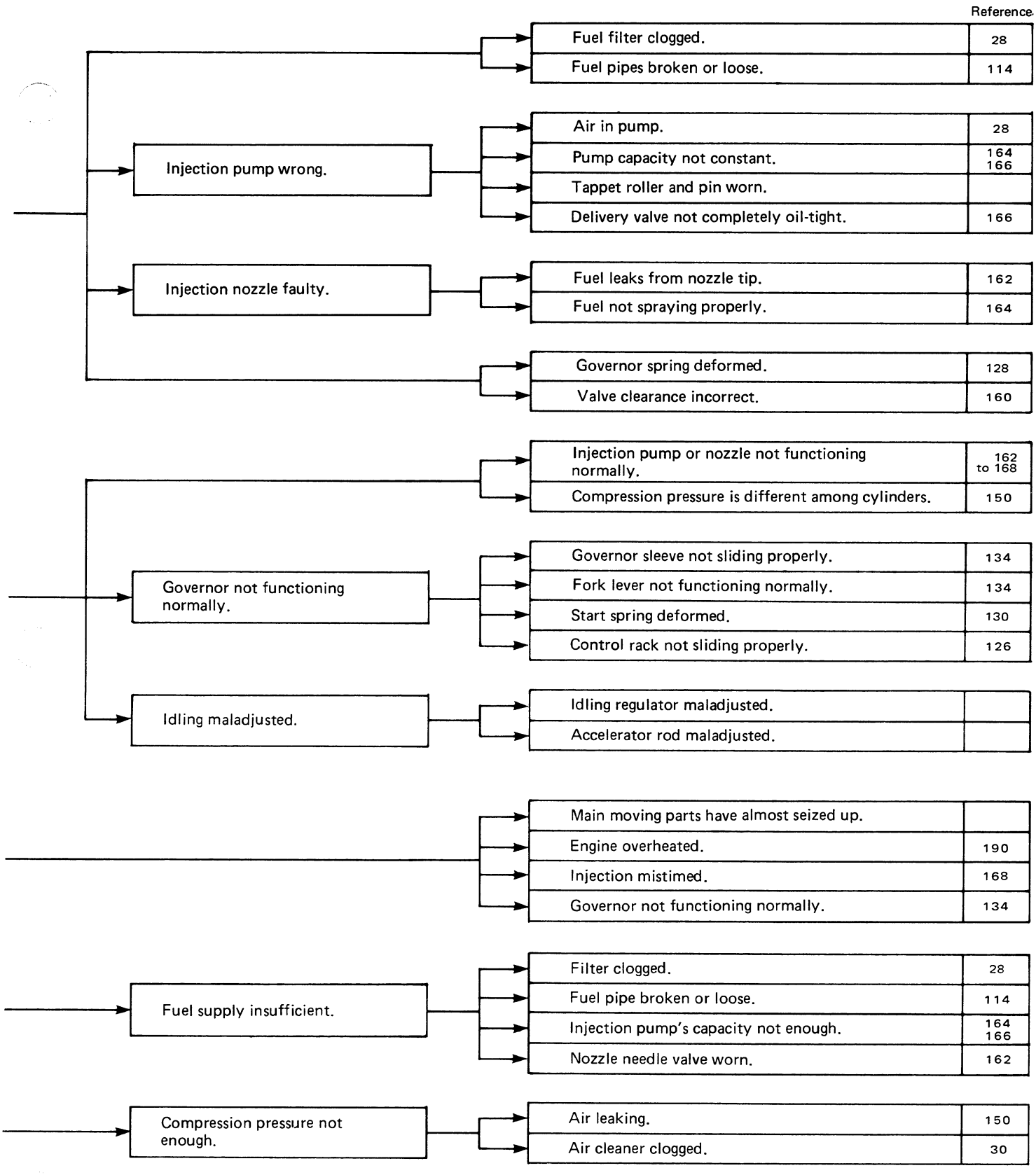
1. TROUBLESHOOTING

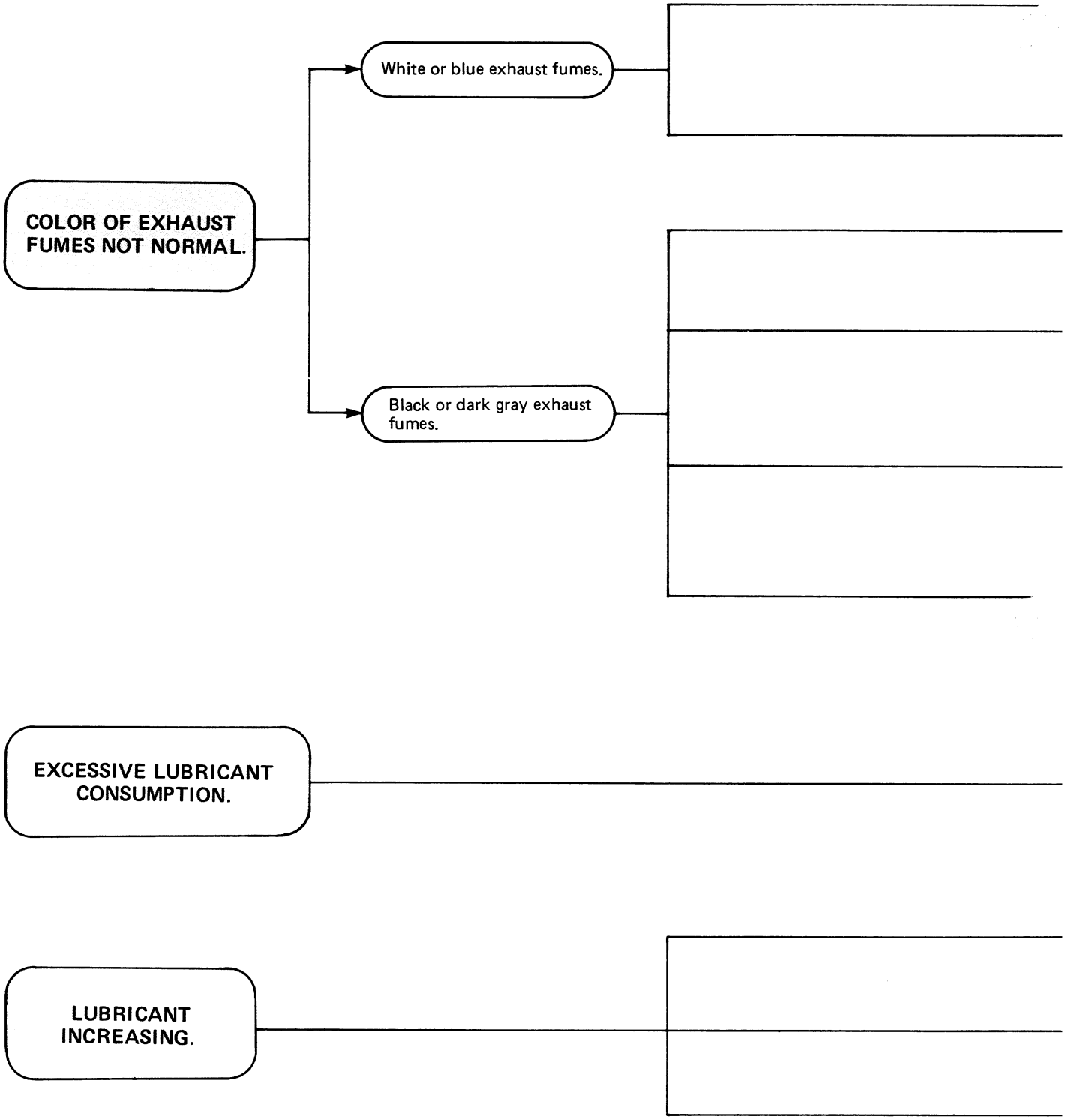


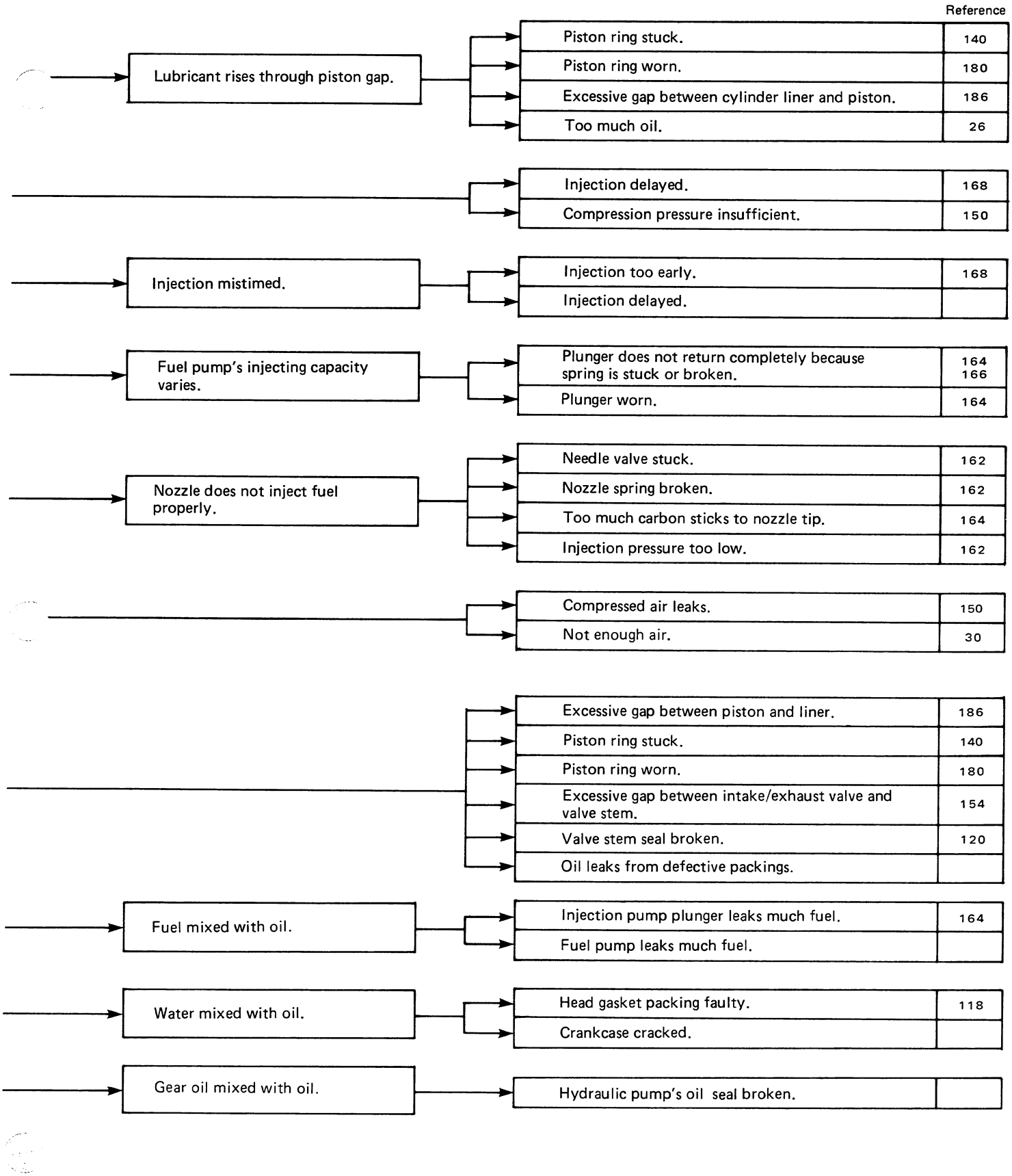

Reference
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Tightness torque of injection nozzle and glow plug not enough. 20 116
Valve action timing improper.
Valve clearance excessive. 160


ENGINE DOES NOT TURN NORMALLY.
Revolution irregular.
Revolution is not smooth at high speeds.
Idling not smooth.

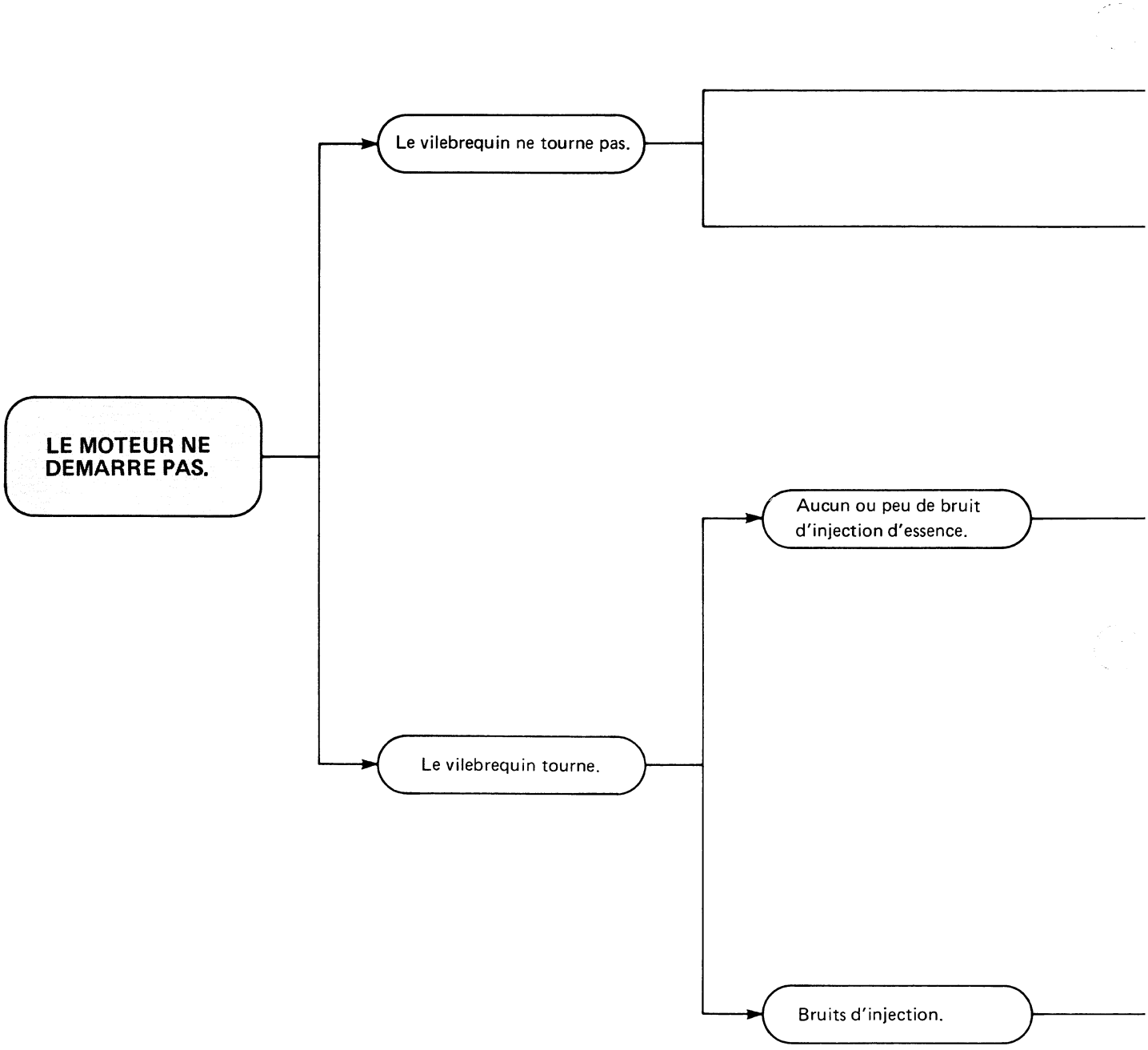

ENGINE OUTPUT INSUFFICIENT.
Slow engine revolutions.

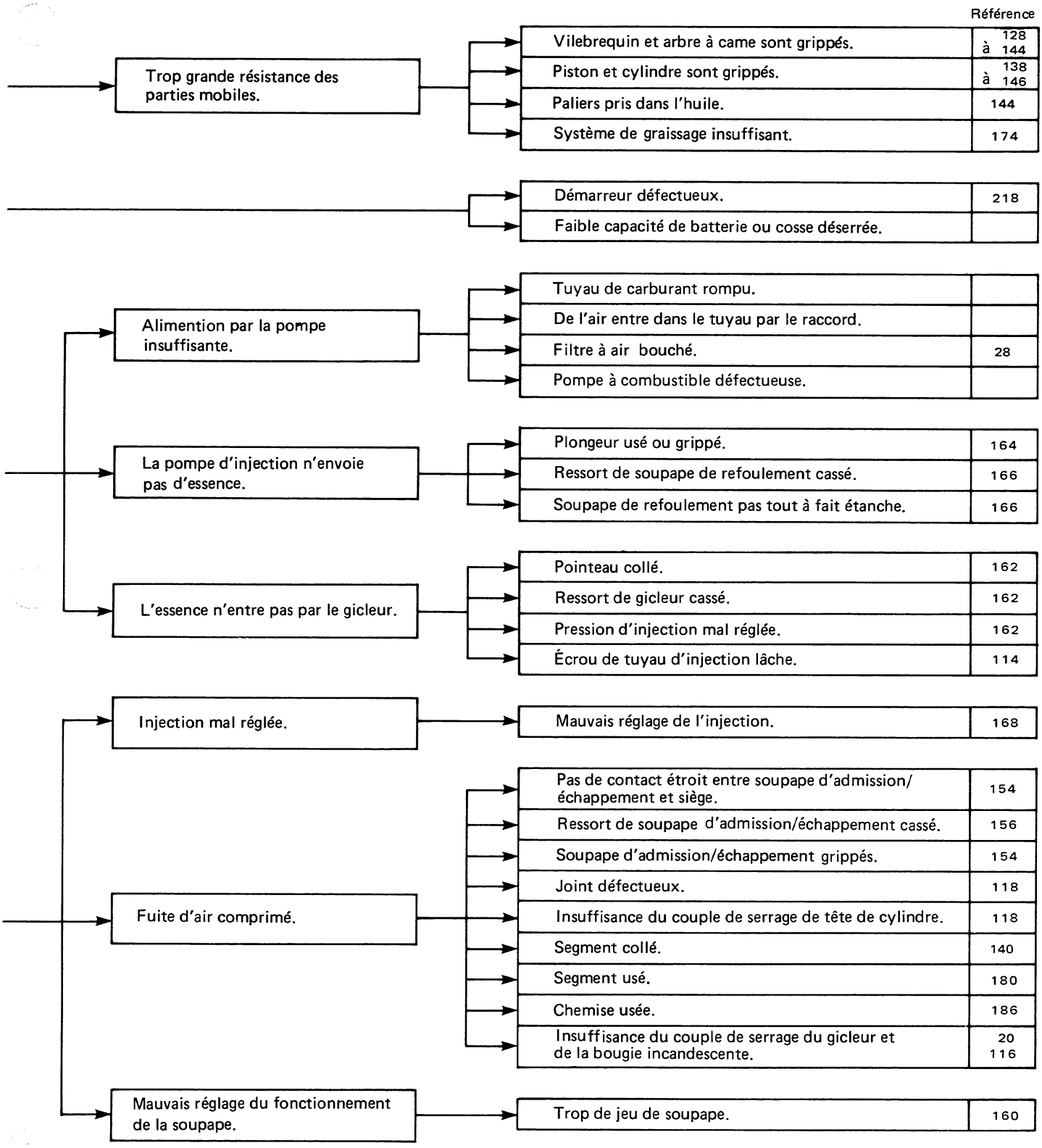

Reference
Fuel filter clogged. 28
Fuel pipes broken or loose. 114
Injection pump wrong.
Air in pump. 28
Pump capacity not constant. 164 166
Tappet roller and pin worn.
Delivery valve not completely oil-tight. 166
Injection nozzle faulty.
Fuel leaks from nozzle tip. 162
Fuel not spraying properly. 164
Governor spring deformed. 128
Valve clearance incorrect. 160
Injection pump or nozzle not functioning normally. 162 to 168
Compression pressure is different among cylinders. 150
Governor not functioning normally.
Governor sleeve not sliding properly. 134
Fork lever not functioning normally. 134
Start spring deformed. 130
Control rack not sliding properly. 126
Idling maladjusted.
Idling regulator maladjusted.
Accelerator rod maladjusted.
Main moving parts have almost seized up.
Engine overheated. 190
Injection mistimed. 168
Governor not functioning normally. 134
Fuel supply insufficient.
Filter clogged. 28
Fuel pipe broken or loose. 114
Injection pump's capacity not enough. 164 166
Nozzle needle valve worn. 162
Compression pressure not enough.
Air leaking. 150
Air cleaner clogged. 30

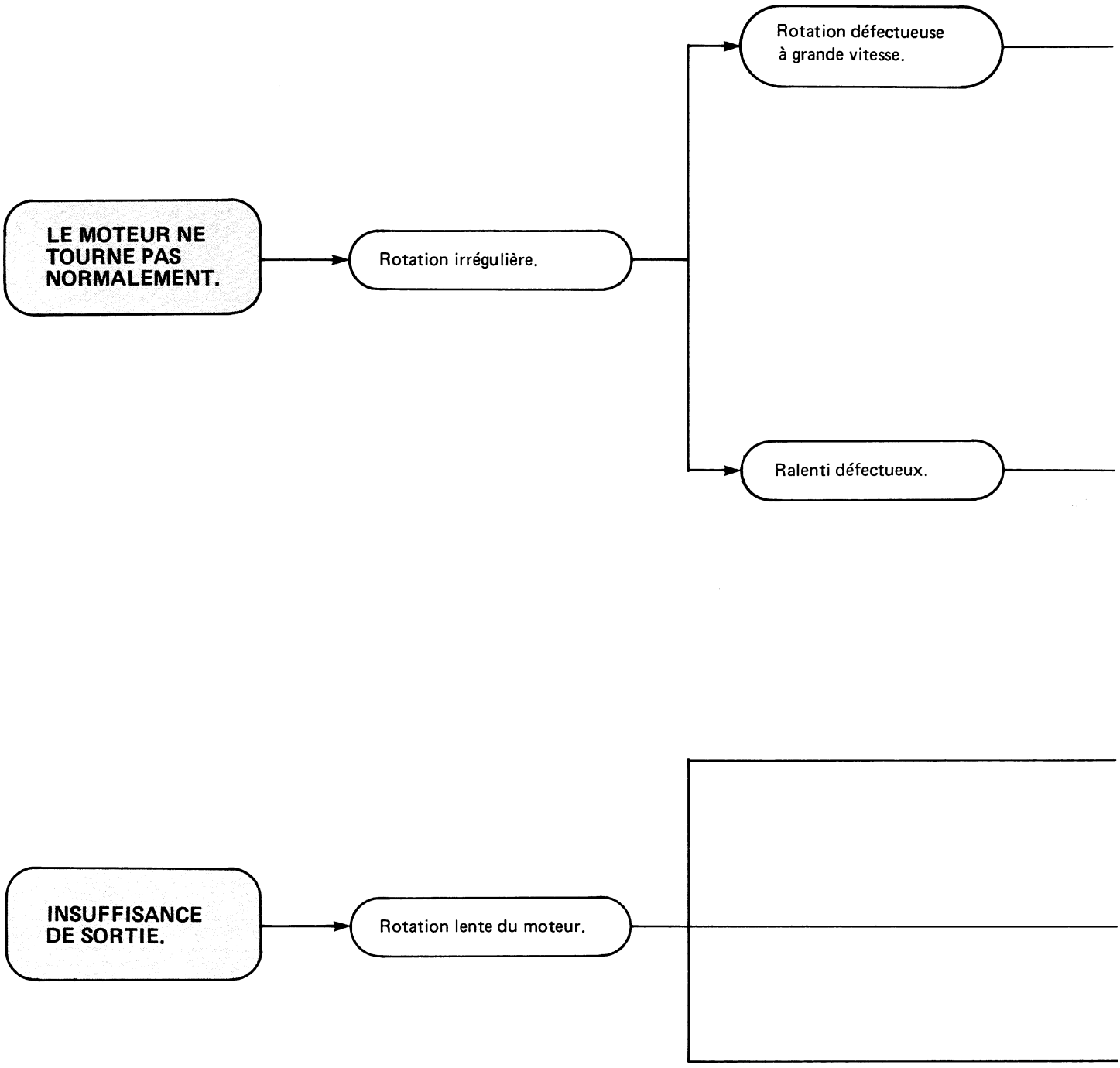

COLOR OF EXHAUST FUMES NOT NORMAL.
White or blue exhaust fumes.
Black or dark gray exhaust fumes.
EXCESSIVE LUBRICANT CONSUMPTION.
LUBRICANT INCREASING.

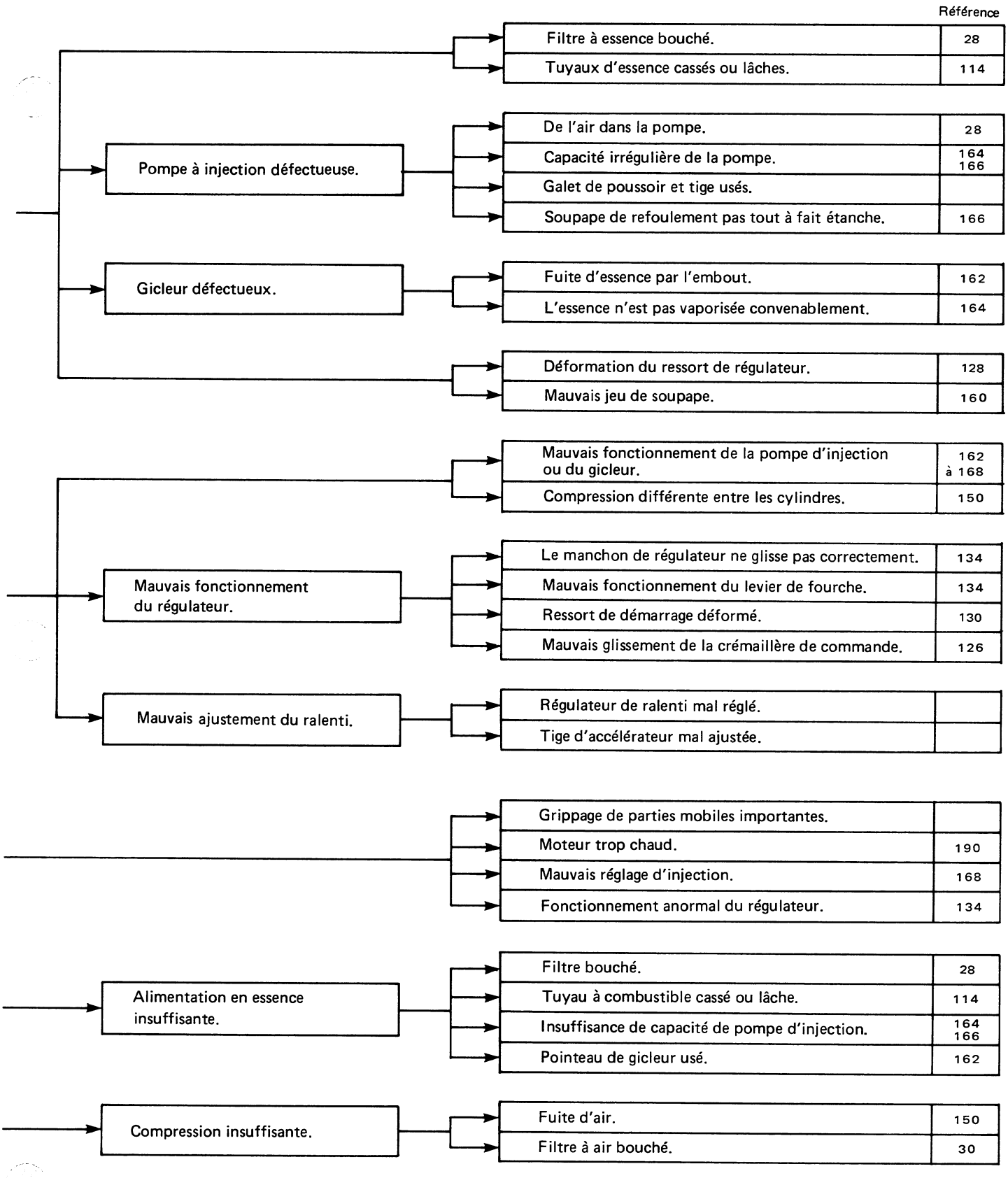

Reference
Lubricant rises through piston gap.
Piston ring stuck. 140
Piston ring worn. 180
Excessive gap between cylinder liner and piston. 186
Too much oil. 26
Injection delayed. 168
Compression pressure insufficient. 150
Injection mistimed.
Injection too early. 168
Injection delayed.
Fuel pump's injecting capacity varies.
Plunger does not return completely because spring is stuck or broken. 164 166
Plunger worn. 164
Nozzle does not inject fuel properly.
Needle valve stuck. 162
Nozzle spring broken. 162
Too much carbon sticks to nozzle tip. 164
Injection pressure too low. 162
Compressed air leaks. 150
Not enough air. 30
Excessive gap between piston and liner. 186
Piston ring stuck. 140
Piston ring worn. 180
Excessive gap between intake/exhaust valve and valve stem. 154
Valve stem seal broken. 120
Oil leaks from defective packings.
Fuel mixed with oil.
Injection pump plunger leaks much fuel. 164
Fuel pump leaks much fuel.
Water mixed with oil.
Head gasket packing faulty. 118
Crankcase cracked.
Gear oil mixed with oil.
Hydraulic pump's oil seal broken.

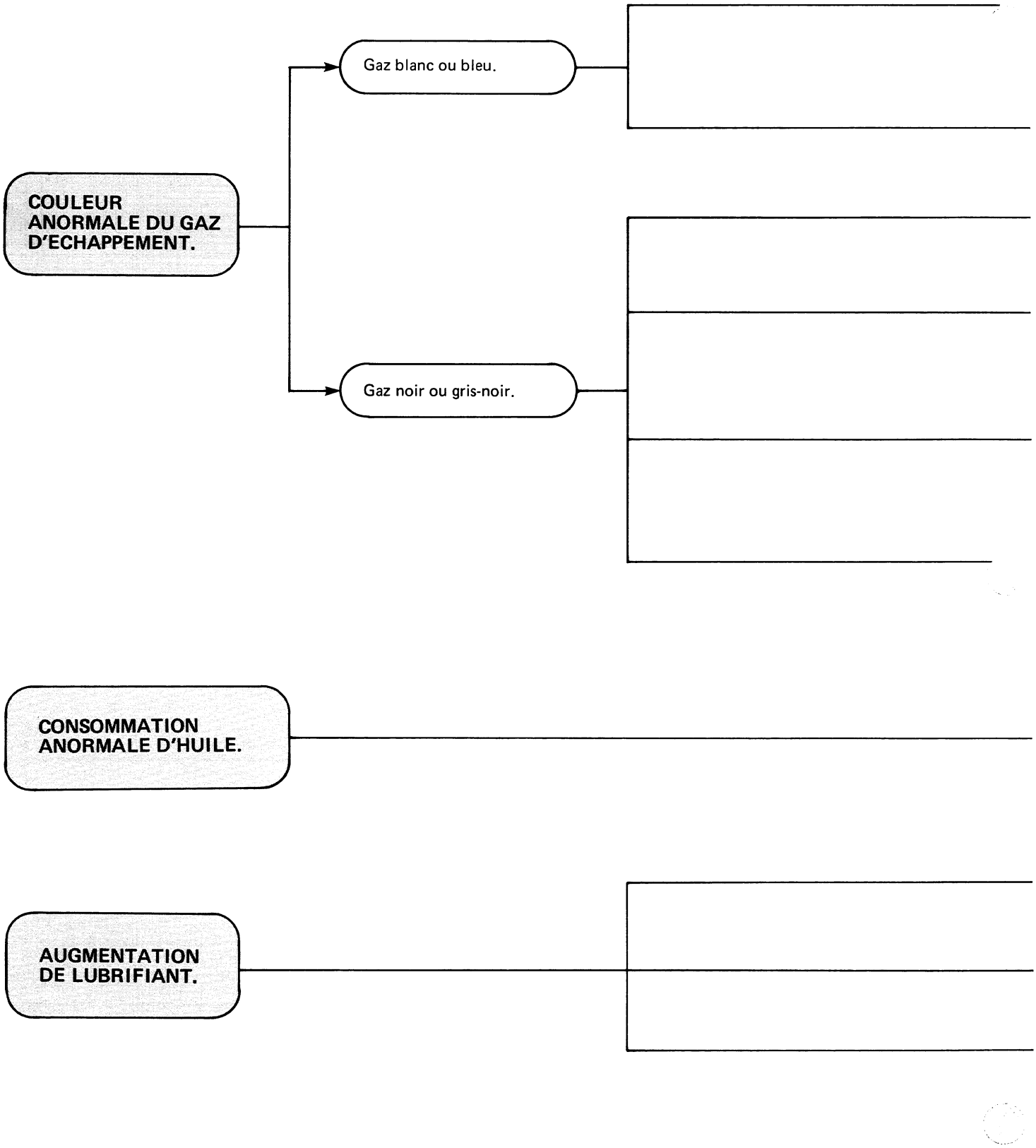
1. DEPANNAGE

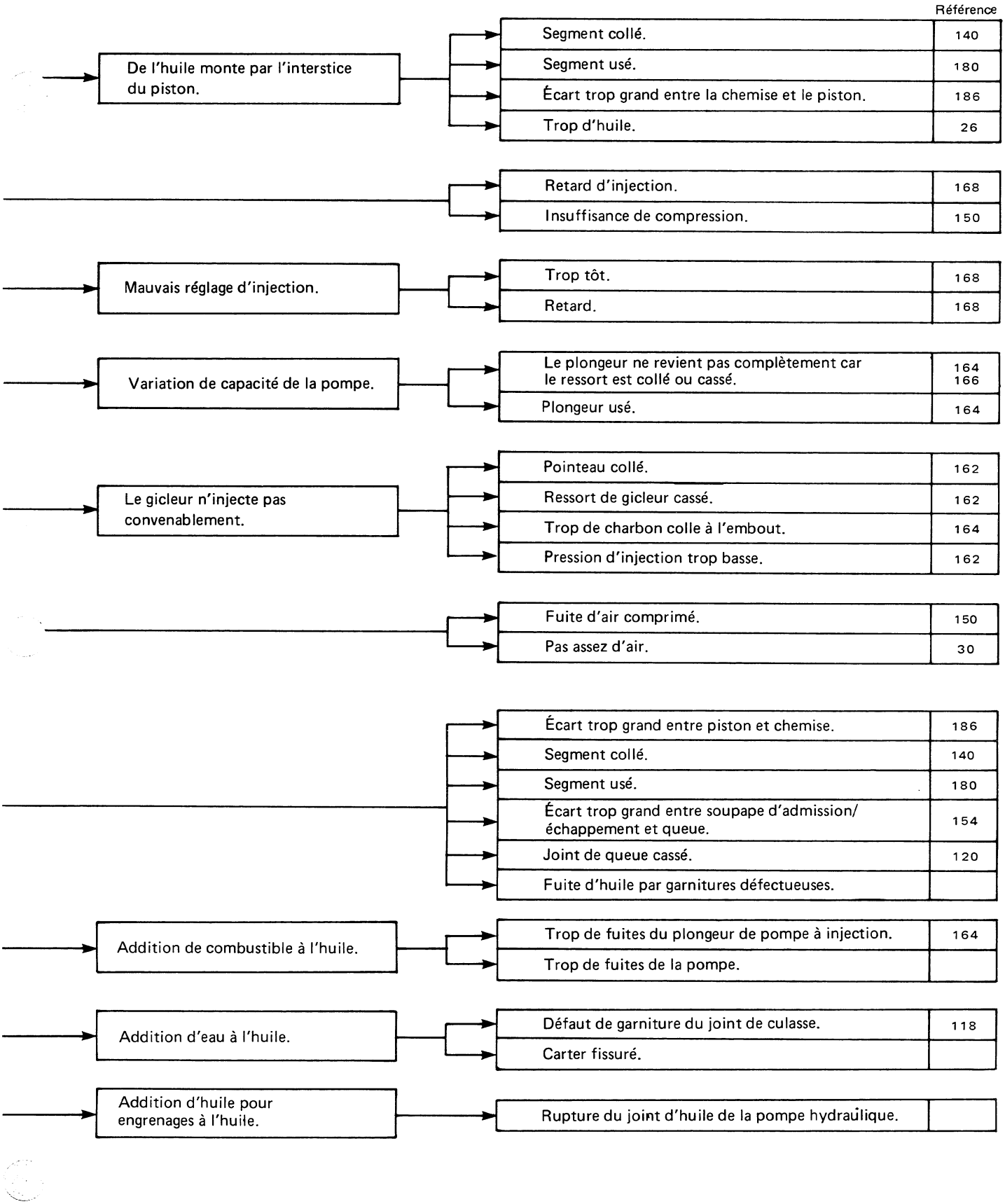

LE MOTEUR NE DEMARRE PAS.
Le vilebrequin ne tourne pas.
Le vilebrequin tourne.
Aucun ou peu de bruit d'injection d'essence.
Bruits d'injection.


Référence
Trop grande résistance des parties mobiles.
Vilebrequin et arbre à came sont grippés. 128 à 144
Piston et cylindre sont grippés. 138 à 146
Paliers pris dans l'huile. 144
Système de graissage insuffisant. 174
Démarreur défectueux. 218
Faible capacité de batterie ou cosse déserrée.
Alimention par la pompe insuffisante.
Tuyau de carburant rompu.
De l'air entre dans le tuyau par le raccord.
Filtre à air bouché. 28
Pompe à combustible défectueuse.
La pompe d'injection n'envoie pas d'essence.
Plongeur usé ou grippé. 164
Ressort de soupape de refoulement cassé. 166
Soupape de refoulement pas tout à fait étanche. 166
L'essence n'entre pas par le gicleur.
Pointeau collé. 162
Ressort de gicleur cassé. 162
Pression d'injection mal réglée. 162
Écrou de tuyau d'injection lâche. 114
Injection mal réglée.
Mauvais réglage de l'injection. 168
Fuite d'air comprimé.
Pas de contact étroit entre soupape d'admission/échappement et siège. 154
Ressort de soupape d'admission/échappement cassé. 156
Soupape d'admission/échappement grippés. 154
Joint défectueux. 118
Insuffisance du couple de serrage de tête de cylindre. 118
Segment collé. 140
Segment usé. 180
Chemise usée. 186
Insuffisance du couple de serrage du gicleur et de la bougie incandescente. 20 116
Mauvais réglage du fonctionnement de la soupape.
Trop de jeu de soupape. 160

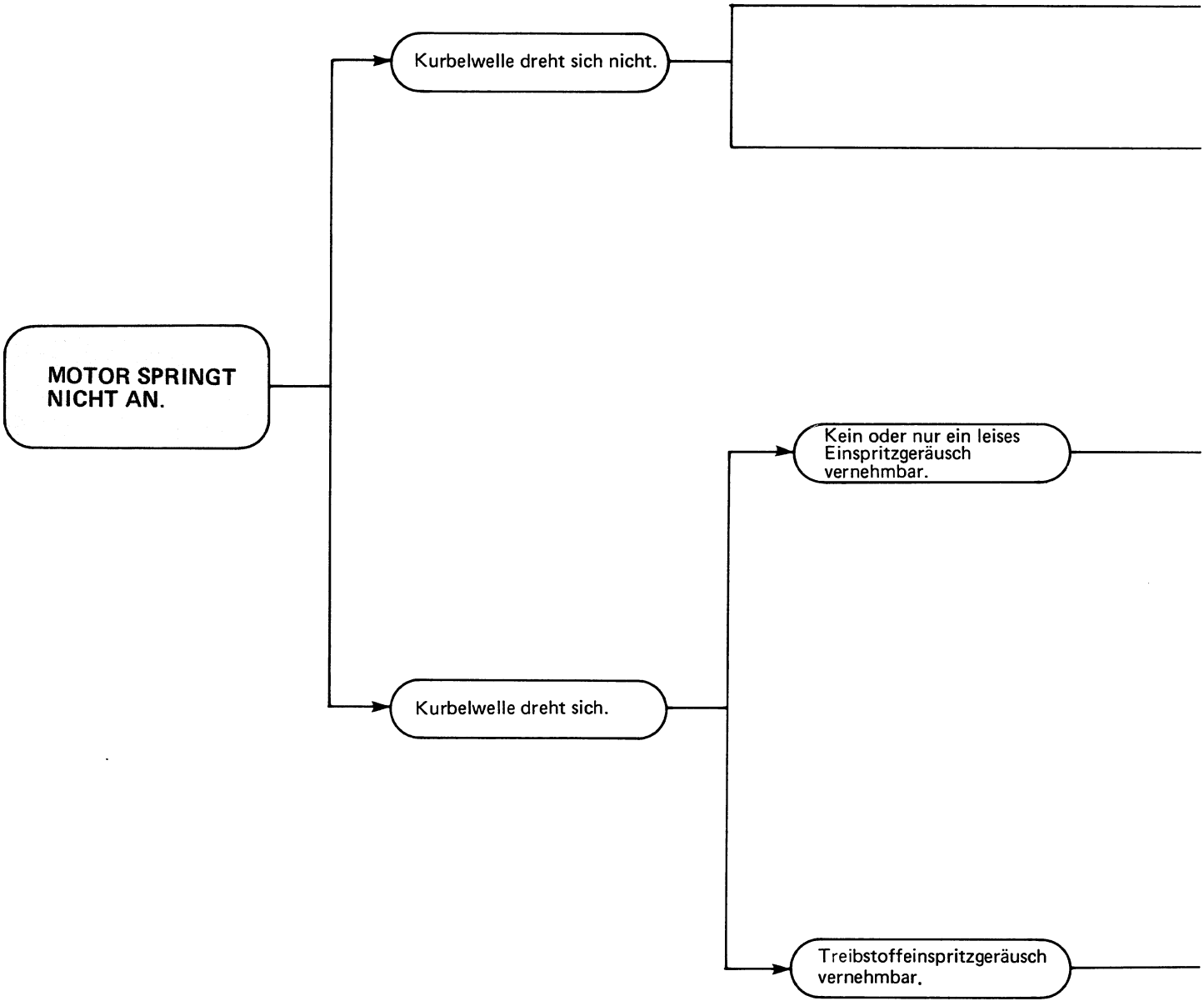

LE MOTEUR NE TOURNE PAS NORMALEMENT.
Rotation irrégulière.
Rotation défectueuse à grande vitesse.
Ralenti défectueux.
INSUFFISANCE DE SORTIE.
Rotation lente du moteur.

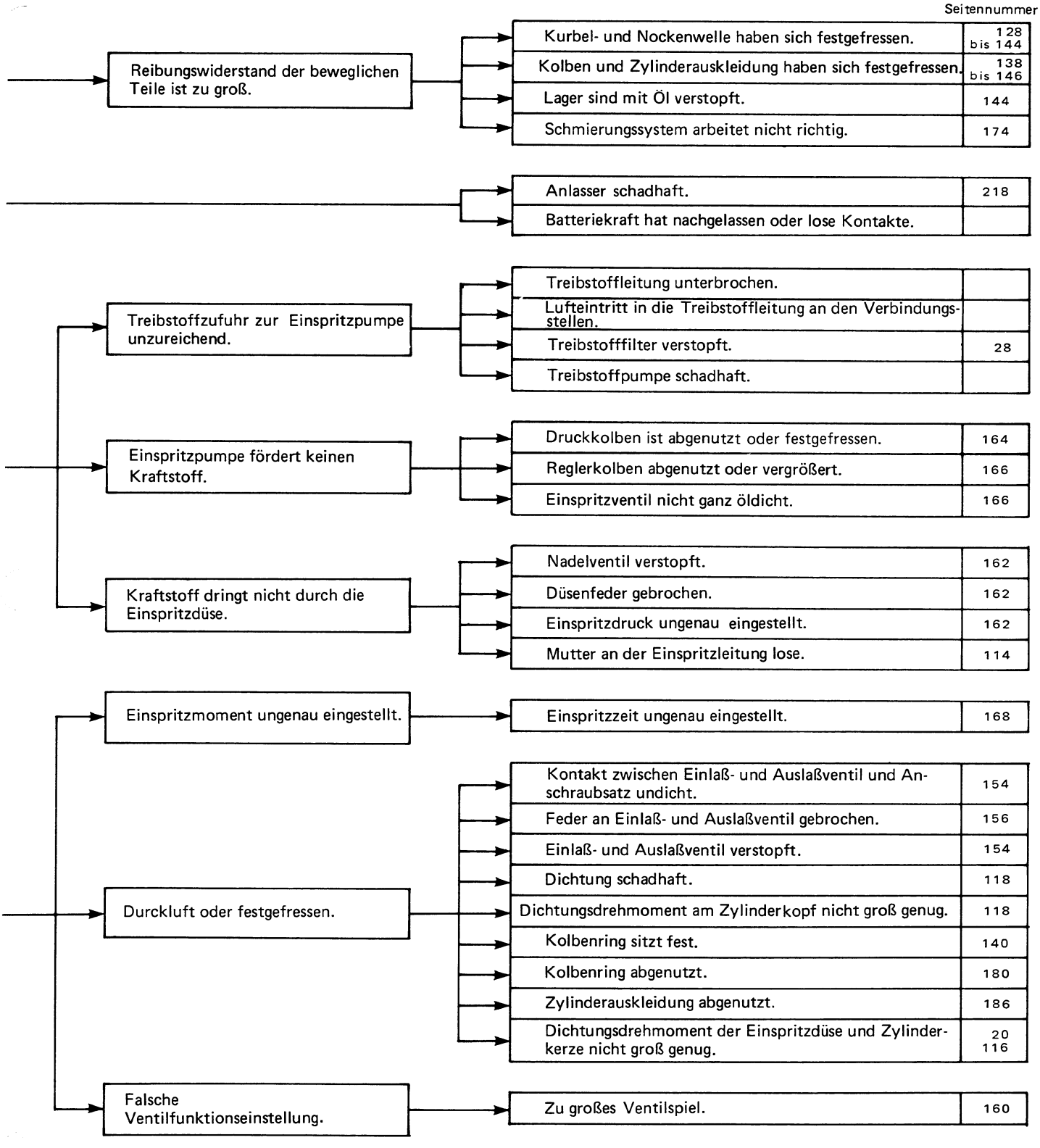

Référence
Filtre à essence bouché. 28
Tuyaux d'essence cassés ou lâches. 114
Pompe à injection défectueuse.
De l'air dans la pompe. 28
Capacité irrégulière de la pompe. 164 166
Galet de poussoir et tige usés.
Soupape de refoulement pas tout à fait étanche. 166
Gicleur défectueux.
Fuite d'essence par l'embout. 162
L'essence n'est pas vaporisée convenablement. 164
Déformation du ressort de régulateur. 128
Mauvais jeu de soupape. 160
Mauvais fonctionnement de la pompe d'injection ou du gicleur. 162 à 168
Compression différente entre les cylindres. 150
Mauvais fonctionnement du régulateur.
Le manchon de régulateur ne glisse pas correctement. 134
Mauvais fonctionnement du levier de fourche. 134
Ressort de démarrage déformé. 130
Mauvais glissement de la crémaillère de commande. 126
Mauvais ajustement du ralenti.
Régulateur de ralenti mal réglé.
Tige d'accélérateur mal ajustée.
Grippage de parties mobiles importantes.
Moteur trop chaud. 190
Mauvais réglage d'injection. 168
Fonctionnement anormal du régulateur. 134
Alimentation en essence insuffisante.
Filtre bouché. 28
Tuyau à combustible cassé ou lâche. 114
Insuffisance de capacité de pompe d'injection. 164 166
Pointeau de gicleur usé. 162
Compression insuffisante.
Fuite d'air. 150
Filtre à air bouché. 30

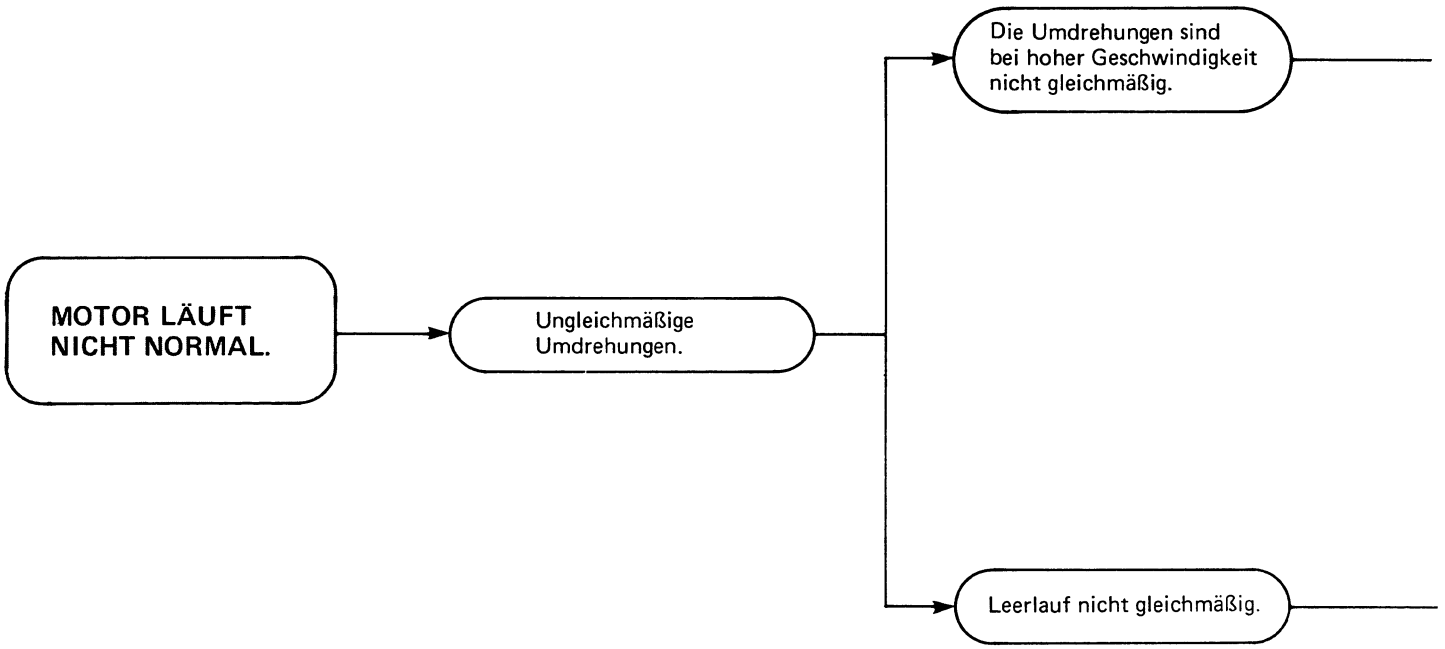

COULEUR ANORMALE DU GAZ D'ECHAPPEMENT.
Gaz blanc ou bleu.
Gaz noir ou gris-noir.
CONSOMMATION ANORMALE D'HUILE.
AUGMENTATION DE LUBRIFIANT.

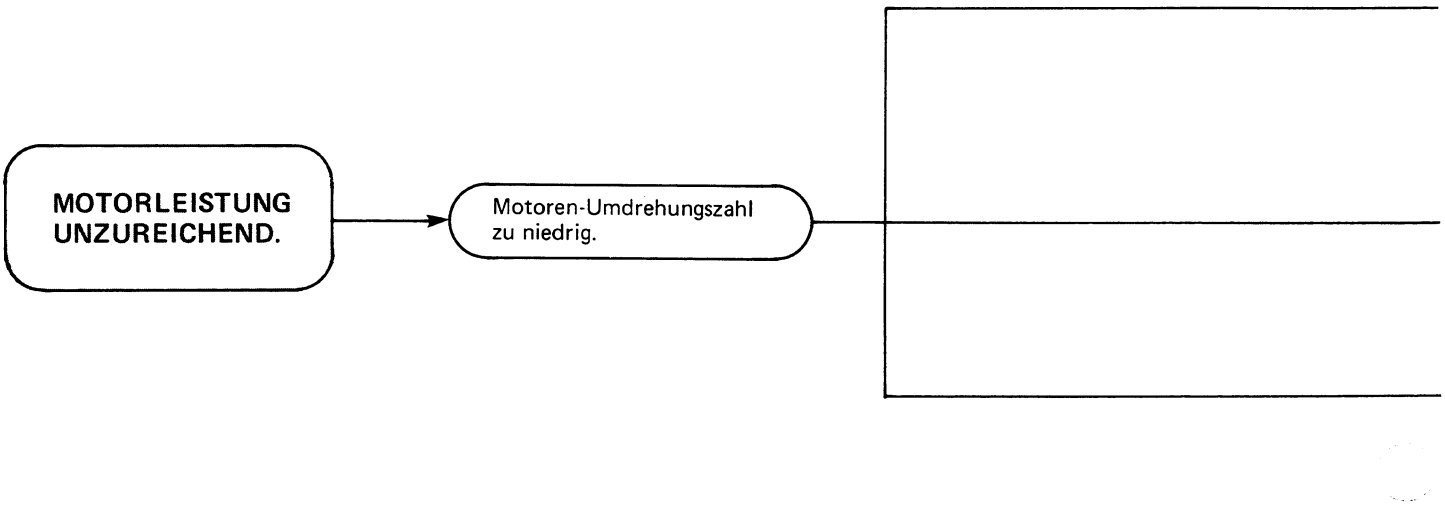

Référence
De l'huile monte par l'interstice du piston.
Segment collé. 140
Segment usé. 180
Écart trop grand entre la chemise et le piston. 186
Trop d'huile. 26
Retard d'injection. 168
Insuffisance de compression. 150
Mauvais réglage d'injection.
Trop tôt. 168
Retard. 168
Variation de capacité de la pompe.
Le plongeur ne revient pas complètement car le ressort est collé ou cassé. 164 166
Plongeur usé. 164
Le gicleur n'injecte pas convenablement.
Pointeau collé. 162
Ressort de gicleur cassé. 162
Trop de charbon colle à l'embout. 164
Pression d'injection trop basse. 162
Fuite d'air comprimé. 150
Pas assez d'air. 30
Écart trop grand entre piston et chemise. 186
Segment collé. 140
Segment usé. 180
Écart trop grand entre soupape d'admission/ échappement et queue. 154
Joint de queue cassé. 120
Fuite d'huile par garnitures défectueuses.
Addition de combustible à l'huile.
Trop de fuites du plongeur de pompe à injection. 164
Trop de fuites de la pompe.
Addition d'eau à l'huile.
Défaut de garniture du joint de culasse. 118
Carter fissuré.
Addition d'huile pour engrenages à l'huile.
Rupture du joint d'huile de la pompe hydraulique.

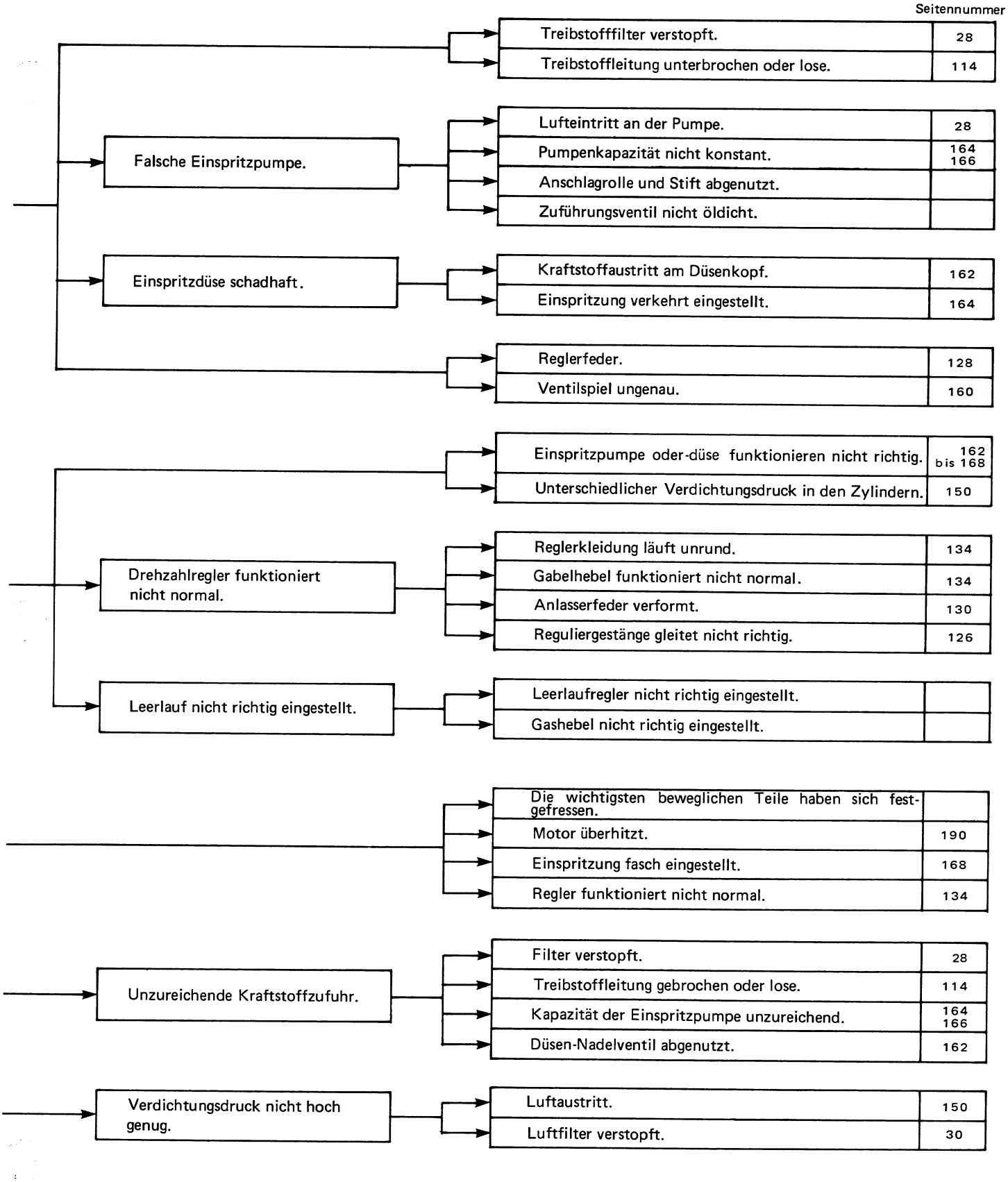
1. STÖRUNGSBESEITIGUNG

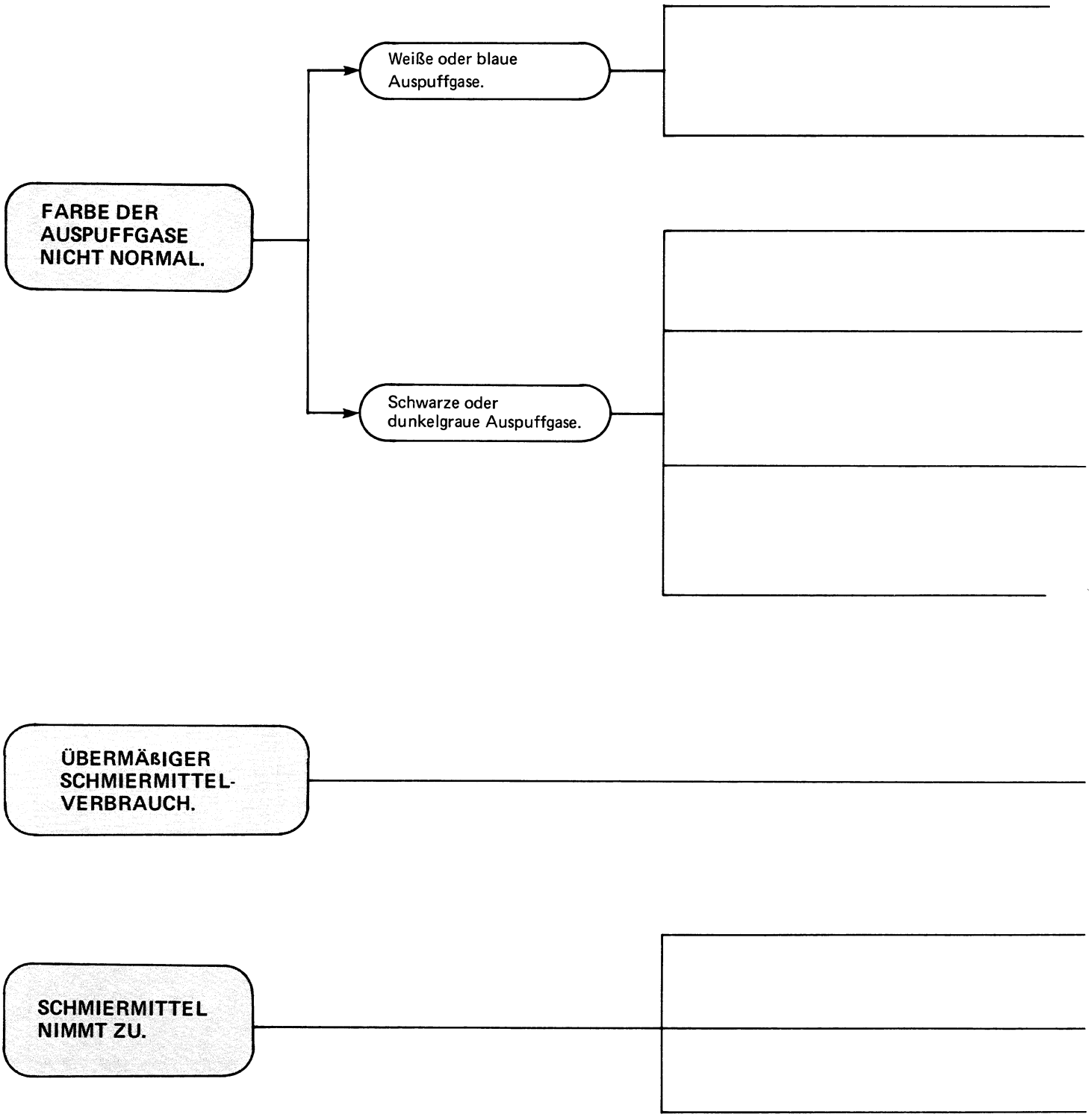


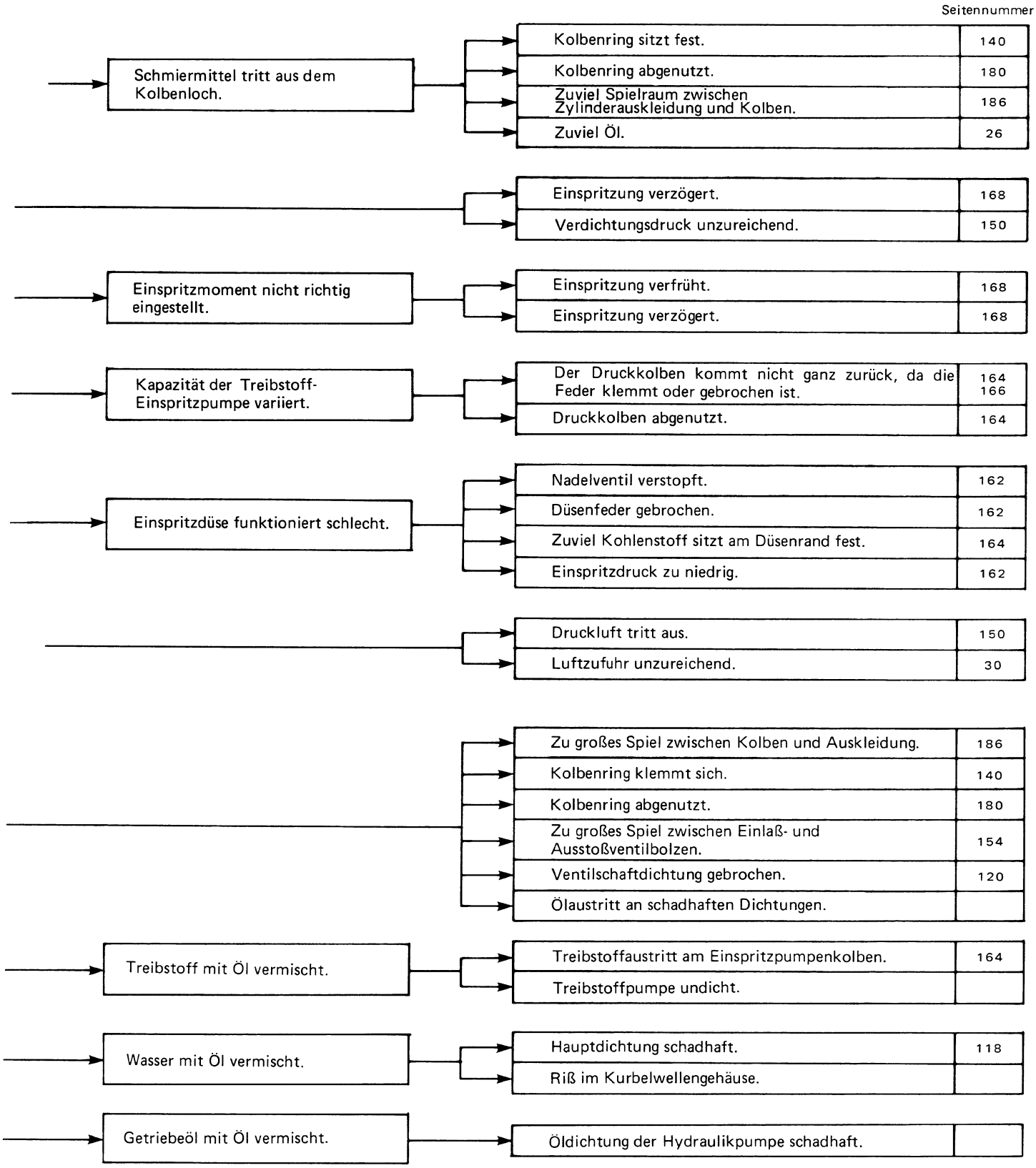

Seitennummer
Reibungswiderstand der beweglichen Teile ist zu groß.
Kurbel- und Nockenwelle haben sich festgefressen. 128 bis 144
Kolben und Zylinderauskleidung haben sich festgefressen. 138 bis 146
Lager sind mit Öl verstopft. 144
Schmierungssystem arbeitet nicht richtig. 174
Anlasser schadhaft. 218
Batteriekraft hat nachgelassen oder lose Kontakte.
Treibstoffzufuhr zur Einspritzpumpe unzureichend.
Treibstoffleitung unterbrochen.
Lufteintritt in die Treibstoffleitung an den Verbindungsstellen.
Treibstofffilter verstopft. 28
Treibstoffpumpe schadhaft.
Einspritzpumpe fördert keinen Kraftstoff.
Druckkolben ist abgenutzt oder festgefressen. 164
Reglerkolben abgenutzt oder vergrößert. 166
Einspritzventil nicht ganz öldicht. 166
Kraftstoff dringt nicht durch die Einspritzdüse.
Nadelventil verstopft. 162
Düsenfeder gebrochen. 162
Einspritzdruck ungenau eingestellt. 162
Mutter an der Einspritzleitung lose. 114
Einspritzmoment ungenau eingestellt.
Einspritzzeit ungenau eingestellt. 168
Durckluft oder festgefressen.
Kontakt zwischen Einlaß- und Auslaßventil und Anschraubsatz undicht. 154
Feder an Einlaß- und Auslaßventil gebrochen. 156
Einlaß- und Auslaßventil verstopft. 154
Dichtung schadhaft. 118
Dichtungsdrehmoment am Zylinderkopf nicht groß genug. 118
Kolbenring sitzt fest. 140
Kolbenring abgenutzt. 180
Zylinderauskleidung abgenutzt. 186
Dichtungsdrehmoment der Einspritzdüse und Zylinderkerze nicht groß genug. 20 116
Falsche Ventilfunktionseinstellung.
Zu großes Ventilspiel. 160


MOTOR LÄUFT NICHT NORMAL.
Ungleichmäßige Umdrehungen.
Die Umdrehungen sind bei hoher Geschwindigkeit nicht gleichmäßig.
Leerlauf nicht gleichmäßig.


MOTORLEISTUNG UNZUREICHEND.
Motoren-Umdrehungszahl zu niedrig.


Seitennummer
Treibstofffilter verstopft. 28
Treibstoffleitung unterbrochen oder lose. 114
Falsche Einspritzpumpe.
Lufteintritt an der Pumpe. 28
Pumpenkapazität nicht konstant. 164 166
Anschlagrolle und Stift abgenutzt.
Zuführungsventil nicht öldicht.
Einspritzdüse schadhaft.
Kraftstoffaustritt am Düsenkopf. 162
Einspritzung verkehrt eingestellt. 164
Reglerfeder. 128
Ventilspiel ungenau. 160
Einspritzpumpe oder-düse funktionieren nicht richtig. 162 bis 168
Unterschiedlicher Verdichtungsdruck in den Zylindern. 150
Drehzahlregler funktioniert nicht normal.
Reglerkleidung läuft unrund. 134
Gabelhebel funktioniert nicht normal. 134
Anlasserfeder verformt. 130
Reguliergestänge gleitet nicht richtig. 126
Leerlauf nicht richtig eingestellt.
Leerlaufregler nicht richtig eingestellt.
Gashebel nicht richtig eingestellt.
Die wichtigsten beweglichen Teile haben sich festgefressen.
Motor überhitzt. 190
Einspritzung fasch eingestellt. 168
Regler funktioniert nicht normal. 134
Unzureichende Kraftstoffzufuhr.
Filter verstopft. 28
Treibstoffleitung gebrochen oder lose. 114
Kapazität der Einspritzpumpe unzureichend. 164 166
Düsen-Nadelventil abgenutzt. 162
Verdichtungsdruck nicht hoch genug.
Luftaustritt. 150
Luftfilter verstopft. 30

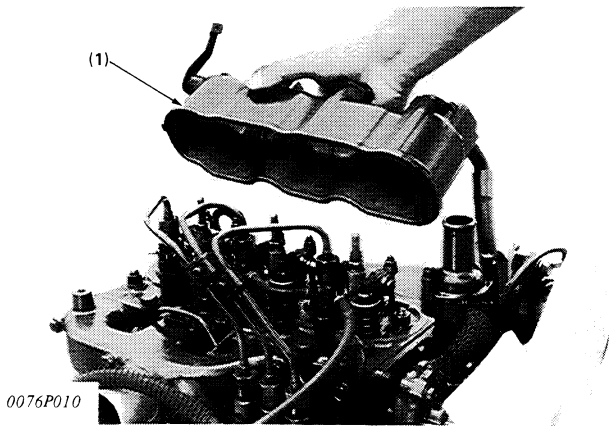

FARBE DER AUSPUFFGASE NICHT NORMAL.
Weiße oder blaue Auspuffgase.
Schwarze oder dunkelgraue Auspuffgase.
ÜBERMÄßIGER SCHMIERMITTEL-VERBRAUCH.
SCHMIERMITTEL NIMMT ZU.


Seitennummer
Schmiermittel tritt aus dem Kolbenloch.
Kolbenring sitzt fest. 140
Kolbenring abgenutzt. 180
Zuviel Spielraum zwischen Zylinderauskleidung und Kolben. 186
Zuviel Öl. 26
Einspritzung verzögert. 168
Verdichtungsdruck unzureichend. 150
Einspritzmoment nicht richtig eingestellt.
Einspritzung verfrüht. 168
Einspritzung verzögert. 168
Kapazität der Treibstoff-Einspritzpumpe variiert.
Der Druckkolben kommt nicht ganz zurück, da die Feder klemmt oder gebrochen ist. 164 166
Druckkolben abgenutzt. 164
Einspritzdüse funktioniert schlecht.
Nadelventil verstopft. 162
Düsenfeder gebrochen. 162
Zuviel Kohlenstoff sitzt am Düsenrand fest. 164
Einspritzdruck zu niedrig. 162
Druckluft tritt aus. 150
Luftzufuhr unzureichend. 30
Zu großes Spiel zwischen Kolben und Auskleidung. 186
Kolbenring klemmt sich. 140
Kolbenring abgenutzt. 180
Zu großes Spiel zwischen Einlaß- und Ausstoßventilbolzen. 154
Ventilschaftdichtung gebrochen. 120
Ölaustritt an schadhaften Dichtungen.
Treibstoff mit Öl vermischt.
Treibstoffaustritt am Einspritzpumpenkolben. 164
Treibstoffpumpe undicht.
Wasser mit Öl vermischt.
Hauptdichtung schadhaft. 118
Riß im Kurbelwellengehäuse.
Getriebeöl mit Öl vermischt.
Öldichtung der Hydraulikpumpe schadhaft.

2. DIASSEMBLY AND REASSEMBLY

■ **ATTENTION:** When reassembling, replace all the O-rings and gaskets by new ones.

CYLINDER HEAD

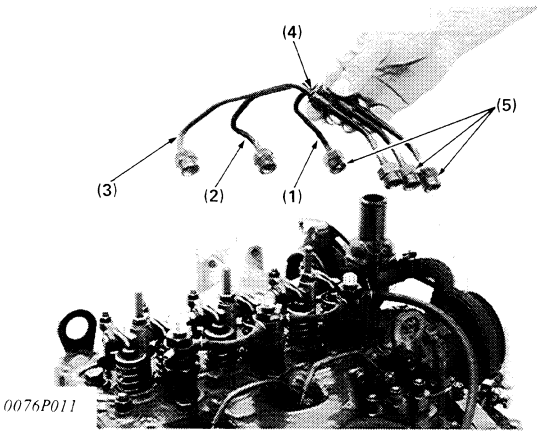


❶ Removing Head Cover

1) Remove the head cover nuts.
2) Remove the head cover.

(Note for reassembling)
- **Check to see if the head cover gasket is not defective.**
- **To prevent valve stem seizure, apply enough engine oil to the valve guide and valve stem.**

(1) Head cover



❷ Removing Injection Pipes 1, 2 and 3

1) Loosen the screws on the pipe clamps.
2) Detach the injection pipes in the order of 1, 2 and 3.

(Note for reassembling)
- **Send compressed air into the pipes to blow out dust. Then, reassemble the pipes in the reverse order.**
- **Tighten the retaining nuts to 15 to 25 Nm (1.5 to 2.5 kgf·m, 11 to 18 ft-lbs).**

(1) Injection pipe 1
(2) Injection pipe 2
(3) Injection pipe 3
(4) Pipe clamp
(5) Retaining nuts

2. DEMONTAGE ET REMONTAGE

■ **ATTENTION:** Au moment du remontage, remplacer par des neufs tous les joints toriques et le joint.

CULASSE

❶ Retrait du capot

1) Retirer les écrous du capot.
2) Retirer le capot.

(Remarques pour le remontage)
- **Vérifier que le joint de culasse n'est pas défectueux.**
- **Pour éviter le grippage des tiges de soupapes, appliquer une bonne quantité d'huile moteur au guide de soupape et aux tiges.**

(1) Capot

❷ Retrait des tuyaux d'injection 1, 2 et 3

1) Desserrer les vis du collier de tuyau.
2) Détacher les tuyaux dans cet ordre: 1, 2 et 3.

(Remarques pour le remontage)
- **Envoyer de l'air comprimé dans les tuyaux pour les débarrasser de leur poussière. Puis les remettre dans l'ordre inverse du démontage.**
- **Serrer les écrous de fixation de 15 à 25 Nm (1,5 à 2,5 kgf·m)**

(1) Tuyau d'injection 1
(2) Tuyau d'injection 2
(3) Tuyau d'injection 3
(4) Collier
(5) Ecrous de fixation

2. ZERLEGEN UND ZUSAMMENSETZEN

■ **ACHTUNG:** Beim Zusammensetzen müssen alle O-Ringe und Dichtungen durch neue ersetzt werden.

ZYLINDERKOPF

❶ Entfernen der Kopfabdeckung

1) Die Muttern der Kopfabdeckung entfernen.
2) Die Kopfabdeckung abnehmen.

(Anmerkung für das Zusammensetzen)
- **Überprüfen, ob die Kopfabdeckungsdichtung nicht defekt ist.**
- **Um das Festkleben der Ventilstäbe zu verhindern, die Ventilführungen und Ventilstäbe entsprechend einölen.**

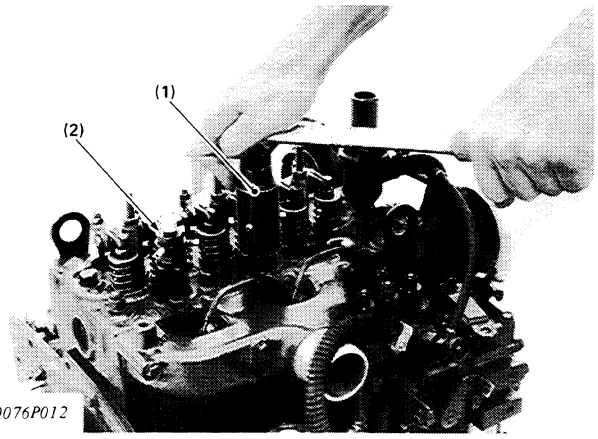
(1) Kopfabdeckung

❷ Entfernen der Einspritzrohre 1, 2 und 3

1) Die Schrauben der Rohrklammer lösen.
2) Die Einspritzrohre in der Reihenfolge von 1, 2 und 3 entfernen.

(Anmerkung für das Zusammensetzen)
- **Die Rohre mit Druckluft ausblasen, um Staub und andere Fremdstoffe zu entfernen.**
  Die Rohre dann in der umgekehrten Reihenfolge der Abnahme wieder an den entsprechenden Stellen anbringen.
- **Die Befestigungsmuttern auf Festziehwerte von 15 bis 25 Nm (1,5 bis 2,5 kp·m) festziehen.**

(1) Einspritzrohr 1
(2) Einspritzrohr 2
(3) Einspritzrohr 3
(4) Rohrklammer
(5) Halterungsmuttern



❸ Removing Nozzle Holder Assemblies

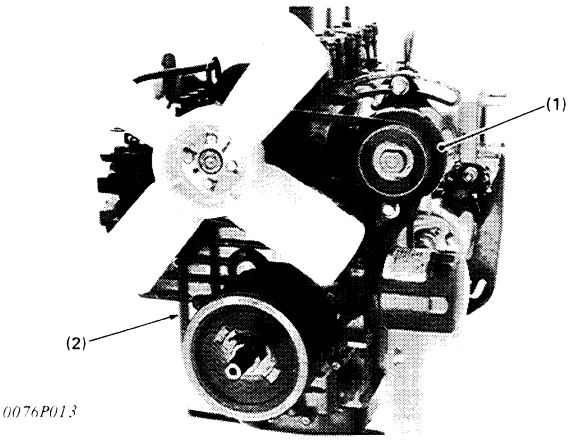
1) Remove the pipe clips holding the fuel overflow pipes, and detach the pipes.
2) Detach the nozzle holders using a 27mm (1.0630 in.) nozzle holder socket wrench, after loosening the rock nuts.
3) Detach the copper gaskets on the seats on which the nozzles are to be installed.

(Note for reassembling)

- **Return the nozzle holders after confirming that there are no metallic particles or foreign matter on the surface on which the nozzles are to be installed.**
- **Tighten the nozzles to 29 to 49 Nm (3.0 to 5.0 kgf·m, 22 to 36 ft-lbs).**

SPECIAL TOOL:
Nozzle holder socket wrench (Code No. 07916-30841)

(1) Nozzle holder socket wrench
(2) Rock nut



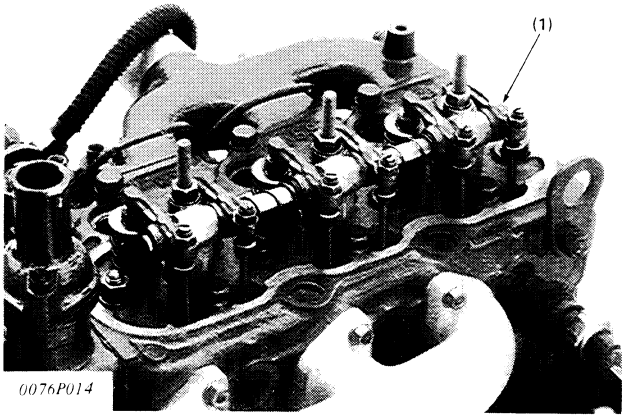
❹ Removing AC dynamo and Fan Belt

1) Remove the AC dynamo.
2) Detach the fan belt.

(Note for reassembling)

- **Check to see if the V-belt is placed in a correct position (where letters on the belt can be read from your side), and there is no oil or grease on the belt.**
- **Fan belt tension:**
  The belt should deflect approx. 7 mm (0.28 in.) when the center of the belt is depressed with a finger pressure of 58.8 to 68.6 N (6 to 7 kgf, 13.2 to 15.4lbs).

(1) AC dynamo
(2) Fan belt



❺ Removing Rocker Arm

1) Remove the set nuts for the rocker arm brackets.
2) Detach the whole rocker arm.

(Note for reassembling)

- **Always adjust the valve clearance.**
- **Before installing the rocker arm bracket, check to see if there are any metallic particles on the surface on which the assembly is mounted.**
- **Tighten the bolts to 17 to 21 Nm (1.7 to 2.1 kgf·m, 12 to 15 ft-lbs).**

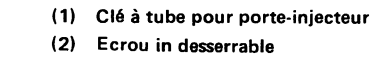
(1) Rocker arm

❸ Retrait de l'ensemble porte-injecteur

1) Retirer la bride du tuyau de trop-plein de combustible et détacher le tuyau.
2) Détacher le porte-injecteur avec une clé à tube de 27 mm, après avoir desserré les écrous indesserrables.
3) Détacher les joints de cuivre des sièges sur lequels les injecteurs doivent être fixés.

(Remarques pour le remontage)
- **Remettre les portes-injecteur après avoir vérifié qu'aucune particule métallique, qu'aucune matière étrangère n'est sur la surface devant recevoir l'injecteur.**
- **Serrer l'injecteur de 29 à 49 Nm (3,0 à 5,0 kgf·m)**

OUTIL SPECIAL:
Clé à tube pour porte-injecteur (N° de code: 07916-30841)

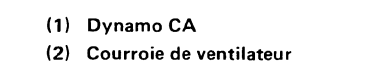


(1) Clé à tube pour porte-injecteur
(2) Ecrou in desserrable

❹ Retrait de la dynamo CA et de la courroie de ventilateur

1) Retirer la dynamo.
2) Retirer la courroie.

(Remarques pour le remontage)
- **Vérifier que la courroie en V est dans une position correcte (où les lettres y figurant sont lisibles de votre côté) et qu'elle ne porte ni huile ni graisse.**
- **Tension de la courroie:**
  La courroie doit avoir une flèche d'environ 7 mm quand le doigt est appuyé sur son centre avec une force de 58,8 à 68,6 N (6 à 7 kgf).



(1) Dynamo CA
(2) Courroie de ventilateur

❺ Retrait du culbuteur

1) Retirer les écrous fixant les paliers de culbuteur.
2) Détacher tout le culbuteur.

(Remarques pour le remontage)
- **Ajuster le jeu de soupapes.**
- **Avant de remonter le palier de culbuteur, vérifier qu'il n'y a aucune particule métallique sur la surface devant recevoir l'ensemble.**
- **Serrer les boulons à 17 à 21 Nm (1,7 à 2,1 kgf·m).**



(1) Culbuteur

❸ Entfernen der Düsenhaltereinheiten

1) Die Rohrklammern, die die Treibstoffüberflußrohre befestigt halten, entfernen, und die Rohre ebenfalls entfernen.
2) Nach dem Lösen der Muttern die Düsenhaltereinheiten unter Verwendung eines 27 mm Düsenhaltersokkelschlüssels entfernen.
3) Die Kupferdichtungen auf den Einsetzsitzen der Düsen entfernen.

(Anmerkungen für das Zusammensetzen)
- **Nach Überprüfung, daß keine Metallpartikel oder andere Fremdstoffe an den Sitzflächen der Düsen vorhanden sind, die Düseneinheiten einsetzen.**
- **Die Düsen auf 29 bis 49 Nm (3,0 bis 5,0 kp·m) festziehen.**

SPEZIALWERKZEUGE:
Düsenhaltersockelschlüssel (Kodenummer 07916-30841)



(1) Düsenhaltersockelschlüssel
(2) Mutter

❹ Entfernen des Wechselstromdynamos und Ventilatorriemens

1) Den Wechselstromdynamo entfernen.
2) Den Ventilatorriemen abnehmen.

(Anmerkung für das Zusammensetzen)
- **Überprüfen, ob der V-Riemen in der richtigen Position aufgesetzt wurde (die Beschriftung des Riemens muß von außen sichtbar sein), und nicht mit Öl oder Fett verschmiert ist.**
- **Ventilatorriemenspannung:**
  Beim Drücken des aufgesetzten Riemens mit dem Finger bei einer Druckanwendung von 58,8 bis 68,6 N (6 bis 7 kp) sollte eine Abweichung von ungefähr 7 mm erzielt werden.



(1) Wechselstromdynamo
(2) Ventilatorriemen

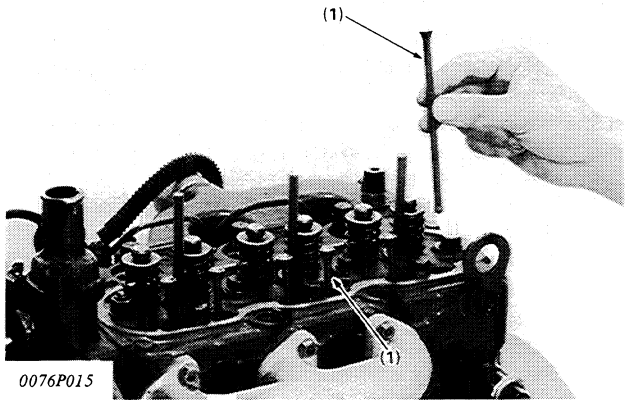
❺ Entfernen des Kipparms

1) Die Stellmuttern für das Kipparmmontagestück entfernen.
2) Den gesamten Kipparm entfernen.

(Anmerkung für das Zusammensetzen)
- **Unbedingt immer den Ventilabstand einstellen.**
- **Vor dem Einsetzen des Kipparmmontagestücks überprüfen, daß keine Metallpartikel oder andere Fremdstoffe auf der Aufsatzstelle vorhanden sind.**
- **Die Befestigungsbolzen auf 17 bis 21 Nm (1,7 bis 2,1 kp·m) festziehen.**



(1) Kipphebel



0076P015

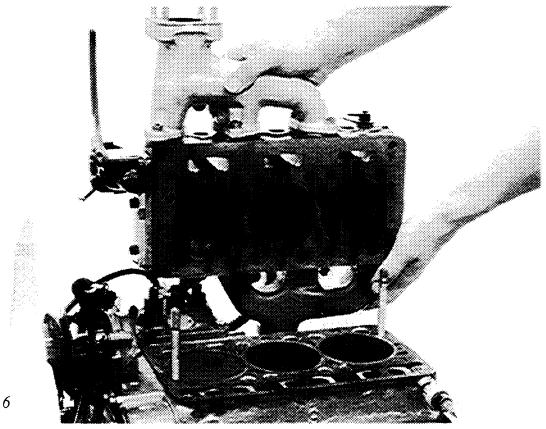
6 Removing Push-rods

1) Remove the six push-rods.

(Note for reassembling)

- **Before inserting the push rods into the tappets, check to see if their ends are properly engaged with the grooves. If a push rod is roughly inserted, it may hit the shoulder of the tappet and be damaged.**

(1) Push-rod


0076P016

7 Removing Cylinder Heads

1) Remove the twelve cylinder head set bolts and two nuts.
2) Lift up the cylinder head to detach.

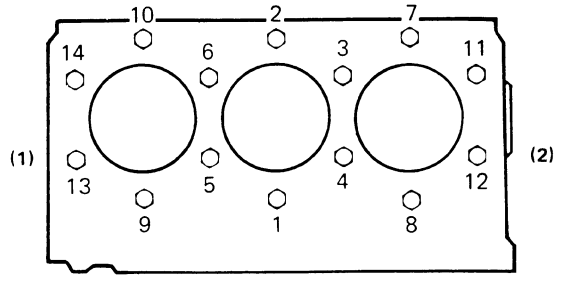
(Note for reassembling)

- **Tighten the bolts and nuts after applying sufficient oil.**
- **Tighten the bolts and nuts in diagonal sequence starting from the center. Tighten them uniformly, or the head may deform in the long run.**

(Important)

- **When overhauling the engine, replace the gasket with a new one without confusing its front and back.**
  Retighten the cylinder head after running the engine for 30 minutes.
- **Tighten the cylinder head bolts and nuts to:**

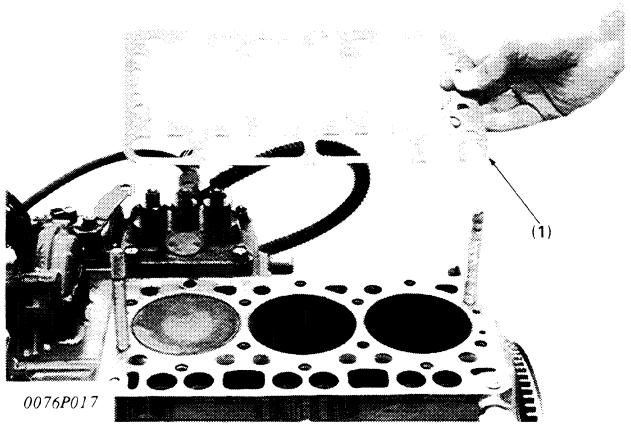
[A] Cylinder head tightening steps



0011F024

D650-B, D750-B	39.2 to 44.1 Nm (4.0 to 4.5 kgf·m / 28.9 to 32.5 ft-lbs)
D850-B, DH850-B, D950-B	64.7 to 69.6 Nm (6.6 to 7.1 kgf·m / 47.7 to 51.3 ft-lbs)

(1) Gear case side
(2) Flywheel side



0076P017

8 Removing Cylinder Head Gasket

1) Detach the cylinder head gasket, being careful not to scratch it.

(Note for reassembling)

- **Before installing the gasket, check to see there is no foreign matter on the cylinder head and the cylinder.**

(1) Cylinder head gasket

⑥ Retrait des tiges-poussoirs

1) Retirer les 6 tiges-poussoirs.

(Remarques pour le remontage)
- **Avant de réintroduire les tiges-poussoirs, vérifier qu'elles sont correctement engagées dans les gorges. Sinon, elles risquent d'être endommagées en heurtant l'embase du poussoir.**

(1) Tige-poussoir

⑦ Retrait de la culasse

1) Retirer les 12 boulons maintenant la culasse et les 2 écrous.
2) Soulever la culasse pour la détacher.

(Remarques pour le remontage)
- **Appliquer une bonne quantité d'huile avant de serrer les boulons et écrous (important).**
- **Serrer boulons et écrous dans l'ordre en partant du centre. Les serrer de façon égale pour éviter que leur tête ne se déforme à la longue.**

(Important)
- **Lors de la révision du moteur, remplacer le joint par un neuf en respectant son orientation. Resserrer la culasse après avoir fait tourner le moteur 30 minutes.**
- **Serrer boulons et écrous comme suit:**

D650-B, D750-B	39,2 à 44,1 Nm (4,0 à 4,5 kgf·m)
D850-B, DH850-B, D950-B	64,7 à 69,6 Nm (6,6 à 7,1 kgf·m)

[A] Ordre de serrage
(1) Côté engrenage
(2) Côté volant

⑧ Retrait du joint de culasse

1) Détacher le joint en veillant à ne pas le griffer.

(Remarques pour le remontage)
- **Avant de replacer le joint, vérifier qu'aucune matière étrangère ne souille la culasse et le cylindre.**

(1) Joint de culasse

⑥ Entfernen der Druckstäbe

1) Die sechs Druckstäbe entfernen.

(Anmerkung für das Zusammensetzen)
- **Vor dem Einsetzen der Druckstäbe in die Nocken überprüfen, ob deren Enden richtig mit den Rillen verbunden sind. Falls ein Druckstab nur ungenau eingesetzt worden ist, könnte er die Nockenschulter streifen und dadurch beschädigt werden.**

(1) Druckstäbe

⑦ Entfernen des Zylinderkopfes

1) Die zwölf Zylinderkopfstellschrauben und die beiden Muttern entfernen.
2) Den Zylinderkopf zum Entfernen anheben.

(Anmerkung für das Zusammensetzen)
- **Die Bolzen (Schrauben) und Muttern nach entsprechender Einölung festziehen.**
- **Die Bolzen und Muttern in diagonaler Reihenfolge von der Mitte beginnend, festziehen. Diese Bolzen und Schrauben müssen gleichmäßig festgezogen werden, da sich der Kopf auf längere Sicht verziehen kann.**

(Wichtig)
- **Beim Überholen des Motors muß die Dichtung durch eine neue ersetzt werden, ohne daß dabei die Vorder- und Rückseiten verwechselt werden.**
  Nach einem Probelauf von 30 Minuten, den Zylinderkopf entsprechend nachziehen.
- **Die Zylinderkopfbolzen und-Muttern auf folgende Werte festziehen.**

D650-B, D750-B	39,2 bis 44,1 Nm (4,0 bis 4,5 kp·m)
D850-B, DH850-B, D950-B	64,7 bis 69,6 Nm (6,6 bis 7,1 kp·m)

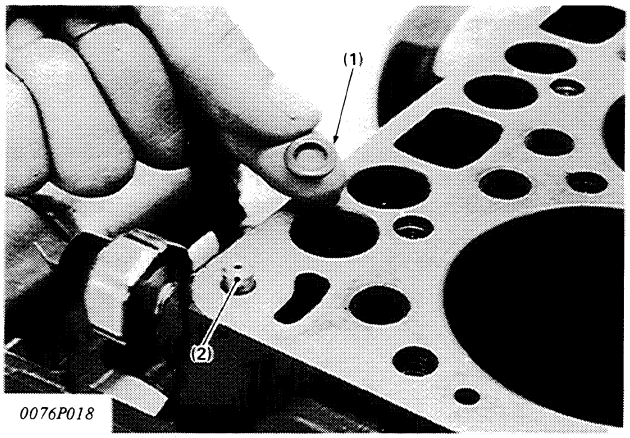
[A] Festziehschritte für den Zylinderkopf
(1) Getriebekastenseite
(2) Schwungscheibenseite

⑧ Entfernen der Zylinderkopfdichtung

1) Die Zylinderkopfdichtung vorsichtig abnehmen, um diese nicht zu verkratzen.

(Anmerkung für das Zusammensetzen)
- **Vor dem Einsetzen der Dichtung überprüfen, daß keine Fremdstoffe auf den Zylinderkopf und den Zylinder gelangt sind.**

(1) Zylinderkopfdichtung

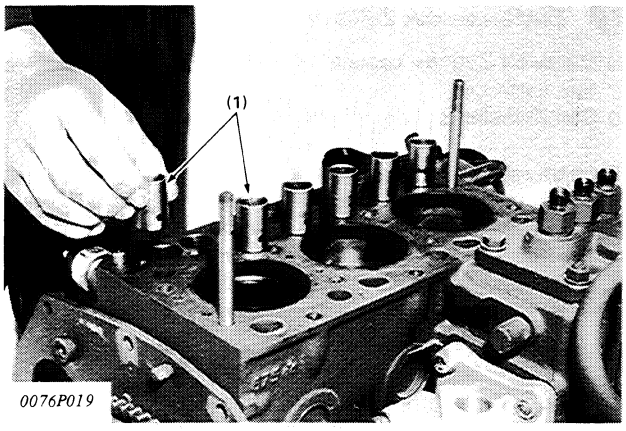


0076P018

⑨ Removing O-ring

1) Remove the O-ring from the periphery of the oil pipe on the crankcase.

(1) O-ring
(2) Pipe pin



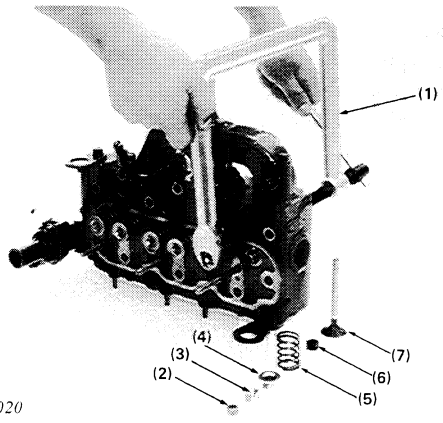
0076P019

⑩ Removing Tappets

1) Remove the six tappets from the crankcase.

(Note for reassembling)
- **Visually check the contact between tappets and cams for proper rotation. If a defect is found, replace tappets.**
- **Before installing the tappets, apply engine oil thinly around them.**

(1) Tappets



0076P020

⑪ Removing Valves

1) Remove the valve caps.
2) Remove the valve spring collet, pushing the valve spring retainer by valve spring replacer.
3) Remove the valve spring retainer, valve spring and valve stem seal.
4) Remove the valve.

(Important)
- **Don't change the combination of valve and valve guide.**

(1) Valve spring replacer
(2) Valve cap
(3) Valve spring collet
(4) Valve spring retainer
(5) Valve spring
(6) Valve stem seal
(7) Valve

⑨ Retrait du joint torique

1) Retirer le joint torique entourant le tuyau d'huile du carter.

(1) Joint torique
(2) Goupille de tube

⑩ Retrait des poussoirs

1) Retirer les 6 poussoirs du carter.

(Remarques pour le remontage)

- **Examiner le contact entre poussoirs et cames, pour avoir une bonne rotation. Si l'on trouve un défaut, remplacer les poussoirs.**
- **Avant de les replacer, leur appliquer une fine couche d'huile moteur.**

(1) Poussoirs

⑪ Retrait des soupapes

1) Retirer le capuchon de soupape.
2) Retirer la cuvette de ressort de soupape, en poussant l'étrier de ressort avec le remplaceur de ressort.
3) Retirer l'étrier, le ressort et le joint de tige de soupape.
4) Retirer la soupape.

(Important)

- **Ne pas changer les couples ressort-joint de tige.**

(1) Ressort de rechange
(2) Capuchon de soupape
(3) Cuvette de ressort
(4) Étrier de ressort
(5) Ressort
(6) Joint de tige
(7) Soupape

⑨ Entfernen der O-Ringe

1) Den O-Ring vom Außenumfang des Ölrohrs und des Kurbelgehäuses abnehmen.

(1) O-Ring
(2) Rohrstift

⑩ Entfernen der Nocken

1) Die sechs Nocken vom Kurbelgehäuse entfernen.

(Anmerkung für das Zusammensetzen)

- **Den Kontakt zwischen den Nocken und Nockenstangen durch Sichtprüfung auf richtige Drehung überprüfen. Falls ein Defekt gefunden werden sollte, die Nocke auswechseln.**
- **Vor dem Einsetzen der Nocken, um diese einen dünnen Motorenölfilm auftragen.**

(1) Nocken

⑪ Entfernen der Ventile

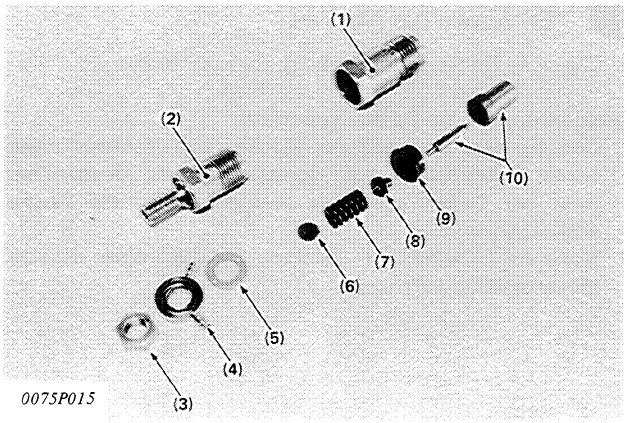
1) Die Ventilkappe entfernen.
2) Die Ventilspiralenmanchette durch Drücken des Ventilspiralenhalters mit einem Ventilspiralenentferner entsprechend entfernen.
3) Die Ventilspiralenhalterung, Ventilspirale und Ventilstababdichtung entfernen.
4) Das Ventil entfernen.

(Wichtig)

- **Nicht die Kombination des Ventils mit der Ventilführung verändern.**

(1) Ventilspiralenentferner
(2) Ventilkappe
(3) Ventilspiralenmanchette
(4) Ventilspiralenhalterung
(5) Ventilspirale
(6) Ventilstababdichtung
(7) Ventil

NOZZLE HOLDER



0075P015

❶ Disassembling Nozzle Holder

1) Secure the retaining nut with a vise.
2) Remove the nut, the eye joint and the plain washer.
3) Remove the nozzle holder body and take out parts inside.

(Note for reassembling)

- **When disassembling and reassembling the nozzle piece, dip it in clean fuel.**
- **Install the push rod, noting its direction (upside down).**
- **Tighten the retaining nut to 58.8 to 78.4 Nm (6 to 8 kgf·m, 43.4 to 57.8 ft-lbs).**
- **Do not tighten it too much, or the needle valve will not slide easily and the injection performance will be decreased.**

(1)	Retaining nut	(6)	Adjusting washer
(2)	Nozzle holder body	(7)	Nozzle spring
(3)	Nut	(8)	Push rod
(4)	Eye joint	(9)	Distance piece
(5)	Plain washer	(10)	Nozzle piece

PORTE-GICLEUR

❶ Démontage du porte-gicleur

1) Fixer l'écrou de retenue dans un étau.
2) Retirer l'écrou, le joint à pitons et la rondelle plate.
3) Retirer le corps du porte-gicleur, en retirer les éléments.

(Remarques pour le remontage)

- **Au démontage et au remontage, tremper le porte-gicleur dans de l'essence propre.**
- **Au remontage, veiller à ce que la tige ne soit pas placée à l'envers.**
- **Serrer l'écrou de retenue à 58,8 à 78,4 Nm (6 à 8 kgf·m).**
- **Ne pas serrer outre mesure, sinon le pointeau aura du mal à glisser et l'injection s'en trouvera diminuée.**

(1) Ecrou de retenue
(2) Bâti du porte-gicleur
(3) Ecrou
(4) Joint à pitons
(5) Rondelle plate
(6) Rondelle de réglage
(7) Ressort de gicleur
(8) Tige de poussée
(9) Pièce d'écartement
(10) Gicleur

DÜSENHALTER

❶ Ausbau des Düsenhalters

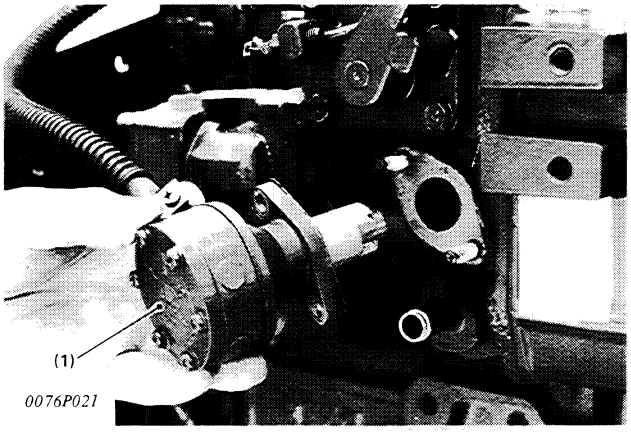
1) Schließringmutter in Schraubstock einspannen.
2) Mutter, Gabelgelenk und Unterlegscheibe entfernen.
3) Düsenhaltergehäuse und innere Teile entfernen.

(Anmerkung für das Zusammensetzen)

- **Beim Aus- und Zusammenbau des Düsenhalterteils in sauberen Treibstoff eintauchen.**
- **Beim Zusammenbau des Schubrohrs nicht verkehrt Richtig beachten (in umgekehrter Richtung).**
- **Befestigungsmutter bis 58,8 bis 78,4 Nm (6 bis 8 kp·m) anziehen.**
- **Darauf achten, daß Sie nicht zu stark anziehen, sonst wird die Nadelklappe nur schwer gleiten und die Einspritzleitung wird reduziert werden.**

(1) Befestigungsmutter
(2) Düsenhaltergehäuse
(3) Mutter
(4) Gabelgelenk
(5) Unterlegscheibe
(6) Stellscheibe
(7) Düsenfeder
(8) Schubrohr
(9) Abstandbüchse
(10) Düsenteil

FUEL PUMP, HYDRAULIC PUMP



0076P021

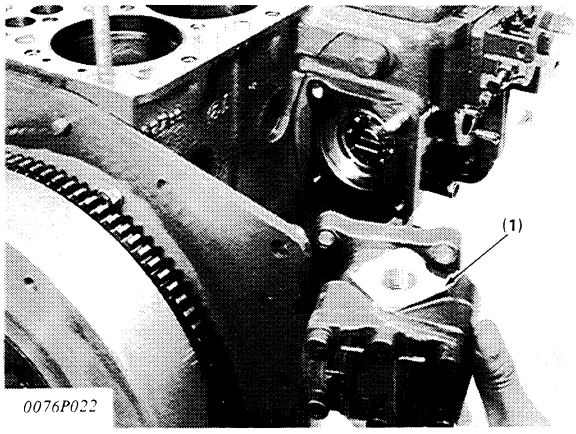
❶ Removing Fuel Pump

1) Remove the two fuel pump mounting nuts.
2) Detach the fuel pump.

(Note for assembling)

- **Be careful about the installation direction of the fuel pump.**
- **Install the fuel pump gasket after applying a non-drying adhesive to it.**

(1) Fuel pump assembly



0076P022

❷ Removing Hydraulic Pump (Optional)

1) Remove the mounting bolts. (When removing the bolts near the pump inlet, be careful not to hit the cap of the idling limit apparatus.)
2) Detach the hydraulic pump (gear pump).

(1) Hydraulic pump

POMPE A COMBUSTIBLE, POMPE HYDRAULIQUE

❶ Retrait de la pompe à combustible

1) Retirer les 2 écrous de montage de la pompe.
2) Détacher la pompe.

(Remarques pour le montage)

- **Veiller à ce que les directives relatives à l'installation de la pompe soient bien sui vies.**
- **Installer le joint de pompe après lui avoir appliqué un adhésif non-séchant.**

(1) Ensemble pompe à combustible

❷ Retrait de la pompe hydraulique (en option)

1) Retirer les boulons de fixation. Au moment de retirer ceux qui sont à côté de l'entrée, éviter de heurter le capuchon du dispositif de ralenti.
2) Détacher la pompe.

(1) Pompe hydraulique

TREIBSTOFFPUMPE, HYDRAULISCHE PUMPE

❶ Entfernen der Treibstoffpumpe

1) Die beiden Befestigungsschrauben der Treibstoffpumpe entfernen.
2) Die Treibstoffpumpe abnehmen.

(Anmerkung für das Zusammensetzen)

- **Darauf achten, daß die Einstellungsanweisung der Pumpe richtig ist.**
- **Die Treibstoffpumpendichtung nach Aufkleben eines nicht trocknenden Klebemittels installieren.**

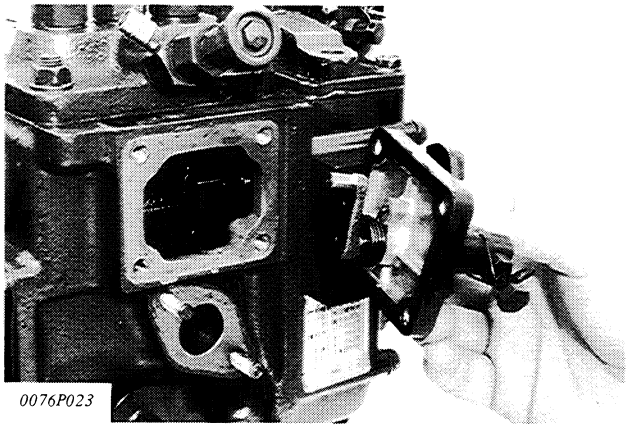
(1) Treibstoffpumpeneinheit

❷ Entfernen der hydraulischen Pumpe (Zusatzgerät)

1) Die Befestigungsbolzen entfernen. Beim Entfernen der Bolzen in der Nähe des Pumpeneinlasses, darauf achten, daß die Kappe des Leerlaufbegrenzungsmechanismus nicht durch Anstoßen beschädigt wird.
2) Die hydraulische Pumpe (Getriebepumpe) abnehmen.

(1) Hydraulische Pumpe

INJECTION PUMP



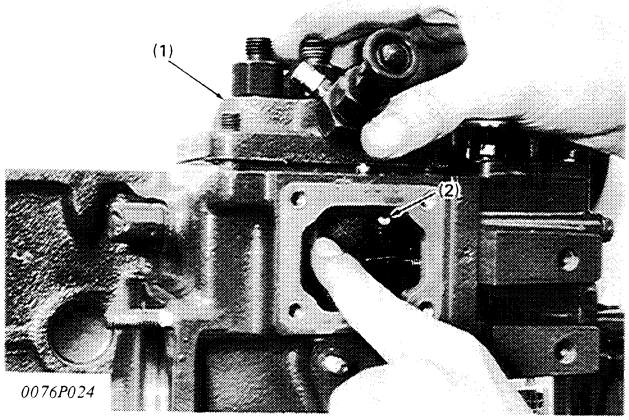
0076P023

❶ Removing Injection Pump Cover

1) Remove the injection pump cover.

(Note for reassembling)

- **Before installing the pump cover gasket, apply a non-drying adhesive to it.**



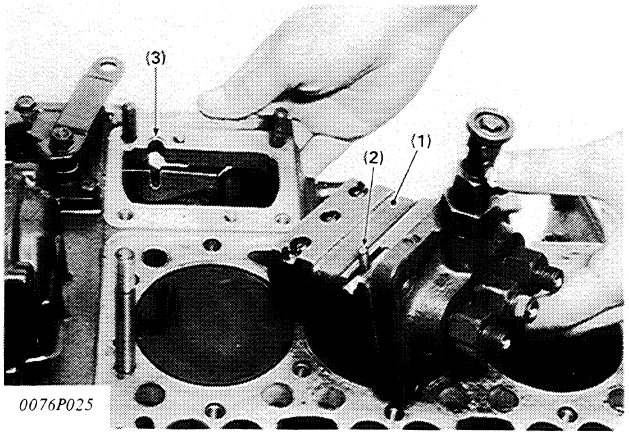
0076P024

❷ Removing Injection Pump

1) Remove the injection pump mounting bolts and nuts.
2) Detach the injection pump. To prevent the pump rack from being caught, detach the pump along the removal groove.
3) Align the control rack pin with the slot on the gear case and remove the injection pump.
4) In principle, the injection pump should not be disassembled.

(Note for reassembling)

- **Install the injection pump by aligning the control rack with the indicated position.**
- **Addition or reduction of one shim delays or advances the injection timing by 0.0262 rad. (1.5°).**
- **Install the injection pump shims after applying thinly a non-drying adhesive.**



0076P025

(1) Injection pump
(2) Control rack
(3) Removal groove

POMPE D'INJECTION

❶ Retirer le capot de la pompe d'injection

1) Retirer le capot de la pompe d'injection.

(Remarques pour le remontage)

- **Avant de fixer le joint de capot, lui appliquer un adhésif non-séchant.**

❷ Retrait de la pompe d'injection

1) Retirer les écrous et boulons maintenant la pompe.
2) Détacher la pompe. Pour que la crémaillère ne soit pas prise, détacher la pompe le long de la rainure de dépose.
3) Dresser le tourillon de la crémaillère de commande pour qu'il coincide avec la rainure de la boîte de vitesses et retirer la pompe d'injection.
4) En principe, la pompe d'injection ne devrait pas être démontée.

(Remarques pour le remontage)

- **Installer la pompe en plaçant la crémaillère en position indiquée.**
- **L'augmention ou la diminution des cales retarde ou avance le timing d'injection de 1,5°.**
- **Installer les cales après leur avoir appliqué une couche mince d'adhésif nonséchant.**

(1) Pompe d'injection
(2) Crémaillère de commande
(3) Encoche de démontage

EINSPRITZPUMPE

❶ Die Abdeckung der Einspritzpumpe entfernen

1) Die Abdeckung der Einspritzpumpe entfernen.

(Anmerkung für das Zusammensetzen)

- **Die Einspritzpumpendichtung nach Aufkleben eines nicht trocknenden Klebemittels installieren.**

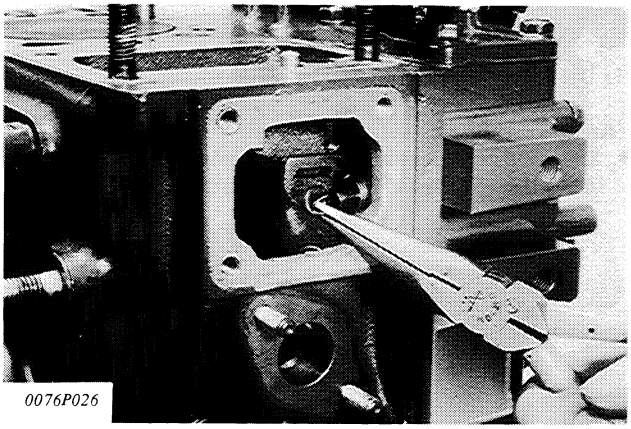
❷ Entfernen der Einspritzpumpe

1) Die Bolzen und Muttern, die die Einspritzpumpe befesten, entsprechend entfernen.
2) Die Einspritzpumpe entfernen. Um das Pumpengestell nicht gegen andere Teile stoßen zu lassen, die Pumpe nur entlang der Entfernungsrille entfernen.
3) Die Pinne am kontrolgestell mit der Führung am Getriebegehäuse in übereinstimmung bringen und Einspritzpumpe entfernen.
4) Die Einspritzpumpe sollte grundsätzlich nicht zerlegt werden.

(Anmerkung für das Zusammensetzen)

- **Die Einspritzpumpe durch Angleichen des Kontrollgestells an die angegebenen Position installieren.**
- **Das Zusetzen oder Abnehmen von Einsetzstücken verzögert oder verschnellert die Einspritzzeit um 0,0262 rad (1,5°).**
- **Die Einsetzstücke der Einspritzpumpe nach Aufkleben eines nicht trocknenden Klebemittels installieren.**

(1) Einspritzpumpe
(2) Kontrollgestell
(3) Entfernungsrille



0076P026

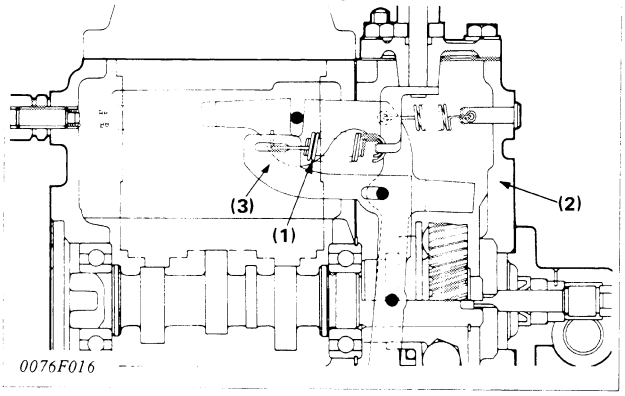
❶ Detaching Governor Spring

1) Detach the governor springs 1 and 2 from governor fork lever 2.

(Note for reassembling)

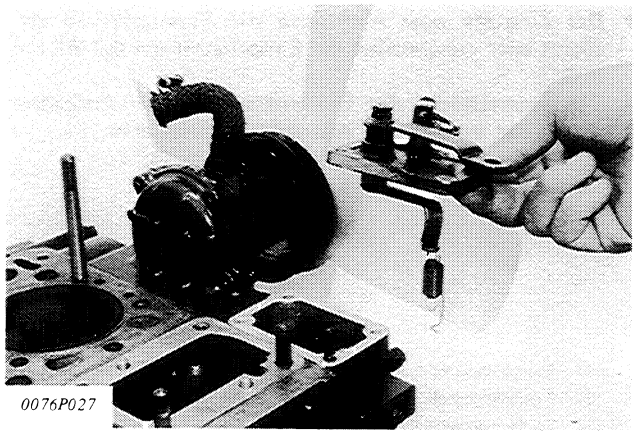
- **Fix the governor spring to the speed control lever, and pull the spring or wire through the window of the injection pump, and spring will be able to be hooked on the governor fork with ease.**
- **Bend the end of the governor spring to prevent it from falling off.**

[A] How to remove governor spring



0076F016

(1) Detach governor spring on the side of fork lever
(2) Gear case
(3) Fork lever 2



0076P027

❷ Removing Speed Control Plate

1) Remove the speed control plate and governor spring.

(Note for reassembling)

- **Be careful not to drop the governor spring in the gear case.**

CARTER DE DISTRIBUTION, PIGNON INTERMEDIAIRE, ARBRE A CAME, POMPE A HUILE

❶ Retrait du ressort de régulateur

1) Retirer les ressorts de régulateur 1 et 2 du levier de fourche 2.

(Remarques pour le remontage)

- **Fixer le ressort de régulateur au levier de commande de vitesse et tirer le ressort ou le fil par la fenêtre de la pompe d'injection; il sera aisé d'accrocher ce ressort à la fourche du régulateur.**
- **Courber l'extrémité du ressort pour qu'il reste en position. Placer la garniture de la plaque de commande de vitesse après lui avoir appliqué un adhésif non-séchant.**

[A] Comment retirer le ressort

(1) Détacher le ressort du côté du levier à fourche 2
(2) Distribution
(3) Levier à fourche 2

❷ Retrait de la plaque de commande de vitesse

1) Retirer la plaque de commande et le ressort de régulateur.

(Remarques pour le remontage)

- **Faire attention à ce que le ressort ne tombe pas dans le carter de distribution.**

GETRIEBEKASTEN, STEUERUNGSGETRIEBE, NOCKENWELLE, ÖLPUMPE

❶ Entfernen der Reglerspirale

1) Die Reglerspiralen 1 und 2 vom Regulator Gabelhebel entfernen.

(Anmerkung für das Zusammensetzen)

- **Die Reglerspirale mit dem Geschwindigkeitsreglungshebel verbinden, und die Spirale oder Draht durch das Fensterloch der Einspritzpumpe ziehen, wodurch die Spirale einfach in die Governor-Gabel eingehakt werden kann.**
- **Das Ende der Reglerspirale umbiegen, um die Spirale nicht abfallen zu lassen.**

[A] Entfernen der Reglerspirale

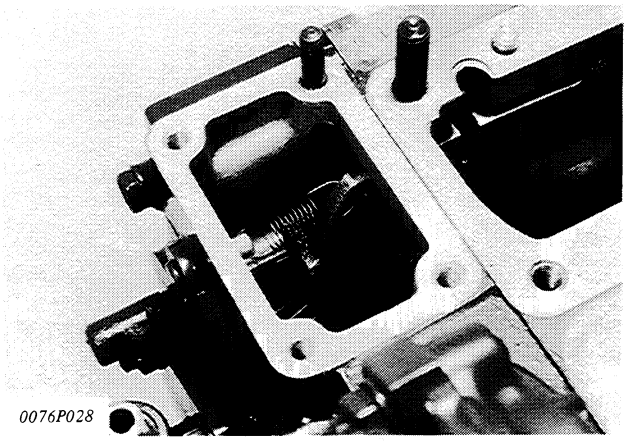
(1) Die Reglerspirale auf der Seite des Gabelhebels 2 entfernen.
(2) Getriebekasten
(3) Gabelhebel 2

❷ Entfernen der Geschwindigkeitsreglerplatte

1) Die Geschwindigkeitsreglerplatte und Reglerspirale entfernen.

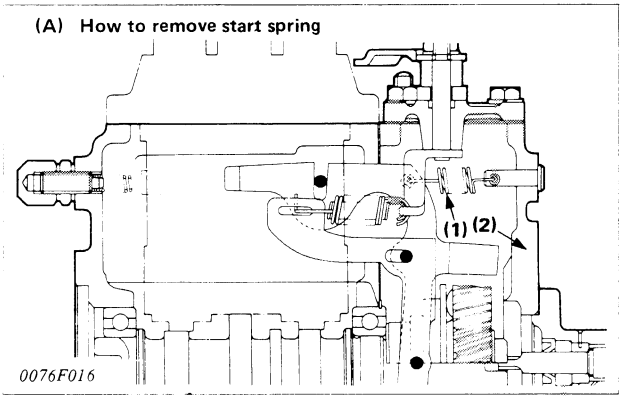
(Anmerkung für das Zusammensetzen)

- **Darauf achten, daß die Reglerspirale nicht in den Getriebekasten fällt.**



0076P028

(A) How to remove start spring

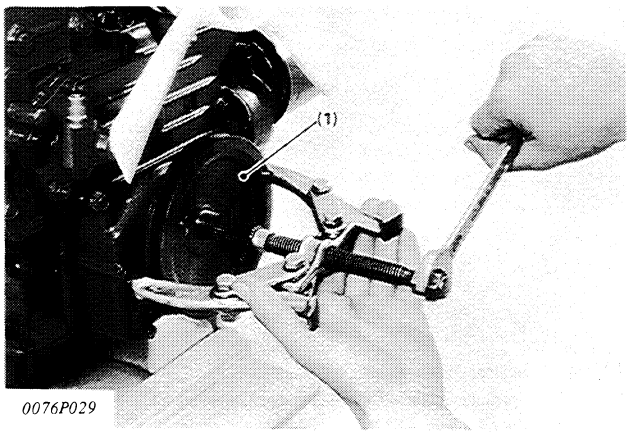


0076F016

❸ Detaching Start Spring

1) Remove the start spring from the gear case.

(1) Detach start spring on the side of gear case
(2) Gear case



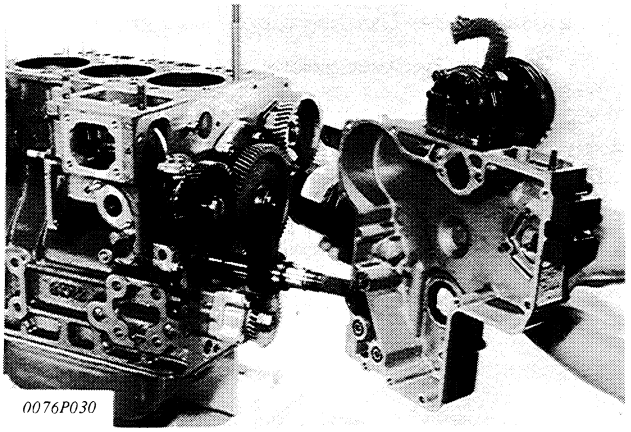
0076P029

❹ Removing Fan Drive Pulley

1) Flatter the crankshaft washer.
2) Loosen and remove the crankshaft nut.
3) Draw out the pulley with a puller.

(Note for reassembling)
- **Bend the crankshaft washer against one side of the nut.**
- **Tighten the nut to 137.3 to 156.9 Nm (14.0 to 16.0 kgf·m, 101.3 to 115.7 ft-lbs).**
- **Do not tighten the nut excessively; it may damage the oil slinger, causing oil leakage.**

(1) Fan drive pulley



0076P030

❺ Removing Gear Case

1) Remove the gear case cover.
2) Remove the O-ring.

- **Check to see if there are three O-rings inside the gear case.**

(Note for reassembling)
- **Apply a thin film of engine oil to the oil seal, and install it, noting the lip come off.**
- **Before installing the gear case gasket, apply a non-drying adhesive.**
- **Tighten the oil filter cartridge by hand.**

❸ Retrait du ressort de démarrage

1) Retirer le ressort de démarrage du carter de distribution.

[A] Comment retirer le ressort
(1) Détacher le ressort du côté de la distribution.
(2) Carter de distribution

❹ Retrait de la poulie d'entraînement du ventilateur

1) Redresser la rondelle de vilebrequin.
2) Desserrer et retirer l'écrou de vilebrequin.
3) Sortir la poulie avec un arrache-poulie.

(Remarques pour le remontage)
- Plier la rondelle contre un côté de l'écrou.
- Serrer l'écrou à 137,3 à 156,9 Nm (14,0 à 16,0 kgf·m).
- Eviter de le serrer trop ou il pourrait en résulter une fuite d'huile, la rondelle d'arrêt d'huile pouvant être endommagée.

(1) Poulie d'entraînement du ventilateur

❺ Retrait de carter de distribution

1) Retirer le capot.
2) Retirer les joints toriques.

- Vérifier que les 3 joints toriques sont bien en place dans le carter au remontage.

(Remarques pour le remontage)
- Appliquer une fine couche d'huile moteur au joint d'étanchéité puis installer celui-ci soigneusement de façon que sa lèvre ne sorte pas.
- Avant d'installer le joint du carter, appliquer un adhésif non-séchant.
- Serrer la cartouche du filtre à huile à la main.

❸ Entfernen der Anlasserspirale

1) Die Anlasserspirale vom Getriebekasten entsprechend abnehmen.

[A] Entfernen der Anlasserspirale
(1) Die Anlasserspirale auf der Seite des Getriebekastens abnehmen.
(2) Getriebekasten

❹ Entfernen der Ventilatortreibriemenscheibe

1) Die Unterlegscheibe der Kurbelwelle ausrichten.
2) Die Kurbelwellenmutter lösen und abnehmen.
3) Die Riemenscheibe mit einem Zieher herausziehen.

(Anmerkung für des Zusammensetzen)
- Die Klammer der Kurbelwellenunterlegscheibe gegen eine Seite der Mutter drücken.
- Die Mutter auf 137,3 bis 156,9 Nm (14,0 bis 16,0 kp·m) festziehen.
- Die Mutter nicht übermäßig festziehen, da andernfalls der Ölspritzring beschädigt werden könnte, welches zu Ölaussickerungen führen kann.

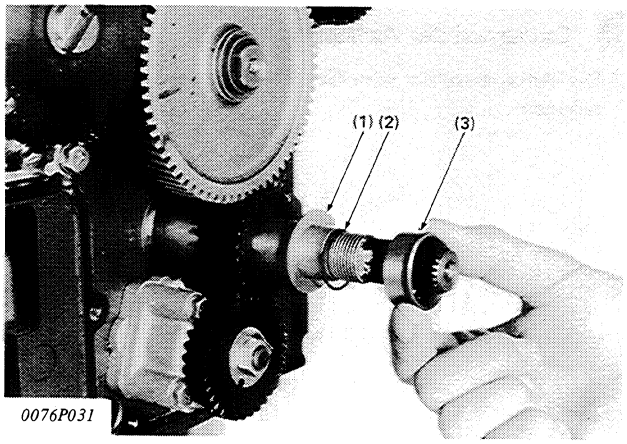
(1) Ventilatorriemenscheibe

❺ Entfernen des Getriebegehäuse

1) Die Getriebegehäuseabdeckung entfernen.
2) Den O-Ring entfernen.

- Überprüfen, ob drei O-Ringe in dem Getriebegehäuse vorhanden sind.

(Anmerkung für des Zusammensetzen)
- Eine dünne Ölschicht auf die Ölabdichtung geben und diese dann entsprechend einsetzen. Dabei muß darauf geachtet werden, daß das Lippenstück nicht abfallen kann.
- Vor dem Installieren der Getriebegehäusedichtung, ein nicht trocknendes Klebemittel aufkleben.
- Die Ölfilter-Patrone mit der Hand festziehen.

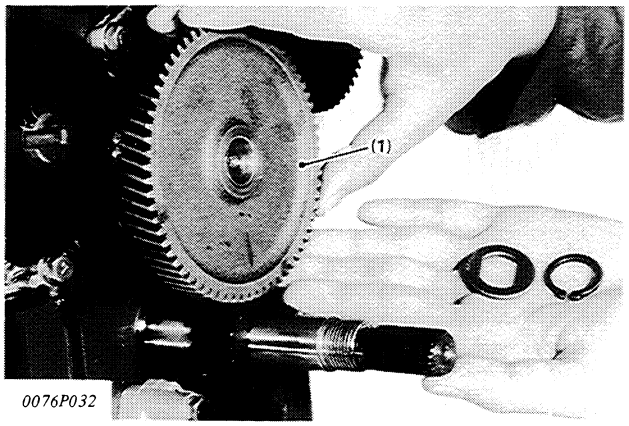


0076P031

⑥ Removing Crankshaft Oil Slinger

1) Remove the crankshaft collar.
2) Remove the O-ring.
3) Detach the crankshaft oil slinger.

(1) Crankshaft oil slinger
(2) O-ring
(3) Crankshaft collar



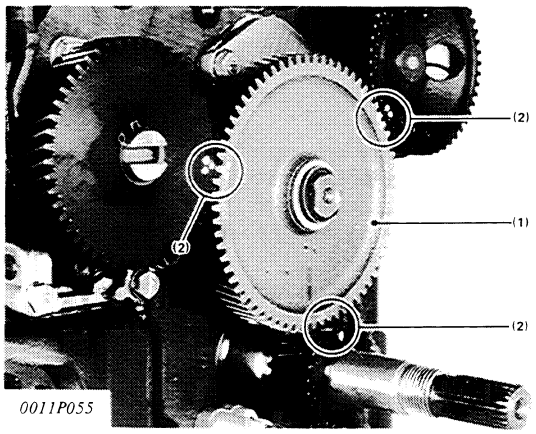
0076P032

⑦ Removing Idle Gear

1) Remove the external circlip.
2) Detach the idle gear collar 2.
3) Detach the idle gear.
4) Detach the idle gear collar 1.

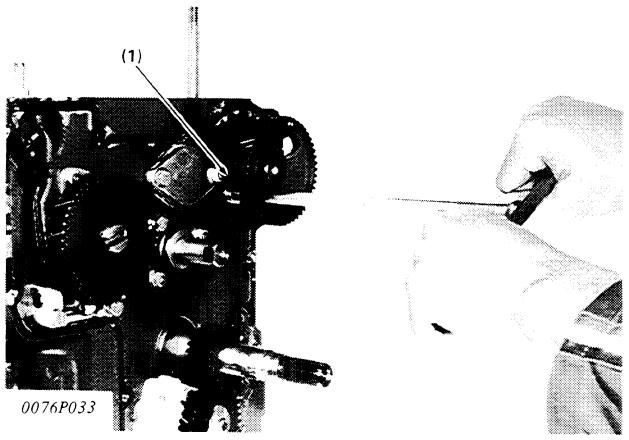
(Note for reassembling)

- **Check to see each gear is aligned with its aligning mark:**
  1) Idle gear and crank gear
  2) Idle gear and camshaft gear
  3) Idle gear and injection pump gear
- **Tighten the idle gear shaft mounting bolt (7T) to 10 to 12 Nm (1.0 to 1.2 kgf·m, 7.2 to 8.7 ft-lbs).**



0011P055

(1) Idle gear
(2) Alignment mark



0076P033

⑧ Removing Camshaft Stopper

1) Align the round hole on the cam gear with the camshaft stopper mounting bolt position.
2) Remove the camshaft stopper mounting bolt.
3) Detach the camshaft stopper.

(1) Camshaft stopper

⑥ Retrait de la rondelle d'arrêt d'huile du vilebrequin

1) Retirer le collier du vilebrequin.
2) Retirer le joint torique.
3) Détacher la rondelle d'arrêt d'huile.

(1) Rondelle d'arrêt d'huile
(2) Joint torique
(3) Collier de vilebrequin

⑦ Retrait du pignon intermédiaire

1) Retirer le circlip extérieur.
2) Détacher le collier 2 du pignon.
3) Détacher le pignon.
4) Détacher le collier 1 du pignon.

(Remarques pour le remontage)

- **Vérifier que chaque pignon est bien aligné:**
  1) Pignon intermédiaire et pignon de vilebrequin.
  2) Pignon intermédiaire et pignon d'arbre à came.
  3) Pignon intermédiaire et pignon de pompe d'injection.
- **Serrer le boulon de fixation de l'arbre du pignon intermédiaire (7T) à 10 à 12 Nm (1,0 à 1,2 kgf·m).**

(1) Pignon intermédiaire
(2) Repères

⑧ Retrait du taquet d'arbre à came

1) Aligner le trou rond au pignon d'arbre à came et le boulon maintenant le taquet de l'arbre.
2) Retirer le boulon maintenant le taquet.
3) Retirer le taquet.

(1) Taquet

⑥ Entfernen des Ölspritzrings der Kurbelwelle

1) Die Kurbelwellenmanchette entfernen.
2) Den O-Ring entfernen.
3) Den Ölspritzring der Kurbelwelle entfernen.

(1) Kurbelwellenölspritzring
(2) O-Ring
(3) Kurbelwellenmanchette

⑦ Entfernen des Zwischenzahnrads (Leerlaufrads)

1) Die externe Außenklammer entfernen.
2) Die Zwischenzahnradmanchette 2 entfernen.
3) Das Zwischenzahnrad entfernen.
4) Die Zwischenzahnradmanchette 1 entfernen.

(Anmerkung für das Zusammensetzen)

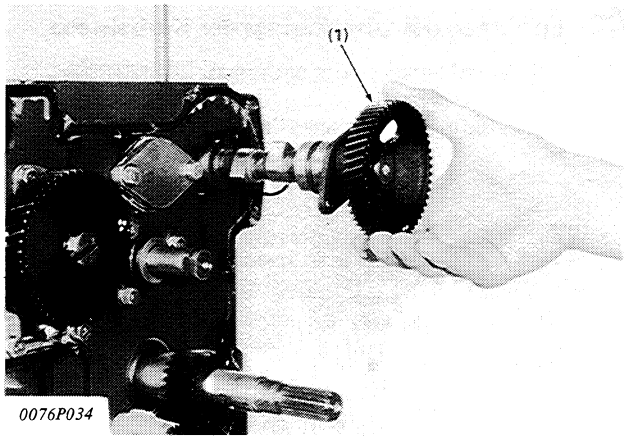
- **Überprüfen, ob jedes der Zahnräder mit den entsprechenden Markierungen abgeglichen ist.**
  1) Zwischenzahnrad und Nockenzahnrad
  2) Zwischenzahnrad und Nockenwellenzahnrad
  3) Zwischenzahnrad und Einspritzpumpenzahnrad
- **Den Montagebolzen der Zwischenzahnradachse (7T) auf 10 bis 12 Nm (1,0 bis 1,2 kp·m) festziehen.**

(1) Zwichenzahnrad
(2) Abgleichsmarkierung

⑧ Entfernen der Nockenwellenstopper

1) Das Rundloch auf dem Nockenzahnrad mit der Befestigungsbolzenposition des Nockenwellenstoppers abgleichen.
2) Den Befestigungsbolzen des Nockenwellenstoppers abnehmen.
3) Den Nockenwellenstopper abnehmen.

(1) Nockenwellenstopper



0076P034

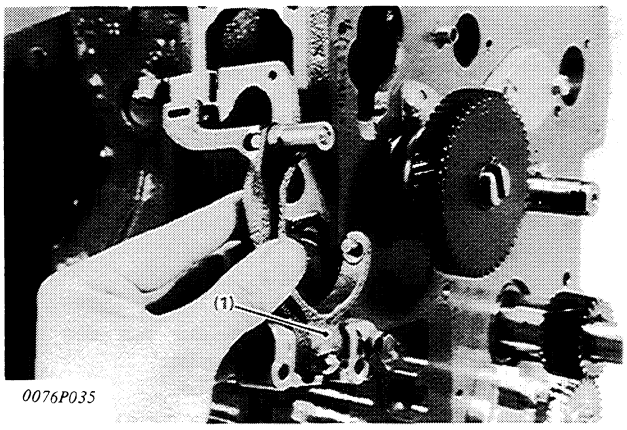
⑨ Removing Gear and Camshaft

1) Draw the camshaft and the cam gear.

(Note for reassembling)

- **Apply a thin film of engine oil to the camshaft before installation.**

(1) Camshaft assembly



0076P035

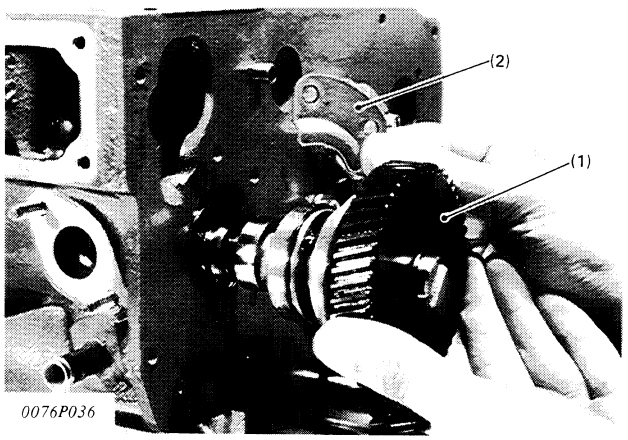
⑩ Removing Fork Lever Assembly

1) Remove the two fork lever holder mounting bolts.
2) Detach the fork lever assembly.

(Note for reassembling)

- **Install the fork lever holder and crankcase after cleaning their contact surfaces.**
- **Install the fork lever so that it will not hit the governor sleeve, and so that equal space is allowed on either side of the lever.**
- **After installation, check to see that the fork lever (1) is fixed to the fork lever shaft, and that it can turn smoothly in the holder.**

(1) Fork lever assembly



0076P036

⑪ Removing Fuel Camshaft

1) Remove the fuel camshaft stopper.
2) Draw out the fuel camshaft and the injection pump gear.

(Note for reassembling)

- **Apply a thin film of engine oil to each part, and reassemble so that the drive groove at the end of the camshaft engages with the drive shaft of the hydraulic gear pump.**
- **The balls to be contained in the governor ball case are thirty 3.97 mm (0.1563 in.) diameter ones and eight 13.46 mm (0.5300 in.) diameter ones.**

(1) Fuel camshaft assembly
(2) Fuel camshaft stopper

⑨ Retrait du pignon et de l'arbre à came

1) Tirer l'arbre à came et le pignon d'arbre.

(Remarques pour le remontage)

- **Appliquer une fine couche d'huile moteur sur l'arbre avant de l'installer.**

(1) Ensemble arbre à came

⑩ Retrait de l'ensemble levier à fourche

1) Retirer les 2 boulons fixant le support de levier.
2) Détacher l'ensemble.

(Remarques pour le remontage)

- **Installer le support de levier et le carter après avoir nettoyé les surfaces de contact.**
- **Installer le levier à fourche de sorte qu'il ne heurte pas le manchon du régulateur et qu'il y ait même distance de chaque côté.**
- **Après installation, vérifier que le levier 1 est fixé à son arbre et qu'il tourne facilement dans son support.**

(1) Ensemble levier à fourche

⑪ Retrait de l'arbre à came de combustible

1) Retirer le taquet d'arbre de pompe.
2) Retirer l'arbre de pompe et le pignon de pompe d'injection..

(Remarques pour le remontage)

- **Appliquer une fine couche d'huile moteur à chaque pièce et remonter de façon que la rainure d'entraînement en bout d'arbre à came soit engrenée avec l'arbre d'entraînement de la pompe hydraulique.**
- **30 des boules contenues dans la boîte du régulateur ont un diamètre de 3,97 mm, 8 de 13,46 mm.**

(1) Pignon de vilebrequin
(2) Pignon d'entraînement de la pompe

⑨ Entfernen des Zahnrads und Nockenwelle

1) Die Nockenwelle und Nockenzahnrad herausziehen.

(Anmerkung für das Zusammensetzen)

- **Vor der Installation der Nockenwelle, diese mit einer dünnen Schicht Maschinenöl einölen.**

(1) Nockenwelleneinheit

⑩ Entfernen der Gabelhebeleinheit

1) Die beiden Haltebolzen des Gabelhebels entfernen.
2) Die Gabelhebeleinheit entfernen.

(Anmerkung für das Zusammensetzen)

- **Den Gabelhebelhalter und das Kurbelgehäuse nach Reinigung der Kontaktflächen wieder einsetzen.**
- **Den Gabelhebel so einsetzen, daß die Regulator-Manchette nicht beschädigt, und gleicher Abstand auf beiden Seiten des Hebels freigehalten wird.**
- **Nach dem Einstetzen überprüfen, daß der Gabelhebel (1) richtig in die Gabelhebelachse eingesetzt ist, und daß er glatt im Halter gedreht werden kann.**

(1) Gabelhebeleinheit

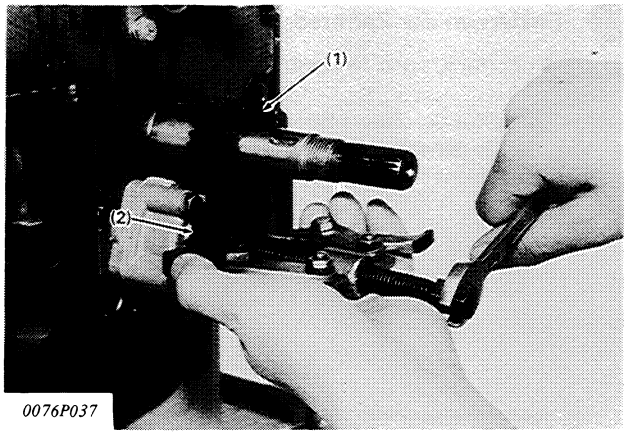
⑪ Entfernen des Treibstoffnockenwelle

1) Den Treibstoffnockenwellenstopper entfernen.
2) Den Treibstoffnockenwellenstopper und das Einspritzpumpenzahnrad herausziehen.

(Anmerkung für das Zusammensetzen)

- **Jeden der Teile mit einem dünnen Film von Motorenöl versehen und so zusammensetzen, daß der Treibschlitz am Ende der Nockenwelle in die Treibachse der hydraulischen Getriebepumpe eingreifen kann.**
- **Die in das Ballgehäuse des Regulators einzusetzende Reglerkugeln sind jeweils Kugeln eines Durchmessers von 3,97 mm (30) und 13,46 mm (8).**

(1) Treibstoffnockenwelleneinheit
(2) Treibstoffnockenwellenstopper



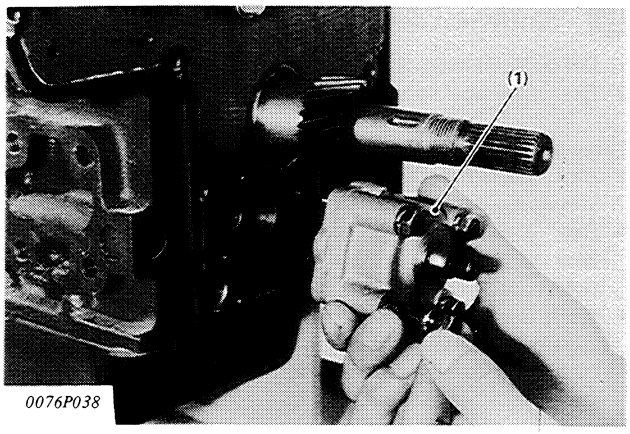
0076P037

⑫ Removing Oil Pump Drive Gear

1) Straighten the claw of the claw washer of the oil pump, and remove the nut.
2) Draw out the oil pump drive gear with gear puller.

(Note for reassembling)
- **Check to see if there is a feather key.**
- **Be sure to bend the claw of the claw washer.**

(1) Crank gear
(2) Oil pump drive gear



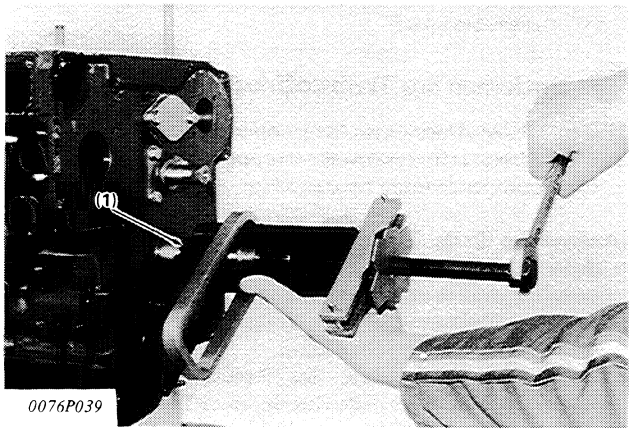
0076P038

⑬ Removing Oil Pump

1) Remove the four oil pump mounting bolts. Detach the oil pump.

(Note for reassembling)
- **Tighten the bolts 10 to 12 Nm (1.0 to 1.2 kgf-m, 7.2 to 8.7 ft-lbs).**

(1) Oil pump assembly



0076P039

⑭ Removing Crank Gear

1) Set a special puller on the crank gear.
2) Screw in the center bolt of the puller, and draw out the crank gear.

(Note for reassembling)
- **Check to see that the key is on the crankshaft.**
- **Heat the crank gear to about 99°C (210°F), and fit on the crankshaft. If there is fear of the shaft being damaged, heat the gear more and fit.**

(1) 13T gear (Crank gear)

⑫ Retrait du pignon d'entraînement de la pompe à huile

1) Redresser la griffe de la rondelle de la pompe à huile et retirer l'écrou.
2) Sortir le pignon de pompe à huile au moyen d'un extracteur.

(Remarques pour le remontage)
- **Vérifier qu'il y a une clavette.**
- **Ne pas oublier de plier la griffe de la rondelle.**

(1) Pignon de vilebrequin
(2) Pignon d'entraînement de la pompe

⑬ Retrait de la pompe à huile

1) Retirer les 4 boulons fixant la pompe et détacher cette dernière.

(Remarques pour le remontage)
- **Serrer les boulons à 10 à 12 Nm (1,0 à 1,2 kgf·m).**

(1) Ensemble pompe à huile

⑭ Retrait du pignon de vilebrequin

1) Fixer un extracteur spécial sur le pignon.
2) Serrer le boulon central de l'extracteur et sortir le pignon.

(Remarques pour le remontage)
- **Vérifier que la clavette est sur le vilebrequin.**
- **Chauffer le pignon à environ 99°C (210°F) et installer le vilebrequin. Si l'arbre risque d'être endommagé, chauffer davantage le pignon.**

(1) Pignon 13 T (vilebrequin)

⑫ Entfernen des Ölpumpentreibzahnrades

1) Die Klammer der Klammerunterlegscheibe der Ölpumpe geradebiegen und die Mutter entfernen.
2) Das Ölpumpentreibzahnrad mit einem Zahnradzieher herausziehen.

(Anmerkung für das Zusammensetzen)
- **Überprüfen, ob ein Federschlüssel vorhanden ist.**
- **Unbedingt die Klammer der Klammerunterlegscheibe entsprechend umbiegen.**

(1) Kurbelwellenzahnrad
(2) Ölpumpentreibzahnrad

⑬ Entfernen der Ölpumpe

1) Die vier Stellbolzen der Ölpumpe entfernen. Die Ölpumpe abnehmen.

(Anmerkung für das Zusammensetzen)
- **Die Bolzen auf 10 bis 12 Nm (1,0 bis 1,2 kp·m) festziehen.**

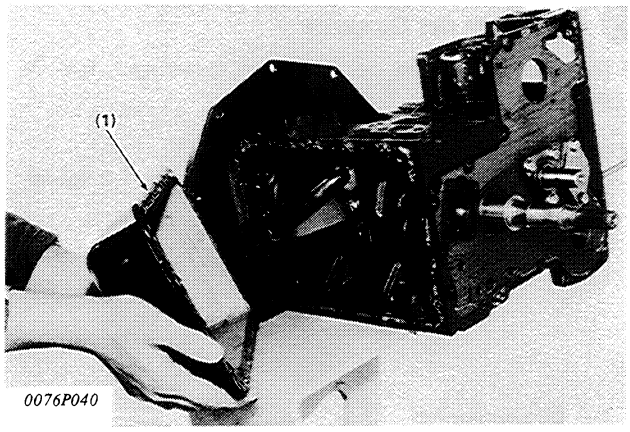
(1) Ölpumpeneinheit

⑭ Entfernen des Kurbelgetriebes

1) Einen Spezialzieher auf dem Kurbelgetriebe ansetzen.
2) Den Mittelbolzen des Ziehers einschrauben und das Kurbelgetriebe herausziehen.

(Anmerkung für das Zusammensetzen)
- **Überprüfen, daß der Schlüssel auf der Kurbelwelle ist.**
- **Das Kurbelgetriebe auf ungefähr 99°C (210°F) anwärmen und auf die Kurbelwelle aufsetzen. Sollte eine Beschädigungsgefahr der Welle vorhanden sein, das Getriebe weiter erhitzen und dann einsetzen.**

(1) 13 T (Kurbelgetriebe)



0076P040

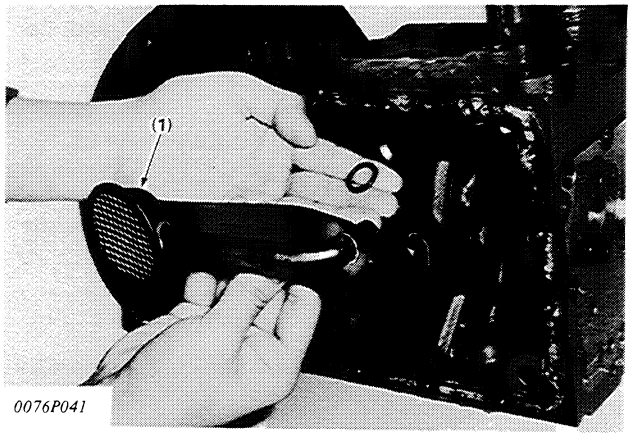
❶ Removing Oil Pan

1) Lay the engine on the engine cradle on its side.
2) Remove the eighteen oil pan mounting bolts.
3) Detach the oil pan by lightly tapping the groove of the pan with a wooden hammer.

(Note for reassembling)

- **Wipe off oil on the oil pan mounting surface, apply a non-drying adhesive, and install the oil pan.**
- **To avoid uneven tightening, tighten mounting bolts in diagonal order from the center.**
- **Check to see that the drain plug is tight.**

(1) Oil pan



0076P041

❷ Removing Oil Filter 1

1) Remove the mounting bolt of oil filter 1.
2) Detach oil filter 1, being careful of the O-ring.

(Note for reassembling)

- **After cleaning the oil filter, check to see that the filter mesh is clean, and install it.**
- **Visually check the O-ring, apply engine oil, and install it.**
- **After checking to see that the O-ring is securely installed, attach the oil filter.**

(1) Oil filter 1

PISTON, VILEBREQUIN

❶ Retrait du carter à huile

1) Poser le moteur couché sur le berceau.
2) Retirer les 18 boulons fixant le carter.
3) Détacher le carter en tapotant le long de son encoche avec un maillet.

(Remarques pour le remontage)

- **Enlever l'huile de la surface de fixation du carter, appliquer un adhésif non-séchant avant de fixer le carter.**
- **Pour éviter de serrer de facon inégale, serrer les boulons en diagonale à partir du centre.**
- **Vérifier que le bouchon de vidange est serré.**

(1) Carter à huile

❷ Retrait du filtre à huile 1

1) Retirer le boulon de fixation du filtre 1.
2) Détacher le filtre 1 en faisant attention au joint torique.

(Remarques pour le remontage)

- **Une fois le filtre nettoyé, vérifier que les mailles sont propres et l'installer.**
- **Jeter un coup d'oeil au joint torique, appliquer de l'huile et l'installer.**
- **Après avoir vérifié que le joint est bien installé, fixer le filtre.**

(1) Filtre à huile 1

KOLBEN, KURBELWELLE

❶ Entfernen der Ölwanne

1) Den Motor auf dem Motorenbock auf die Seite legen.
2) Die achtzehn Montagebolzen der Ölwanne entfernen.
3) Die Ölwanne durch leichtes Schlagen der Rille der Wanne mit einem Holzhammer entsprechend entfernen.

(Anmerkung für das Zusammensetzen)

- **Das Öl von den Befestigungsflächen der Ölwanne abwischen und ein nicht trocknendes Klebemittel tragen, aufgeben, wonach die Ölwanne eingesetzt werden kann.**
- **Um ungleichmäßiges Festziehen zu vermeiden, die Befestigungsbolzen in diagonaler Reihenfolge von der Mitte an festziehen.**
- **Überprüfen, ob der Ablaufstutzen fest eingesetzt wurde.**

(1) Ölwanne

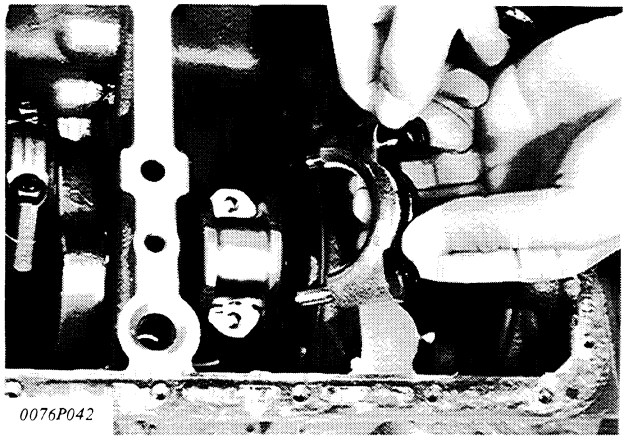
❷ Entfernen des Ölfilters 1

1) Die Montagebolzen des Ölfilters 1 entfernen.
2) Den Ölfilter 1 entfernen, wobei auf den O-Ring geachtet werden muß.

(Anmerkung für das Zusammensetzen)

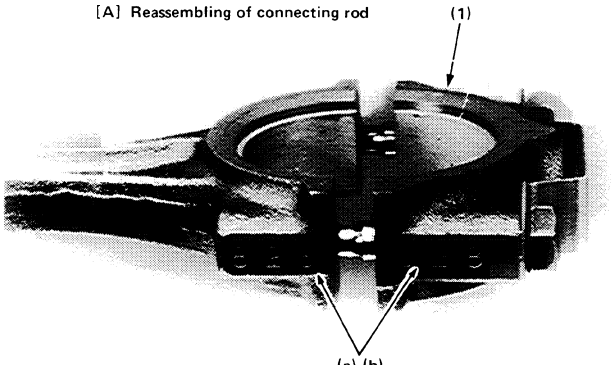
- **Nach Reinigung des Ölfilters überprüfen, ob das Filtergitter sauber ist, und dann den Filter einsetzen.**
- **Den O-Ring auf Sicht überprüfen, mit Maschinenöl einölen und dann einsetzen.**
- **Nach der Überprüfung, ob der O-Ring richtig eingesetzt wurde, den Ölfilter entsprechend anbringen.**

(1) Ölfilter 1



0076P042

[A] Reassembling of connecting rod



0011P099

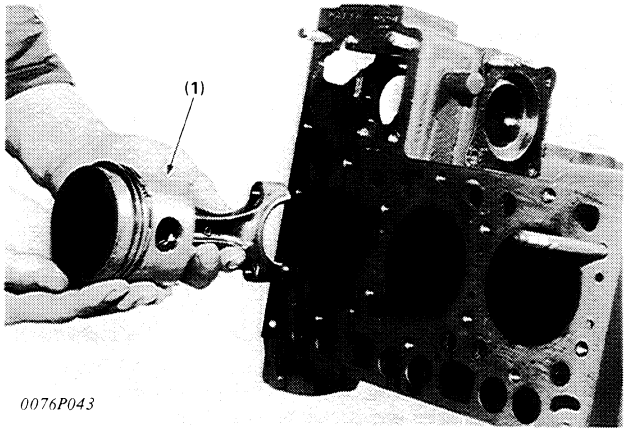
❸ Removing Connecting Rod Cap

1) Remove the connecting rod bolts from connecting rod cap.
2) Detach the connecting rod caps.

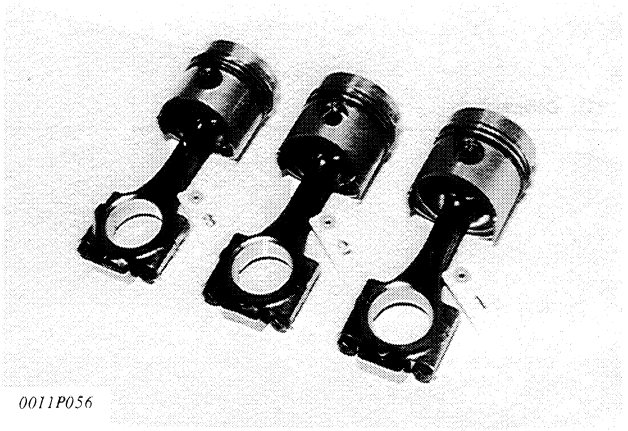
(Important)

- **Apply engine oil to the connecting rod bolts and tighten them to 26 to 30 Nm (2.7 to 3.1kgf·m, 20 to 22 ft-lbs).**

(1) Connecting rod cap
(a) Align the marks with each other.
(b) Face the marks toward the injection pump.



0076P043



0011P056

❹ Removing Pistons

1) Turn the crankshaft by 3.14 rad (180°) and bring the piston to top dead center.
2) Draw out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.
3) Draw out the other two pistons in the same method as above.

(Note for reassembling)

- **Before inserting the pistons into the cylinders, apply enough engine oil to the pistons.**

(Important)

- **Install the piston rings with their gaps making an angle of 2.09 rad (120°) or 3.14 rad (180°) to each other. (Place the top ring with their gaps on the opposite side of the combustion chamber.)**
- **Attach a ring to the pistons securely with a piston ring compressor, and set them to the cylinder, being careful about the cylinder number and the position of the connecting rod (Connecting rods must be installed with their ends bearing the number toward the fuel injection pump).**
- **Carefully insert the pistons. Otherwise, their chrome-plated section may be scratched, causing trouble inside the liner.**

(1) Piston

❸ Retrait des chapeaux de tête de bielle

1) Retirer du chapeau les boulons de bielle.
2) Détacher les chapeaux.

(Important)
- **Appliquer de l'huile sur les boulons de bielle et serrer ceux-ci à 26 à 30 Nm (2,7 à 3,1 kgf·m).**

[A] Remontage de la bielle
(1) Chapeau de bielle
(a) Aligner les repères.
(b) Placer les repères vers la pompe d'injection.

❹ Retrait des pistons

1) Tourner le vilebrequin de 180° et amener le piston en haut de course.
2) Sortir le piston à la verticale en le tapotant par le bas du carter avec le manche d'un marteau.
3) Sortir les 2 autres pistons de la même manière.

(Remarques pour le remontage)
- **Avant d'introduire les pistons dans les cylindres, appliquer suffisamment d'huile moteur.**

(Important)
- **Installer les segments de sorte que leurs écartements fassent un angle de 120° ou 180° entre eux. Placer les segments supérieurs avec l'écartement du côté à l'opposé de la chambre de combustion.**

- **Fixer le segment avec un serreur de piston, introduire le piston dans le cylindre en faisant attention au numéro de cylindre et à la position de la bielle (les bielles doivent être fixées avec leur numéro de palier tourné vers la pompe d'injection).**
- **Introduire les pistons soigneusement, sinon, on risque de griffer leur section chromée et d'avoir des ennuis de chemise.**

(1) Piston

❸ Entfernen der Anschlußstabkappen

1) Die Befestigungsbolzen des Anschlußstabs von der Kappe des Anschlußstabs entfernen.
2) Die Kappen des Anschlußstabs entfernen.

(Wichtig)
- **Den Verbindungsstab mit Maschinenöl einölen und die Befestigungsbolzen auf 26 bis 30 Nm, (2,7 bis 3,1 kp·m) festziehen.**

[A] Zusammensetzen des Verbindungsstabs
(1) Kappe des Anschlußstabs
(a) Die Markierungen miteinander abgleichen.
(b) Die Markierung gegen die Einspritzpumpe zeigen lassen.

❹ Entfernen der Kolben

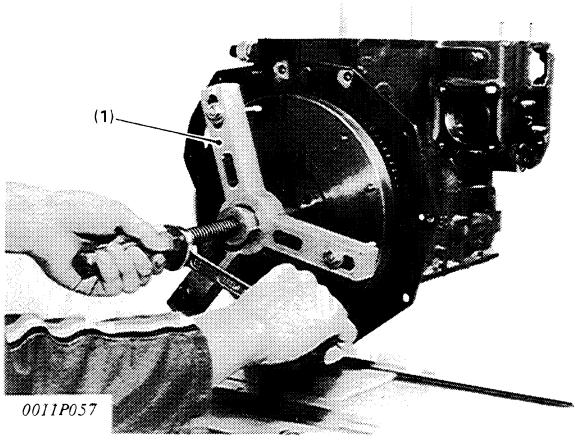
1) Die Kurbelwelle um 3,14 rad (180°) drehen, und den Kolben auf die absolute obere Mittelstellung bringen.
2) Den Kolben durch leichtes Schlagen mit dem Hammerstiel gegen den Kurbelgehäuseboden nach oben abziehen.
3) Die anderen beiden Kolben auf gleiche Weise herausziehen.

(Anmerkung für das Zusammensetzen)
- **Vor dem Einsetzen der Kolben in den Zylinder müssen diese genügend mit Maschinenöl (Motorenöl) eingeölt werden.**

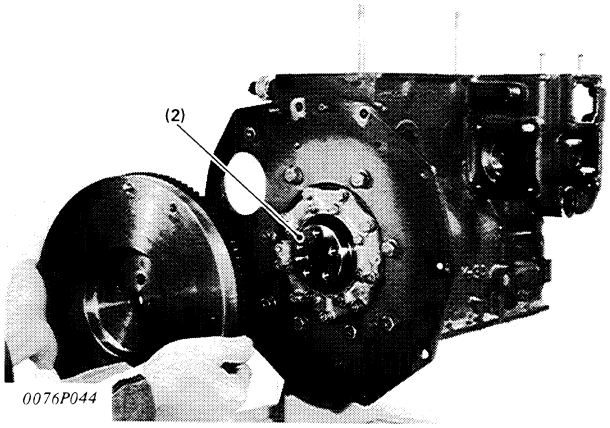
(Wichtig)
- **Die Kolbenringe mit deren Zwischenräumen in einem Winkel von 2,09 rad. (120°) oder 3,14 rad. (180°) gegeneinander entsprechend einsetzen. (Den Oberring mit dessen Zwischenräumen auf die gegenüberliegende Seite der Verbrennungskammer anbringen.)**

- **Den Ring auf dem Kolben mit einem Kolbenringkompressor fest anbringen. Die Kolben dann in den Zylinder einsetzen, wobei auf die Zylindernummer und die Position des Verbindungsstabs (Die Verbindungsstäbe müssen auf eine Weise eingesetzt werden, daß das mit der Nummer versehene Endteil gegen die Treibstoffeinspritzpumpe zeigt) geachtet werden muß.**
- **Die Kolben mit größter Vorsicht einsetzen, da andernfalls deren chrombeschichteter Teil verkratzt werden könnte, wodurch Störungen in der Laufbuchse erzeugt werden können.**

(1) Kolben



0011P057



0076P044

❺ Removing Flywheel

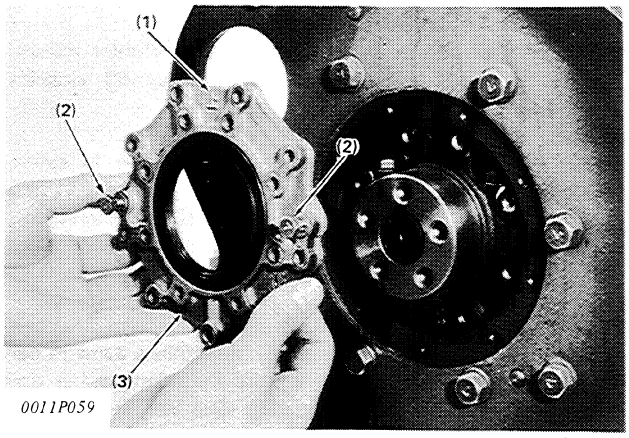
1) Flatter the flywheel washers.
2) Remove the flywheel bolts, except for two which must be loosened and left as they are.
3) Set a flywheel puller, and remove the flywheel.

(Note for reassembling)

- **Apply a thin film of grease to the bearing and oil seal at the back of the crankshaft.**
- **Check the ring gear for any uneven wear, lack or crack of teeth.**
- **Check to see that there are no metal particles left on the flywheel mounting surface.**
- **To ease alignment of the crankshaft and the flywheel, bring the crank of one of the cylinders to TC (top dead center). Make sure of the flywheel TC, align it with the punch mark of the rear end plate, and set the flywheel.**
- **Tighten the flywheel bolts to 54 to 59 Nm (5.5 to 6.0 kgf·m, 40 to 43 ft-lbs) in diagonal order.**
- **Bend the tangs of the flywheel washer against the bolts.**

SPECIAL TOOL:
Flywheel puller (Code No.: 07916-06041)

(1) Flywheel puller
(2) Crankshaft



0011P059

❻ Removing Bearing Case Cover

1) Remove the bearing case cover mounting bolts. First unscrew the eight bolts inside, and then work on the nine outside.
2) Screw the two bolts removed above into the two right and left holes for the bearing case cover, and pull off the cover by jacking it up.

(Note for reassembling)

- **When installing the main bearing case cover, check to see that there are no scratches on the oil seal lip. Then, apply a thin film of engine oil, and install. Be sure to check the top mark (上) on the cover during installation.**
- **Tighten the mounting bolts in diagonal order to 10 to 12 Nm (1.0 to 1.2 kgf·m, 7.2 to 8.7 ft-lbs).**

(1) Top mark (上)
(2) Lift bolt
(3) Bearing case cover

❺ Retrait du volant

1) Redresser les rondelles de volant.
2) Retirer les boulons de volant, à l'exception des 2 qui doivent être desserrés et laissés en place.
3) Fixer un arrache-volant et retirer le volant.

(Remarques pour le remontage)
- **Appliquer une fine couche de graisse au palier et au joint d'huile à l'arrière du vilebrequin.**
- **Vérifier la couronne dentée (usure inégale, dent fendue manquante).**
- **Vérifier qu'il n'y a pas de particules métalliques sur la surface de fixation du volant.**
- **Pour faciliter l'alignement du vilebrequin et du volant, amener un des cylindres en TC (haut de course), vérifier le TC du volant et le placer devant le repère estampé sur la plaque arrière; placer le volant.**
- **Serrer les boulons à 54 à 59 Nm (5,5 à 6,0 kgf·m), en diagonale.**
- **Plier les rondelles de volant sur les boulons.**

OUTIL SPECIAL:
Arrache-volant (N° de code: 07916-06041)

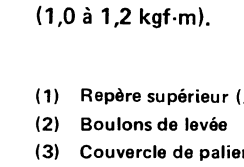


(1) Arrache-volant
(2) Vilebrequin

❻ Retrait du couvercle de palier

1) Retirer les boulons maintenant le couvercle de palier. Commencer par dévisser les 8 boulons intérieurs, puis les 9 extérieurs.
2) Visser les 2 boulons retirés au-dessus dans les 2 trous droite-gauche du couvercle de palier puis tirer ce couvercle en le soulevant.

(Remarques pour le remontage)
- **En installant le couvercle de palier principal, vérifier qu'il n'y a pas de rayures sur le bord du joint d'huile. Ensuite, appliquer une fine couche d'huile moteur et l'installer. Ne pas oublier de vérifier la position du repère supérieur (上) du couvercle.**
- **Serrer les boulons de fixation en diagonale de 10 à 12 Nm (1,0 à 1,2 kgf·m).**



(1) Repère supérieur (上)
(2) Boulons de levée
(3) Couvercle de palier

❺ Entfernen der Schwungscheibe

1) Die Schwungscheibenunterlegscheibe geradebiegen.
2) Die Schwungscheibenbolzen entsprechend entfernen. Dabei sind zwei Bolzen die gelöst werden müssen, jedoch an der Schwungscheibe verbleiben.
3) Einen Schwungscheibenzieher ansetzen, und die Schwungscheibe herausziehen.

(Anmerkung für das Zusammensetzen)
- **Eine dünne Schicht von Fett auf das Lager und Öl-abdichtung auf der Rückseite der Kurbelwelle geben.**
- **Das Ringzahnrad auf ungleichmäßige Beanspruchung untersuchen wie das Nichtvorhandensein oder Beschädigung von Zähnen.**
- **Überprüfen, daß keine Metallpartikel auf der Schwungscheibenmontagefläche zurückgeblieben sind.**
- **Um den Abgleich der Kurbelwelle und der Schwungscheibe zu erleichtern, einen der Zylinder auf die obere Mittelstellung (TC = top dead center) bringen. Die Schwungscheibe auch auf die TC-Stellung bringen und diese mit den Schlagmarkierungen auf der hinteren Endplatte abgleichen, und die Schwungscheibe entsprechend aufsetzen.**
- **Die Schwungscheibenbolzen auf 54 bis 59 Nm (5,5 bis 6,0 kp·m,) in diagonaler Reihenfolge festziehen.**
- **Den Zapfen der Schwungscheibenunterlegscheibe dann gegen die Bolzen drücken.**

SPEZIALWERKZEUG:
Schwungscheibenzieher (Kodenummer: 07916-06041)

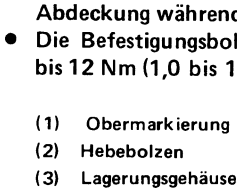


(1) Schwungscheibenzieher
(2) Kurbelwelle

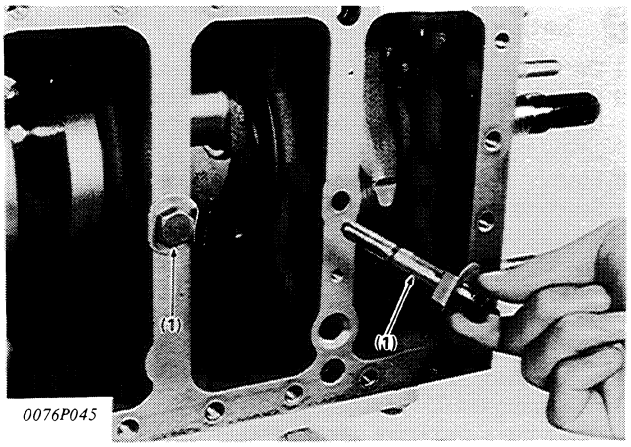
❻ Entfernen der Lagerungsgehäuseabdeckung

1) Die Montagebolzen des Lagerungsgehäuses entfernen. Zuerst die acht Bolzen der Innenseite herausschrauben, wonach die neun Außenbolzen herausgeschraubt werden können.
2) Die beiden oben entfernten Bolzen in die beiden Löcher auf der rechten und linken Seite der Lagerungsgehäuseabdeckung einschrauben, und die Abdeckung dann durch hochbocken entsprechend abnehmen.

(Anmerkung für das Zusammensetzen)
- **Beim Installieren der Hauptlagergehäuseabdeckung muß darauf geachtet werden, daß keine Kratzer an der Öl-abdichtungslippe vorhanden sind. Dann eine dünne Schicht von Maschinenöl (Motorenöl) auftragen und installieren. Unbedingt die Obermarkierung (上) auf der Abdeckung während der Installation überprüfen.**
- **Die Befestigungsbolzen in diagonaler Reihenfolge auf 10 bis 12 Nm (1,0 bis 1,2 kp·m) festziehen.**



(1) Obermarkierung (上)
(2) Hebebolzen
(3) Lagerungsgehäuseabdeckung



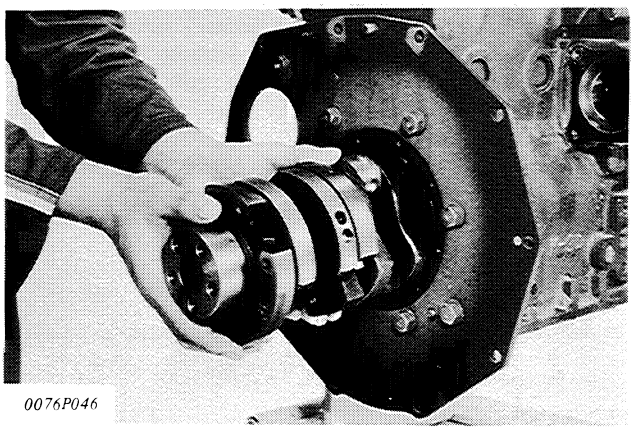
0076P045

❼ Removing Bearing Case Bolt 2

1) Straighten the washers for the bearing case bolt 2.
2) Detach the bearing case bolts.

(Note for reassembling)
- **When tightening the main bearing case bolts, align the direction of the holes so that the crankshaft can be easily installed.**
- **Tighten the bearing case bolts 2 to 30 to 34 Nm (3.0 to 3.5 kgf·m, 22 to 25 ft-lbs).**
- **Securely bend tangs of the washers.**

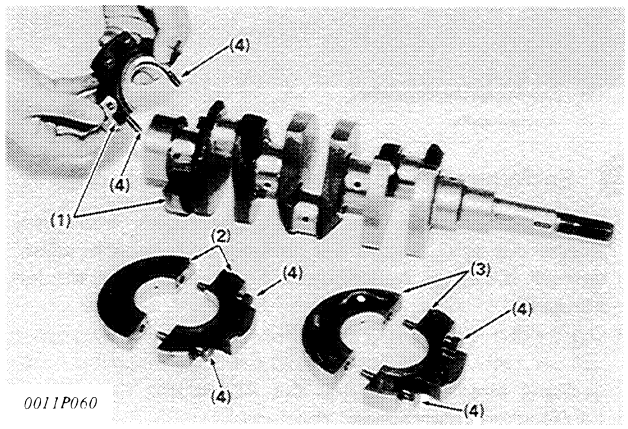
(1) Bearing case bolt 2


0076P046

❽ Removing Crankshaft

1) Draw out the crankshaft from the back of the crankcase by lightly tapping it with a copper hammer.

(Note for reassembling)
- **Before installing the crankshaft, clean the oil holes in the crankshaft with compressed air.**



0011P060

❾ Removing Main Bearing Case

1) Remove the two mounting bolts for main bearing case assembly 1.
2) Detach the main bearing case, being careful with the side and crankshaft bearings.
3) Detach the other bearing cases 2 and 3 in the same method. Be careful not to mix them up.

(Note for reassembling)
- **Clean the oil holes in the main bearing case.**
- **Install the main bearing case with their side marks toward the flywheel.**
- **Be sure to install main bearing 1 with its oil groove facing outward.**
- **Tighten the bearing case bolts 1 to 20 to 24 Nm (2.0 to 2.4 kgf·m, 15 to 17 ft-lbs).**

(1) Main bearing case assembly 1
(2) Main bearing case assembly 2
(3) Main bearing case assembly 3
(4) Bearing case bolt 1

⑦ Retrait du boulon de palier 2

1) Redresser les rondelles des 2 boulons.
2) Détacher les boulons.

(Remarques pour le remontage)
- **Au moment de serrer les boulons du palier principal, aligner les trous de façon à installer aisément le vilebrequin.**
- **Serrer les boulons de 30 à 34 Nm (3,0 à 3,5 kgf·m).**
- **Plier correctement le bord des rondelles.**

(1) Boulon du palier 2

⑧ Retrait du vilebrequin

1) Sortir le vilebrequin par l'arrière du carter en le tapotant avec un maillet de cuivre.

(Remarques pour le remontage)
- **Avant d'installer le vilebrequin, nettoyer les trous de graissage à l'air comprimé.**

⑨ Retrait du palier principal

1) Retirer les 2 boulons maintenant l'ensemble du palier 1.
2) Détacher le palier principal en prenant soin des antifrictions de côté et de vilebrequin.
3) Détacher les paliers 2 et 3 de la même facon. Veiller à ce qu'ils soient bien séparés.

(Remarques pour le remontage)
- **Nettoyer les trous de graissage du palier principal.**
- **Installer le palier avec son repère latéral vers le volant.**
- **Ne pas oublier d'installer le palier 1 avec sa rainure de graissage tournée vers l'extérieur.**
- **Serrer les boulons de 1 à 20 à 24 Nm (2,0 à 2,4 kgf·m).**

(1) Ensemble palier principal 1
(2) Ensemble palier principal 2
(3) Ensemble palier principal 3
(4) Boulon 1 de palier

⑦ Entfernen der Lagerungsgehäusebolzen 2

1) Die Unterlegscheiben der Lagerungsgehäusebolzen 2 geradebiegen.
2) Die Lagerungsgehäusebolzen entfernen.

(Anmerkung für das Zusammensetzen)
- **Beim Festziehen der Bolzen des Hauptlagerungsgehäuses, die Richtung der Löcher auf eine Weise in Übereinstimmung bringen, daß die Kurbelwelle einfach installiert werden kann.**
- **Die Bolzen auf 30 bis 34 Nm (3,0 bis 3,5 kp·m,) festziehen.**
- **Unbedingt die Zapfen der Unterlegscheiben umbiegen.**

(1) Lagerungsgehäusebolzen 2

⑧ Entfernen der Kurbelwelle

1) Die Kurbelwelle von der Rückseite des Kurbelgehäuses durch leichtes Schlagen des Gehäuses mit einem Kupferhammer herausziehen.

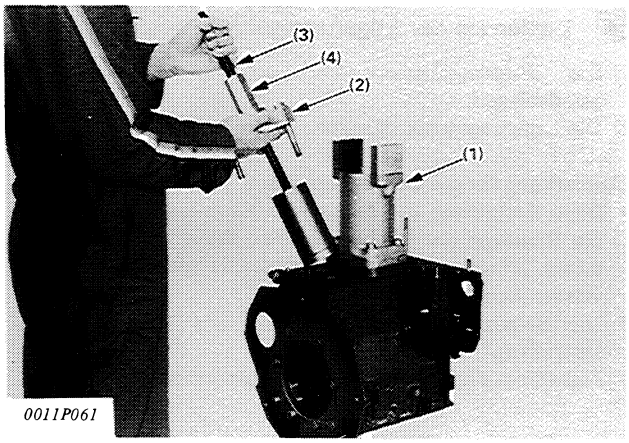
(Anmerkung für das Zusammensetzen)
- **Vor dem Installieren der Kurbelwelle, die Öllöcher der Kurbelwelle mit Druckluft reinigen.**

⑨ Entfernen des Hauptlagerungsgehäuses

1) Die beiden Befestigungsbolzen für die Hauptlagerungsgehäuseeinheit 1 entfernen.
2) Das Hauptlagerungsgehäuse entfernen, wobei auf die Seiten und das Kurbelwellenmetall geachtet werden muß.
3) Die anderen Lagerungsgehäuse auf gleiche Weise entfernen. (Gehäuse 2 und 3) Darauf achten, daß diese nicht verwechselt werden.

(Anmerkung für das Zusammensetzen)
- **Die Öllöcher des Hauptlagerungsgehäuses reinigen.**
- **Das Hauptlagerungsgehäuse mit den Seitenmarkierungen gegen die Schwungscheibe zeigend, installieren.**
- **Darauf achten, daß die Hauptlagerung 1 mit der Ölrille nach außen zeigend eingesetzt wird.**
- **Die Lagerungsgehäusebolzen auf 20 bis 24 Nm (2,0 bis 2,4 kp·m) festziehen.**

(1) Hauptlagerungsgehäuse 1
(2) Hauptlagerungsgehäuse 2
(3) Hauptlagerungsgehäuse 3
(4) Lagerungsgehäusebolzen 1



0011P061

⑩ Removing Cylinder Liner

1) Grind the cylinder head mounting surface with an oil grinding stone.
2) Set a dry liner centering base and adaptor on the frme head.
3) Set the dry liner centering base.
4) Set the bearing cradle to the dry liner centering base with the bearing on top.
5) Insert the pulling-out adaptor coupling and fix the center bolt.
6) Contact the pulling-out adaptor with the bottom of the liner from the bottom of the crankcase.
7) Pull out the liner by turning the nut with a ratchet handle.

(Important)

- **For how to use the dry liner changer, refer to the catalogue for Kubota repairing tools.**

(Note for reassembling)

- **Clean the frame holes and oil where the liner fits.**
- **Clean the surface of the liner and apply oil.**
- **Insert the liner with its most-chamfered end downward.**
- **After installation, insert a feeler gauge through the check window on the bottom of the liner centering base and check to see the liner has been properly pressed in. Tolerance: Liner projection ±0.025 mm (±0.0010 in.)**
- **Hone the cylinder liner.**
  1.2 μ R max to 2 μR max.

SPECIAL TOOL:
Dry liner changer (Code No.: 07916-30042)

(1) Dry liner centering base
(2) Bearing cradle
(3) Center bolt
(4) Nut

⑩ Retrait de la chemise de cylindre

1) Passer une pierre à huile sur la surface de fixation de la culasse.
2) Positionner une base de centrage de chemise sèche ainsi que le guide sur le couvercle du bâti.
3) Positionner une base de centrage de chemise sèche.
4) Fixer le berceau sur le socle de centrage, palier en haut.
5) Introduire l'adapteur-extracteur et fixer le boulon central.
6) Raccorder, à partir de la base du carter, le guide d'arrachage au fond de la chemise.
7) Sortir la chemise en tournant l'écrou au moyen d'une poignée à rochet.

(Important)

- **Pour l'utilisation du changeur de chemise, voir le Catalogue Kubota des outils de dépannage.**

(Remarques pour le remontage)

- **Nettoyer et huiler les trous du châssis où s'applique la chemise.**
- **Nettoyer et huiler la surface de la chemise.**
- **Introduire la chemise, extrémité la plus biseautée en bas.**
- **Après l'installation, introduire un calibre d'épaisseur par le regard du fond du socle de centrage et vérifier que la chemise a été enfoncée correctement.**
  Tolérance: saillie de chemise ± 0,025 mm
- **Passer la chemise à la pierre à huile de 1,2 μR à 2 μR max.**

OUTIL SPECIAL:
Changeur de chemise à sec (N° de code: 07916-30042)

(1) Base de centrage de chemise sèche
(2) Logement de palier
(3) Boulon central
(4) Ecrou

⑩ Entfernen der Zylinderlaufbuchse

1) Die Zylinderkopfmontagefläche mit einem Ölschleifstein entsprechend schleifen.
2) Eine trockene Buchsenzentrierbasis und Zwischenstück auf die Rahmenoberseite des Gestells einstellen.
3) Eine trockene Buchsenzentrierbasis auf das Gestell einstellen.
4) Die Lagerungswiege auf die Trockenel Laufbuchsenzentrierbasis mit oben aufgesetzter Lagerung aufsetzen.
5) Die Herausziehadaptorkupplung einsetzen und den Mittelbolzen befestigen.
6) Das Herauszieh-Zwischenstück mit dem Bodenstück der Laufbuchse vom Boden des Kurbelwellengehäuses berühren.
7) Die Laufbuchse durch Drehen der Mutter mit einer Ratsche entsprechend herausziehen.

(Wichtig)

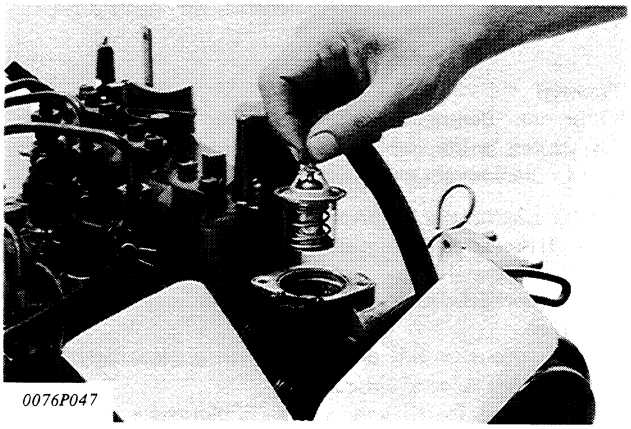
- **Für die Benutzungsweise des Trockenlaufbuchsenauswechslers sollte der Katalog für Kubota-Reparaturwerkzeuge berücksichtigt werden.**

(Anmerkung für das Zusammensetzen)

- **Die Rahmenlöcher zum Einsetzen der Laufbuchse reinigen und einölen.**
- **Die Oberfläche der Laufbuchse reinigen und entsprechend einölen.**
- **Die Laufbuchse mit der am meisten abgeschrägten Seite nach unten zeigend einsetzen.**
- **Nach dem Installieren einen Fühlermesser duch das Prüfungsfenster im Boden der Laufbuchsenzentrierbasis einführen und überprüfen, ob die Laufbuchse richtig eingedrückt wurde.**
  Toleranz: Laufbuchsenvorsprung ± 0,025mm
- **Die Zylinderlaufbuchse entsprechend abziehen.**
  1.2 μR max bis 2 μR max.

SPEZIALWERKZEUG:
Trockenlaufbuchsenauswechsler (Kodenummer: 07916-30042)

(1) Trockenlaufbuchsenzentrierbasis
(2) Führungsstück
(3) Zentralbolzen
(4) Mutter



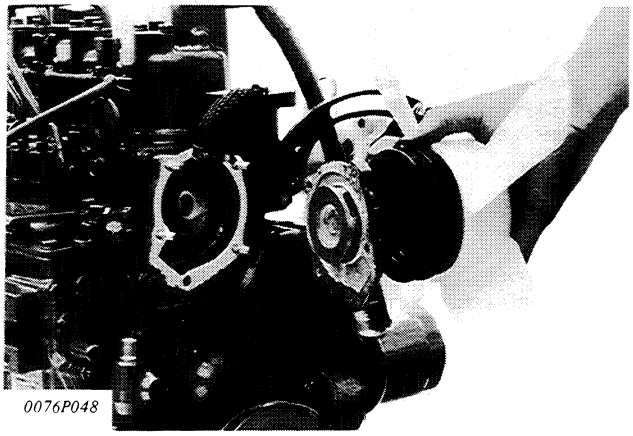
0076P047

❶ Removing Thermostat

1) Remove the thermostat cover.
2) Remove the thermostat.

(Note for reassembling)

- **Apply a non-drying adhesive only at the thermostat cover side of the gasket.**



0076P048

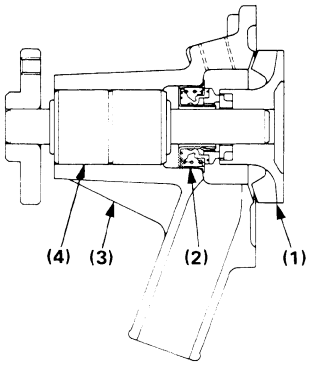
❷ Removing Water Pump

1) Remove the water pump from gear case cover.
2) Remove the fan and fan pulley.

(Important)

- **If changing the water pump, change the whole one (Code No.: 15531-7303-1)**
- **If disassembling the water pump, check to see the clearance between the water pump impeller and body.**

[A] Water pump assembly



0076P011

(1) Water pump impeller
(2) Seal set
(3) Water pump body
(4) Bearing

THERMOSTAT, POMPE A EAU

❶ Retrait du thermostat

1) Retirer le capot du thermostat.
2) Retirer le thermostat.

(Remarques pour le remontage)

- **N'appliquer un adhésif non-séchant que sur le côté du joint près de la couverture du thermostat.**

❷ Retrait de la pompe à eau

1) Retirer la pompe à eau du capot de carter de distribution.
2) Retirer le ventilateur et sa poulie.

(Important)

- **Si l'on remplace la pompe, la remplacer complètement. (N° de code: 15531-7303-1)**
- **Si l'on démonte la pompe, vérifier le jeu entre la turbine et la pompe.**

[A] Ensemble pompe à eau
(1) Turbine
(2) Joint d'étanchéité
(3) Corps de pompe
(4) Palier

THERMOSTAT, WASSERPUMPE

❶ Entfernen des Thermostats

1) Die Abdeckung des Thermostats entfernen.
2) Den Thermostat entfernen.

(Anmerkung für das Zusammensetzen)

- **Ein nicht trockenendes Klebemittel nur auf die Thermostaten-Abdeckungsseite der Dichtung auftragen.**

❷ Entfernen der Wasserpumpe

1) Die Wasserpumpe von der Getriebegehäuseabdeckung entfernen.
2) Den Ventilator und den Ventilatorriemen entfernen.

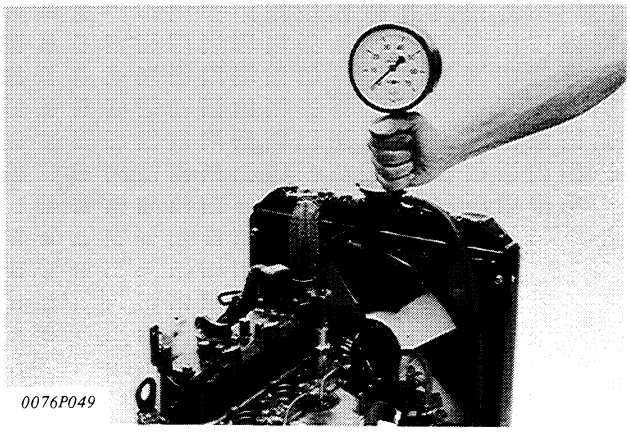
(Wichtig)

- **Beim Auswechseln der Wasserpumpe muß die gesamte Pumpeneinheit ausgewechselt werden. (Kodenummer: 15531-7303-1)**
- **Beim Zerlegen der Wasserpumpe überprüfen, ob der entsprechende Abstand zwischen dem Flugelrad und dem Gehäuse der Wasserpumpe vorhanden ist.**

[A] Wasserpumpeneinheit
(1) Wasserpumpenimpeller
(2) Abdichtungseinstellung
(3) Wasserpumpengehäuse
(4) Lagerung

3. SERVICING

CYLINDER HEAD


0076P049

❶ Checking Compression Pressure

1) Warm up the engine.
2) Remove the air cleaner and the nozzle holders from all the cylinders.
3) Set a compresson tester to the cylinder to be measured.
4) Run the engine with the starter at 200 to 300 rpm and read constant maximum on the tester. Execute the test at least twice. (Run the engine for 5 to 10 seconds for each test.)

- **For the test, use a fully charged battery and the specified valve clearance.**
- **If the compression pressure is below the given allowable limit, pour a small amount of oil through the nozzle holder hole and test again.**

■ **Judgment**

1) **If the pressure recovers to the standard level, inadequate pressure may be caused by wear or adhesion of the piston rings. Check the related points.**
2) **If the pressure does not recover, cylinder head or valve problems may be the cause. Check the related points.**
3) **If the compression differs more than 10% among the cylinders, trace the cause of pressure variation and take corrective measures.**

TEST EQUIPMENT:
Compression tester (Code No.: 07909-30201)

Reference value	
Reference compression pressure	3.09 MPa 31.5 kgf/cm^2 448 psi
Compression pressure allowable limit should be more than 75% of reference compression pressure.	2.32 MPa 23.7 kgf/cm^2 337 psi

- Difference in compression pressure among cylinders should be within 10%.

3. ENTRETIEN

CULASSE

❶ Vérification de la pression de compression

1) Faire chauffer le moteur.
2) Retirer l'épurateur d'air et les porte-injecteurs de tous les cylindres.
3) Fixer un vérificateur d'étanchéité au cylindre à examiner.
4) Régler la vitesse du moteur entre 200 à 300 tr/mn et garder un maximum constant sur le vérificateur.
   Effectuer l'essai au moins 2 fois (faire marcher le moteur entre 5 à 10 secondes chaque fois).

- **Pour l'essai, utiliser une batterie chargée au maximum, avec le jeu de soupape spécifié.**
- **Si la compression est inférieure à la norme tolérée, introduire une petite quantité d'huile par l'orifice du porte-injecteur et recommencer l'essai.**

■ **Résultat**

1) **Si la compression remonte jusqu'à la valeur normale, c'était peut-être dû à l'usure ou à un segment collé. Vérifier ces 2 points.**
2) **Si la compression ne remonte pas, des défauts de culasse ou de soupape peuvent en être la cause. Vérifier.**
3) **Si la compression varie de plus de 10% entre les cylindres, rechercher la cause de cette différence et prendre les mesures adéquates.**

MATERIEL DE VERIFICATION:
Vérificateur de compression (N° de code: 07909-30201)

Norme de référence	
Reférence de pression de compression	3,09 MPa 31,5 kgf/cm²
La limite de pression de compression doit être supérieure à 75% de la pression de référence	2,32 MPa 23,7 kgf/cm²

- La différence de pression de compression parmi les cylindres doit être inférieure à 10%.

3. WARTUNG

ZYLINDERKOPF

❶ Prüfung des Kompressionsdrucks

1) Den Motor anwärmen.
2) Die Luftfilter und Düsenhalter von allen Zylindern abnehmen.
3) Einen Kompressionsdruckprüfer an alle zu messenden Zylinder anbringen.
4) Den Motor mit dem Starter bei Umdrehungszahlen von 200 bis 300 Upm drehen lassen, und die konstanten Maximalwerte des Prüfers ablesen. Diese Überprüfung wenigstens zweimal ausführen. (Der Motor sollte für jede Überprüfung für 5 bis 10 Sekunden laufen.)

- **Bei dieser Überprüfung sollte eine vollaufgeladene Batterie und die vorgeschriebenen Ventilabstände benutzt werden.**
- **Falls sich der Kompressionsdruck unter dem erlaubten Wert befindet, eine geringe Ölmenge durch das Düsenhalterloch eingießen und erneut überprüfen.**

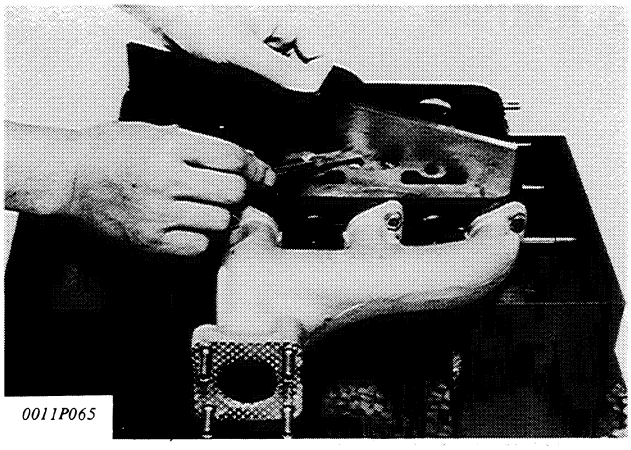
■ **Beurteilung**

1) **Gelangt der Druck durch diese Maßnahme auf den Standardwert, könnte der ungenügende Druck durch Verschleiß und Festkleben der Kolbenringe hervorgerufen worden sein. Die in Frage kommenden Teile überprüfen.**
2) **Gelangt der Druck nicht auf seinen Standardwert zurück, könnten Zylinderkopf- oder Ventilprobleme die Ursache sein. Die in Frage kommenden Teile überprüfen.**
3) **Sollte der Druck der einzelnen Zylinder gegeneinander um mehr als 10% abweichen, die Ursache dieser Druckabweichung feststellen, und entsprechende Abhilfsmaßnahmen ergreifen.**

PRÜFGERÄT:
Druckprüfgerät (Kodenummer: 07909-30201)

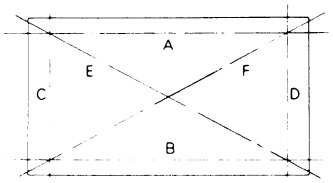
Richtwert	
Richtwert für den Verdichtungsdruck	3,09 Mpa 31,5 kp/cm²
Als zulässiger Verdichtungsdruck gelten mehr als 75% vom aufgeführten Richtwert	2,32 Mpa 23,7 kp/cm²

- Der Unterschied der Kompressionswerte zwischen den Zylindern sollte innerhalb von 10% verbleiben.



0011P065

[A] How to check cylinder head surface



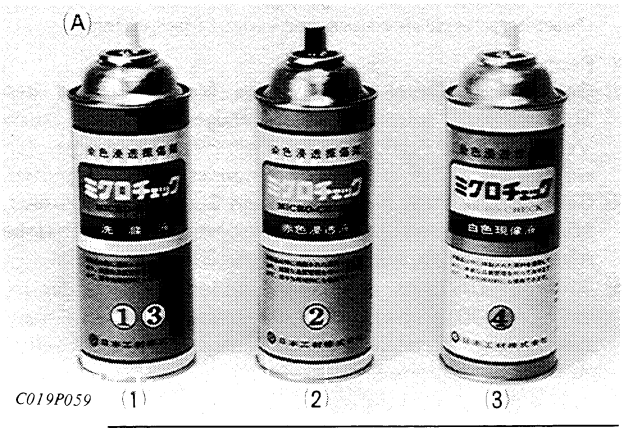
C019F013

❷ Checking Flatness of Cylinder Head Surface

1) Clean the surface of the cylinder head.
2) Place a straight edge on each of the cylinder head's four sides and two diagonally as shown at the left to check the straightness of the surface.
3) Insert a feeler gauge between the straight edge and the cylinder head surface.
4) The maximum thickness that can be inserted is the amount of flatness.
5) If the measurement exceeds the allowable limit, correct with a surface grinder.

- **Do not place the straight edge on the combustion chamber.**

Allowable limit	0.05 mm (0.002 in.) per 100 mm (4 in.) of cylinder head surface length.



C019P059

❸ Checking Flaw of Cylinder Head Surface

1) Clean the surface of the cylinder head.
2) Spray the cylinder head surface with the red permeative liquid.
3) Wash away the red permeative liquid on the cylinder head surface with the detergent.
4) Spray the cylinder head surface with the developer. If flawed, it can be identified as red marks.

Reference value	Should be no flaw.

[A] Air spray red check
(1) Detergent
(2) Red permeative liquid
(3) White developer

❷ Vérification des déformations de surface de la culasse

1) Nettoyer la surface de la culasse.
2) Placer une règle sur chacun des quatre côtés de la culasse, et deux en diagonale, comme indiqué à gauche, pour vérifier si la surface est plane.
3) Introduire un calibre d'épaisseur entre la règle et la surface de la culasse.
4) L'épaisseur maximum de calibre introduit représente la déformation.
5) Si cette épaisseur dépasse la valeur tolérée, rectifier à la polisseuse.

- **Ne pas placer la règle sur la chambre de combustion.**

Limite autorisée	0,05 mm par 100 mm de longueur de la surface de culasse.

[A] **Comment vérifier la surface de la culasse**

❸ Vérification des pailles de surface de la culasse

1) Nettoyer la surface de la culasse.
2) Pulvériser le liquide imprégnant rouge sur la surface de la culasse.
3) Retirer ce liquide de la surface de la culasse à l'aide d'un détergent.
4) Pulvériser l'agent révélateur sur la surface, les pailles vont apparaître en rouge s'il y en a.

Norme de référence	Sans paille

[A] **Vérifieation par pulvéisation rouge**
- (1) **Détergent**
- (2) **Liquide imprégnant rouge**
- (3) **Agent révélateur blanc**

❷ Überprüfung auf Verformung der Zylinderkopfoberfläche

1) Die Oberfläche des Zylinderkopfes reinigen.
2) Ein Abrichtlineal auf die vier Seiten des Zylinderkopfes legen, und zwei dieser Lineale in diagonaler Richtung auflegen, wie in der nebenstehenden Abbildung gezeigt wird, um die Ebenmäßigkeit der Zylinderkopfoberfläche zu überprüfen.
3) Einen Abstandsmesser zwischen die Abrichtlineale und der Oberfläche des Zylinderkopfes einführen.
4) Der Verziehungswert ergibt sich aus der Maximalstärke des Abstandsmessereinsatzes zwischen die Lineale und dem Zylinderkopf.
5) Sollte diese Überprüfung eine Überschreitung des erlaubten Wertes ergeben, diese mit einem Oberflächenschleifer ausgleichen.

- **Die Abrichtlineale nicht auf die Verbrennungskammer legen.**

Zugelassener Grenzwert	0,05 mm pro 100 mm der Zylinderkopf-Oberfläche.

[A] **Überprüfen der Zylinderkopfoberfläche**

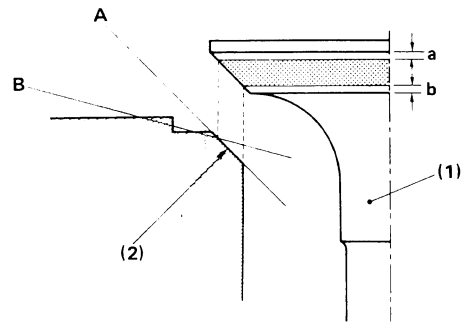
❸ Prüfung Aufrisse in der Zylinderkopfoberfläche

1) Die Oberfläche des Zylinderkopfes reinigen.
2) Die Oberfläche des Zylinderkopfes mit der roten Durchlässigkeits-Prüfflüßigkeit besprühen.
3) Die rote Prüfflüßigkeit mit einem Reinigungsmittel wieder abwaschen.
4) Die Oberfläche des Zylinderkopfes mit dem Entwickler besprühen. Wenn Risse vorhanden sind, kann man diese klar durch die rote Markierung erkennen.

Richtwert	Es sollten keine Risse auftreten.

[A] Rotes Aufsprühmittel
- (1) Reinigungsmittel
- (2) Rotes Prüfsprühmittel
- (3) Weißer Entwickler

[A] How to repair the valve seat



0075F034

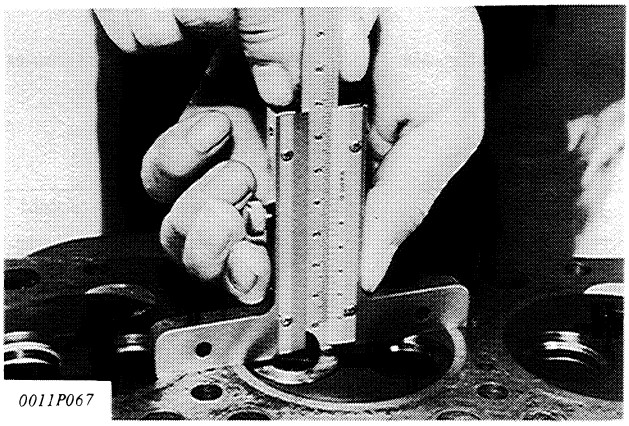
4 Repairing the Valve Seat

1) Clean the valve seat surface.
2) Use a 45° cutter suitable for the valve guide and the valve seat.
3) Grind the upper surface of valve seat with 15° cutter so that the valve seat fits to the valve center (so as to ensure a = b as shown in the figure).

(Note)

- **After correcting the valve seat, check for valve recessing.**

A 45° cutter B 15° cutter
(1) Valve (2) Corrected surface of valve seat

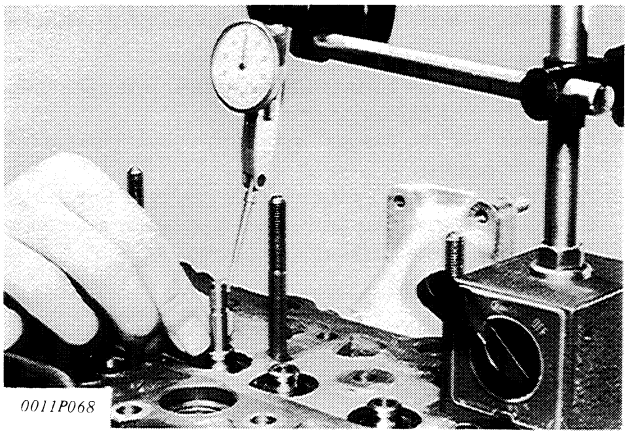


0011P067

5 Checking Valve Recessing

1) Clean the face of the valve.
2) Measure the recessing with a depth gauge.

Reference value	0.9 to 1.1 mm 0.035 to 0.043 in.
Allowable limit	1.3 mm 0.051 in.



0011P068

6 Checking Guide Clearance

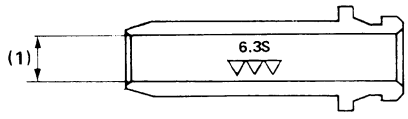
1) Remove carbon from the valve guide.
2) After making sure that the valve stem is straight, insert the valve into the valve guide.
3) Measure the stem guide clearance with a dial gauge.
4) If the measurement exceeds the allowable limit, replace the stem guide and the valve.

(Important)

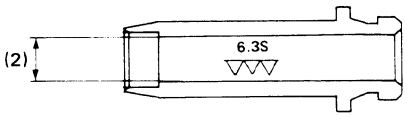
- **When changing the valve guide, be sure to ream as the figure indicates after inserting the valve guide.**

Reference value	0.035 to 0.065 mm 0.0014 to 0.0026 in.
Allowable limit	0.1 mm 0.004 in.

[A] Finishing size of inlet valve guide



[B] Finishing size of exhaust valve guide



0075F035

(1) 7.010 to 7.025mm
0.2760 to 0.2766 in.
(2) 7.010 to 7.025mm
0.2760 to 0.2766 in.

❹ Réparation du siège de soupape

1) Nettoyer la surface du siège de soupape.
2) Se servir d'une fraise conique d'angle à 45° qui convient au guide de soupape et au siège de soupape.
3) Rectifier la surface supérieure du siège de soupape à l'aide d'une fraise de 15° de façon à ce que le siège de soupape s'adapte au centre de la soupape (ainsi, s'assurer de a = b comme le montre la figure).

(Note)

- **Après avoir rectifié le siège de soupape, vérifier l'abaissement de la soupape.**

[A] Comment réparer le siège de soupape
A Fraise conique à angle de 45° B Fraise conique à angle de 15°
(1) Soupape (2) Surface rectifiée du siège de soupape

❺ Vérification du recul de la soupape

1) Nettoyer la surface de la soupape.
2) Mesurer le recul avec une jauge de profondeur.

Norme de référence	0,9 à 1,1 mm
Limite autorisée	1,3 mm

❻ Vérification du jeu du guide

1) Enlever le charbon de la surface du guide.
2) Après avoir vérifié que la queue de soupape est droite, introduire la soupape dans le guide.
3) Mesurer le jeu du guide de queue avec une jauge à indicateur.
4) Si la valeur indiquée dépasse la tolérance, remplacer le guide et la soupape.

(Important)

- **En remplaçant les guides de soupape, s'assurer qu'ils sont placés comme indiqué sur la figure.**

Norme de référence	0,035 à 0,065 mm
Limite autorisée	0,1 mm

[A] Guide de la soupape d'admission — Mesures finales
(1) 7,010 à 7,025 mm
[B] Guide de la soupape d'échappement — Mesures finales
(2) 7,010 à 7,025 mm

❹ Reparatur des Ventilsitzes

1) Die Oberfläche des Ventilsitzes entsprechend reinigen.
2) Einen für die Ventilführung und den Ventilsitz vorgesehenen 45° —Schneider verwenden.
3) Die Oberfläche des Ventilsitzes mit Hilfe von einem 15° Schneidwerkzeug schleifen, so daß der Ventilsitz auf die Ventilmitte paßt (um a = b, wie in der Abbildung gezeigt, zu versichern).

(Anmerkung)

- **Nach Berichtigen des Ventilsitzes die Ventilsenkung überprüfen.**

[A] Reparieren des Ventilsitzes
A 45°-Schneider B 15°-Schneider
(1) Ventil (2) Korrigierte Oberfläche des Ventilsitzes

❺ Prüfung des Ventilrücksprungs

1) Die Ventilvorderseite (face) reinigen.
2) Den Ventilrücksprung mit einem Tiefenmesser messen.

Richtwert	0,9 bis 1,1 mm
Zugelassener Grenzwert	1,3 mm

❻ Prüfung des Ventilabstands

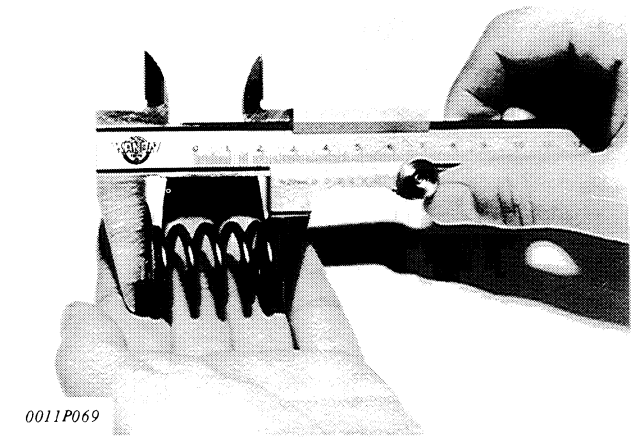
1) Kohlenreste von der Ventilführung entfernen.
2) Nach Vergewissern, daß der Ventilstab gerade ist, das Ventil in die Ventilführung einsetzen.
3) Den Stabführungsabstand mit einem Skalenmesser messen.
4) Falls diese Überprüfung überschreitende Grenzwerte ergibt, die Stabführung und das Ventil austauschen.

(Wichtig)

- **Beim Auswechseln der Ventilführungen muß darauf geachtet werden, daß diese gemäß der Abbildung eingesetzt werden.**

Richtwert	0,035 bis 0,065 mm
Zugelassener Grenzwert	0,1 mm

[A] Endabmessungen der Einlaßventilführung
(1) 7,010 bis 7,025 mm
[B] Endabmessungen der Ausstoßventilführung
(2) 7,010 bis 7,025 mm

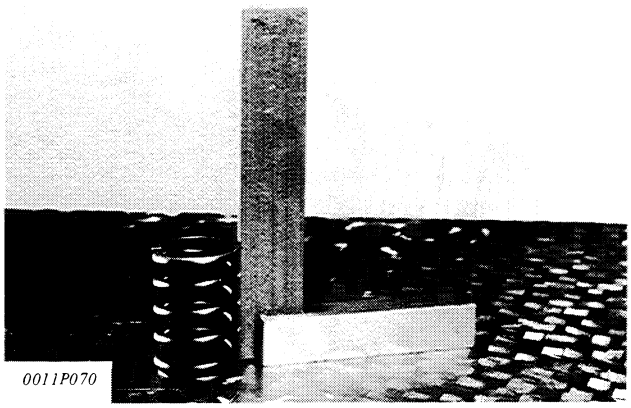


0011P069

⑦ Checking Valve Spring Free Length

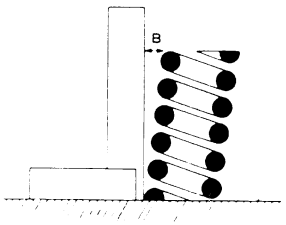
1) Measure the spring with a set of vernier calipers.
2) If the measurement exceeds the allowable limit, replace.

Reference value	35.1 to 35.6 mm 1.382 to 1.402 in.
Allowable limit	34.8 mm 1.37 mm



0011P070

[A] How to measure squareness of valve spring

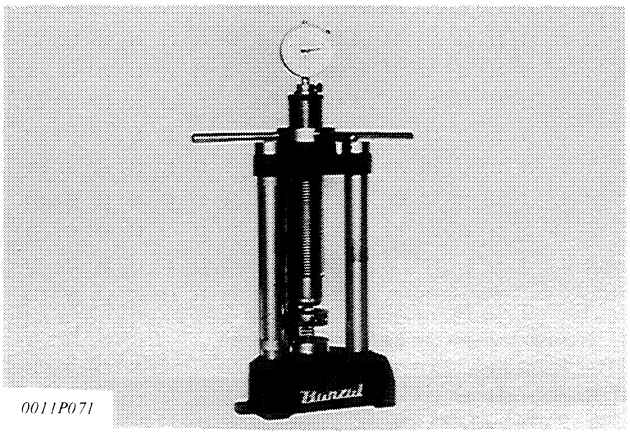


C019F021

⑧ Checking Valve Spring Squareness

1) Put the spring on a surface plate, place a square on the side of the spring, and check to see if the entire side is in contact with the square.
2) Rotate the spring and measure the maximum B. (See the illustration at left.)
3) If the measurement exceeds the allowable limit, replace. The flat surface at the end of the spring coil must exceed the full circumference by two-thirds.
   Check the entire surface of the spring for scratches.

Allowable limit	1.3 mm 0.051 in.



0011P071

⑨ Checking Valve Spring Tension

1) Place the spring on a tester and compress it to the same degree that it is actually compressed in the engine. (31mm, 1.2in.)
2) Read the compression load on the gauge.
3) If the measurement exceeds the allowable limit, replace.

Reference value	74 N/31 mm 7.5 kgf/31 mm 16.5 lbs/1.22 in.
Allowable limit	63 N/31 mm 6.4 kgf/31 mm 14.1 lbs/1.22 in.

❼ Vérification de la longueur libre du ressort

1) Mesurer le ressort au pied à coulisse.
2) Si la limite tolérée est dépassée, le remplacer.

Norme de référence	35,1 à 35,6 mm
Limite autorisée	34,8 mm

❽ Vérification de la perpendicularité du ressort

1) Placer le ressort sur un marbre, placer une équerre le long pour vérifier si tout le côté est en contact avec elle.
2) Tourner le ressort et mesurer pour obtenir la plus grande dimension B (cf. illustration).
3) Si la tolérance est dépassée, remplacer.
   La surface plane en bout de ressort doit être supérieure des 2/3 à la circonférence totale.
   Vérifier la surface totale du ressort pour les rayures.

Limite autorisée	1,3 mm

[A] **Comment mesurer la verticalité du ressort de soupape**

❾ Vérification de la tension du ressort

1) Placer le ressort sur un vérificateur avec lequel on le comprime de la même façon qu'il est comprimé dans le moteur. (31 mm)
2) Lire la mesure indiquée.
3) Si cette mesure dépasse la tolérance, remplacer.

Norme de référence	74 N/31 mm 7,5 kgf/31 mm
Limite autorisée	63 N/31 mm 6,4 kgf/31 mm

❼ Prüfung der Freilänge der Ventilspirale

1) Die Spirale mit einer Schublehre abmessen.
2) Falls die Spirale nicht innerhalb des Richtwertes sein sollte, muß diese ausgewechselt werden.

Richtwert	35,1 bis 35,6 mm
Zugelassener Grenzwert	34,8 mm

❽ Prüfung der Gradlinigkeit der Ventilspirale

1) Die Spirale auf eine gerade Oberfläche stellen, einen Winkel gegen die Spiralenseite geben und überprüfen, ob die gesamte Seite Kontakt mit dem angesetzten Winkel hat.
2) Die Spirale herumdrehen, und den Maximalabstand "B" messen. (Siehe nebenstehende Abbildung).
3) Falls die Messungen Überschreitungen der erlaubten Werte ergeben, die Ventilspirale auswechseln.
   Die gerade Fläche am Spiralenende muß den vollen Umfang um zwei Drittel überschreiten.
   Die gesamte Spirale auf Kratzer überprüfen.

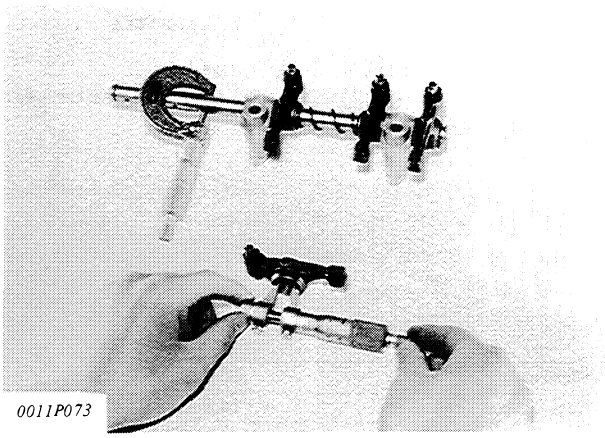
Zugelassener Grenzwert	1,3 mm

[A] **Messen der Gradlinigkeit der Ventilspirale**

❾ Prüfung des Ventilspiralendrucks

1) Die Spirale in ein Prüfgerät einsetzen und auf gleiche Weise zusammendrücken, wie sie normalerweise im Motor zusammengedrückt wird (31 mm).
2) Den Kompressionsdruckwert auf dem Meßgerät ablesen.
3) Falls die Messung Überschreitungen der erlaubten Werte ergibt, die Ventilspirale auswechseln.

Richtwert	74 N/31 mm 7,5 kp/31 mm
Zugelassener Grenzwert	63N/31 mm 6,4 kp/31 mm

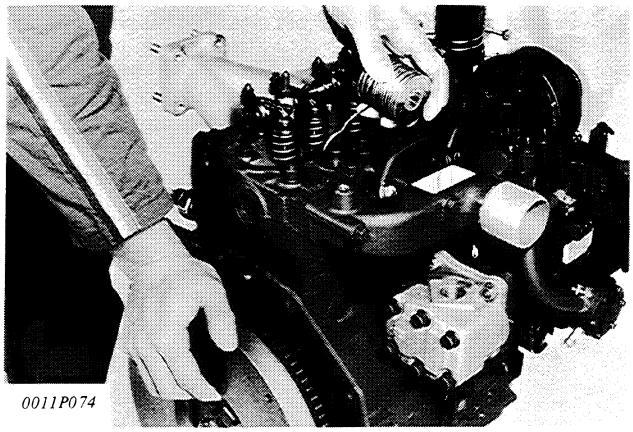


0011P073

⑩ Checking Oil Clearance between Rocker Arm Shaft and Bushing

1) Measure the rocker arm I.D.
2) Measure the rocker arm O.D.
3) If the clearance exceeds the allowable limit, replace.

Reference value	0.013 to 0.065 mm 0.0005 to 0.0026 in.
Allowable limit	0.12 mm 0.0047 in.
Rocker arm shaft O.D.	10.973 to 10.984 mm 0.4320 to 0.4324 in.
Rocker arm bushing I.D.	10.997 to 11.038 mm 0.4330 to 0.4346 in.



0011P074

⑪ Checking Top Clearance

1) Remove the nozzle holder.
2) Lower the piston in the cylinder to be measured.
3) Insert a high-quality fuse from the nozzle holder hole. Be careful not to let the fuse touch the valve surface.
4) Rotate the engine with your hand.
5) Take the fuse out carefully.
6) Measure the place where the fuse was crushed with vernier calipers.
7) If the clearance is not within the reference value, adjust by inserting a shim between the cylinder head and the gasket.

Reference value	0.6 to 0.8 mm 0.0236 to 0.0315 in.
Thickness of gasket when tightened	1.05 to 1.15 mm 0.0413 to 0.0453 in.
Thickness of gasket shim	0.20 mm 0.0079 in.

⑩ Vérification de l'écartement entre l'arbre de culbuteur et le coussinet

1) Mesurer le diamètre intérieur des coussinet del'arbre de culbuteur.
2) Mesurer le diamètre intérieur des coussinets de l'arbre de calculer l'écartement.
3) Si la mesure dépasse la tolérance, remplacer.

Norme de référence	0,013 à 0,065 mm
Limite autorisée	0,12 mm

D.E. de l'arbre de culbuteur	10,973 à 10,984 mm
D.I. du coussinet	10,997 à 11,038 mm

⑪ Vérification de la chasse supérieure

1) Retirer le porte-injecteur.
2) Abaisser le piston dans le cylindre à vérifier.
3) Introduire un plomb de grande qualité par le trou du porte-injecteur. Veiller à ce qu'il ne touche pas la surface de soupape.
4) Faire tourner le moteur à la main.
5) Retirer le plomb délicatement.
6) Mesurer au pied à coulisse l'endroit où le plomb a été écrasé.
7) Si la tolérance n'est pas atteinte, rectifier en introduisant une cale entre la culasse et le joint.

Norme de référence	0,6 à 0,8 mm

Epaisseur du joint	1,05 à 1,15 mm
Epaisseur de la cale	0,20 mm

⑩ Prüfung des Ölabstands zwischen der Kipphebelwelle und Buchse

1) Den Innendurchmesser der Kipphebelwellenbuchse messen.
2) Den Außendurchmesser der Kipphebelwelle messen und den Abstand errechnen.
3) Falls die Messungen Überschreitungen der erlaubten Werte ergeben sollten, entsprechend auswechseln.

Richtwert	0,013 bis 0,065 mm
Zugelassener Grenzwert	0,12 mm

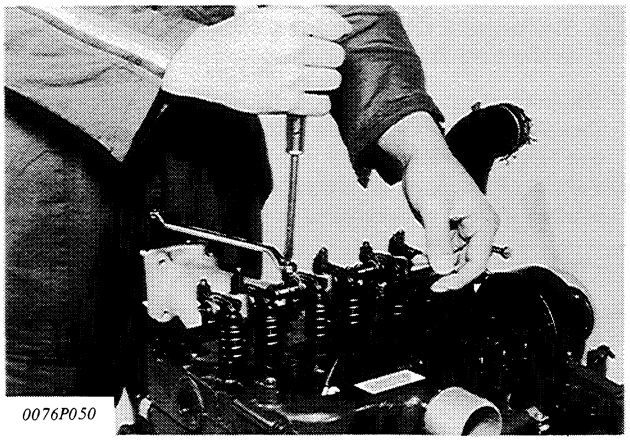
Außendurchmesser der Kipphebelwelle	10,973 bis 10,984 mm
Innendurchmesser der Kipphebelbuchse	10,997 bis 11,038 mm

⑪ Prüfung des Oberabstands

1) Den Düsenhalter entfernen.
2) Den Kolben in den Zylinder einsenken, der zu messen ist.
3) Einen Luntendraht (fuse) einer hohen Qualitätsstufe durch das Düsenhalterloch einführen. Dabei darauf achten, daß der Draht die Oberfläche des Ventils nicht berührt.
4) Den Motor dann mit der Hand drehen.
5) Den Draht vorsichtig herausnehmen.
6) Die Stelle an der der Draht zerquetscht wurde mit einer Schublehre messen.
7) Falls diese Messung Werte ergibt, die nicht innerhalb der Vergleichswerte sind, ein Einpaßstück zwischen Zylinderkopf und Abdichtung einsetzen.

Richtwert	0,6 bis 0,8 mm

Stärke der Dichtung nach Festziehen	1,05 bis 1,15 mm
Stärke des Dichtungeinpaßstückes	0,20 mm



0076P050

⑫ Adjusting Valve Clearance

1) Measure the clearance with a feeler gauge after aligning each cylinder with the top dead center of compression.

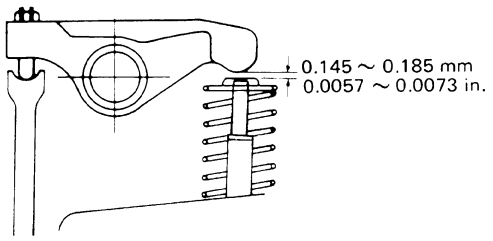
(Note)

- **Align the flywheel mark (TC) with the timing check mark on the crankcase.**

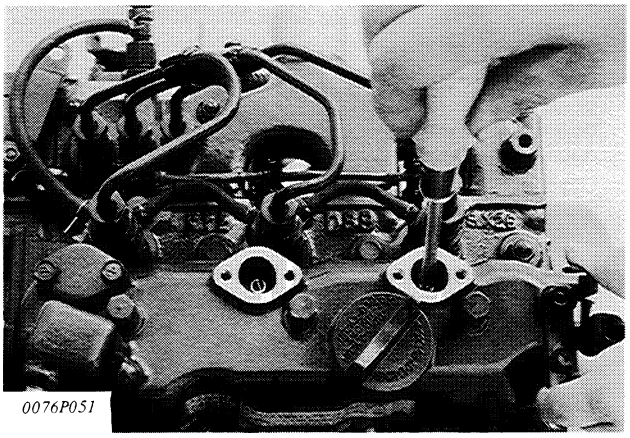
Reference value	0.145 to 0.185 mm 0.0057 to 0.0073 in.

• For either intake or exhaust valve (when cool)

[A] Valve clearance



C019F026



0076P051

⑬ Adjusting Compression Release

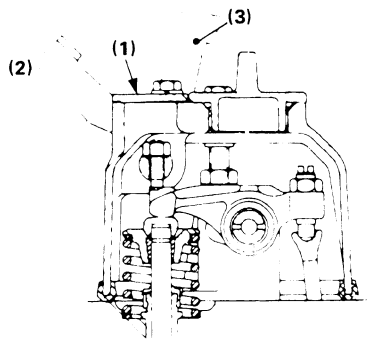
1) Close the exhaust valve completely.
2) Remove the compression release window cover from the head cover.
3) Pull the compression release lever.
4) Reduce the valve clearance to zero by the compression release adjustment bolt. Reach for the bolt through the window. Then, screw in the bolt by 1 to 1.5 turns and tighten the lock nut.

(Note)

- **After adjustment, turn the crankshaft by hand and check to see that the valve and the piston should not be in contact with each other.**

Reference value	0.750 to 1.125 mm 0.0295 to 0.0443 in.

[A] Compression release adjustment



0011F018

(1) Compression release window cover
(2) Compression position
(3) Compression release position

⑫ Ajustement du jeu des soupapes

1) Mesurer le jeu au calibre après avoir aligné chaque cylindre sur le haut de course.

(Remarque)

- **Aligner le repère (TC-Haut de course du premier piston) du volant sur le repère de vérification de la distribution se trouvant sur le carter du moteur.**

Norme de référence	0,145 à 0,185 mm

• Pour soupapes d'admission et d'échappement (à froid)

[A] Jeu des Soupapes

⑫ Einstellen des Ventilabstands

1) Nach Abgleich jedes Zylinders auf obere Kompressionsmittelstellung, die Abstände mit einem Abstandsmesser ausmessen.

(Anmerkung)

- **Die Schwungradmarkierung mit der Taktgebermarkierung auf dem Kurbelgehäuse in Übereinstimmung bringen.**

Richtwert	0,145 bis 0,185 mm

• Entweder für Einlaß- oder Auslaßventil (im Kaltzustand)

[A] Ventilspiel

⑬ Réglage de la décompression

1) Fermer entièrement la soupape d'échappement.
2) Retirer le capot de décompression du capot de tête.
3) Tirer le levier de décompression.
4) Réduire à zéro le jeu de soupape au moyen du boulon de réglage de la décompression, atteint par le regard. Puis, visser ce boulon d'un tour ou un tour et demi et serrer le contre-écrou.

(Remarque)

- **Après avoir procédé à l'ajustment, tourner le vilebrequin à la main et s'assurer que la soupape et le piston ne se touchent pas, ce qui pourrait se produire si l'espace libre était trop réduit.**

Norme de référence	0,750 à 1,125 mm

[A] Réglage de la décompression
(1) Capot de décompression
(2) Position de compression
(3) Position de décompression

⑬ Einstellung der Kompressionsbefreiung

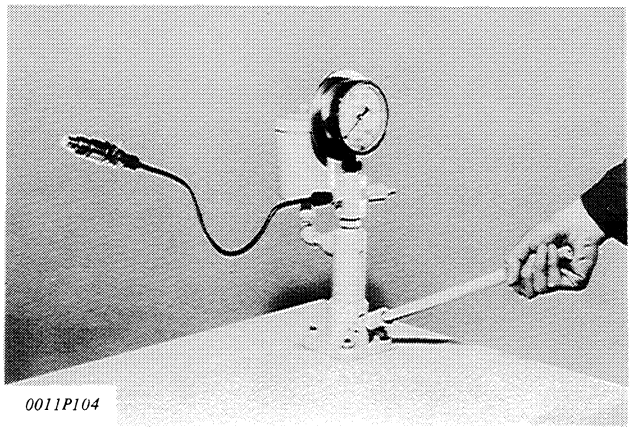
1) Das Auslaßventil völlig schließen.
2) Die Fensterabdeckung der Kompressionsbefreiung entfernen.
3) Den Kompressionsbefreiungshebel ziehen.
4) Den Ventilabstand auf Null, durch Einstellung des Einstellbolzen der Kompressionsbefreiung, reduzieren. Der Bolzen kann durch das Fenster erreicht werden. Den Bolzen dann um 1 bis 1,5 Umdrehungen einschrauben und die Verriegelungsmutter festziehen.

(Anmerkung)

- **Nach Ausrichtung, die Kurbelwelle mit der Hand drehen und prüfen, daß das Ventil und der Kolben nicht in Berührung miteinander kommen, sonst ist der Senkungs-Abstand zu klein.**

Richtwert	0,750 bis 1,125 mm

[A] Einstellung der Kompressionsbefreiung
(1) Fensterabdeckung der Kompressionsbefreiung
(2) Kompressionsposition
(3) Kompressionsbefreiungsposition



0011P104

❶ Testing Opening Pressure of Nozzle

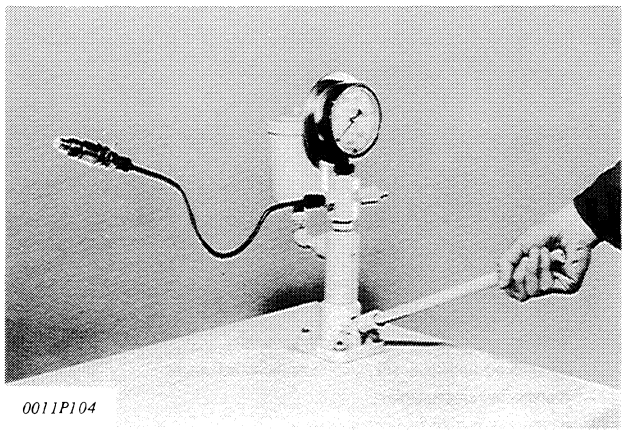
1) Move the tester handle up and down to prime fuel. Measure the pressure of fuel jetting from the nozzle tip.

2) If the measurement is not within the reference value, adjust with the adjustment washer inside the nozzle holder. (See page 122) Each extra 0.1 mm (0.0039 in.) of washer thickness causes an approximate 980.6 kPa (10 kgf/cm^2, 142.2 psi) increase in fuel injection pressure.

(Danger)

- **Be careful not to come into direct contact with the injected fumes.**
  The fumes destroy any cells they may touch. They may also cause blood poisoning.

Reference value	13.7 to 14.7 MPa 140 to 150 kgf/cm^2 1990 to 2133 psi



0011P104

❷ Checking Fuel Tightness of Nozzle Valve Seat

1) Apply a pressure 12.7 MPa (130 kgf/cm^2, 1848.6 psi).
2) After keeping the nozzle under this pressure for 10 seconds, check to see if fuel leaks from the nozzle valve seat.
3) If fuel should leak, replace the nozzle piece.

Reference value
When the pressure is 12.7 MPa (130 kgf/cm^2, 1848.6 psi), m the valve seat must be oil-tight.

SYSTEME DE DISTRIBUTION DU COMBUSTIBLE

❶ Vérification de la pression d'ouverture de l'injecteur

1) Lever et baisser le levier du vérificateur pour appeler le carburant. Mesurer la pression du carburant qui jaillit de l'injecteur.
2) Si la mesure est inférieure à la tolérance, ajuster au moyen de la rondelle de réglage qui est à l'intérieur du porte-injecteur gicleur. (Cf. page 122) Une augmentation de 0,1 mm de l'épaisseur de la rondelle amène une élévation d'environ 980,6 kPa (10 kgf/cm²) de la pression d'injection.

(Attention)

- **Veiller à ce que les vapeurs d'injection ne vous atteignent pas.**
  Celles-ci détruisent les cellules qu'elles touchent et peuvent aussi provoquer un empoisonnement du sang.

Norme de référence	13,7 à 14,7 MPa 140 à 150 kgf/cm²

❷ Vérification de l'étanchéité du siège de soupape de l'injecteur

1) Appliquer une pression de 12,7 MPa (130 kgf/cm²).
2) Après avoir laissé le gicleur 10 secondes sous cette pression, vérifier si du carburant fuit par le siège de soupape de l'injecteur.
3) Remplacer en cas de fuite.

Norme de référence
Le siège de la soupape doit être étanche à l'huile lorsque la pression est de 12,7 MPa (130 kgf/cm²)

TREIBSTOFFSYSTEM

❶ Prüfung des Düsenbetriebsdrucks

1) Den Prüfgerätegriff hoch und herunterbewegen, um Treibstoff zu pumpen. Den Treibstoffdruck von der Düsenspitze messen.
2) Falls diese Überprüfung Werte ergeben sollte, die von den Vergleichswerten abweichen, entsprechende Einstellungen mit der Einstellscheibe im Düsenhalter vornehmen. (Siehe Seite 122) Eine Erhöhung von jeweils 0,1 mm der Scheibenstärke verursacht eine Erhöhung von ungefähr 980,6 kPa (10 kp/cm²) des Einspritzdruckes.

(Gefahr)

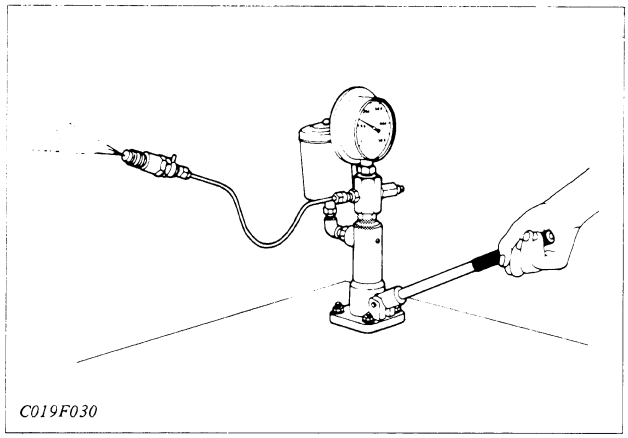
- **Darauf achten, daß Personen nicht in direkten Kontakt mit der eingespritzten Zerstäubungsmasse kommen.**
  Die Zerstäubungsdämpfe zerstören jede mit ihnen in Berührung kommende Zelle.
  Diese Zerstäubungsdämpfe können außerdem auch Blutvergiftungen hervorrufen.

Richtwert	13,7 bis 14,7 MPa 140 bis 150 kp/cm²

❷ Prüfung Treibstoffdichte des Düsenventilsitzes

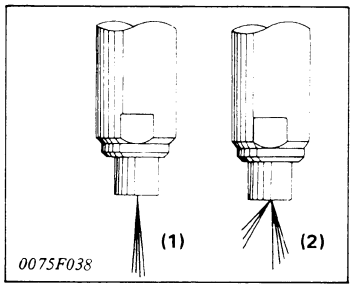
1) Einen Druck um 12,7 MPa (130 kp/cm²) geringer als den Öffnungsdruck eingeben.
2) Nachdem die Düse unter diesem Druck für 10 Sekunden gehalten wurde, überprüfen ob Treibstoff vom Düsenventilsitz aussickern kann.
3) Sollte Treibstoff aussickern, das Düsenstück auswechseln.

Richtwert
Wenn der Druck 12,7 MPa (130 kp/cm²) ist, so muß der Ventilsitz öldicht sein.

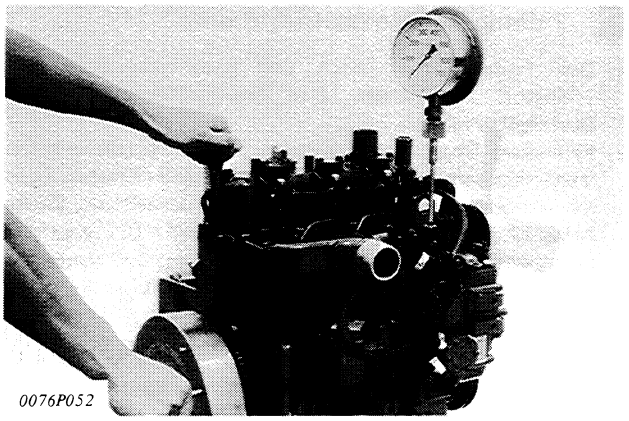


❸ Checking Shape of Fumes Across Nozzle Tip

1) Set the nozzle to a nozzle tester and shoot it in the air. Check the shape of the fumes.
2) If the shape is defective, replace the nozzle piece.



(1) Good
(2) Bad



❹ Checking Fuel Tightness of Pump Element

1) Set a pressure tester to the fuel injection pump.
2) Rotate the flywheel to increase the pressure to 39.23MPa (400 kgf/cm^2, 5689 psi).
3) Align the plunger with the top dead center.
4) Measure the time needed to decrease the pressure from 39.23 to 34.32 MPa (from 400 to 350 kgf/cm^2, from 5689 to 4978 psi).
5) If the measurement is less than allowable limit, replace the pump element or the injection pump assembly.

Fuel tightness of pump element	Reference value	60 seconds or more 39.23 MPa → 34.32 MPa 400 kgf/cm^2 → 350 kgf/cm^2 5689 psi → 4978 psi
	Allowable limit	30 seconds 39.23 MPa → 34.32 MPa 400 kgf/cm^2 → 350 kgf/cm^2 5689 psi → 4978 psi

■ Important:

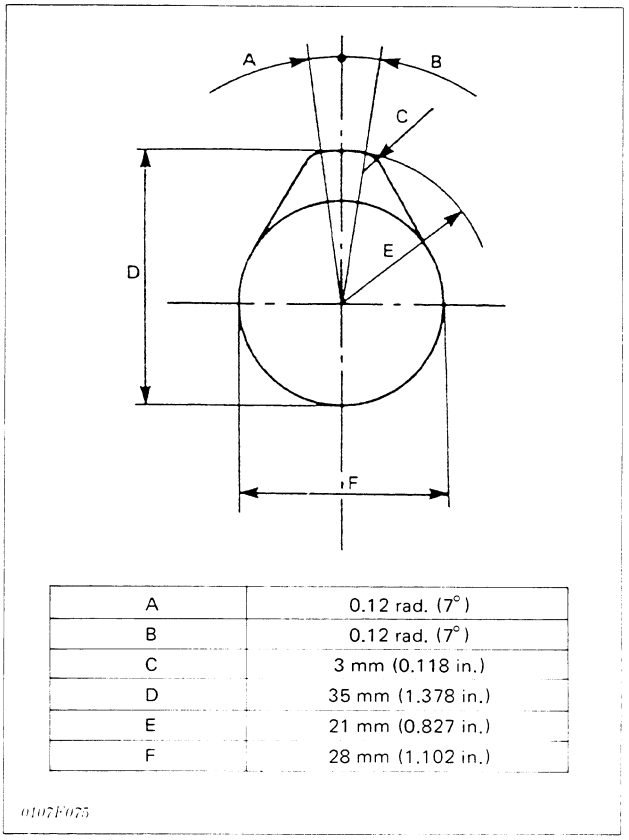
- After replacing the pump element, be sure to adjust amount of fuel injection using a pump tester and a test bench [DIESEL KIKI CO. LTD: Code No. 105760-0010 (for 50Hz) or 105760-0020 (for 60Hz)].

[Test Conditions]

Driving stand	DIESEL KIKI CO. LTD: Code No. 105781-4150
Nozzle	DN12SD12T
Opening pressure	11.77 MPa [120 kgf/cm^2, 1707 psi]
Injection pipe	6 mm dia. x 2 mm dia. x 600 mm long 0.24 in. dia. x 0.08 in. dia. x 23.62 in. long
Fuel feed pressure	49 kPa [0.5 kgf/cm^2, 7 psi]
Test fuel	Diesel fuel No. 2-D
Pre-stroke	2.15 to 2.25 mm, 0.0846 to 0.0886 in.
Cam profile	PFK-T-00 (See figure)

[Adjustment Reference Data]

Control rack position (mm)	Speed (r.p.m.)	Amount of fuel (CC/100st)
a + 2	1400	2.21 to 2.55
a	1400	1.52 to 1.58
a − 1	1400	0.95 to 1.35
a − 1	400	0.45 to 0.77



A	0.12 rad. (7°)
B	0.12 rad. (7°)
C	3 mm (0.118 in.)
D	35 mm (1.378 in.)
E	21 mm (0.827 in.)
F	28 mm (1.102 in.)

❸ Vérification du nuage sortant de l'ajutage de l'injecteur

1) Fixer un vérificateur à l'injecteur et le faire gicler en l'air. Vérifier la forme du nuage.
2) Si elle n'est pas satisfaisante, remplacer cet télément de l'injecteur.



(1) Bonne
(2) Mauvaise

❹ Vérification de l'étanchéité au carburant de l'élément de pompe

1) Mettre un manomètre sur la pompe d'injection.
2) Faire tourner le volant pour augmenter la pression jusqu'à 39,23 MPa (400 kgf/cm^2).
3) Aligner le plongeur sur le point mort haut.
4) Mesurer le temps nécessaire pour faire diminuer la pression de 39,23 à 34,32 MPa (de 400 à 350 kgf/cm^2).
5) Si la mesure est inférieure à la tolérance, remplacer l'élément de pompe ou l'ensemble de pompe d'injection.

Etanchéité au carburant de l'élément de pompe	Valeur de référence	60 secondes ou plus (39,23 MPa → 34,32 MPa / 400 kgf/cm^2 → 350 kgf/cm^2)
	Tolérance	30 secondes (39,23 MPa → 34,32 MPa / 400 kgf/cm^2 → 350 kgf/cm^2)

■ Important:

- Après avoir remplacé l'élément de pompe, veiller à régler le débit d'injection avec un appareil d'essai pour pompes et un banc d'essai [DIESEL KIKI Co. LTD: Référence 105760-0010 (pour 50 Hz) ou 105760-0020 (pour 60 Hz)].

[Conditions d'essai]

Banc d'entrainement	DIESEL KIKI Co. LTD: Référence 105781-4150
Gicleur	DN 12SD 12T
Pression d'ouverture	11,77 MPa [120 kgf/cm^2]
Conduit d'injection	dia. 6 mm x dia. 2 mm x long. 600 mm
Pression d'alimentation	49 kPa [0,5 kgf/cm^2]
Carburant d'essai	Carburant diesel N° 2-D
Course préalable	2,15 à 2,25 mm
Profil de came	PFK-T-00 (Voir figure)

[Données de référence de réglage]

Position de la crémaillère pilotage (mm)	Régime tr/mn	Quantité de carburant (cc/100 course)
a + 2	1400	2,21 à 2,55
a	1400	1,52 à 1,58
a − 1	1400	0,95 à 1,35
a − 1	400	0,45 à 0,77

❸ Prüfung der Zerstäubungsform über die Düsenspitze

1) Die Düse an einem Düsentester befestigen und in die Luft spritzen lassen. Die Form der Zerstäubung überprüfen.
2) Falls die Zerstäubungsform nicht den Anforderungen entspricht, sollte das Düsenstück ausgewechselt werden.

(1) Gut
(2) Schlecht

❹ Prüfung der Kraftstoffdichtigkeit des Pumpenelementes

1) Einen Druckmesser an der Kraftstoff-Einspritzpumpe anschließen.
2) Das Schwungrad drehen, um den Druck auf 39,23 MPa (400 kp/cm^2) zu erhöhen.
3) Den Tauchkolben mit dem oberen Totpunkt ausrichten.
4) Die Zeit messen, die erforderlich ist, damit der Druck von 39,23 auf 34,32 MPa (von 400 auf 350 kp/cm^2) abfällt.
5) Wenn die Messung unter dem zulässigen Grenzwert liegt, das Pumpenelemente oder die Einspritzpumpe austauschen.

Kraftstoffdichtigkeit des Pumpenelementes	Bezugswert	60 Sekunden oder mehr (39,23 MPa → 34,32 MPa / 400 kp/cm^2 → 350 kp/cm^2)
	Zulässiger Grenzwert	30 Sekunden (39,23 MPa → 34,32 MPa / 400 kp/cm^2 → 350 kp/cm^2)

■ Wichtig:

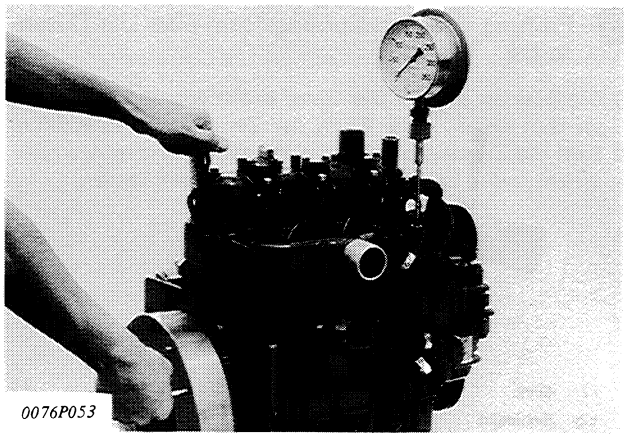
- Nach Austausch des Pumpenelementes muß die Kraftstoffeinspritzung mit Hilfe eines Pumpenprüfgerätes [DIESEL KIKI CO., LTD.: Code Nr. 105760-0010 (für 50Hz) oder 105760-0020 (für 60Hz)] eingestellt werden.

[Prüfbedingungen]

Antriebseinheit	DIESEL KIKI CO., LTD.: Code Nr. 105781-4150
Düsen	DN 12 SD 12T
Öffnungsdruck	11,77 MPa [120 kp/cm^2]
Einspritzleitung	6 mm Durchm. x 22 mm Durchm. x 600 mm Länge
Kraftstoff-Förderdruck	49 kPa [0,5 kp/cm^2]
Prüfkraftstoff	Dieselkraftstoff Nr. 2-D
Vorhub	2,15 bis 2,25 mm
Nockenprofil	PFK-T-00 (Siehe Abbildung)

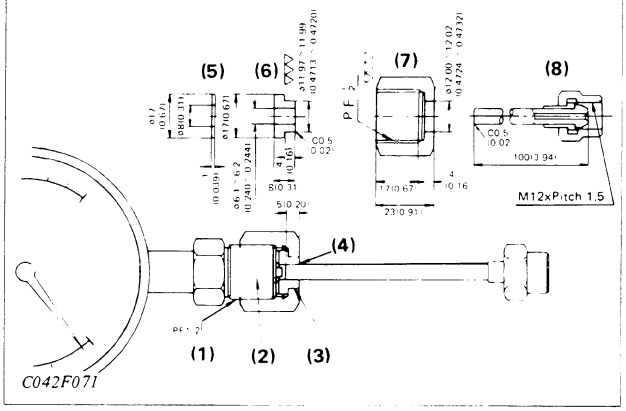
[Bezugsdaten der Einstellung]

Position Regelstange (mm)	Geschwindigkeit (U/min.)	Kraftstoffmenge (ccm/100st)
a + 2	1400	2,21 bis 2,55
a	1400	1,52 bis 1,58
a − 1	1400	0,95 bis 1,35
a − 1	400	0,45 bis 0,77



0076P053

[A] **Pressure gauge construction** Unit: mm (in.)



C042F071

❺ Checking Fuel Tightness of Delivery Valve of Fuel Injection Pump

1) Set a pressure gauge to the pump.
2) Rotate the flywheel to increase the pressure to 21.57 MPa (220 kgf/cm^2, 3129 psi).
3) Align the plunger with the bottom dead center.
4) Measure the time needed to decrease the initial pressure from 21.57 to 20.59 MPa (220 to 210 kgf/cm^2, 3129 to 2987 psi).
5) If the measurement is less than allowable limit, replace the delivery valve.

Reference value	10 seconds or more
Allowable limit	5 seconds

(1) Connector
(2) Pressure sensor
68.6 MPa (700 kgf/cm^2, 9954 psi)
(3) Non-drying adhesive
(4) Weld entire circumference
(5) Copper packing
(6) S45C Steel tube
(7) S45C Hexagonal steel tube
(8) Injection pipe

❺ Vérification de l'étanchéité de la soupape de refoulement de la pompe à injection

1) Fixer un manomètre à la pompe.
2) Tourner le volant pour élever la pression à 21,57 MPa (220 kgf/cm^2).
3) Aligner le piston sur le fond de course.
4) Mesurer le temps nécessaire pour abaisser la pression initiale de 21,57 à 20,59 MPa (de 220 à 210 kgf/cm^2).
5) Si la mesure n'est pas satisfaisante, remplacer la soupape.

Norme de référence	Plus de 10 secondes
Limite autorisée	5 secondes

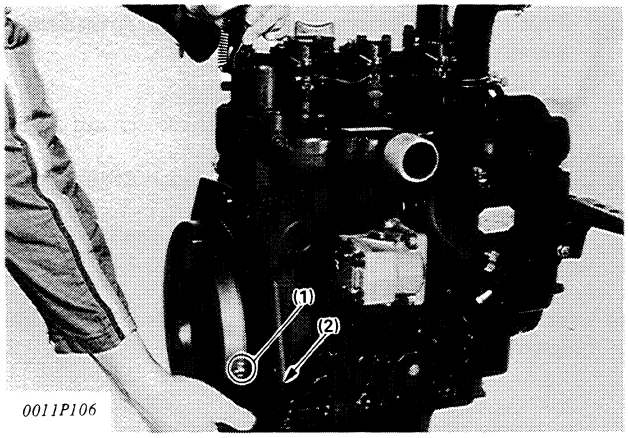
[A] Agencement du manomètre
(1) Raccord
(2) Détecteur de pression 68,6MPa (700kgf/cm^2)
(3) Adhésif non-siccatif
(4) Souder toute la circonférence
(5) Garniture en cuivre
(6) Tube en acier S45C
(7) Tube hexagonal en acier S45C
(8) Tuyau d'injection

❺ Prüfung der Benzindichtigkeit des Abflußventils der Benzineinspritzpumpe

1) Druckprüfgerät an der Pumpe anschließen.
2) Das Schwungrad drehen damit der Druck sich auf 21,57 MPa erhöht (220 kp/cm^2).
3) Den Druckkolben mit der oberen genauen Mitte abgleichen.
4) Messen Sie die Zeit die benötigt wurde um den Druck vom Anfangsdruck 21,57 bis 20,59 MPa (220 bis 210 kp/cm^2) zu erniedrigen.
5) Kann die Messung nicht akzeptiert werden, das Zuführungsventil austauschen.

Richtwert	10 Sekunden oder mehr
Zugelassener Grenzwert	5 Sekunden

[A] Konstruktion des Druckmessers
(1) Verbinder
(2) Druckfühler 68,6MPa (700kp/cm^2)
(3) Nichttrockendes Klebemittel
(4) Schweißverschluß des Gesamtumfanges
(5) Kupferdichtung
(6) S45C Stahlrohr
(7) S45C Sechskantstahlrohr
(8) Einspritzrohr

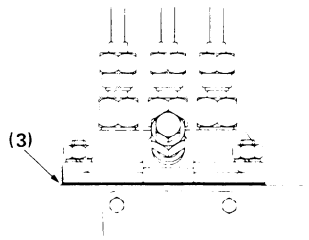


0011P106

6 Checking and Adjusting Injection Timing

1) Disconnect the injection pipe from the fuel injection pump.
2) Set the acceleration lever for maximum fuel discharge.
3) Turn the flywheel until fuel jets out from the delivery valve holder of the fuel injection pump.
4) Continue to turn the flywheel slowly, and stop it as soon as the fuel level at the tip of the valve holder begins to increase.
5) Check to see if the FI mark on the flywheel is aligned with the dot mark.
6) If the timing is out of adjustment, readjust with shims.

(A) Adjustment of injection timing



C019F039

- **Adding or removing one shim (0.15 mm, 0.0059 in.) varies the crank angle by approx. 1.5°.**
- **After adjustment, apply a thin film of non-drying adhesive to both sides of the shims.**

Reference value
0.401 to 0.436 rad. (23° to 25°) before TDC

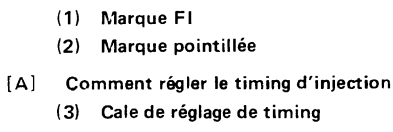
(1) FI mark
(2) Mark
(3) Injection timing adjusting shim

⑥ Vérification et réglage de la distribution de l'injection

1) Retirer le tuyau d'injection sur la pompe d'injection.
2) Tirer le levier d'accélération au maximum.
3) Tourner le volant jusqu' à ce que le combustible s'échappe du portesoupape de refoulement de la soupape d'injection.
4) Continuer de tourner le volant lentement et arrêter dès que le niveau de combustible à l'extrémité du porte-injecteur commence à monter.
5) Vérifier que la marque FI sur le volant coincide avec la marque pointillée.
6) Si le temps d'injection de la pompe n'est pas juste, ajuster avec des cales.

- **Chaque cale (0,15 mm) change l'angle du vilebrequin d'environ 1,5°.**
- **Après l'ajustement, appliquer une mince garniture de fluide aux deux côtés de, la cale.**

Norme de référence
23 à 25 avant haut de course



(1) Marque FI
(2) Marque pointillée

[A] Comment régler le timing d'injection
(3) Cale de réglage de timing

⑥ Prüfung und Einstellung vom Einspritzmoment

1) Einspritzleitung von der Kraftstoff-Einspritzpumpe lösen.
2) Den Gashebel auf maximale Kraftstoffzufuhr stellen.
3) Das Schwungrad drehen, bis Kraftstoff aus dem Zufuhrventilhalter tritt.
4) Das Schwungrad langsam weiter drehen und dann anhalten, wenn der Kraftstoffspiegel am Rand des Ventilhalters anfängt zu steigen.
5) Nachprüfen, ab der FI-Markierungspunkt auf dem Schwungrad mit dem Markierungspunkt übereinstimmt.
6) Wenn der Einspritzmoment nicht richtig eingestellt wurde, sollte eine Neueinstellung mittels einer Ausgleichscheibe erfolgen.

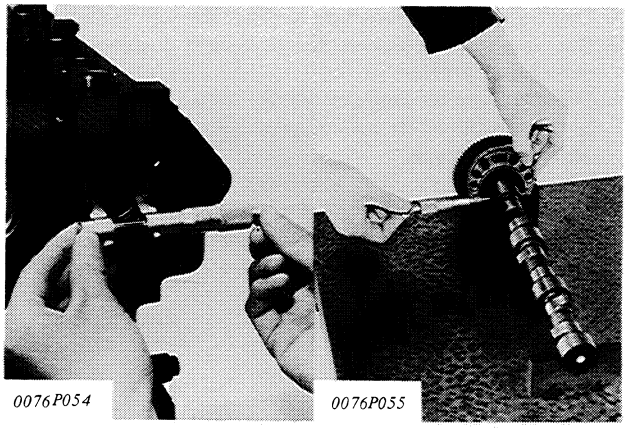
- **Zulegen oder Wegnahme einer Ausgleichscheibe (0,15 mm) ergibt eine Winkeländerung der Kurbelwelle von ungefähr 1,5°.**
- **Nach der Einstellung sollte ein dünner Film der Flüßigkeitsdichtung an beiden Seiten der Ausgleichscheiben aufgetragen werden.**

Richtwert
23° bis 25° vor der oberen Mittelstellung



(1) FI-Markierung
(2) Markierung

[A] Einstellung des Einspritzmoments
(3) Ausgleichscheibe zur Einstellung des Einspritzmoments.



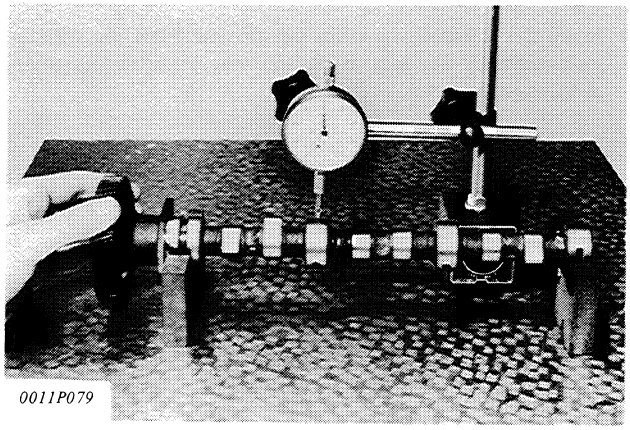
0076P054 0076P055

❶ Checking Oil Clearance of Camshaft

1) Measure the camshaft bearing in the crankcase with an inside micrometer.
2) Measure the camshaft journal with an outside micrometer. Calculate the clearance.
3) If the clearance exceeds the allowable limit, replace the camshaft.

Reference value	0.050 to 0.091 mm 0.0020 to 0.0036 in.
Allowable limit	0.15 mm 0.0059 in.

Camshaft bearing journal O.D.	32.934 to 32.950 mm 1.2966 to 1.2972 in.
Camshaft bearing I.D.	33.000 to 33.025 mm 1.2992 to 1.3002 in.

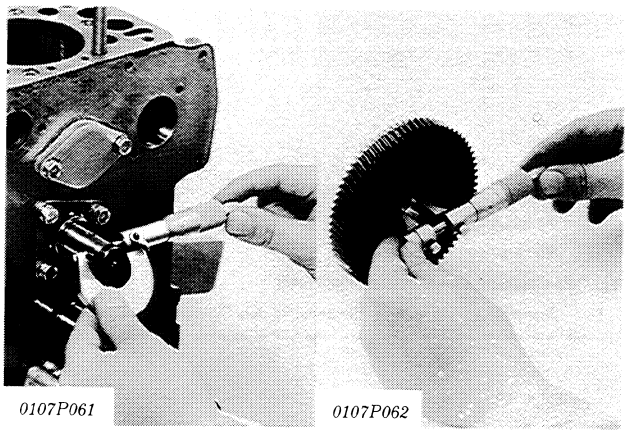


0011P079

❷ Checking Camshaft Alignment

1) Gently put the camshaft on V blocks.
2) Set a dial gauge to the journal.
3) While slowly rotating the camshaft, read the dial gauge. The camshaft flexure is half of the reading.
4) If the measurement exceeds the allowable limit, replace the camshaft.

Allowable limit	0.08 mm 0.0031 in.



0107P061 0107P062

❸ Checking Clearance between Idle Gear Shaft and Idle Gear Bushings

1) Measure the idle gear shaft O.D. with an outside micrometer.
2) Measure the idle gear bushings I.D. with an inside micrometer, and calculate the clearance.
3) If the clearance exceeds the allowable limit, replace the bushing.

Reference value	0.016 to 0.045 mm 0.0007 to 0.0017 in.
Allowable limit	0.1 mm 0.0039 in.

Idle gear shaft O.D.	17.973 to 17.984 mm 0.7076 to 0.7080 in.
Idle gear bushing I.D.	18.000 to 18.018 mm 0.7087 to 0.7093 in.

Engine serial number: 407507 and beyond (D650-B, D750-B, D850-B, DH850-B)
393782 and beyond (D950-B)

Reference value	0.020 to 0.054 mm 0.0008 to 0.0021 in.
Allowable limit	0.1 mm 0.039 in.

Idle gear shaft O.D.	23.967 to 23.980 mm 0.9436 to 0.9441 in.
Idle gear bushing I.D.	24.000 to 24.021 mm 0.9449 to 0.9457 in.

ENGRENAGES INTERMEDIAIRES, ARBRE A CAMES

❶ Vérification du jeu de l'arbre à cames

1) Mesurer le palier de l'arbre dans le carter avec un micromètre intérieur.
2) Mesurer le tourillon de l'arbre avec un micromètre extérieur. Mesurer le jeu.
3) Si la tolérance est dépassée, remplacer l'arbre.

Norme de référence	0,050 à 0,091 mm
Limite autorisée	0,15 mm

D.E. du coussinet de l'arbre	32,934 à 32,950 mm
D.I. du palier de l'arbre	33,000 à 33,025 mm

❷ Vérification de l'alignement de l'arbre à cames

1) Déposer délicatement l'arbre sur deux blocs en V.
2) Fixer une jauge à cadran au tourillon.
3) Tout en tournant lentement l'arbre, regarder l'indication du cadran. La courbure de l'arbre est égale à la moitié de l'indication donnée.
4) Si la tolérance est dépassée, remplacer l'arbre.

Limite autorisée	0,08 mm

❸ Vérification du jeu entre l'axe du pignon de renvoi et les bagues du pignon de renvoi

1) Mesurer le diamètre extérieur de l'axe du pignon de renvoi à l'aide d'un micromètre extérieur.
2) Mesurer le diamètre inférieur des bagues des pignons de renvoi avec un micromètre intérieur et calculer le jeu.
3) Si le jeu dépasse la limite autorisée, remplacer les bagues.

Norme de référence	0,016 à 0,045 mm
Limite autorisée	0,1 mm

D.E. d'axe de pignon de renvoi	17,973 à 17,984 mm
D.I. de bague de pignon de renvoi	18,000 à 18,018 mm

Numéro de série moteur: à partir de 407507 (D650-B, D750-B, D850-B, DH850-B) à partir de 393782 (D950-B)

Norme de référence	0,020 à 0,054 mm
Limite autorisée	0,1 mm

D.E. d'axe de pignon de renvoi	23,967 à 23,980 mm
D.I. de bague de pignon de renvoi	24,000 à 24,021 mm

STEUERUNGSVORRICHTUNG, NOCKENWELLE

❶ Prüfung des Ölabstandes an der Nockenwelle

1) Das Nockenwellenlager im Kurbelgehäuse mit einem Innenmikrometer messen.
2) Das Nockenwellenende mit einem Außen-Mikrometer messen und den Abstand errechnen.
3) Falls die Messungen über den zugelassenen Grenzwert hinausgehen, die Nockenwelle ersetzen.

Richtwert	0,050 bis 0,091 mm
Zugelassener Grenzwert	0,15 mm

Außendurchmesser der Nockenwellenlager-Buchse	32,934 bis 32,950 mm
Innendurchmesser des Nockenwellenlagers	33,000 bis 33,025 mm

❷ Prüfung der Nockenwellenabgleichung

1) Das Nockenwellenlager vorsichtig auf die V-Blöcke legen.
2) Das Meßgerät ansetzen.
3) Während die Nockenwelle langsam dreht, das Meßgerät ablesen. Der abgelesene Wert entspricht der Biegefestigkeit der Nockenwelle.
4) Falls die Messung den zugelassenen Grenzwert übersteigt, die Nockenwelle ersetzen.

Zugelassener Grenzwert	0,08 mm

❸ Prüfung des Spiels zwischen Leerlaufachse und Leerlaufbuchse

1) Den Außendurchmesser der Leerlaufachse mit Hilfe eines Außenmikrometers messen.
2) Den Innendurchmesser der Leerlaufbuchsen mit Hilfe eines Innenmikrometers messen und das Spiel berechnen.
3) Wenn das Spiel den zugelassenen Grenzwert überschreitet, die Buchse austauschen.

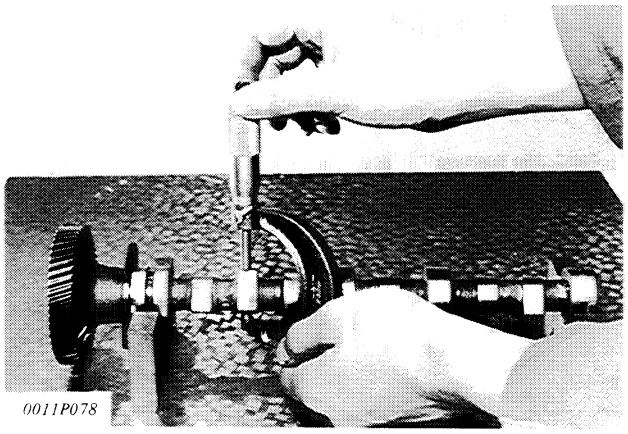
Richtwert	0,016 bis 0,045 mm
Zugelassener Grenzwert	0,1 mm

Leerlaufachse Außendurchmesser	17,973 bis 17,984 mm
Leerlaufbuchse innendurchmesser	18,000 bis 18,018 mm

Seriennummer des Motors: 407507 und höher (D650-B, D750-B, D850-B, DH850-B) 393782 und höher (D950-B)

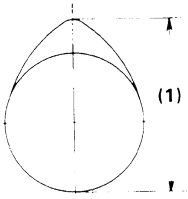
Richtwert	0,020 bis 0,054 mm
Zugelassener Grenzwert	0,1 mm

Leerlaufachse Außendurchmesser	23,967 bis 23,980 mm
Leerlaufbuchse innendurchmesser	24,000 bis 24,021 mm



0011P078

[A] Cam height measuring points



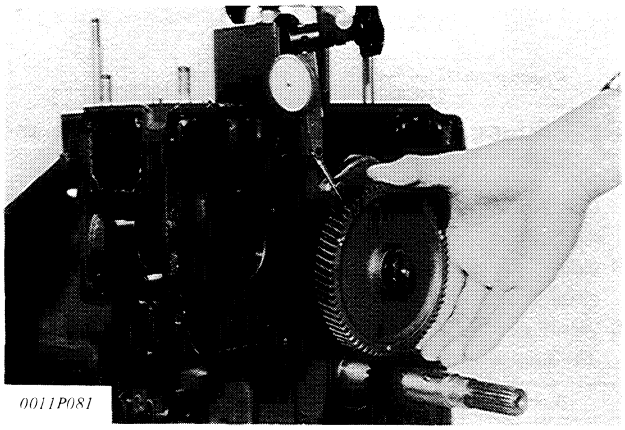
0075F039

(1) Cam height

❹ Checking Cam Heights of Intake and Exhaust

1) Measure the height of the cam at its highest point with a micrometer.
2) If the measurement exceeds the allowable limit, replace the camshaft.

Reference value	26.88 mm 1.0583 in.
Allowable limit	26.83 mm 1.0563 in.



0011P081

❺ Checking Gear Backlash

1) Install a lever-type indicator between the gear teeth.
2) Clamp one gear, rotate the other and measure the backlash.
3) If the backlash exceeds the allowable limit, replace.

Reference value	0.042 to 0.115 mm 0.0017 to 0.0045 in.
Allowable limit	0.2 mm 0.0079 in.

❹ Vérification de la hauteur de came à l'admission et à l'échappement

1) Mesurer la hauteur de la came à son point le plus haut avec un micromètre.
2) Si la tolérance est dépassée, remplacer l'arbre.

Norme de référence	26,88 mm
Limite autorisée	26,83 mm

[A] **Points de mesure de la hauteur**
(1) **Hauteur de came**

❺ Vérification du battement des dents de pignon

1) Placer un indicateur de type levier entre les dents de pignon.
2) Fixer un engrenage et tourner l'autre pour mesurer le battement.
3) Si la tolérance est dépassée, remplacer.

Norme de référence	0,042 à 0,115 mm
Limite autorisée	0,2 mm

❹ Prüfung der Nockenhöhe beim Ansaugen und Ausstoßen

1) Die Höhe der Nocke am höchsten Punkt mit einem Mikrometer messen.
2) Falls die Messung über den zugelassenen Grenzwert geht, die Nockenwelle ersetzen.

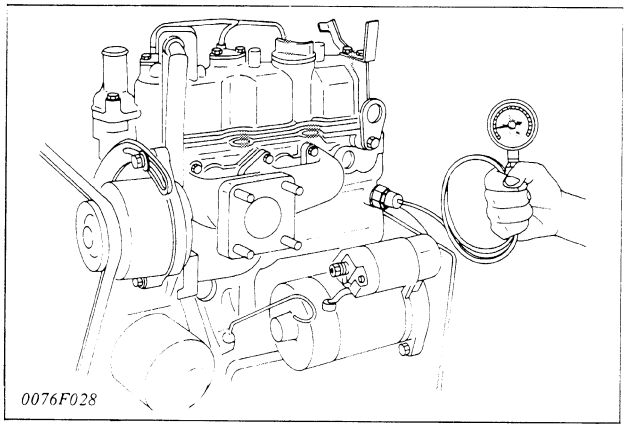
Richtwert	26,88 mm
Zugelassener Grenzwert	26,83 mm

[A] **Nockenhöhenmeßpunkte**
(1) **Nockenhöhe**

❺ Prüfung des Spielraums der Getriebeenden

1) Ein Hebelmeßgerät zwischen den Zahnradzähnen installieren.
2) Ein Zahnrad festklemmen, das andere drehen und das Endspiel messen.
3) Falls die Messung über den zugelassenen Grenzwert geht, ersetzen.

Richtwert	0,042 bis 0,115 mm
Zugelassener Grenzwert	0,2 mm

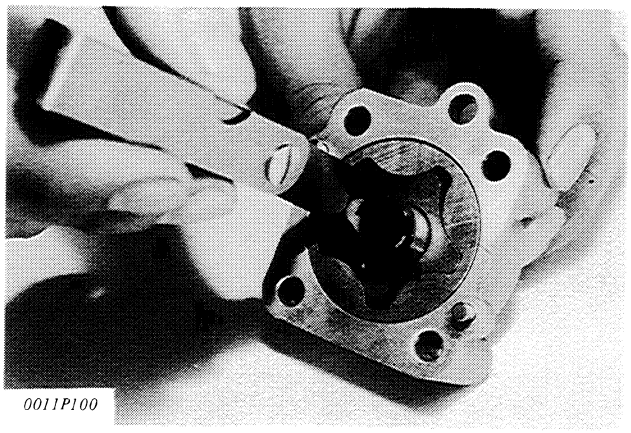

0076F028

❶ Testing Oil Pressure

1) Remove the oil switch and set a pressure gauge. (Code No: 07916-32031)
2) Start the engine. Measure the oil pressure both at idling and at the rated speed.
3) If the measurement is not within the reference value, check the oil pump, oilways, oil clearances and pressure regulating valve.

(Notes for measuring)
- **Supply the specified amount of recommended oil.**
- **The oil filter must not be clogged or broken.**

Reference value	At rated speed	196 to 441 kPa 2.0 to 4.5 kgf/cm^2 28 to 64 psi
Allowable limit	At rated speed	196 kPa 2.0 kgf/cm^2 28 psi
	At idle speed	69 kPa 0.7 kgf/cm^2 10 psi


0011P100

❷ Oil Pump (Rotor type)

(1) Checking Rotor Lobe Clearance

1) Insert a feeler gauge into the gap between the inner and outer rotors and measure the clearance.
2) If the clearance exceeds the allowable limit, replace.

Reference value	0.11 to 0.15 mm 0.0043 to 0.0059 in.
Allowable limit	0.2 mm 0.0079 in.

SYSTEME DE GRAISSAGE

❶ Vérification de la pression d'huile

1) Retirer l'interrupteur à l'huile et fixer un manomètre. (N° de code: 07916-32031)
2) Lancer le moteur. Mesurer la pression d'huile au ralenti et à vitesse de régime.
3) Si la mesure obtenue n'est pas comprise dans la tolérance, vérifier la pompe à huile, les tubes de graissage, la soupape de réglage de la pression.

(Remarques pour la mesure)
- **Fournir la quantité indiquée d'huile préconisée.**
- **Le filtre à huile ne doit pas être colmaté ou endommagé.**

Norme de référence	A la vitesse indiquée	196 à 441 kPa 2,0 à 4,5 kgf/cm^2
Limite autorisée	A la vitesse indiquée	196 kPa 2,0 kgf/cm^2
	Au ralenti	69 kPa 0,7 kgf/cm^2

❷ Pompe à huile (rotor)

(1) Vérification du jeu du lobe de rotor

1) Insérer un calibre d'épaisseur dans l'intervalle séparant les rotors intérieur et extérieur et mesurer le jeu.
2) Si la tolérance est dépassée, remplacer.

Norme de référence	0,11 à 0,15 mm
Limite autorisée	0,2 mm

SCHMIERUNGSSYSTEM

❶ Prüfung des Öldrucks

1) Den Ölschalter abnehmen und einen Druckanzeiger anschließen. (Kodenummer: 07916-32031)
2) Motor anlassen, den Öldruck im Leerlauf und bei Nennleistung messen.
3) Sind die Messungen nicht innerhalb der angegebenen Richtwerte, sind Ölpumpe, Ölleitungen, Ölspiel und Druckregulationsventil zu überprüfen.

(Anmerkungen für das Messen)
- **Die nötige Ölmenge nachfüllen.**
- **Darauf achten, daß das Ölfilter nicht verstopft oder abgenutzt ist.**

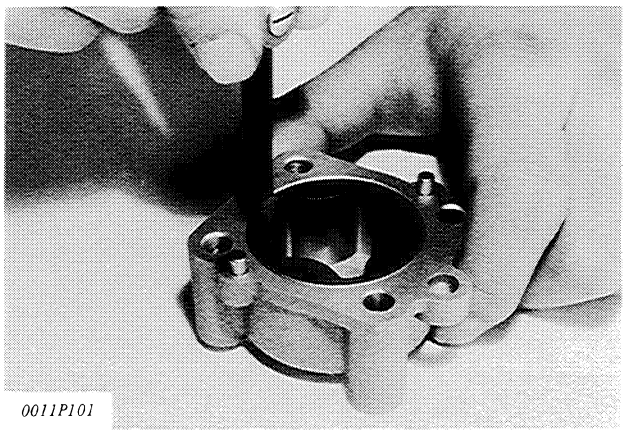
Richtwert	Bei einer bestimmten Umdrehungzahl	196 bis 441 kPa 2,0 bis 4,5 kp/cm^2
Zugelassener Grenzwert	Bei einer bestimmten Umdrehungzahl	196 kPa 2,0 kp/cm^2
	Im Leerlauf	69 kPa 0,7 kp/cm^2

❷ Ölpumpe (Rotortyp)

(1) Prüfung des Rotorflügelabstandes

1) Einen Spaltmesser in den Spalt zwischen den inneren und äußeren Rotor führen und den Abstand messen.
2) Geht die Messung über den zugelassenen Grenzwert, ersetzen.

Richtwert	0,11 bis 0,15 mm
Zugelassener Grenzwert	0,2 mm

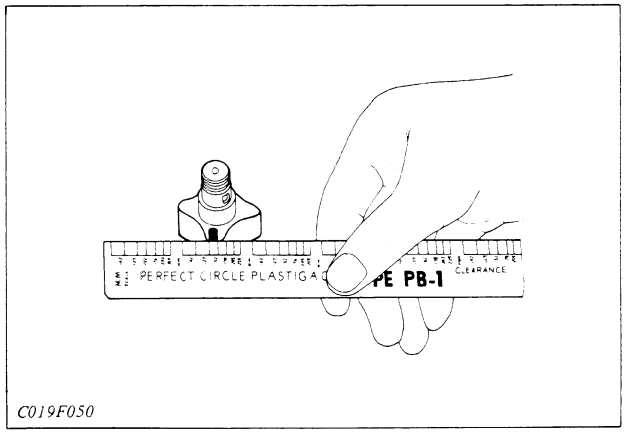


0011P101

(2) Checking Radial Clearance between Outer Rotor and Pump Body

1) Insert a feeler gauge into the gap between the oil pump body and the outer rotor and measure the clearance.
2) If the measurement exceeds the allowable limit, replace.

Reference value	0.07 to 0.15 mm 0.0028 to 0.0059 in.
Allowable limit	0.25 mm 0.0098 in.



C019F050

(3) Checking End Clearance between Rotor and Cover

1) Paste a press gauge to the surface of the gear with grease.
2) Attach the cover.
3) Gently remove the cover. Measure the clearance by placing the gauge (paper) on the press gauge where it is crushed.
4) If the measurement is not within the reference value, replace.

Reference value	0.08 to 0.13 mm 0.0031 to 0.0051 in.

(2) Vérification du jeu radial entre le rotor extérieur et le bâti de pompe

1) Insérer un calibre d'épaisseur dans l'intervalle séparant le bâti de pompe à huile et le rotor extérieur, mesurer le jeu.
2) Si la tolérance est dépassée, remplacer.

Norme de référence	0,07 à 0,15 mm
Limite autorisée	0,25 mm

(3) Vérifier l'écartement entre le rotor et le capot

1) Coller avec de la graisse un manomètre à la surface du pignon.
2) Fixer le capot.
3) Retirer doucement le capot. Mesurer l'ecartement en plaçant la jauge (papier) sur le manomètre où elle est écrasée.
4) Si la mesure obtenue n'est pas comprise dans la tolérance, remplacer.

Norme de référence	0,08 à 0,13 mm

(2) Prüfung des Radialspiels zwischen dem Außenrotor und Ölpumpengehäuse

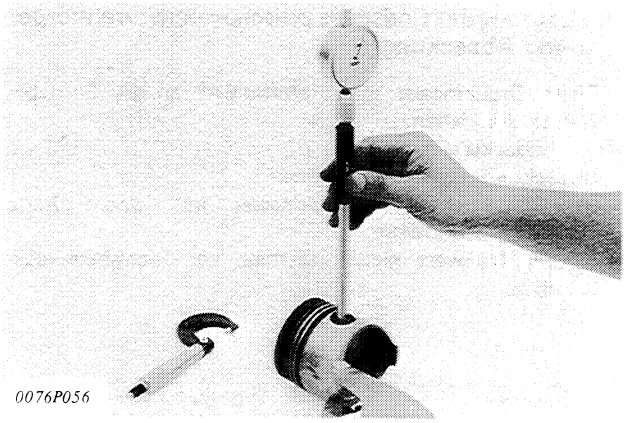
1) Einen Abstandmesser in der Spalte zwischen Gehäuse und Außenrotor befestigen und den Abstand messen.
2) Geht die Messung über den zugelassenen Grenzwert, austauschen.

Richtwert	0,07 bis 0,15 mm
Zugelassener Grenzwert	0,25 mm

(3) Prüfung des Endspiels zwischen dem Drehkörper und Abdeckung

1) Einen Druckmesser mit Starrschmiere an die Getriebe-Oberfläche kleben.
2) Die Abdeckung montieren.
3) Abdeckung vorsichtig abnehmen.
   Den Eindruck am Druckmesser mit einem Blatt Meßpapier überprüfen.
4) Ist der Meßwert nicht innerhalb der Richwerte, austauschen.

Richtwert	0,08 bis 0,13 mm

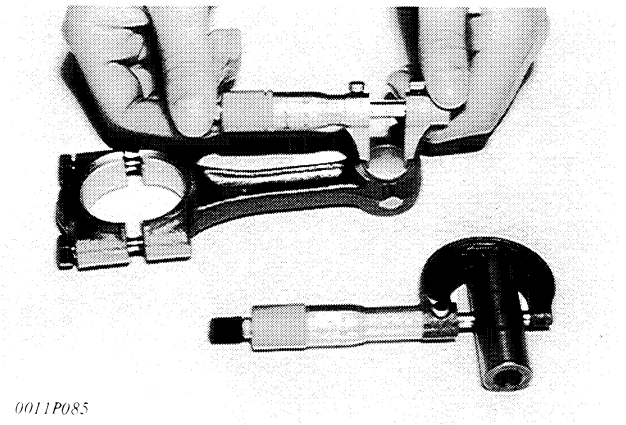


0076P056

❶ Checking Inside Diameter of Piston Bosses

1) Measure the piston bosses with a cylinder gauge. Set the cylinder gauge's reference measurement to 23mm, and carry out zero point adjustment with an outside micrometer.
2) If the measurement exceeds the allowable limit, replace.

Reference value	20.000 to 20.013 mm 0.7874 to 0.7879 in.
Allowable limit	20.03 mm 0.7886 in.



0011P085

❷ Checking Clearance between Piston Pin and Small End Bushing

1) Measure the piston pin with an outside micrometer.
2) Measure the I.D. of connecting rod small end bushing with an inside micrometer. Calculate the clearance.
3) If the clearance exceeds the allowable limit, replace.

Reference value	0.014 to 0.038 mm 0.0006 to 0.0015 in.
Allowable limit	0.15 mm 0.0059 in.

PISTON, BIELLE

❶ Vérification du diamètre intérieur des moyeux de piston

1) Mesurer les moyeux de piston avec une jauge de cylindre. La norme de référence de cette jauge devrait être 23 mm; verifier le zérotage avec un micromètre extérieur.
2) Si la mesure obtenue dépasse la tolérance, remplacer.

Norme de référence	20,000 à 20,013 mm
Limite autorisée	20,03 mm

❷ Vérification du jeu entre l'axe de piston et le coussinet de pied

1) Mesurer l'axe de piston avec un micromètre extérieur.
2) Mesurer le diamètre interne du coussinet de pied de bielle avec un micromètre intérieur. Calculer le jeu.
3) Si la mesure obtenue dépasse la tolérance, remplacer.

Norme de référence	0,014 à 0,038 mm
Limite autorisée	0,15 mm

KOLBEN, PLEUELSTANGE

❶ Prüfung des Innendurchmessers der Kolbennaben

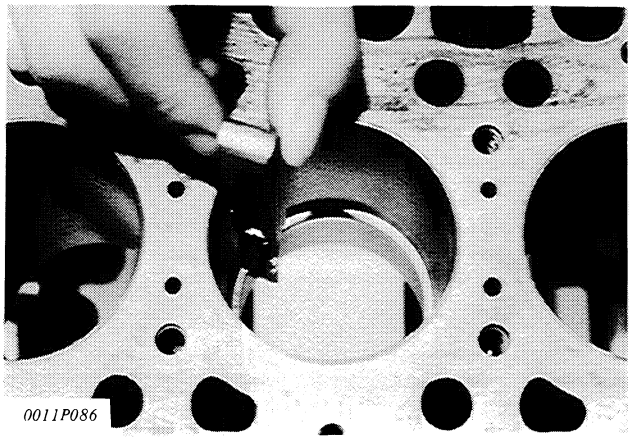
1) Kolbennabe mit einem Kaliberzylinder messen. Die Bezugsgrüße des Kaliberzylinders auf 23mm festzetzen und mit einem Außen-Mikrometer Nulljustierung vornehmen.
2) Geht der Meßwert über den zugelassenen Grenzwert hinaus, austauschen.

Richtwert	20,000 bis 20,013 mm
Zugelassener Grenzwert	20,03 mm

❷ Prüfung des Abstandes zwischen Kolbenzapfen und Pleuel buchse

1) Den Kolbenzapfen mit einem Außen-Mikrometer messen.
2) Den Innendurchmesser der kleinen Pleuelstangenbuchse mit einem Innen-Mikrometer messen. Den Abstand errechnen.
3) Geht der Meßwert über den zugelassenen Grenzwert hinaus, austauschen.

Richtwert	0,014 bis 0,038 mm
Zugelassener Grenzwert	0,15 mm



0011P086

D850-B · DH850-B

	Reference value	Allowable limit
Top ring Second ring	0.25 to 0.40 mm 0.0098 to 0.0157 in.	1.25 mm 0.0492 in.
Oil ring	0.25 to 0.40 mm 0.0098 to 0.0157 in.	1.25 mm 0.0492 in.

❸ Checking Piston Ring Clearance

1) Put the piston ring in the cylinder.
2) Turn the piston upside down and push the ring into the cylinder with the piston head.
3) Insert a feeler gauge into the piston ring gap.
4) If the clearance exceeds the allowable limit, replace.

(Important)

- **Measure the piston ring gap at the point of the minimum inside diameter of the cylinder liner.**

D650-B · D750-B

	Reference value	Allowable limit
Top ring Second ring	0.25 to 0.40 mm 0.0098 to 0.0157 in.	1.25mm 0.0492 in.
Oil ring	0.20 to 0.40 mm 0.0079 to 0.0157 in.	1.25 mm 0.0492 in.

D950-B

	Reference value	Allowable limit
Top ring	0.20 to 0.35 mm 0.0079 to 0.0138 in.	1.25 mm 0.0492 in.
Second ring	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.25 mm 0.0492 in.
Oil ring	0.25 to 0.40 mm 0.0098 to 0.0157 in.	1.25 mm 0.0492 in.



0011P087

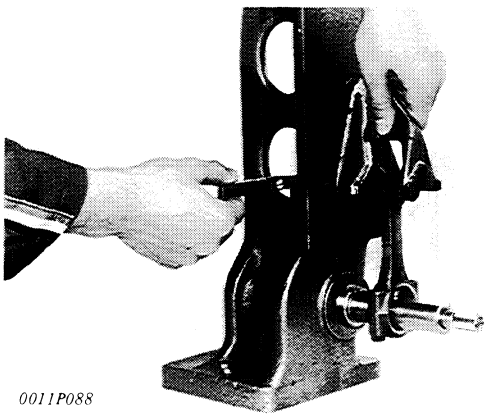
❹ Checking Side Clearance of Ring in Groove

1) Remove the piston ring from the piston.
2) Place the ring in its groove as is shown at left, and measure the clearance.
3) If the clearance is not within the reference value, replace the ring.

(Note)

- **As the top ring is a keystone type, it cannot be measured by this method.**

Reference value	
Second ring	0.085 to 0.112 mm 0.0033 to 0.0044 in.
Oil ring	0.020 to 0.055 mm 0.0008 to 0.0022 in.



0011P088

❺ Checking Connecting Rod Alignment

1) Remove the connecting rod crank pin bearing and tighten the rod bolts.
2) Set the connecting rod to a connecting rod aligner.
3) Place the gauge on the piston pin. Measure the gap between the pin of the gauge and the flat surface of the aligner.
4) If the measurement exceeds the allowable limit, replace.

(Important)

- **Because the I.D. of the connecting rod small end bushing is used as the basis for this check, check it is not worn beforehand.**

Reference value	0.02 mm 0.0008 in.
Allowable limit	0.05 mm 0.0020 in.

❸ Vérification des espacements de segment de piston

1) Placer le segment de piston dans le cylindre.
2) Renverser le piston et enfoncer le segment dedans ainsi que la tête du piston.
3) Insérer un calibre d'épaisseur dans l'écart du segment.
4) Si la tolérance est dépassée, remplacer.

(Important)

- **Mesurer le jeu du segment à l'endroit où le diamètre intérieur de la chemise de cylindre est minimum.**

D650-B · D750-B

	Norme de référence	Limite autorisée
Segment coup de feu Segment d'étanchéité	0,25 à 0,40 mm	1,25 mm
Segment racleur	0,20 à 0,40 mm	1,25 mm

D850-B · DH850-B

	Norme de référence	Limite autorisée
Segment coup de feu Segment d'étanchéité	0,25 à 0,40 mm	1,25 mm
Segment racleur	0,25 à 0,40 mm	1,25 mm

D950-B

	Norme de référence	Limite autorisée
Segment coup de feu	0,20 à 0,35 mm	1,25 mm
Segment d'étanchéité	0,30 à 0,45 mm	1,25 mm
Segment racleur	0,25 à 0,40 mm	1,25 mm

❹ Vérification du jeu latéral du segment dans la gorge

1) Retirer le segment du piston.
2) Placer le segment dans sa gorge (voir à gauche) et mesurer le jeu.
3) Si la mesure obtenue n'est pas comprise dans la tolérance, remplacer le segment.

(Remarque)

- **Le premier segment étant de type coup de feu, on ne peut le mesurer de cette manière.**

Norme de référence	
Segment d'étanchéité	0,085 à 0,112 mm
Segment racleur	0,020 à 0,055 mm

❺ Vérification de l'alignement de la bielle

1) Retirer la tige de maneton de la bielle et serrer les boulons.
2) Fixer la bielle à une règle.
3) Placer le calibre sur la tige de piston. Mesurer l'écart entre la tige de jauge et la surface plane de la règle.
4) Si la mesure dépasse la tolérance, remplacer.

(Important)

- **Le diamètre intérieur du pied de bielle servant de référence pour cette vérification, vérifier soigneusement son usure préalablement.**

Norme de référence	0,02 mm
Limite autorisée	0,05 mm

❸ Prüfung der Kolbenringfuge

1) Den Kolbenring in den Zylinder einsetzen.
2) Den Kolben umdrehen und den Ring mit dem Kolbenkopf in den Zylinder drücken.
3) Einen Abstandsfühler in die Kolbenringfuge führen.
4) Geht die Messung über den zugelassenen Grenzwert, hinaus austauschen.

(Wichtig)

- **Die Kolbenringfuge an dem Punkt des kleinsten Innendurchmessers des Zylindereinsatzes messen.**

D650-B · D750-B

	Richtwert	Zugelassener Grenzwert
Oberer Ring Zweiter Ring	0,25 bis 0,40 mm	1,25 mm
Ölring	0,20 bis 0,40 mm	1,25 mm

D850-B · DH850-B

	Richtwert	Zugelassener Grenzwert
Oberer Ring Zweiter Ring	0,25 bis 0,40 mm	1,25 mm
Ölring	0,25 bis 0,40 mm	1,25 mm

D950-B

	Richtwert	Zugelassener Grenzwert
Oberer Ring	0,20 bis 0,35 mm	1,25 mm
Zweiter Ring	0,30 bis 0,45 mm	1,25 mm
Ölring	0,25 bis 0,40 mm	1,25 mm

❹ Prüfung des Seitenabstandes des Kolben-Ringes in der Fuge

1) Den Kolbenring vom Kolben entfernen.
2) Den Ring in seine Aushöhlung wie links gezeigt stellen und den Abstand messen.
3) Liegt die Messung nicht innerhalb der Referenzwerte, den Ring ersetzen.

(Anmerkung)

- **Da der obere Ring ein Bogenschlußtyp ist, kann er nicht mit dieser Methode gemessen werden.**

Richtwert	
Zweiter Ring	0,085 bis 0,112 mm
Ölring	0,020 bis 0,055 mm

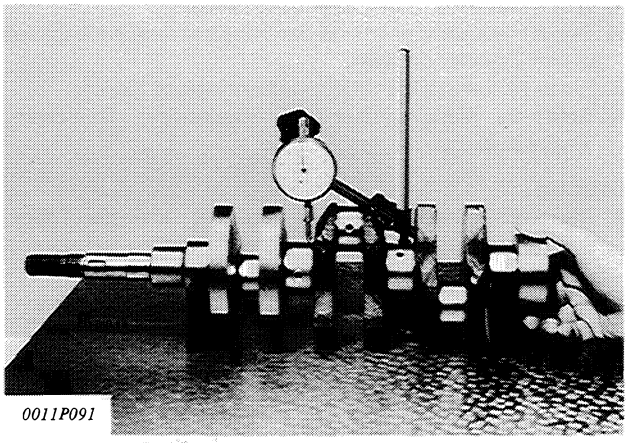
❺ Prüfung der Pleuelstangen-Abgleichung

1) Den Pleuelstangenkeil entfernen und den Bolzen anziehen.
2) Die Pleuelstange mit einem Verbindungsstangenausrichter befestigen.
3) Den Anzeiger auf dem Kolbenzapfen plazieren.
   Die Spalte zwischen dem Zapfen des Anzeigers und der flachen Oberfläche des Ausrichters messen.
4) Geht die Messung über den zugelassenen Grenzwert hinaus, ersetzen.

(Wichtig)

- **Da der Innendurchmesser der pleuelbuchse als Basis für diesen Test benutzt wird, versichern Sie sich, daß sie vorher nicht verschlissen wurde.**

Richtwert	0,02 mm
Zugelassener Grenzwert	0,05 mm

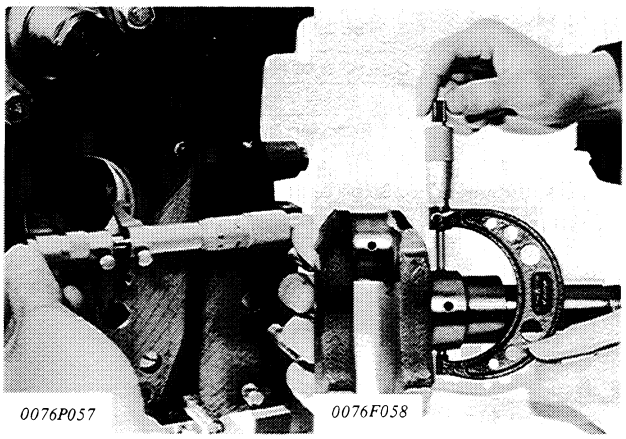


0011P091

❶ Checking Crankshaft Alignment

1) Place V blocks on the surface plate, and support the journals at both ends of the crankshaft on the V blocks.
2) Set a dial gauge to the central journal.
3) Read the dial gauge while rotating the crankshaft slowly. Crankshaft flexure is half of the reading.
4) If the reading exceeds the allowable limit, replace.

Reference value	0.02 mm 0.0008 in.
Allowable limit	0.08 mm 0.0031 in.



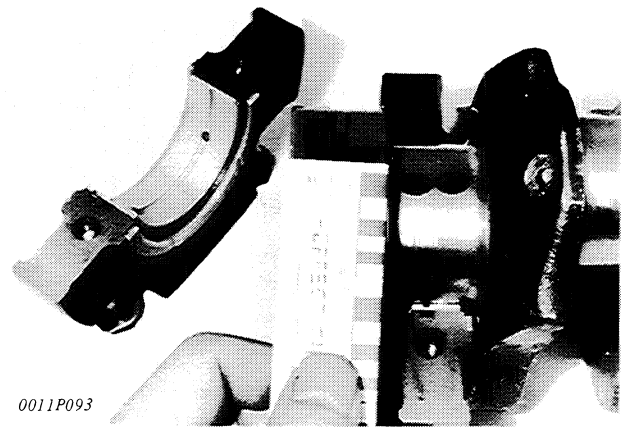
0076P057 0076F058

❷ Checking Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1

1) Measure the crankshaft journal (on the side of the crankshaft bearing 1) with an outside micrometer.
2) Measure the crankshaft bearing 1 with an inside micrometer. Calculate the clearance.
3) If the clearance exceeds the allowable limit, replace the crankshaft bearing 1.

Reference value	0.034 to 0.106 mm 0.0013 to 0.0042 in.
Allowable limit	0.2 mm 0.079 in.

Crankshaft journal O.D.	43.934 to 43.950 mm 1.7297 to 1.7303 in.
Crankshaft bearing 1 I.D.	43.984 to 44.040 mm 1.7317 to 1.7339 in.



0011P093

❸ Checking Oil Clearance between Crankshaft Journals and Crankshaft Bearings 2

1) Paste a press gauge with grease on the crankshaft bearing.
2) Tighten the crankshaft bearing case onto the crankshaft journal to the specified torque 20 to 24 Nm (2.0 to 2.4 kgf-m, 15 to 17 ft-lbs).
3) Detach the bearing case slowly, and measure the depression of the press gauge with a sheet of gauge (paper).
4) If the measurement exceeds the allowable limit, replace the crankshaft bearing 2.

Reference value	0.034 to 0.092 mm 0.0013 to 0.0036 in.
Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D.	43.934 to 43.950 mm 1.7297 to 1.7303 in.
Crankshaft bearing 2 I.D.	43.984 to 44.026 mm 1.7317 to 1.7339 in.

VILEBREQUIN

❶ Vérification de l'alignement du vilebrequin

1) Placer des blocs en V sur un marbre et poser les tourillons par les extrémités sur ces blocs.
2) Fixer une jauge à cadran sur le tourillon central.
3) Lire le cadran tout en tournant lentement le vilebrequin. La courbure de celui-ci est égale à la moitié de la mesure indiquée.
4) Si la mesure obtenue dépasse la tolérance, remplacer.

Norme de référence	0,02 mm
Limite autorisée	0,08 mm

❷ Vérification du jeu d'huilage entre le tourillon et le palier 1

1) Mesurer le tourillon (sur le côté du palier 1) avec un micromètre extérieur.
2) Mesurer le palier 1 avec un micromètre intérieur. Calculer le jeu.
3) Si le jeu dépasse la limite autorisée, remplacer la bague du palier 1.

Norme de référence	0,034 à 0,106 mm
Limite autorisée	0,2 mm

D.E. de tourillon	43,934 à 43,950mm
D.I. de tourillon 1	43,984 à 44,040 mm

❸ Vérification du jeu d'huilage entre le tourillon et les paliers 2

1) Graisser et placer une jauge de pression sur la palier de vilebrequin.
2) Resserrer le carter de palier sur le tourillon à la pression dynamométrique spécifiée: 20 à 24 Nm (2,0 à 2,4 kgf·m).
3) Retirer le carter doucement. Mesurer la dépression de la jauge de pression avec une jauge de papier.
4) Si la mesure dépasse la limite autorisée, remplacer la bague de palier 2.

Norme de référence	0,034 à 0,092 mm
Limite autorisée	0,20 mm

D.E. de tourillon	43,934 à 43,950 mm
D.I. des palier 2 de vilebrequin	43,984 à 44,026 mm

KURBELWELLE

❶ Prüfung der Kurbelwellenausfluchtung

1) V-Blocke auf die Meßplatte legen und darauf beide Kurbelwellenenden abstützen.
2) Eine Messuhr an das Zentralachslager anbringen.
3) Kurbelwelle langsam drehen und Messuhr ablesen. Kurbelwellenauslenkung ist gleich 50% der Ablesung.
4) Wenn der Messwert den zugelassenen Grenzwert überschreitet, Kurbelwelle austauschen.

Richtwert	0,02 mm
Zugelassener Grenzwert	0,08 mm

❷ Prüfung des Ölspiels zwischen Kurbelwellenende und Kurbelwellenlager 1

1) Kurbelwellenende (auf der Seite des Kurbelwellenlagers 1) mit einem Außenmikrometer messen.
2) Kurbelwellenlager 1 mit einem Innenmikrometer messen. Das Spiel ausrechnen.
3) Wenn das Lagerspiel die zugelassenen Grenzwerte überschreitet ist das Kurbelwellenlager 1 auszutauschen.

Richtwert	0,034 bis 0,106 mm
Zugelassener Grenzwert	0,2 mm

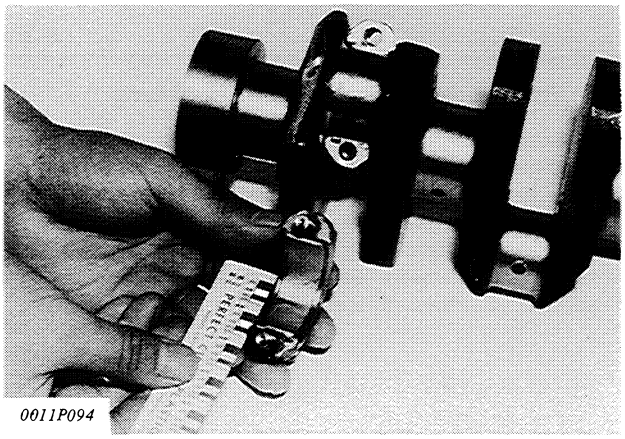
Außendurchmesser Kurbelwellenende	43,934 bis 43,950 mm
Innendurchmesser Kurbelwellenlager 1	43,984 bis 44,040 mm

❸ Prüfung des Ölspiels zwischen Kurbelwellenende und Kurbelwellenlager 2

1) Einen Druckmesser mit Starrschmiere an das Kurbelwellenlager kleben.
2) Das Lagergehäuse auf das Kurbelwellenende mit der spezifizierten Drehungskraft 20 bis 24 Nm (2,0 bis 2,4 kp·m) festziehen.
3) Das Lagergehäuse vorsichtig abnehmen und den Eindruck am Durchmesser mit einem Blatt Meßpapier messen.
4) Wenn das Meßergebnis den zugelassenen Grenzwert übersteigt, ist das Kurbelwellenlager 2 auszutauschen.

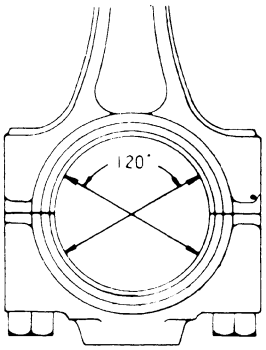
Richtwert	0,034 bis 0,092 mm
Zugelassener Grenzwert	0,20 mm

Außendurchmesser Kurbelwellenzapfen	43,934 bis 43,950 mm
Innendurchmesser Kurbelwellenzapfenlager 2	43,984 bis 44,026 mm



0011P094

[A] Crank pin measuring points



C019F062

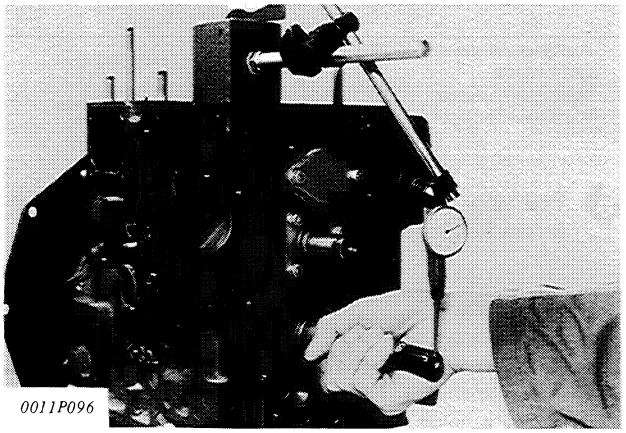
❹ Checking Oil Clearance between Crank Pins and Crank Pin Bearings

1) Paste a press gauge onto the crank pin bearing with grease.
2) Tighten the connecting rod onto the crank pin to the specified torque 26.5 to 30.4 Nm. (2.7 to 3.1 kgf·m, 19.52 to 22.42 ft-lbs).
3) Remove the connecting rod gently, and measure the depression of the press gauge with a sheet of gauge (paper).
4) If the measurement exceeds the allowable limit, replace the crankpin bearing.

(Note for measuring)

- **Fasten the crankshaft so that it does not turn.**
- **Do not insert the press gauge into the crank pin hole.**
- **Crankpin bearing measuring points are shown below.**

Reference value	0.029 to 0.091 mm 0.0011 to 0.0036 in.
Allowable limit	0.20 mm 0.0079 in.



0011P096

❺ Checking End Play of Crankshaft

1) Move the crankshaft to the crank gear side.
2) Set a dial gauge to the crankshaft.
3) Push the crankshaft toward the flywheel and measure the clearance.
4) If the measurement exceeds the allowable limit, replace the side bearing.

- **When replacing the side bearing, face the oil grooves of side bearing outward.**

Reference value	0.15 to 0.31 mm 0.0059 to 0.0122 in.
Allowable limit	0.5 mm 0.0197 in

❹ Vérification du jeu d'huilage entre les manetons et les bagues de maneton

1) Graisser et placer une jauge de pression sur la bague de maneton.
2) Resserrer la bielle sur le maneton selon la pression dynamométrique spécifiée de 26,5 à 30,4 Nm (2,7 à 3,1 kgf·m)
3) Retirer doucement et mesurer la dépression avec une jauge papier.
4) Si la mesure depasse la limite autorisée, remplacer la bague de maneton.

(Note pour mesurer)
- **Fixer le vilebrequin de façon à ce qu'il ne tourne pas.**
- **Ne pas introduire la jauge de pression dans l'orifice d'huilage.**
- **Les points de mesure de la bague de maneton sont indiqués ci-dessous.**

Norme de référence	0,029 à 0,091 mm
Limite autorisée	0,20 mm

[A] Points pour mesurer le maneton de vilebrequin

❺ Vérification du jeu latéral du vilebrequin

1) Pousser le vilebrequin vers le côté du pignon.
2) Placer un comparateur sur le vilebrequin.
3) Pousser le vilebrequin vers le côté du volant et mesurer le jeu.
4) Si la mesure n'entre pas dans la limite autorisée, remplacer la bague de butée latérale.

- **Pour remplacer la bague de butée latérale, placer les gorges d'huilage vers l'extérieur.**

Norme de référence	0,15 à 0,31 mm
Limite autorisée	0,5 mm

❹ Prüfung des Ölspiels zwischen Kurbelwellenzapfen und Kurbelwellen-Zapfenlager

1) Einen Druckmesser mit Starrschmiere an das Kurbelwellen-Zapfenlager Kleben.
2) Die Reglerstange an den Kurbelwellenbolzen mit der spezifizierten Drehkraft von 26,5 bis 30,4 N·m (2,7 bis 3,1 kp·m) drücken.
3) Die Pleuelstange vorsichtig abnehmen und den Eindruck des Druckmessers mit einem Blatt Meßpapier messen.
4) Wenn das Meßergebnis den zugelassenen Grenzwert übersteigt, ist das Kurbelwellen-Zapfenlager auszutauschen.

(Anmerkung für das Messen)
- **Die Kurbelwelle so befestigen, daß sie sich nicht dreht.**
- **Den Druckmesser nicht in das Kurbelwellenzapfenloch führen.**
- **Die Meßpunkte für den Kurbelwellenzapfen sind wie folgt:**

Richtwert	0,029 bis 0,091 mm
Zugelassener Grenzwert	0,20 mm

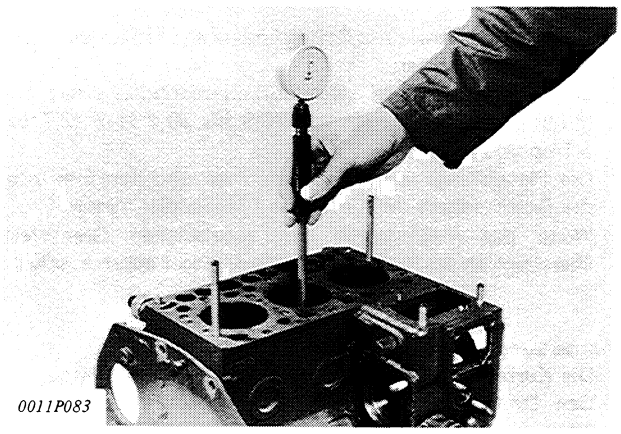
[A] Meßpunkte für den Kurbelwellenzapfen

❺ Prüfung des Kurbelwellen- Endspiels

1) Die Kurbelwelle zur Getriebesteite hindrehen.
2) Die Meßuhr auf die Kurbelwelle setzen.
3) Die Kurbelwelle in Richtung Schwungrad drücken und das Spiel messen.
4) Wenn das Meßergebnis den vorgegebenen Grenzwert übersteigt ist das Seitenmetall auszutauschen.

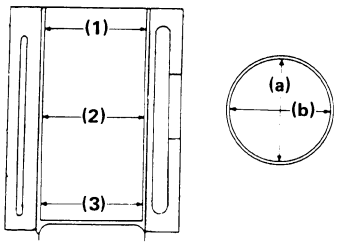
- **Beim Auswechseln des Seitenmetalls müssen die Ölnuten nach außen liegen.**

Richtwert	0,15 bis 0,31 mm
Zugelassener Grenzwert	0,5 mm



0011P083

[A] Measuring points of cylinder liner



C019F066

❶ Checking Wear of Cylinder Liner

1) Set a cylinder gauge and adjust it to the reference value of the cylinder liner with an outside micrometer.
2) To find out the maximum wear, measure the diameters at six points on the cylinder liner with the cylinder gauge, as shown below.

- **When the cylinder liner is worn beyond the allowable limit, bore and hone it by 0.5 mm (0.0197 in.).**

1) For the finish dimensions of the cylinder liners, refer to the table below.

2) The cylinder liner which has been oversized by 0.5 mm (0.0197 in.) should use a piston and ring of the same oversize. (See the Table 2)

- **When the oversized cylinder liner is worn beyond the allowable limit, replace the cylinder liner, and bore and hone it.**

Model	Reference value	Allowable limit
D650-B	64.000 to 64.019 mm 2.5197 to 2.5204 in.	+0.15 mm +0.0059 in.
D750-B	68.000 to 68.019 mm 2.6772 to 2.6779 in.	
D850-B DH850-B	72.000 to 72.019 mm 2.8346 to 2.8353 in.	
D950-B	75.000 to 75.019 mm 2.9528 to 2.9535 in.	

(1) Top
(2) Middle
(3) Bottom (Skirt)

(a) Right-angle to the piston pin
(b) Parallel to the piston pin

Table 1

Model	Oversized Cylinder Liner	Finishing
D650-B	64.500 to 64.519 mm 2.5393 to 2.5401 in.	Hone to 1.2 to 2 μR max. ▽▽▽
D750-B	68.500 to 68.519 mm 2.6968 to 2.6976 in.	
D850-B DH850-B	72.500 to 72.519 mm 2.8543 to 2.8550 in.	
D950-B	75.500 to 75.519 mm 2.9724 to 2.9732 in.	

Table 2

Model	Oversize	Part name	Code number	Mark
D650-B	0.5 mm 0.0197 in.	Piston 05	15281-2191-1	050S
		Piston ring 05 assy	15361-2109-1	
D750-B	0.5 mm 0.0197 in.	Piston 05	15261-2191-1	
		Piston ring 05 assy	15271-2109-1	
D850-B DH850-B	05 mm 0.0197 in.	Piston 05	15901-2191-1	
		Piston ring 05 assy	15901-2109-1	
D950-B	0.5 mm 0.0197 in.	Piston 05	15531-2191-1	
		Piston 2 05	15531-2192-1	
		Piston ring 05 assy	15531-2109-1	

CHEMISE DE CYLINDRE

❶ Vérification de l'usure des chemise

1) Placer un calibre à tube et le régler avec un micromètre extérieur à la valeur de référence de la chemise de cylindre.
2) Pour déterminer l'usure maximum, mesurer les diamètres en six points de la chemise, comme indiqué ci-dessous.

- **Quand l'usure de la chemise dépasse la tolérance, aléser et passer à la pierre à huile (0,5 mm).**

1) Pour les dimensions de finition des chemises, voir le tableau ci-dessous.

2) La chemise de cylindre qui a été réalesée de 0,5 mm doit être utilisée avec un piston et segments sur-calibré. (Voir la table 2)

- **Quand la chemise de cylindre réalésée est usée au-delà de la limite autorisée, remplacer la chemise, recalibrer et rectifier.**

Modèle	Norme de référence	Limite autorisée
D650-B	64,000 à 64,019 mm	+0,15 mm
D750-B	68,000 à 68,019 mm	
D850-B DH850-B	72,000 à 72,019 mm	
D950-B	75,000 à 75,019 mm	

[A] **Points de mesure de la chemise**
- (1) **Haut**
- (2) **Milieu**
- (3) **Bas (Jupe)**

- (a) **A angle droit de l'axe de piston**
- (b) **Parallèle à l'axe de piston**

Table 1

Modèle	Chemise de cylindre sur-calibré	Terminant
D650-B	64,500 à 64,519 mm	Rectifier de 1, 2 à 2 μR max ▽▽▽
D750-B	68,500 à 68,519 mm	
D850-B DH850-B	72,500 à 72,519 mm	
D950-B	75,500 à 75,519 mm	

Table 2

Modèle	Sur-calibré	Numéro de code	Nome de pièces	Marque
D650-B	0,5 mm	Piston 05	15281-2191-1	050S
		Assemblage de segment de piston 05	15361-2109-1	
D750-B	0,5 mm	Piston 05	15261-2191-1	
		Assemble de segment de piston 05	15271-2109-1	
D850-B DH850-B	0,5 mm	Piston 05	15901-2191-1	
		Assemblage desegment de piston 05	15901-2109-1	
D950-B	0,5 mm	Piston 05	15531-2191-1	
		Piston 2 05	15531-2192-1	
		Assemblage de segment de piston 05	15531-2109-1	

ZYLINDERAUSKLEIDUNG

❶ Prüfung der Abnutzung der Zylinderauskleidung

1) Mit einem Außenmikrometer einen Kaliberzylinder einstellen, damit er dem Richwert der Zylinderauskleidung entspricht.
2) Um den größten Abnutzungsgrad festzustellen, sechs Punkte am Durchmesser der Zylinderauskleidung mit dem Kaliberzylinder messen, wie nachstehend gezeigt ist.

- **Wenn die Zylinderkleidung bis unter dem Grenzwert abgenutzt ist, den Zylinder um 0,5mm aufbohren und schleifen.**

1) Für die endgültige Größe der Zylinderauskleidungen siehe die nachstehende Tabelle.

2) Eine Zylinderauskleidung mit einem Übermaß von 0,5 mm sollte mit einem Kolben und Kolbenring mit gleichem Übermaß ausgerüstet werden. (Siehe Tabelle 2)

- **Wenn die Übermaß-Zylinderauskleidung über dem Grenzwert hinaus abgenutzt ist, Zylinderauskleidung austauschen.**

Modell	Richtwert	Zugelassener Grenzwert
D650-B	64,000 bis 64,019 mm	+0.15 mm
D750-B	68,000 bis 68,019 mm	
D850-B DH850-B	72,000 bis 72,019 mm	
D950-B	75,000 bis 75,019 mm	

[A] **Meßpunkte an der Zylinderauskleidung**
- (1) **Oben**
- (2) **Mitte**
- (3) **Unten (Unterer Rand)**

- (a) **Rechtwinklig zur Drehung des Kolbenzapfens**
- (b) **Parallel zum Kolbenzapfen**

Tabelle 1

Modell	Übergröße für Zylinderauskleidung	Bearbeitung
D650-B	64,500 bis 64,519 mm	Schleifen bis 1,2 bis 2 μR max. ▽▽▽
D750-B	68,500 bis 68,519 mm	
D850-B DH850-B	72,500 bis 72,519 mm	
D950-B	75,500 bis 75,519 mm	

Tabelle 2

Modell	Übermaß	Bezeichnung	Stück-Nr	Markierung
D650-B	0,5 mm	Kolben 05	15281-2191-1	050S
		Montage Kolbenring 05	15361-2109-1	
D750-B	0,5 mm	Kolben 05	15261-2191-1	
		Montage Kolbenring 05	15271-2109-1	
D850-B DH850-B	0,5 mm	Kolben 05	15901-2191-1	
		Montage Kolbenring 05	15901-2109-1	
D950-B	0,5 mm	Kolben 05	15531-2191-1	
		Kolben 2 05	15531-2192-1	
		Montage Kolbenring 05	15531-2109-1	

Reference

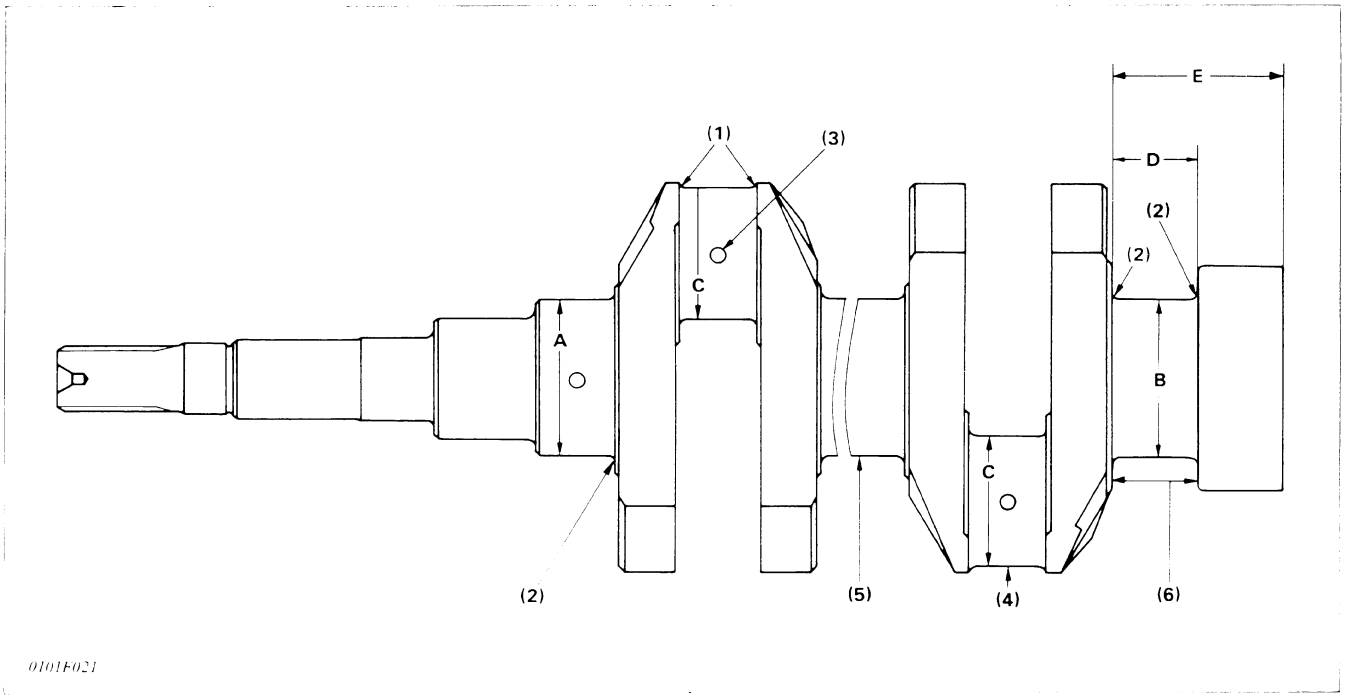
Undersize and Oversize

If the standard-size bearing cannot be employed due to excessive wear of the crankpin and crank journal, employ undersize or oversize bearings.
For undersize or oversize bearing use, follow the precautions noted below.

- Grind the crankpin and journal with a wheel which has specified round corner and width without shoulder.

(1) 3.3 to 3.7 mm (0.1300 to 0.1457 in.)
(2) 2.8 to 3.2 mm (0.1102 to 0.1260 in.)
(3) Be sure to chamfer the oil hole circumference to 1 to 1.5 mm (0.04 to 0.06 in.) radius with an oil stone.
(4) The crankpin must be fine-finished to higher than ▽▽▽ (0.4-S).
(5) The crank journal must be fine-finished to higher than ▽▽▽ (0.4-S).
(6) The crank journal side surface must be fine-finished to higher than ▽▽▽ (0.4-S).

	Dimension "E"
Oversize 0.2 mm 0.008 in.	48.0 to 48.2 mm 1.890 to 1.898 in.
Oversize 0.4 mm 0.016 in.	48.1 to 48.3 mm 1.894 to 1.902 in.

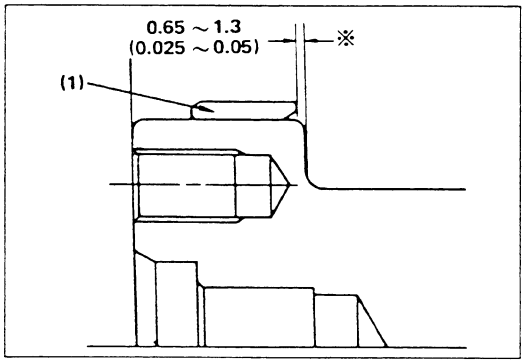


01011021

※ Replacement of Crankshaft Sleeve

After force-fitting the sleeve, make sure that its end plane is not outside the crankshaft.

(1) Crankshaft sleeve (Code No. 19215–2328–1)



Use the auxiliary socket for fixing crankshaft sleeve (Code No. 07909-33011)

	Size	Code Number	Name of Parts	Dimension	Mark
A	0.2 mm 0.008 in.	15261-2391-1	Crankshaft Bearing 1 (0.2 minus)	43.743 to 43.750 mm 1.7218 to 1.7224 in.	020US
	0.4 mm 0.016 in.	15261-2392-1	Crankshaft Bearing 1 (0.4 minus)	43.534 to 43.550 mm 1.7139 to 1.7146 in.	040US
B	0.2 mm 0.008 in.	15261-2393-1	Crankshaft Bearing 2 (0.2 minus)	43.734 to 43.750 mm 1.7218 to 1.7224 in.	020US
	0.4mm 0.016 in.	15261-2394-1	Crankshaft Bearing 2 (0.4 minus)	43.534 to 43.550 mm 1.7139 to 1.7146 in.	040US
C	0.2 mm 0.008 in.	15531-2297-1	Crank Pin Bearing (0.2 minus)	36.759 to 36.775 mm 1.4472 to 1.4478 in.	020US
	0.4 mm 0.016 in.	15531-2298-1	Crank Pin Bearing (0.4 minus)	36.559 to 36.575 mm 1.4393 to 1.4400 in.	040US
D	0.2 mm 0.008 in.	15261-2395-1 15261-2397-1	Crank Side Bearing (0.2 plus)	24.20 to 24.25 mm 0.9528 to 0.9547 in.	0.20OS
	0.4 mm 0.016 in.	15261-2396-1 15261-2398-1	Crank Side Bearing (0.4 plus)	24.40 to 24.45 mm 0.9606 to 0.9626 in.	0.40OS

Référence

Sous-calibration et Sur-calibration

Si le coussinet de cote normale ne peut être utilisé à cause d'une usure excessive du maneton et du tourillon de vilebrequin, employer des coussinets de cote minorée ou de cote majorée.
Pour utilisation des coussinets de cote minorée ou de cote majorée, prendre les précautions suivantes.

- Rectifier le maneton et le tourillon de vilebrequin à l'aide d'une meule sans épaulement ayant un coin arrondi et une largeur spécifiés.

(1) 3,3 à 3,7 mm
(2) 2,8 à 3,2 mm
(3) Ne pas manquer de chanfreiner à l'aide d'une pierre à huile la circonférence du trou de graissage à un rayon de 1 à 1,5 mm.
(4) Terminer la surface du tourillon à plus de ▽▽▽ (0,4-S).
(5) Terminer la surface du tourillon à plus de ▽▽▽ (0,4-S).
(6) Terminer la surface du tourillon à plus de ▽▽▽ (0,4-S).

	Dimension "E"
Sur-calibration 0,2 mm	48,0 à 48,2 mm
Sur-calibration 0,4 mm	48,1 à 48,3 mm

	Calibre	Numéro de Code	Dénomination	Dimension	Marque
A	0,2 mm	15261-2391-1	Palier de Vilebrequin 1 (0,2 minus)	43,743 à 43,750 mm	020US
	0,4 mm	15261-2392-1	Palier de Vilebrequin 1 (0,4 minus)	43,534 à 43,550 mm	040US
B	0,2 mm	15261-2393-1	Palier de Vilebrequin 2 (0,2 minus)	43,734 à 43,750 mm	020US
	0,4 mm	15261-2394-1	Palier de Vilebrequin 2 (0,4 minus)	43,534 à 43,550 mm	040US
C	0,2 mm	15531-2297-1	Palier de Tête de Bielle (0,2 minus)	36,759 à 36,775 mm	020US
	0,4 mm	15531-2298-1	Palier de Tête de Bielle (0,4 minus)	36,559 à 36,575 mm	040US
D	0,2 mm	15261-2395-1 15261-2397-1	Palier du Butée Latéral (0,2 plus)	24,20 à 24,25 mm	020OS
	0,4 mm	15261-2396-1 15261-2398-1	Palier du Butée Lateral (0,4 plus)	24,40 à 24,45 mm	040OS

※ Remplacement du manchon de vilebrequin

Après avoir emmanché à force le manchon, s'assurer que sa face plane ne soit en dehors du vilebrequin.

(1) Manchon de vilebrequin
(Code N° 19215–2328–1)

Utiliser la douille auxiliaire pour fixer le manchon de vilebrequin. (Code N° 07909-33011)

Nachweis

Übermaß und Untermaß

Wenn wegen starker Abnutzung des Kurbelwellenzapfens ein Normallager nicht mehr verwendet werden kann, ist dieses gegen ein Untermaßlager auszutauschen.
Beim Einsatz eines Untermaßlagers sind nachstehende Vorsichtsmaßnahmen zu beachten:

- Den Zapfen und das Ende der Kurbelwelle mit einem Schleifrad schleifen, das die vorgeschriebene Rundung und Breite hat und keine Abstufungen.

(1) 3,3 bis 3,7 mm
(2) 2,8 bis 3,2 mm
(3) Das Ölloch mit einem Ölwetzstein auf einen Radius von 1 bis 1,5 mm abschrägen.
(4) Der Kurbelwellenzapfen muß feinstbearbeitet sein und zwar besser als Güteklasse ▽▽▽ (0,4-S).
(5) Das Kurbelwellenende muß feinstbearbeitet werden und zwar Güteklasse ▽▽▽ (0,4-S).
(6) Die Seitenfläche vom Kurbelwellenende muß feinstbearbeitet sein, besser als Güteklasse ▽▽▽ (0,4-S).

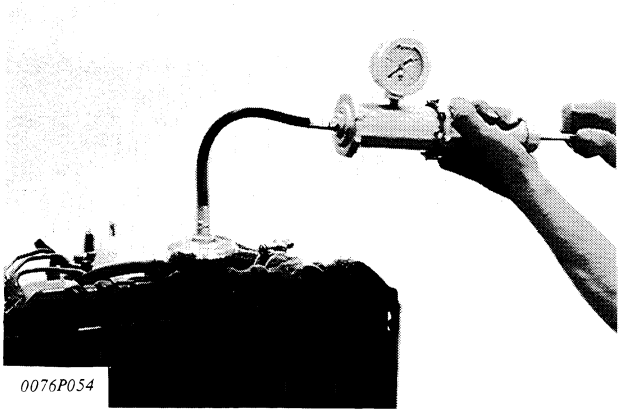
	Abmessungen "E"
Übermaß 0,2 mm	48,0 bis 48,2 mm
Übermaß 0,4 mm	48,1 bis 48,3 mm

※ Auswechslung der Kurbelwellenhülse

Nach Preßpassung der Hülse prüfen Sie nach, daß sich die Planfläche nicht außer der Kurbelwelle befindet.

(1) Kurbelwellenhülse (Teil-Nr. 19215–2328–1)
Den Hilfsstutzen verwenden, um die Kurbelwellenbüchse anzubringen.(Teil-Nr. 07909-33011)

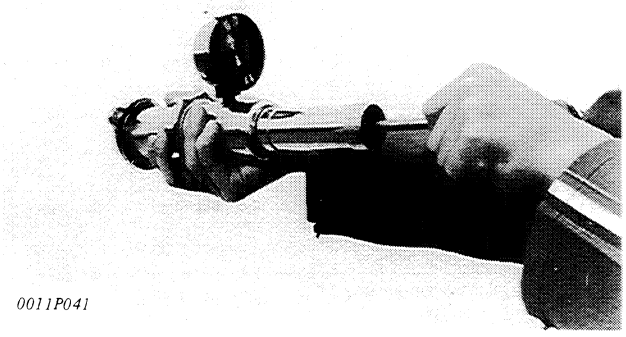
	Maß	Kodenummer	Bezeichnung	Abmessungen	Markierung
A	0.2 mm	15261-2391-1	Kurbelwellenlager 1 (0,2 minus)	43,743 bis 43,750 mm	020US
	0.4 mm	15261-2392-1	Kurbelwellenlager 1 (0,4 minus)	43,534 bis 43,550 mm	040US
B	0,2 mm	15261-2393-1	Kurbelwellenlager 2 (0,2 minus)	43,734 bis 43,750 mm	020US
	0,4 mm	15261-2394-1	Kurbelwellenlager 2 (0,4 minus)	43,534 bis 43,550 mm	040US
C	0,2 mm	15531-2297-1	Kurbelwellen-Zapfenlager (0,2 minus)	36,759 bis 36,775 mm	020US
	0,4 mm	15531-2298-1	Kurbelwellen-Zapfenlager (0,4 minus)	36,559 bis 36,575 mm	040US
D	0,2 mm	15261-2395-1 15261-2397-1	Kurbelwellen-Seitenlager (0,2 plus)	24,20 bis 24,25 mm	020OS
	0,4 mm	15261-2396-1 15261-2398-1	Kurbelwellen-Seitenlager (0,4 plus)	24,40 bis 24,45 mm	040OS


0076P054

❶ Testing Water Tightness of Radiator

1) Pour the specified amount of water into the radiator.
2) Warm up the engine.
3) Set a radiator tester. Increase to the specified pressure. 88.3 kPa (0.9 kgf/cm^2, 12.8 psi).
4) Check to see if water leaks from any part.

Reference value
Water tight at the specified pressure. (88.3 kPa, 0.9 kgf/cm^2, 12.8 psi)


0011P041

❷ Testing Opening Pressure of Radiator Cap

1) Set a radiator tester to the radiator cap.
2) Apply the specified pressure 88.3 kPa (0.9 kgf/cm^2, 12.8 psi).
3) Check to see if the pressure drops by 29.4 kPa (0.3 kgf/cm^2, 4.3 psi) or more in 10 seconds.

Reference value
Pressure should drop by 29.4 kPa (0.3 kgf/cm^2, 4.3 psi) or less in 10 seconds.

SYSTEME DE REFROIDISSEMENT

❶ Vérification de l'étanchéité du radiateur

1) Verser dans le radiateur la quantité d'eau spécifiée.
2) Chauffer le moteur.
3) Fixer un contrôleur de radiateur. Augmenter à la pression spécifiée de 88,3 kPa (0,9 kgf/cm^2).
4) Vérifier que l'eau ne fuit nulle part.

Norme de référence
Etanche à la pression spécifiée (88,3 kPa, 0,9 kgf/cm^2)

❷ Vérification de la pression d'ouverture du bouchon de radiateur

1) Fixer un contrôleur de radiateur au bouchon du radiateur.
2) Appliquer la pression spécifiée de 88,3 kPa (0,9 kgf/cm^2).
3) Voir si la pression descend de 29,4 kPa (0,3 kgf/cm^2), ou plus, en 10 secondes.

Norme de référence
Le chute de pression doit descendre de 29,4 kPa (0,3 kgf/cm^2) ou moins en 10 secondes.

KÜHLERSYSTEM

❶ Prüfung der Wasserdichtigkeit des Kühlers

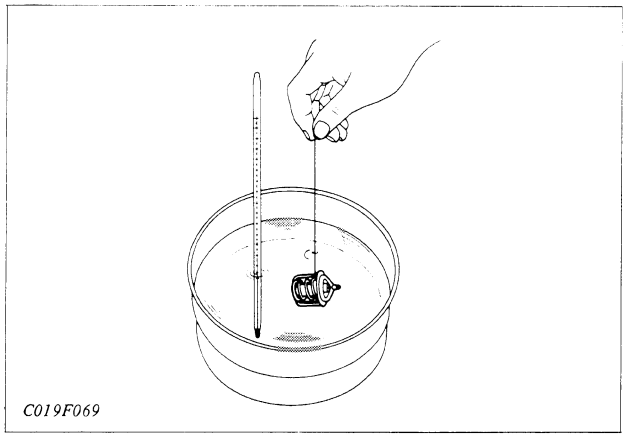
1) Die vorgeschriebene Menge Wasser in den Kühler füllen.
2) Den Motor laufen lassen.
3) Den Kühlerprüfer anschließen. Bis auf spezifizierten Druck 88,3 kPa (0,9 kp/cm^2) erhöhen.
4) Überprüfen ob der Kühler an allen Stellen dicht ist.

Richtwert
Wasserdichtigkeit beim spezifizierten Druck (88,3 kPa, 0,9 kp/cm^2)

❷ Prüfung des Öffnungsdrucks der Kühler-Verschlußkappe

1) Das Kühlerprüfgerat an der Kühler-Verschlußkappe befestigen.
2) Auf den vorgeschriebenen Druck von 88,3 kPa (0,9 kp/cm^2).
3) Prüfen ob der Druck in 10 Sekunden nicht mehr als 29,4 kPa (0,3 kp/cm^2) abfällt.

Richtwert
Der Druck sollte in 10 Sekunden nicht mehr als 29,4 kPa (0,3 kp/cm^2) abfallen.

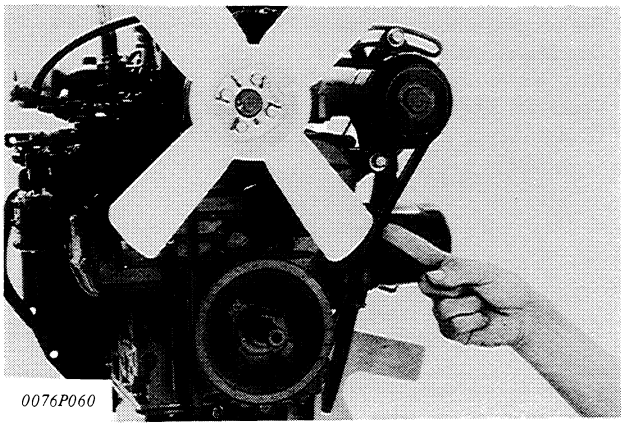


C019F069

❸ Testing Operating Temperature of Thermostat

1) Place a thermostat and a thermometer in water and heat the water.
2) Check to see if the thermostat begins to open at 80.5 to 83.5°C (176.9 to 182.3°F).
3) Check to see if the thermostat opens fully around 95°C (203°F).
4) If the measurement is defective, replace the thermostat.

Reference value		
Temperature at which thermostat should start to open	Temperature at which thermostat completely opens	Distance of lift
80.5 to 83.5°C 176.9 to 182.3°F	95°C 203°F	8 mm 0.3150 in.



0076P060

❹ Checking and Adjusting Fan Belt Tension

1) Check to see if the belt tension allows a depression of the specified amount when the belt is pressed down by a finger midway between the fan drive pulley and the dynamo pulley.
2) Adjust the tension by moving the dynamo.

Reference value
7 to 9 mm (0.2756 to 0.3543 in.) When the belt is pressed down with pressure of 58.8 to 68.6 N. (6 to 7 kgf., 13.2 to 15.4 lb.)

❸ Contrôle de la température d'ouverture du thermostat

1) Placer un thermostat et un thermomètre dans l'eau et chauffer l'eau.
2) Vérifier si le thermostat commence à s'ouvrir à une température de 80,5 à 83,5°C.
3) Le thermostat va s'ouvrir complètement autour de 95°C.
4) Si la mesure n'est pas acceptable, remplacer le thermostat.

Norme de référence		
Température pour début d'ouverture	Température pour ouverture totale	Distance d'ouverture
80,5 à 83,5°C	95°C	8 mm

❹ Vérification et réglage de la tension de la courroie de ventilateur

1) Voir si la tension de la courroie amène un abaissement de la quantité spécifiée quand on appuie sur la courroie avec le doigt à mi-chemin de la poulie d'entraînement du ventilateur et de celle de l'alternateur.
2) Régler la tension en déplaçant l'alternateur.

Norme de référence
7 à 9 mm En pressant par une pression de 58,8 à 68,6 N (6 à 7 kgf).

❸ Prüfung der Betriebstemperatur des Temperaturreglers

1) Temperaturregler und Thermometer in Wasser stellen und erhitzen.
2) Prüfen ob der Regler sich bei Temperaturen zwischen 80,5 bis 83,5°C beginnt zu öffnen.
3) Prüfen ob der Regler bei ungef. 95°C völlig geöffnet ist.
4) Wenn die Meßergebnisse nicht akzeptabel sind, ist der Regler auszutauschen.

Richtwert		
Temperaturen bei denen der Regler sich öffnen sollte	Temperatur bei denen der Regler sich ganz öffnet	Öffnungsweite
80,5 bis 83,5°C	95°C	8 mm

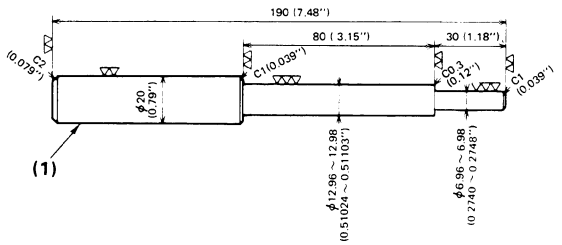
❹ Prüfung und Einstellung der Keilriemenspannung

1) Die Keilriemenspannung auf den zulässigen Richtwert überprüfen, indem dieser in der Mitte mit dem Daumen nach unten ged rückt wird.
2) Die Keilriemenspannung durch Einstellung der Spann-Riemenscheibe regulieren.

Richtwert
7 bis 9 mm Der Keilriemen sollte in der Mitte mit einem Fingerdruck von ca. 58,8 bis 68,6 N. (6 bis 7 kp) belastet werden.

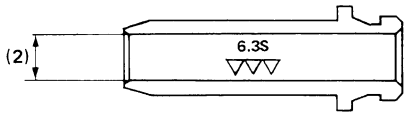
REPLACING VALVE GUIDES, BUSHINGS AND BEARINGS

[A] Tool for replacing valve guides

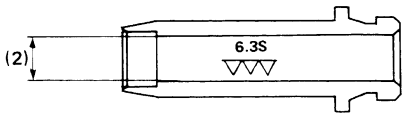


C042F038

[B] Finishing size of inlet valve guide



[C] Finishing size of exhaust valve guide



0075F035

❶ Replacing valve guides

1) Prepare the necessary tool as shown in Fig. [A].
2) Press out the used valve guide from the cylinder head's lower end.
3) Apply engine oil to the outer surface of the new valve guide; press fit the valve guide from the upper end of the cylinder head until the flange part of the valve guide contacts the cylinder head.
4) After press-fitting, finish the valve guide by means of reemer machining to dimensions shown in Figs. [B] and [C].

(Note)

- **Be careful not to strike valve guides with a hammer, etc. during replacement.**

(1) **Material : S43C**
Heat treatment : Quenching & tempering

(2) **7.010 to 7.025 mm (0.27598 to 0.27657 in.)**

REMPLACEMENT DES GUIDES DE SOUPAPE, DES COUSSINETS ET DES PALIERS

❶ Remplacement des guides de soupape

1) Agencer l'outil requis selon les indications du schéma [A].
2) Retirer le guide de soupape usé en pressant par l'extrémité inférieure de la culasse à petits coups secs.
3) Appliquer une couche d'huile de machine sur la surface du guide de soupape neuf; procéder à un calage à la presse de ce guide en l'enfonçant, à partir de l'extrémité supérieure de la culasse, jusqu'à ce que la section de la bride touche la culasse.
4) Ce calage à la presse étant effectué, usiner le guide de soupape à l'alésoir pour lui donner les dimensions indiquées sur les schémas [B] et [C].

(Note)

- **Lors du remplacement, veiller à ce que le marteau ne heurte pas les guides de soupape.**

[A] Outil pour remplacer les guides de soupape
(1) Matériau : S43C
Traitement thermique : Trempe et revenu
[B] Dimension d'usinage du guide de la soupape d'admission
(2) de 7,010 à 7,025 mm
[C] Dimension d'usinage du guide de la soupape d'échappement

AUSWECHSELN DER VENTILSITZE, TÜLLEN UND LAGERUNGEN

❶ Auswechseln der Ventilsitze

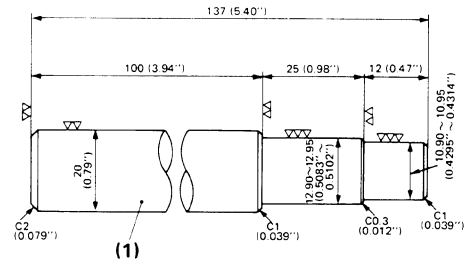
1) Die notwendigen Werkzeuge gemäß der Aufstellung in Abbildung [A] bereitstellen.
2) Die auszuwechselnde Ventilführung vom unteren Ende des Ventilkopfes herausdrücken.
3) Die Außenflächen des neuen Ventilsitzes mit Motorenöl entsprechend einölen. Die neue Ventilführung dann vom oberen Ende des Zylinderkopfes mit entsprechendem Druck einpassen, bis der Flanschteil der Ventilführung mit dem Zylinderkopf kontakt bekommt.
4) Nach diesem Einsetzvorgang dann die Ventilführung mit der "Reemer"-Bearbeitungsmethode auf die Maße der Abbildungen [B] und [C] bringen.

(Anmerkung)

- **Beim Auswechseln muß unbedingt darauf geachtet werden, daß die Ventilführungen nicht mit Werkzeugen wie Hammer usw. durch unbeabsichtigtes Dagegenschlagen beschädigt werden.**

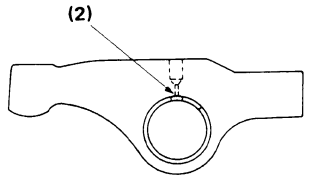
[A] Werkzeuge für das Auswechseln der Ventilführungen
(1) Material : S43C
Hitzebehandlung : Härtung und Abschreckung
[B] Bearbeitungsgröße der Einlaßventilführungen
(2) 7,010 bis 7,025 mm
[C] Bearbeitungsgröße der Einlaßventilführungen

[A] Tool for repalcing rocker arm bushing



0076F028

[B] Rocker arm and bushing, as assembled



0076F029

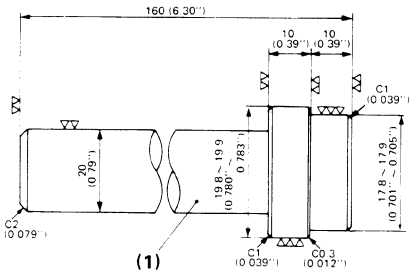
❷ Replacing rocker arm bushings

1) Prepare the necessary tool as shown in Fig. [A].
2) Press out the used bushing and, using this tool, press fit the new bushing, taking due care to see that the rocker arm hole matches the bushing hole.

(1) Material : S43C
Heat treatment : Quenching & tempering

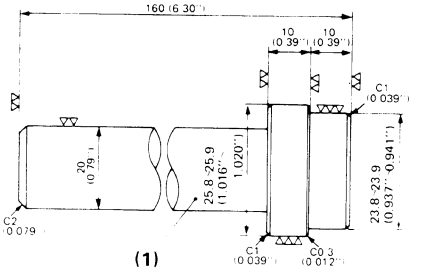
(2) Match the rocker arm hole and bushing hole

[A] Tool for replacing idle gear bushing



ST10F059

[B] Tool for replacing idle gear bushing [from engine serial numbers 407507 (D650-B, D750-B, D850-B, DH850-B) and 393782 (D950-B)]



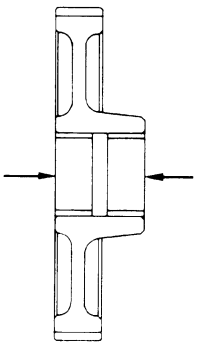
ST10F059

❸ Replacing idle gear bushings

1) Prepare the necessary tool as shown in Fig. [A].
2) Press out the used bushing and press a new part in, using this tool.

- **New part code number**
  15261-24981
  15532-99342 [from engine serial numbers 407507 (D650-B, D750-B, D850-B, DH850-B) and 393782 (D950-B)]

[C] Idle gear and bushing, as assembled



C042F033

(1) Material : S43C
Heat treatment : Quenching & tempering

❷ Remplacement des coussinets de culbuteur

1) Agencer l'outil requis selon les indications du schéma [A].
2) Faire sortir en pressant le coussinet usé, et à l'aide de l'outil, ajuster à la presse le nouveau coussinet en prenant soin que le trou du culbuteur corresponde au trou du coussinet.

[A] Outil pour remplacer le coussinet de culbuteur
(1) Matériau : S43C
Traitement thermique : Trempe et revenu
[B] Culbuteur et coussinet, après assemblage
(2) Faire correspondre le trou du culbuteur avec celui du coussinet

❸ Remplacement des bagues du pignon de renvoi

1) Agencer l'outil requis selon les indications du schéma [A].
2) Fair sortir en present la bague usé et en enfoncer un nouveau, à l'aide de l'outil préalablement agencé.

- **Nouveau numéro de code des pièces**
  15261-24981
  15532-99342 [à partir des numéros de série 407507 (D650-B, D750-B, D850-B, DH850-B) et 393782 (D950-B)]

[A] Outil pour remplacer les bague du pignon de renvoi
(1) Matériau : S43C
Traitement thermique : Trempe et revenu
[B] Outil pour remplacer les bagues du pignon de renvoi
[à partir des numéros de série 407507 (D650-B, D750-B, D850-B, DH850-B) et 393782 (D950-B)]
[C] Pignon de renvoi et bague, après assemblage

❷ Auswechseln der Kipphebelbuchsen

1) Die notwendigen Werkzeuge gemäß der Aufstellung in Abbildung [A] bereitstellen.
2) Die auszuwechselnde Buchse herausschlagen. Dann unter Verwendung des aufgeführten Werkzeuges die neue Buchse mit entsprechendem Druck einpassen, wobei darauf geachtet werden muß, daß das Kipphebelloch mit dem Buchsenloch in Übereinstimmung gebracht wird.

[A] Werkzeuge für das Auswechseln der Kipphebelbuchse
(1) Material : S43C
Hitzebehandlung : Härtung und Abschreckung
[B] Zusammenbau von Kipphebel und Buchse
(2) Das Kipphebelloch und das Buchsenloch in Übereinstimmung bringen.

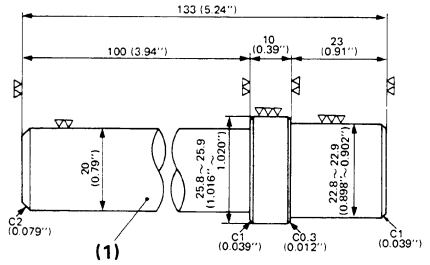
❸ Auswechseln der Zwischenradbuchse

1) Die notwendigen Werkzeuge gemäß der Aufstellung in Abbildung [A] bereitstellen.
2) Die auszuwechselnde Buchse herausschlagen und die neue Buchse mit entsprechendem Druck unter Verwendung des vorgeschriebenen Werkzeuges einpassen.

- **Neue Teil-Codenummer**
  15261-24981
  15532-99342 [für Motoren der Seriennummern 407507 (D650-B, D750-B, D850-B, DH850-B) und 393782 (D950-B)]

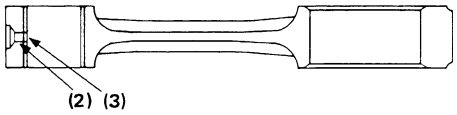
[A] Werkzeuge zum Auswechseln der Zwischenradbuchse
(1) Material : S43C
Hitzebehandlung : Härtung und Abschreckung
[B] Werkzeug zum Auswechseln der Zwischenradbuchse
[für Motoren der Seriennummern 407507 (D650-B, D750-B, D850-B, DH850-B) und 393782 (D950-B)]
[C] Zusammenbau von Leerlaufgetriebe und Buchse

[A] Tool for replacing small end bushings



0076F031

[B] Connecting rod and bushing, as assembled



C042F029

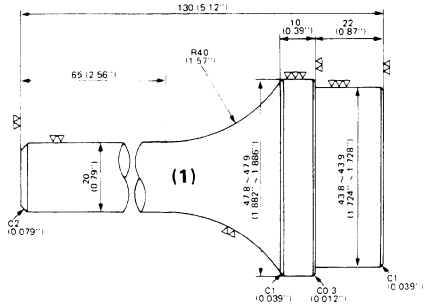
4 Replacing small end bushings

1) Prepare the necessary tool as shown in Fig. [A].
2) Press out the used bushing and, using this took, press a new bushing (Code No. 15261-21981 service part) in, taking due care to see that the connecting rod hole matches the bushing hole.

(1) Material : S43C
Heat treatment : Quenching & tempering

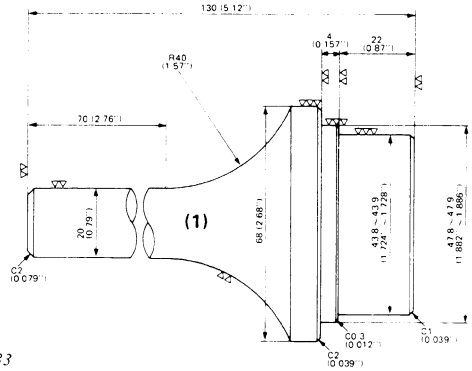
(2) Connecting rod hole
(3) Bushing hole

[A] Tool for extracting crankshaft bearing 1



0076F032

[B] Tool for inserting crankshaft bearing 1

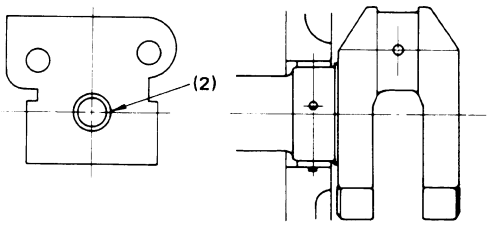


0076F033

5 Replacing crankshaft bearing 1

1) Prepare the necessary tool as shown in Figs. [A] and [B].
2) Press out the bearing 1, using the extracting tool.
3) Insert a new bearing 1, using the inserting tool, taking due care to see that the contact edge of bearing 1 faces the exhaust manifold side.

[C] Crankshaft and crankshaft bearing 1, as assembled



0076F034

(1) Material : S43C
Heat treatment : Quenching & tempering

(2) Contact edge (the exhaust manifold side)

❹ Remplacement des coussinets du pied de bielle

1) Agencer l'outil requis selon les indications du schéma [A].
2) Fair sortir en present le coussinet usé et en enfoncer un nouveau (N° de code: 15261-21981, section entretien), à l'aide de l'outil préalablement agencé, en veillant à ce que le trou de la bielle corresponde avec celui du coussinet.

[A] Outil pour remplacer les coussinets du pied de bielle.
(1) Matériau : S43C
Traitement thermique : Trempe et revenu
[B] Bielle et coussinet, après assemblage
(2) Trou de la bielle
(3) Trou du coussinet

❺ Remplacement du palier 1 de vilebrequin

1) Agencer les outils requis selon les indications des schémas [A] et [B].
2) Fair sortir en present le palier 1 à l'aide de l'extracteur.
3) Loger un nouveau palier 1, à l'aide de l'outil à enfoncer, en veillant à ce que la surface de contact du palier 1 et le côté collecteur d'échappement soient placés en vis-à-vis.

[A] Outil pour extraire le palier 1 de vilebrequin
(1) Matériau : S43C
Traitement thermique : Trempe et revenu
[B] Outil pour enfoncer le palier 1 de vilebrequin
(1) Matériau: S43C
Traitement thermique : Trempe et revenu
[C] Pâlier 1 de vilebrequin et vilebrequin, aprés assemblage
(2) Surface de contact (côté collecteur d'échappement)

❹ Auswechseln der Kolbenstangenkopfbüchsen

1) Die notwendigen Werkzeuge gemäß der Aufstellung in Abbildung [A] bereitstellen.
2) Die auszuwechselnde Buchse (Kolbenstangenkopfbuchse) herausschlagen. Dann unter Verwendung des vorgeschriebenen Werkzeuges die neue Buchse mit entsprechendem Druck einpassen, wobei darauf geachtet werden muß, daß das Pleuelstangenloch mit dem Buchsenloch (Kolbenstangenkopfbuchsenloch) in Übereinstimmung gebracht wird.
(Kodenummer: 15261-21981 Wartungsteil)

[A] Werkzeuge für das Auswechseln der Kolbenstangenkopfbüchsen
(1) Material: S43C
Hitzebehandlung: Härtung und Abschreckung
[B] Zusammenbau von Pleuelstange und Buchse (Kolbenstangenkopfbuchse)
(2) Pleuelstangenloch
(3) Buchsenloch (Kolbenstangenkopfbuchsenloch)

❺ Auswechseln der Kurbelwellenlagerung 1

1) Die notwendigen Werkzeuge gemäß der Aufstellung in den Abbildungen [A] und [B] bereitstellen.
2) Die Lagerung 1 mit dem Ausziehwerkzeug entsprechend herausdrücken.
3) Unter Verwendung des Einsetzwerkzeuges, die neue Lagerung 1 entsprechend einsetzen. Dabei muß besonders darauf geachtet werden, daß die Kontaktkante der Lagerung 1 gegen die Auspuffkrümmerseite gerichtet ist.

[A] Werkzeug für das Herausziehen der Kurbelwellenlagerung 1
(1) Material : S43C
Hitzebehandlung : Härtung und Abschreckung
[B] Werkzeug für das Einsetzen der Kurbelwellenlagerung 1
(1) Material : S43C
Hitzebehandlung : Härtung und Abschreckung
[C] Zusammenbau der Kurbelwelle und Kurbelwellenlagerung 1
(2) Kontaktkante (Auspuffkrümmerseite)

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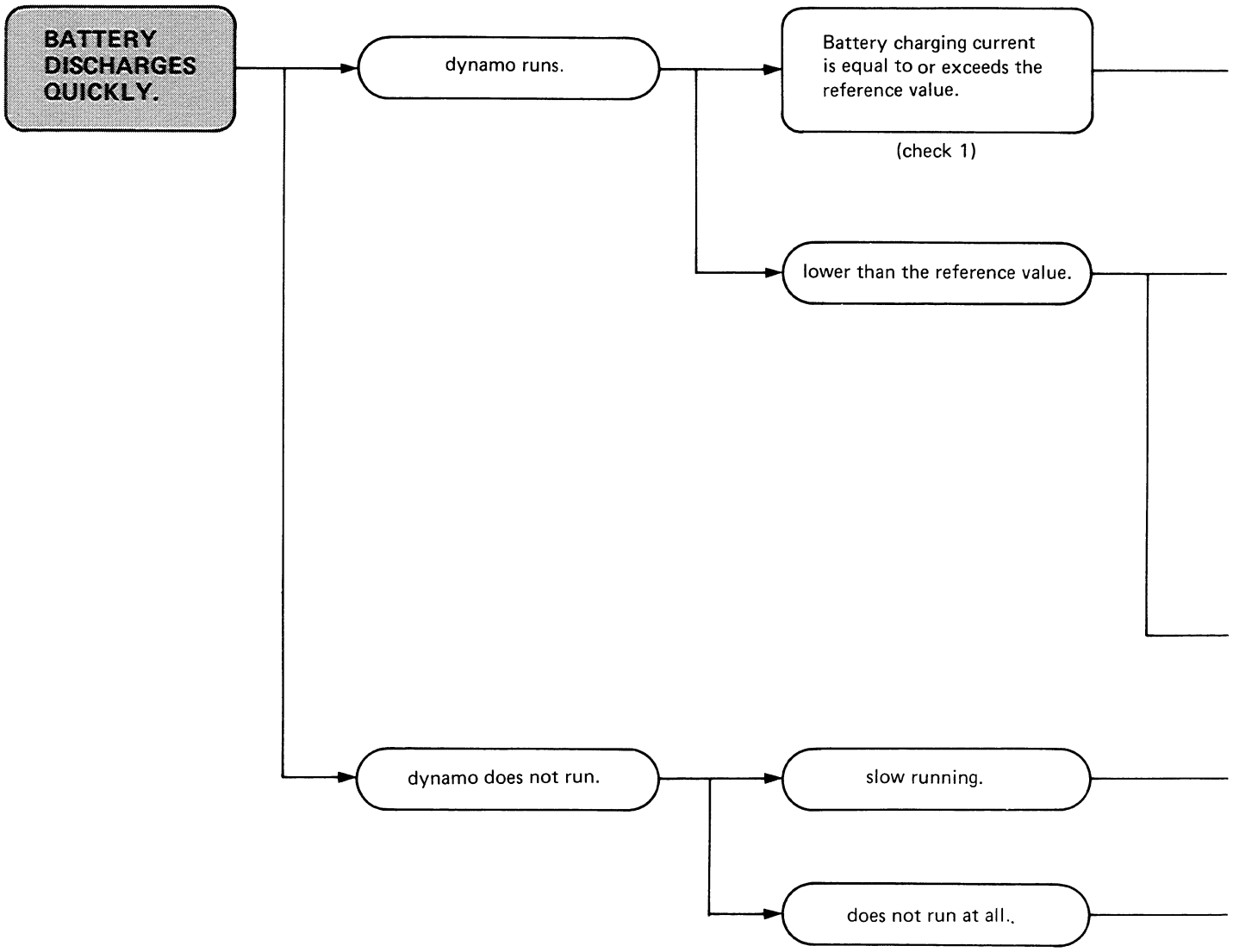
SYSTEME ELECTRIQUE

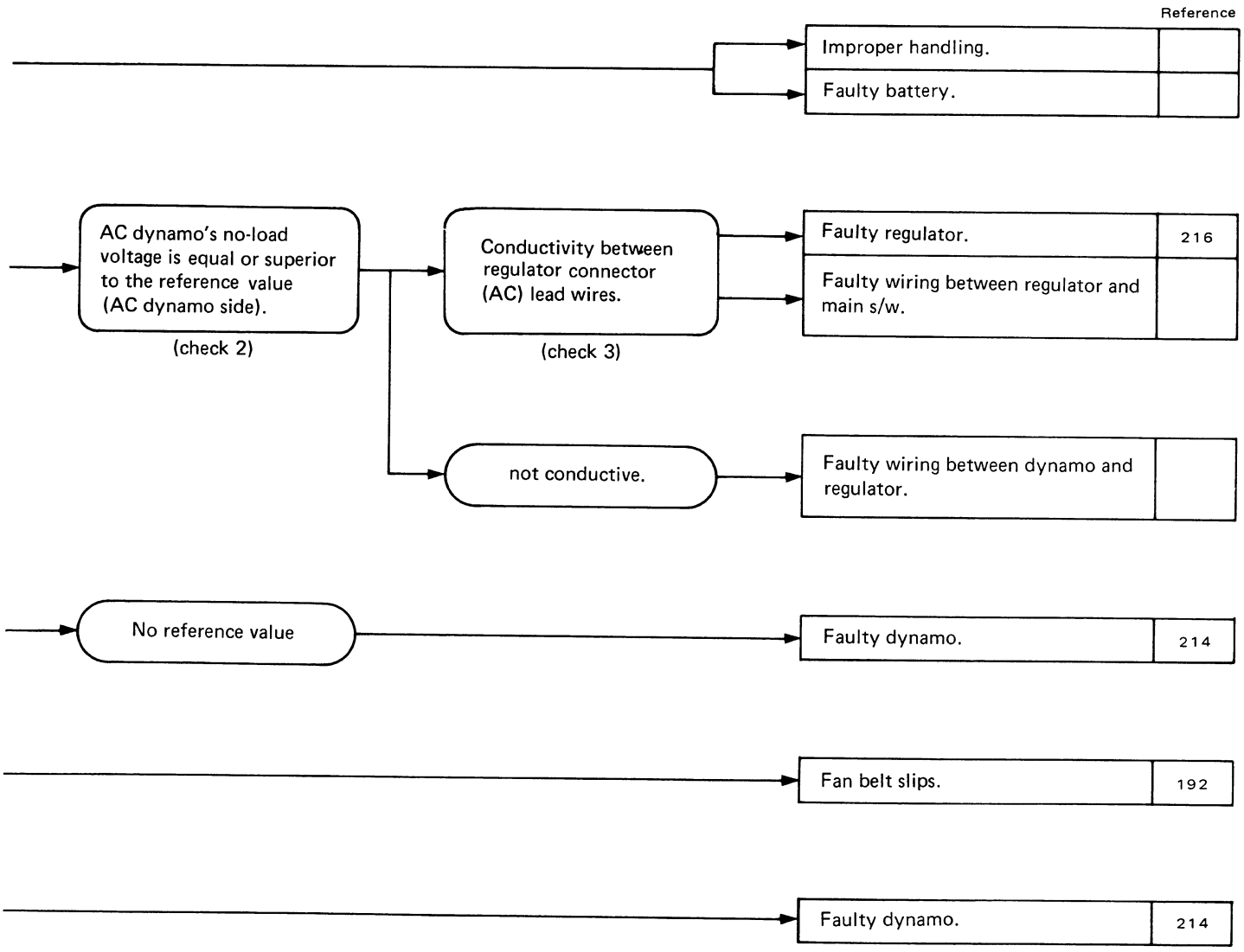
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   - Entretien 228

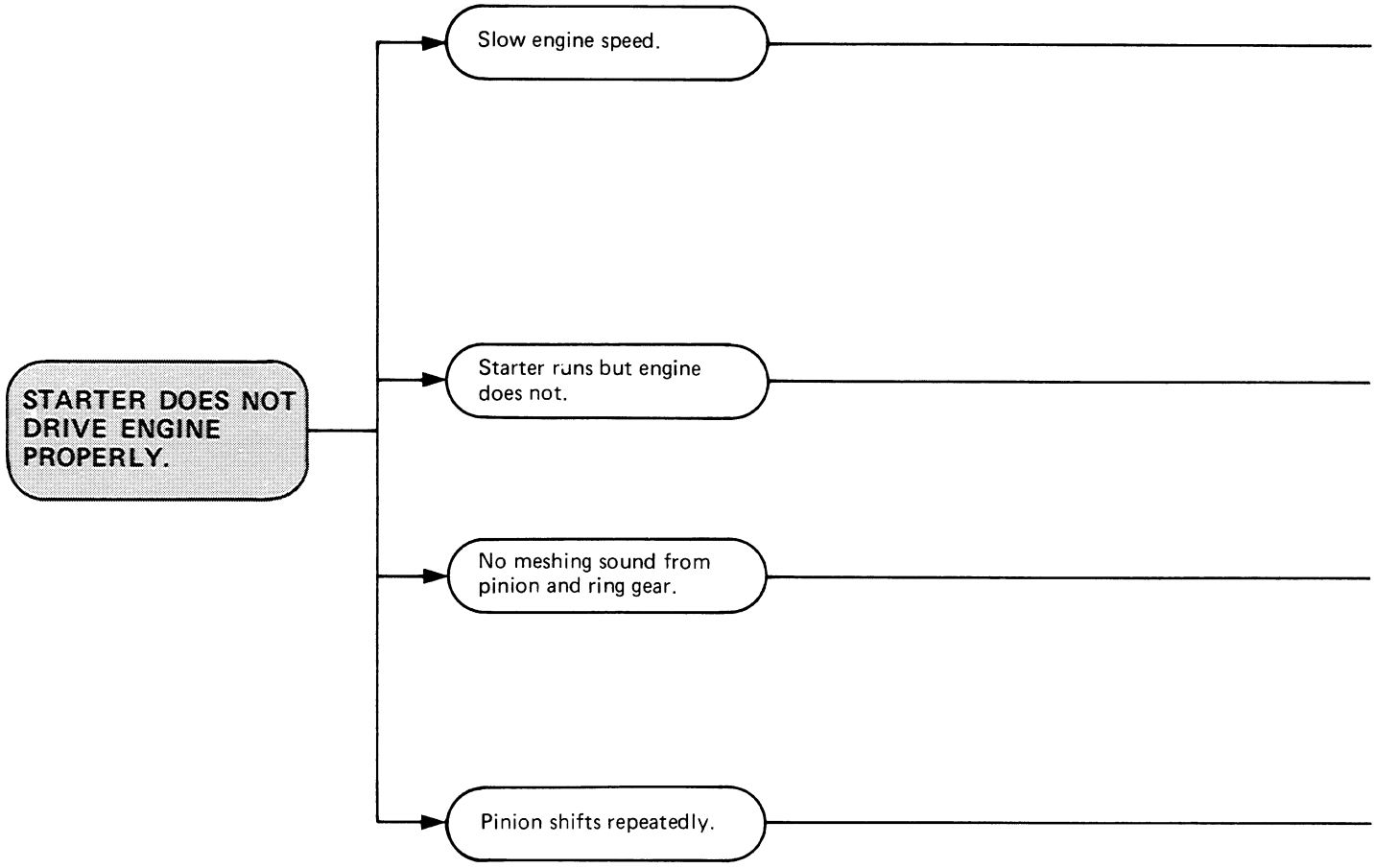
ELEKTRISCHE AUSRÜSTUNG

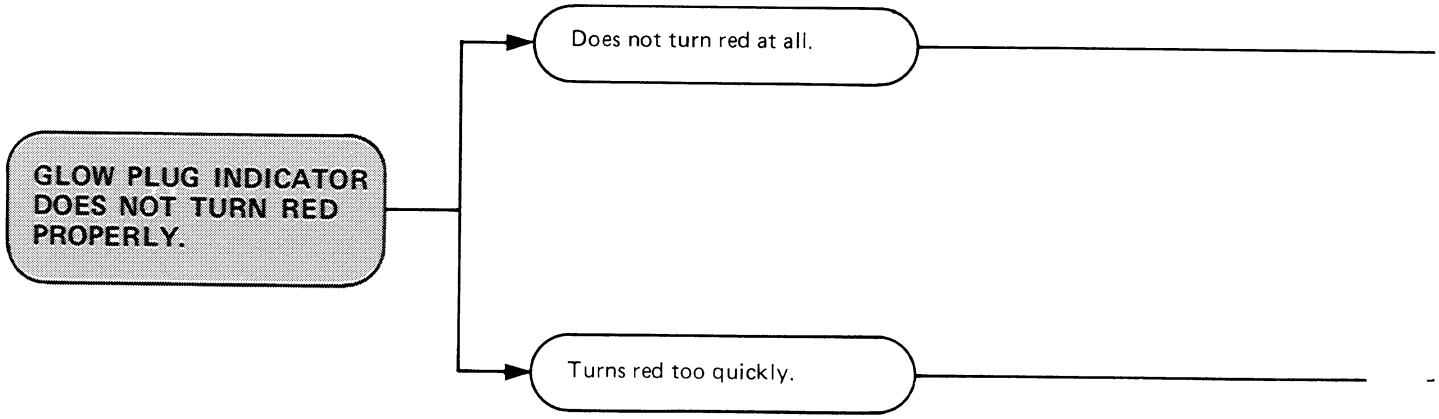
1. STÖRUNGSBESEITIGUNG 210
2. DYNAMO UND REGULATOR 214
3. STARTER UND GLÜHKERZE 218
   - Prüfungen 218
   - Zerlegen 224
   - Wartung 228

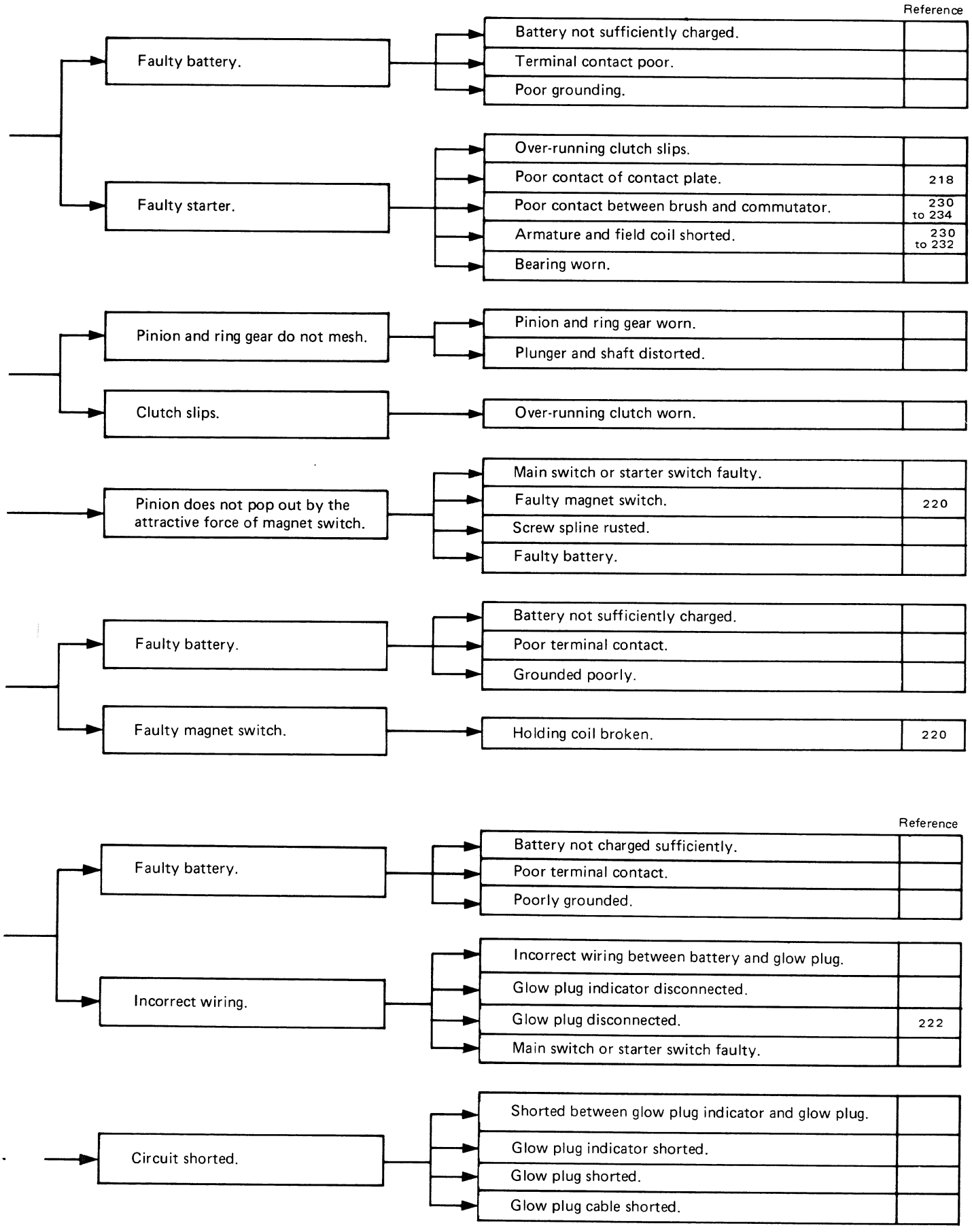
1. TROUBLESHOOTING



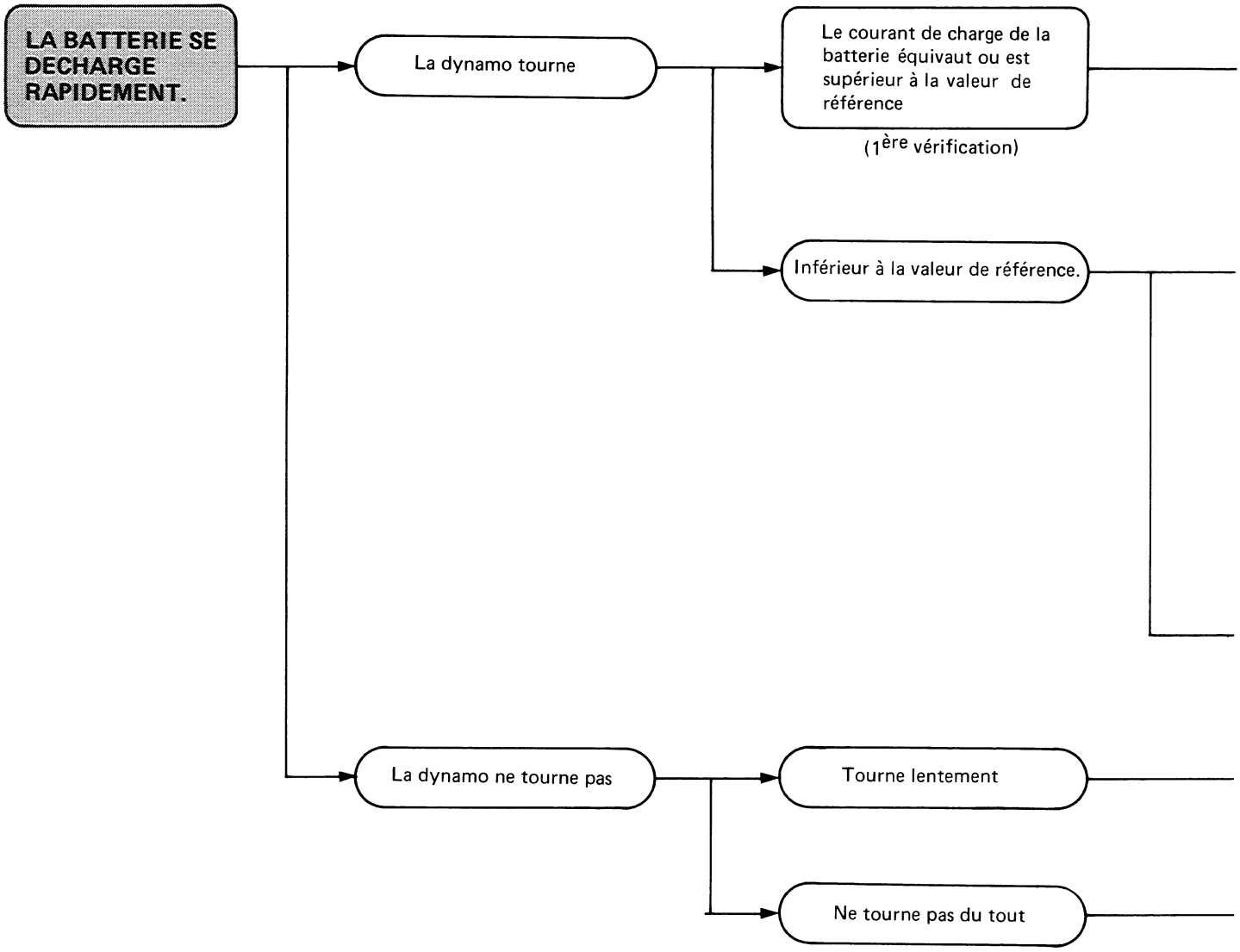

Reference
Improper handling.
Faulty battery.
AC dynamo's no-load voltage is equal or superior to the reference value (AC dynamo side).
(check 2)
Conductivity between regulator connector (AC) lead wires.
(check 3)
Faulty regulator.
216
Faulty wiring between regulator and main s/w.
not conductive.
Faulty wiring between dynamo and regulator.
No reference value
Faulty dynamo.
214
Fan belt slips.
192
Faulty dynamo.
214

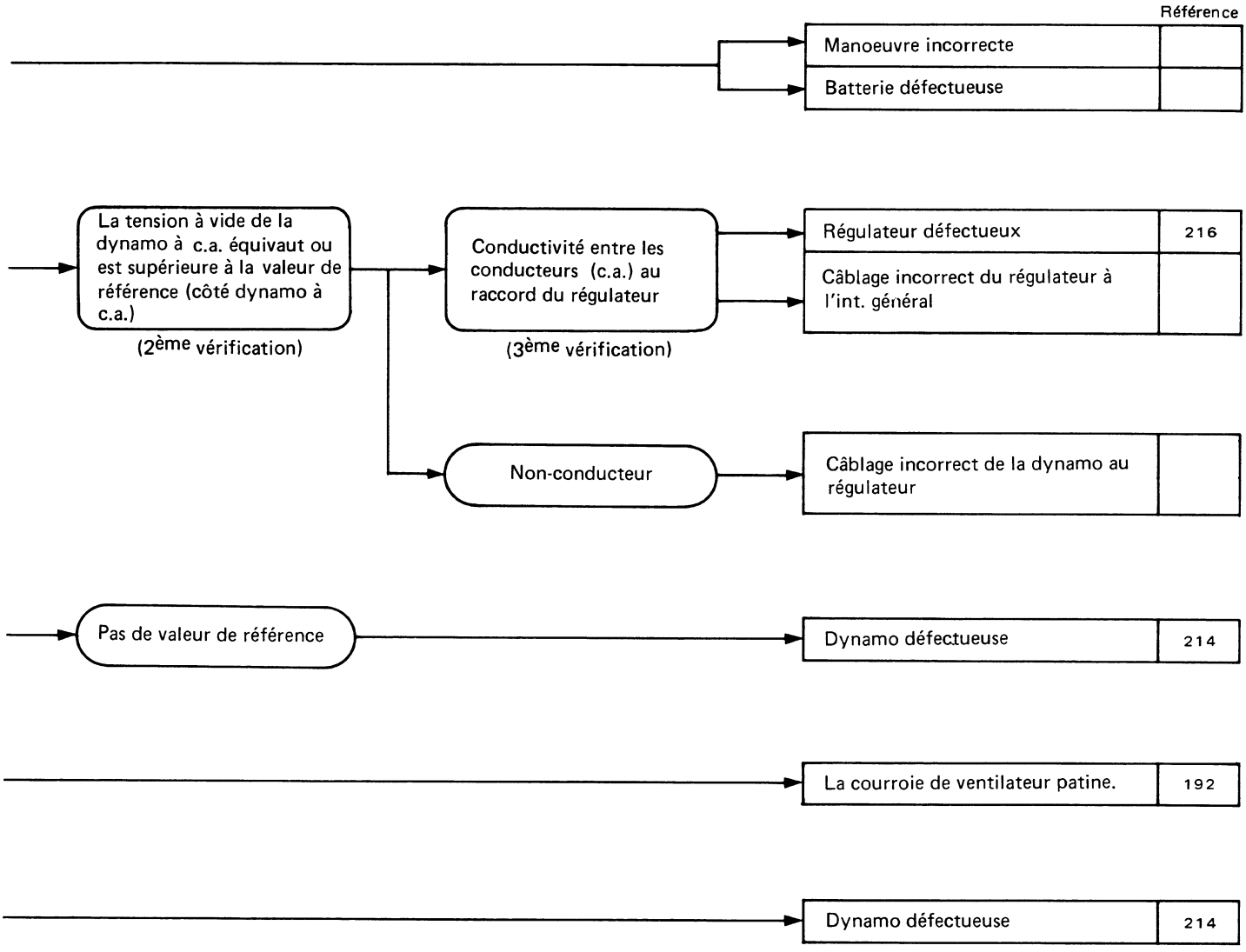

STARTER DOES NOT DRIVE ENGINE PROPERLY.
Slow engine speed.
Starter runs but engine does not.
No meshing sound from pinion and ring gear.
Pinion shifts repeatedly.

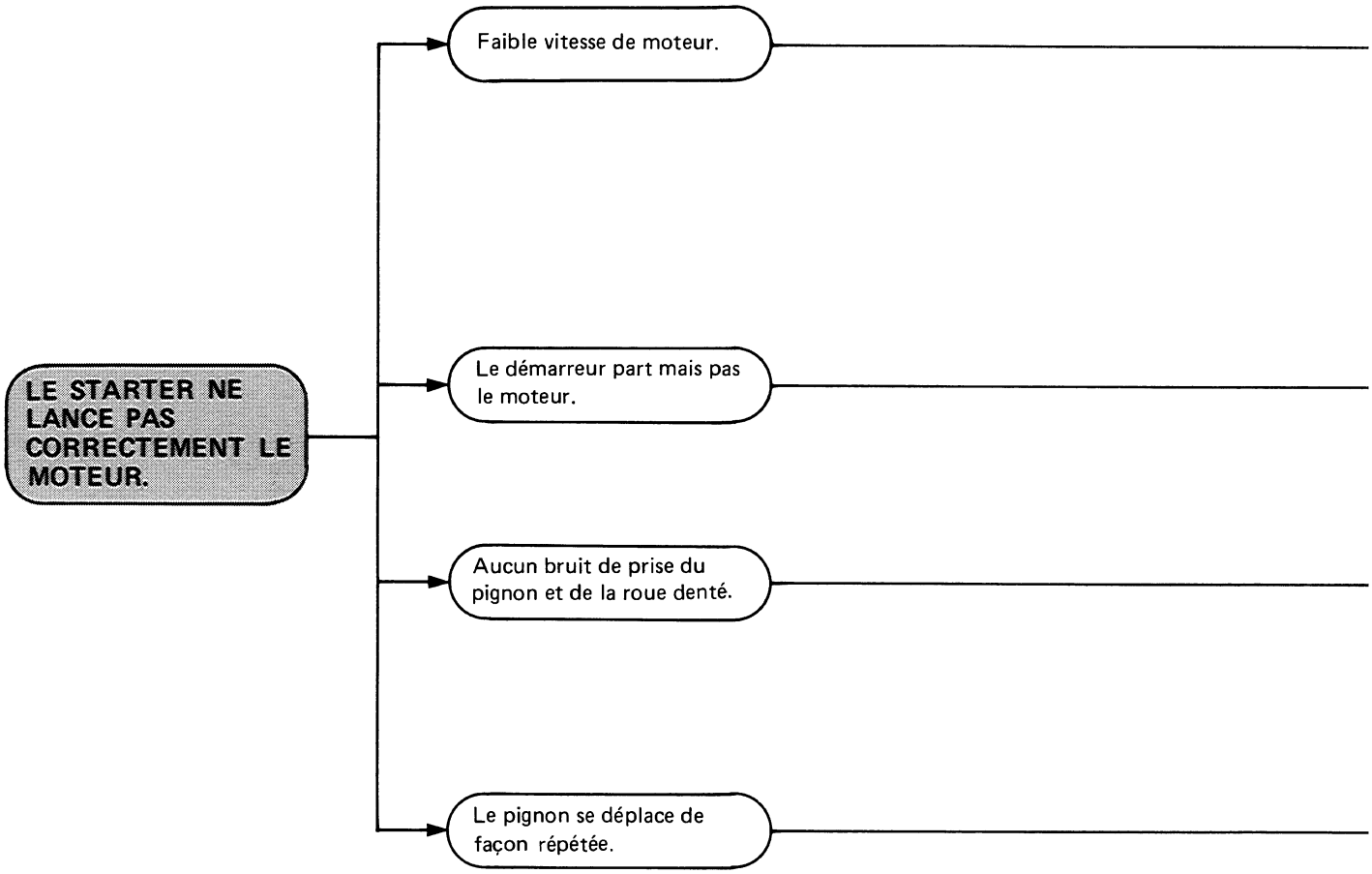

GLOW PLUG INDICATOR DOES NOT TURN RED PROPERLY.
Does not turn red at all.
Turns red too quickly.

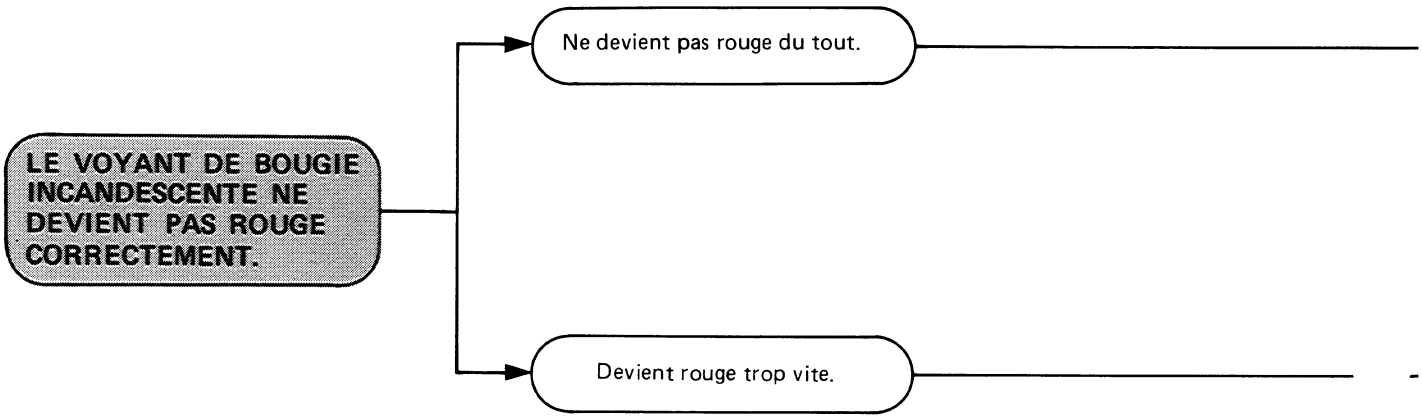

Reference
Faulty battery.
Battery not sufficiently charged.
Terminal contact poor.
Poor grounding.
Faulty starter.
Over-running clutch slips.
Poor contact of contact plate. 218
Poor contact between brush and commutator. 230 to 234
Armature and field coil shorted. 230 to 232
Bearing worn.
Pinion and ring gear do not mesh.
Pinion and ring gear worn.
Plunger and shaft distorted.
Clutch slips.
Over-running clutch worn.
Pinion does not pop out by the attractive force of magnet switch.
Main switch or starter switch faulty.
Faulty magnet switch. 220
Screw spline rusted.
Faulty battery.
Faulty battery.
Battery not sufficiently charged.
Poor terminal contact.
Grounded poorly.
Faulty magnet switch.
Holding coil broken. 220
Reference
Faulty battery.
Battery not charged sufficiently.
Poor terminal contact.
Poorly grounded.
Incorrect wiring.
Incorrect wiring between battery and glow plug.
Glow plug indicator disconnected.
Glow plug disconnected. 222
Main switch or starter switch faulty.
Circuit shorted.
Shorted between glow plug indicator and glow plug.
Glow plug indicator shorted.
Glow plug shorted.
Glow plug cable shorted.

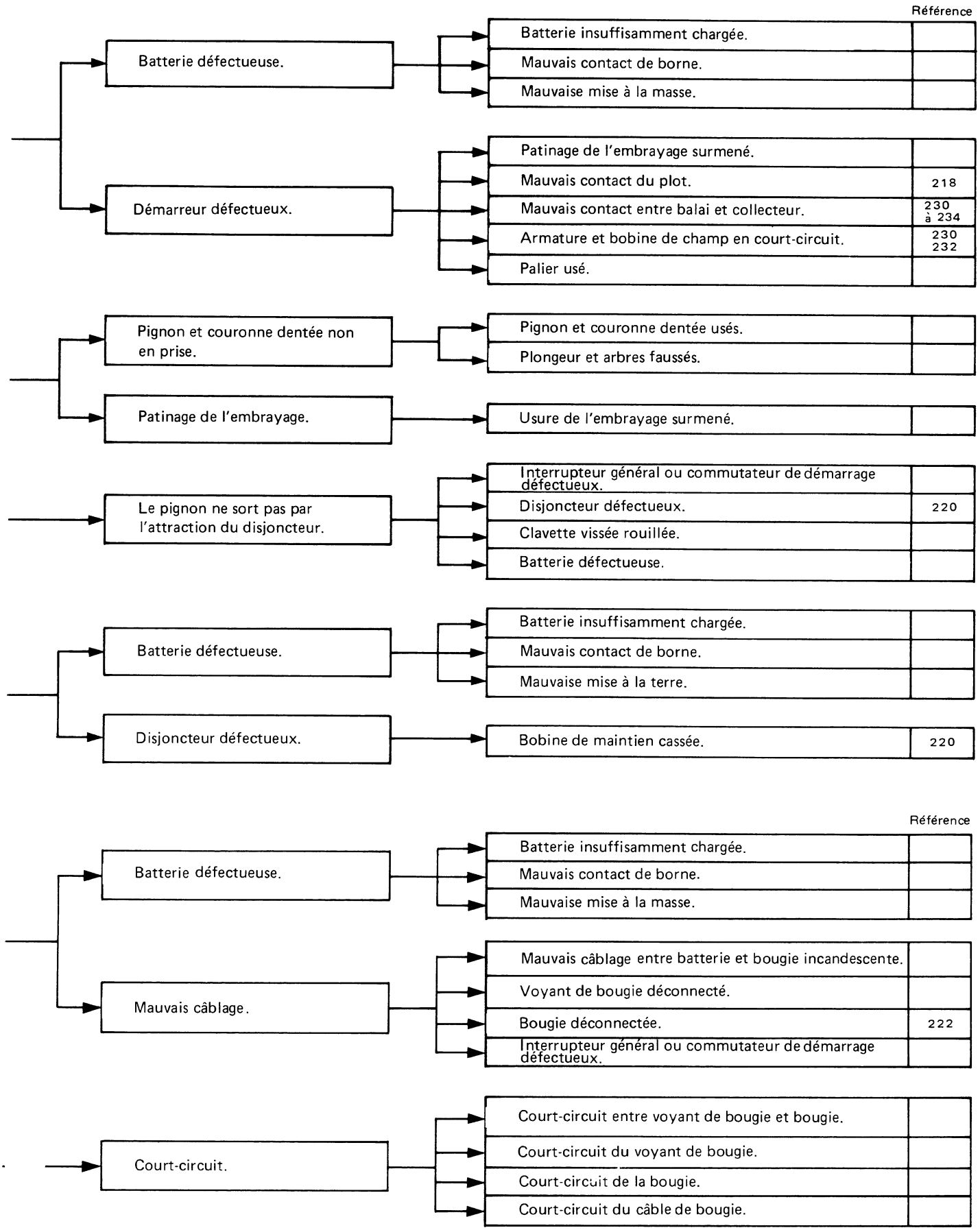
1. DEPANNAGE


LA BATTERIE SE DECHARGE RAPIDEMENT.
La dynamo tourne
Le courant de charge de la batterie équivaut ou est supérieur à la valeur de référence
(1ère vérification)
Inférieur à la valeur de référence.
La dynamo ne tourne pas
Tourne lentement
Ne tourne pas du tout

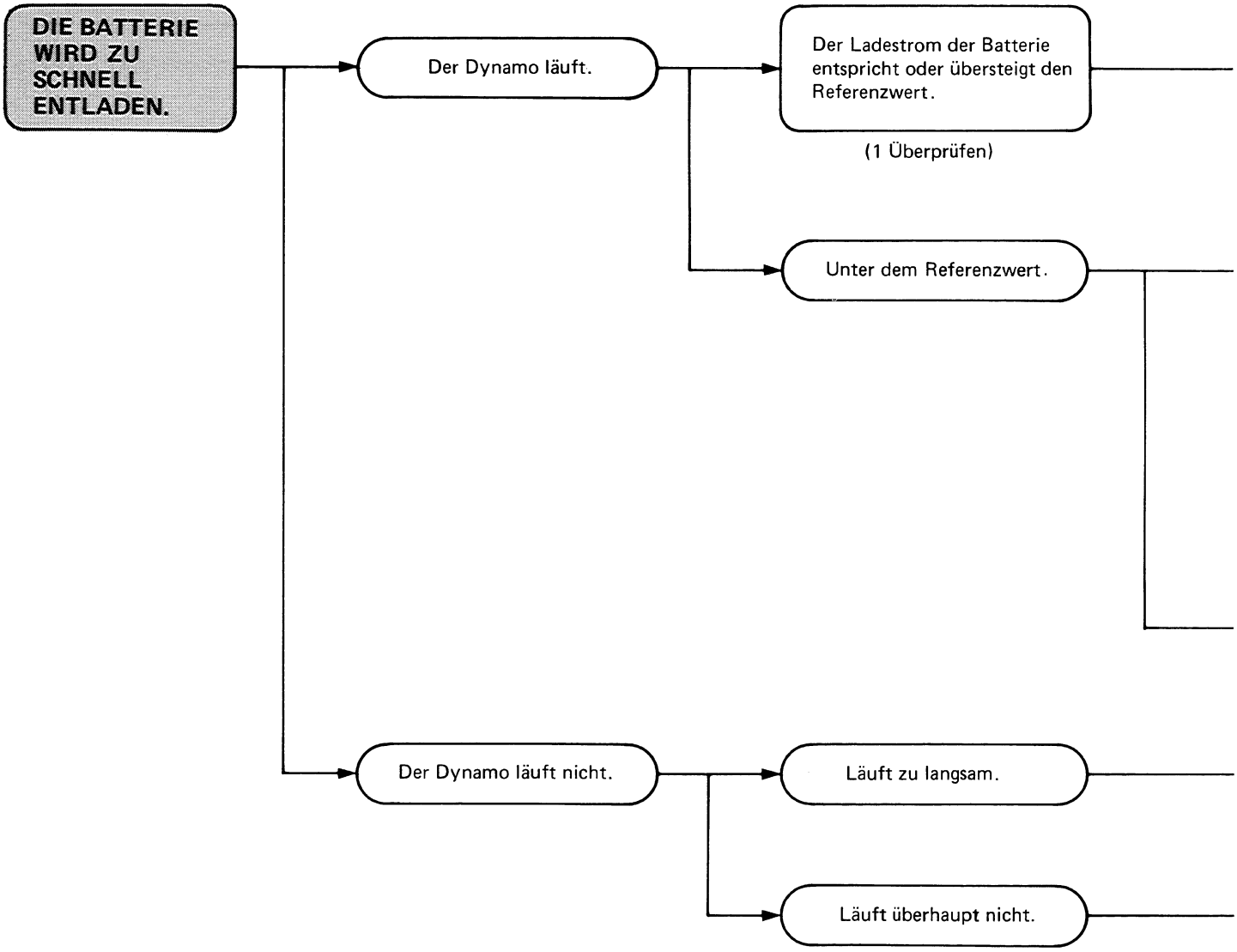

Référence
Manoeuvre incorrecte
Batterie défectueuse
La tension à vide de la dynamo à c.a. équivaut ou est supérieure à la valeur de référence (côté dynamo à c.a.)
(2ème vérification)
Conductivité entre les conducteurs (c.a.) au raccord du régulateur
(3ème vérification)
Régulateur défectueux
216
Câblage incorrect du régulateur à l'int. général
Non-conducteur
Câblage incorrect de la dynamo au régulateur
Pas de valeur de référence
Dynamo défectueuse
214
La courroie de ventilateur patine.
192
Dynamo défectueuse
214

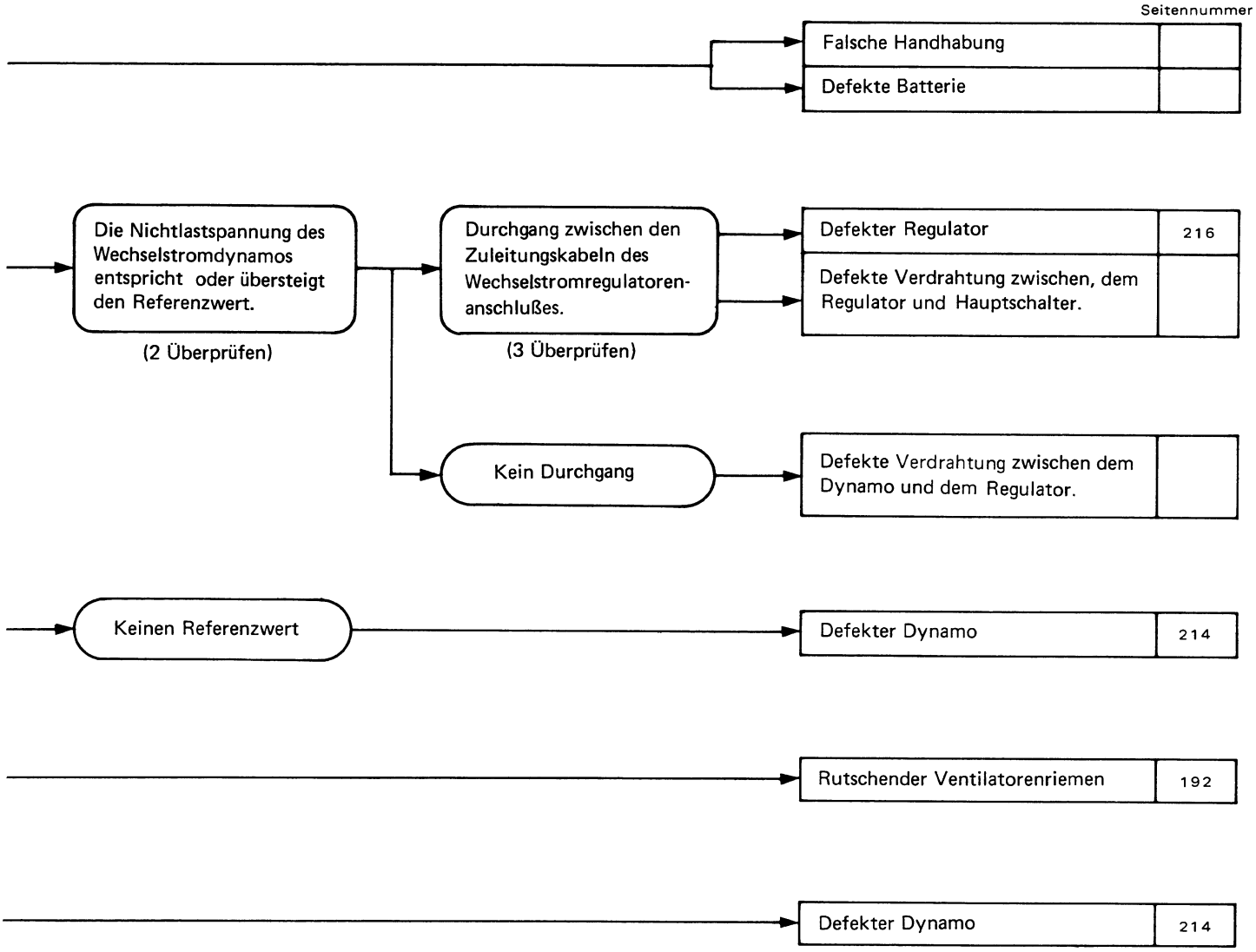

LE STARTER NE LANCE PAS CORRECTEMENT LE MOTEUR.
Faible vitesse de moteur.
Le démarreur part mais pas le moteur.
Aucun bruit de prise du pignon et de la roue denté.
Le pignon se déplace de façon répétée.

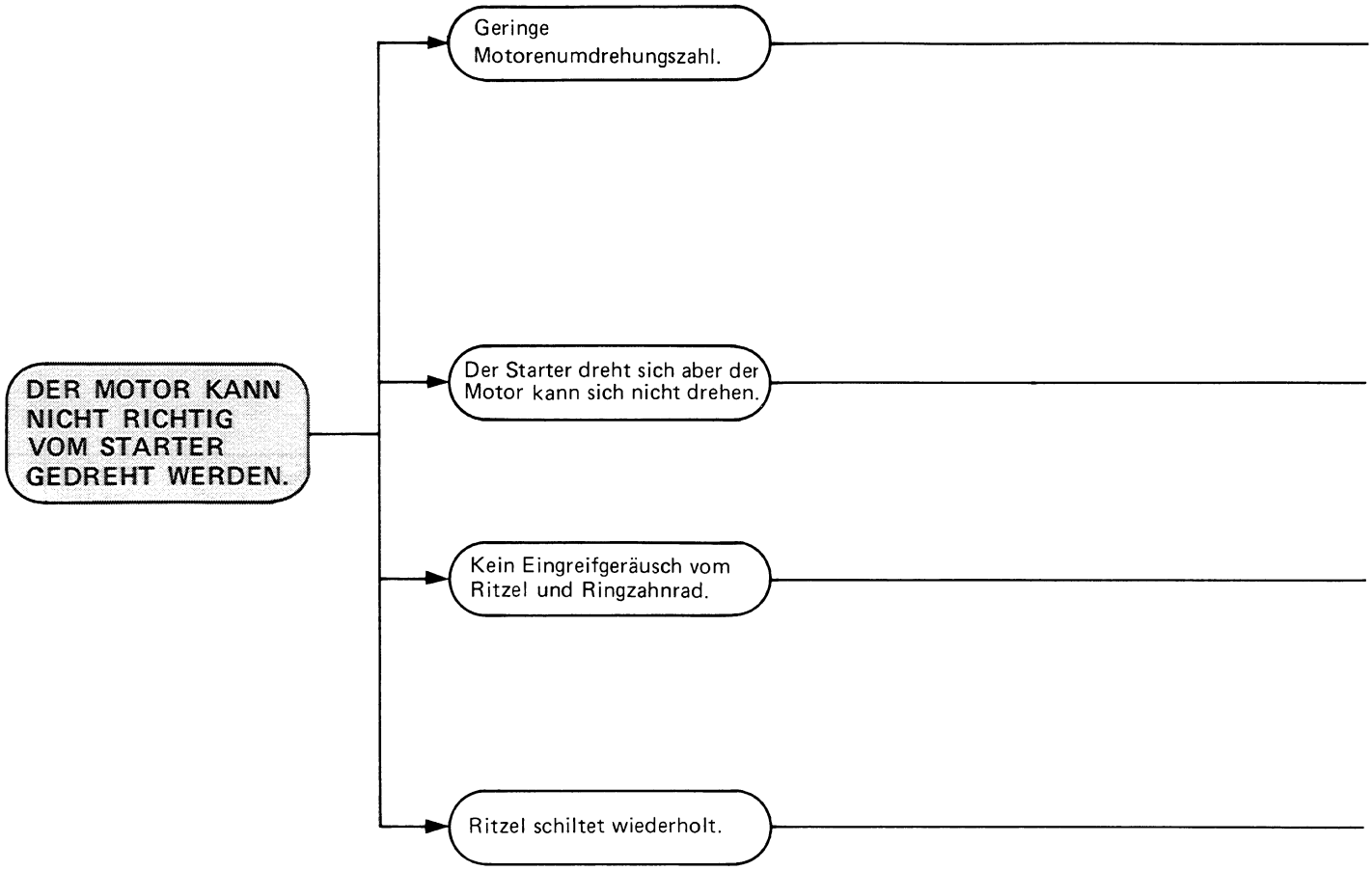

LE VOYANT DE BOUGIE INCANDESCENTE NE DEVIENT PAS ROUGE CORRECTEMENT.
Ne devient pas rouge du tout.
Devient rouge trop vite.

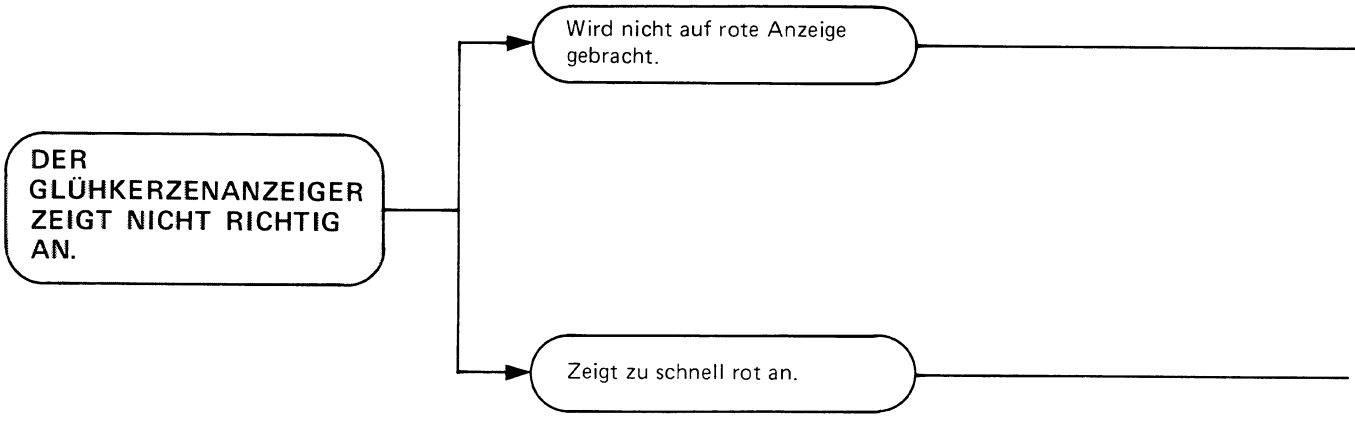

Référence
Batterie défectueuse.
Batterie insuffisamment chargée.
Mauvais contact de borne.
Mauvaise mise à la masse.
Démarreur défectueux.
Patinage de l'embrayage surmené.
Mauvais contact du plot. 218
Mauvais contact entre balai et collecteur. 230 à 234
Armature et bobine de champ en court-circuit. 230 232
Palier usé.
Pignon et couronne dentée non en prise.
Pignon et couronne dentée usés.
Plongeur et arbres faussés.
Patinage de l'embrayage.
Usure de l'embrayage surmené.
Le pignon ne sort pas par l'attraction du disjoncteur.
Interrupteur général ou commutateur de démarrage défectueux.
Disjoncteur défectueux. 220
Clavette vissée rouillée.
Batterie défectueuse.
Batterie défectueuse.
Batterie insuffisamment chargée.
Mauvais contact de borne.
Mauvaise mise à la terre.
Disjoncteur défectueux.
Bobine de maintien cassée. 220
Référence
Batterie défectueuse.
Batterie insuffisamment chargée.
Mauvais contact de borne.
Mauvaise mise à la masse.
Mauvais câblage.
Mauvais câblage entre batterie et bougie incandescente.
Voyant de bougie déconnecté.
Bougie déconnectée. 222
Interrupteur général ou commutateur de démarrage défectueux.
Court-circuit.
Court-circuit entre voyant de bougie et bougie.
Court-circuit du voyant de bougie.
Court-circuit de la bougie.
Court-circuit du câble de bougie.

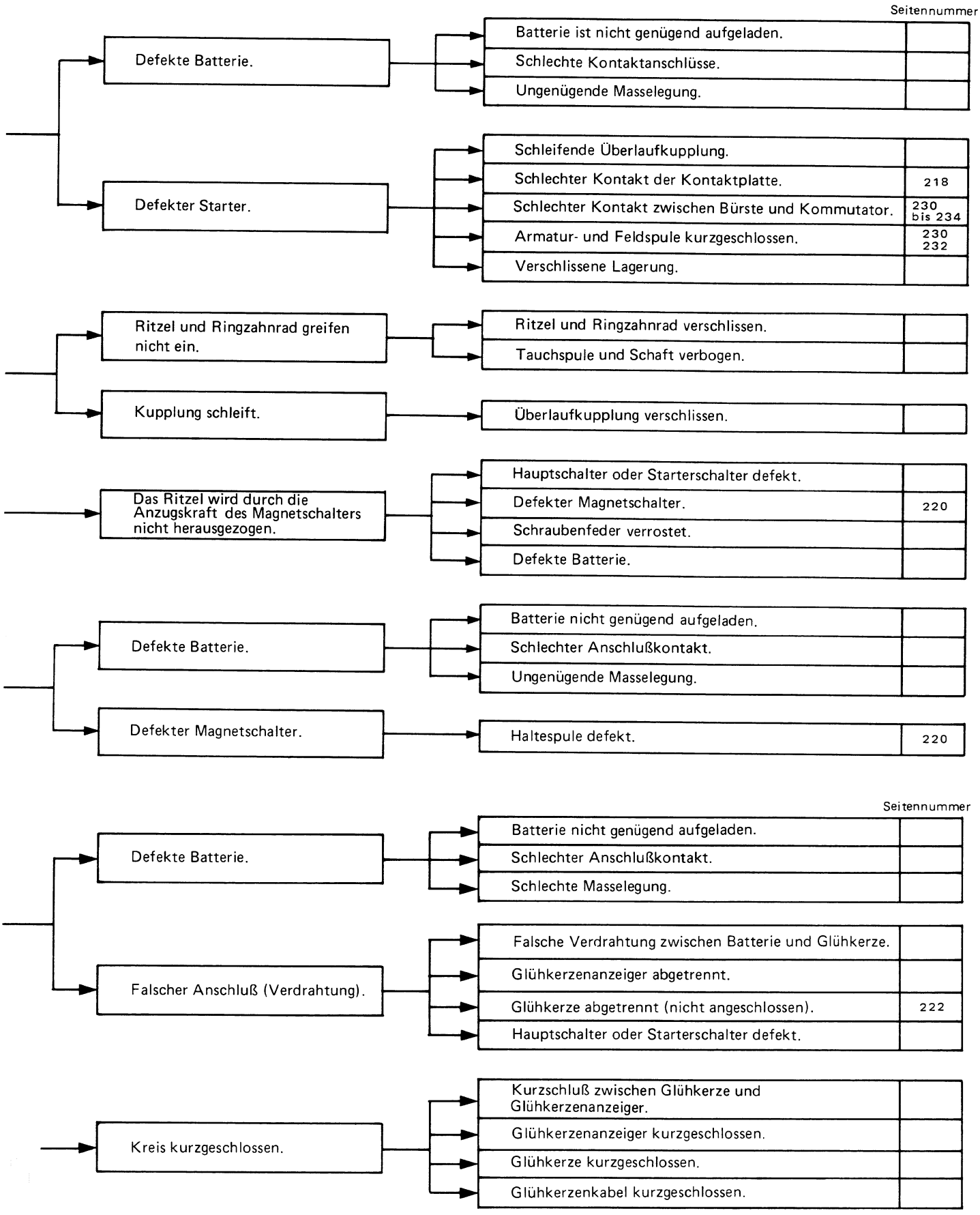
1. STÖRUNGSBESEITIGUNG




Seitennummer
Falsche Handhabung
Defekte Batterie
Die Nichtlastspannung des Wechselstromdynamos entspricht oder übersteigt den Referenzwert.
(2 Überprüfen)
Durchgang zwischen den Zuleitungskabeln des Wechselstromregulatoren-anschlußes.
(3 Überprüfen)
Defekter Regulator
216
Defekte Verdrahtung zwischen, dem Regulator und Hauptschalter.
Kein Durchgang
Defekte Verdrahtung zwischen dem Dynamo und dem Regulator.
Keinen Referenzwert
Defekter Dynamo
214
Rutschender Ventilatorenriemen
192
Defekter Dynamo
214

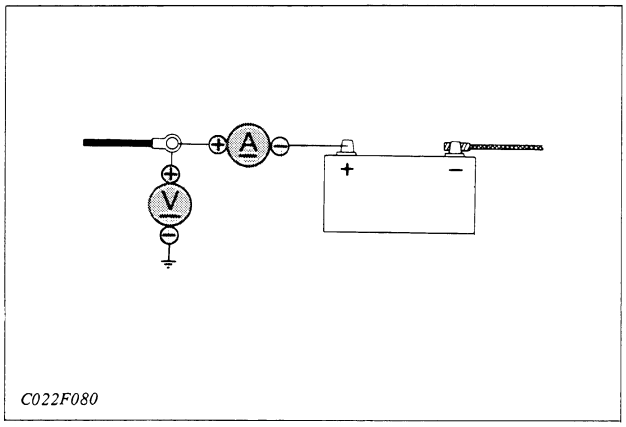

DER MOTOR KANN NICHT RICHTIG VOM STARTER GEDREHT WERDEN.
Geringe Motorenumdrehungszahl.
Der Starter dreht sich aber der Motor kann sich nicht drehen.
Kein Eingreifgeräusch vom Ritzel und Ringzahnrad.
Ritzel schiltet wiederholt.


DER GLÜHKERZENANZEIGER ZEIGT NICHT RICHTIG AN.
Wird nicht auf rote Anzeige gebracht.
Zeigt zu schnell rot an.


Seitennummer
Defekte Batterie.
Batterie ist nicht genügend aufgeladen.
Schlechte Kontaktanschlüsse.
Ungenügende Masselegung.
Defekter Starter.
Schleifende Überlaufkupplung.
Schlechter Kontakt der Kontaktplatte. 218
Schlechter Kontakt zwischen Bürste und Kommutator. 230 bis 234
Armatur- und Feldspule kurzgeschlossen. 230 232
Verschlissene Lagerung.
Ritzel und Ringzahnrad greifen nicht ein.
Ritzel und Ringzahnrad verschlissen.
Tauchspule und Schaft verbogen.
Kupplung schleift.
Überlaufkupplung verschlissen.
Das Ritzel wird durch die Anzugskraft des Magnetschalters nicht herausgezogen.
Hauptschalter oder Starterschalter defekt.
Defekter Magnetschalter. 220
Schraubenfeder verrostet.
Defekte Batterie.
Defekte Batterie.
Batterie nicht genügend aufgeladen.
Schlechter Anschlußkontakt.
Ungenügende Masselegung.
Defekter Magnetschalter.
Haltespule defekt. 220
Seitennummer
Defekte Batterie.
Batterie nicht genügend aufgeladen.
Schlechter Anschlußkontakt.
Schlechte Masselegung.
Falscher Anschluß (Verdrahtung).
Falsche Verdrahtung zwischen Batterie und Glühkerze.
Glühkerzenanzeiger abgetrennt.
Glühkerze abgetrennt (nicht angeschlossen). 222
Hauptschalter oder Starterschalter defekt.
Kreis kurzgeschlossen.
Kurzschluß zwischen Glühkerze und Glühkerzenanzeiger.
Glühkerzenanzeiger kurzgeschlossen.
Glühkerze kurzgeschlossen.
Glühkerzenkabel kurzgeschlossen.

2. DYNAMO AND REGULATOR

CHECKS



C022F080

❶ Checking battery charging current

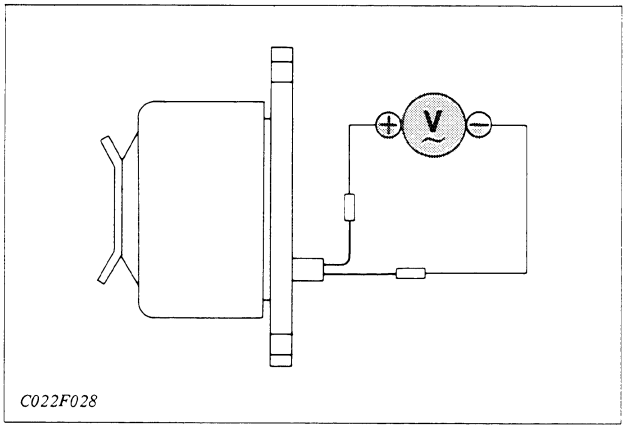
1) After starting the engine, disconnect the + lead of the battery and connect an amperemeter.
2) Measure charging current with full electric load (with lights, etc).

(Notes on checking)

- **Connect the amperemeter only after starting the engine.**
- **In the event of a lower electric load or fully charged battery, the stipulated value may not be given.**

Reference value
14 to 15A with dynamo turning at 5200 rpm.

(1) Battery + lead



C022F028

❷ Checking AC dynamo's no-load voltage

1) Disconnect lead wire from the dynamo.
2) Start the engine and measure the voltage generated by the single dynamo.

Reference value
AC 20V or more with the dynamo turning at 5200rpm.

2. DYNAMO ET REGLATEUR

VERIFICATIONS

❶ Vérification du courant de charge de la batterie

1) Attendre que le moteur ait démarré pour débrancher le conducteur + de la batterie et pour raccorder un ampèremètre.
2) Mesurer le courant de charge en pleine charge (feux allumés).

(Notes concernant la vérification)

- **Ne raccorder l'ampèremètre qu'après démarrage du moteur.**
- **Il se peut que la valeur prescrite ne soit pas donnée si la charge électrique s'avère plus faible ou si la batterie est en pleine charge.**

Norme de référence
14 à 15A lorsque la dynamo tourne à 5200 tr/mn

(1) Batterie conducteur +

❷ Vérification de la tension à vide de la dynamo à c.a.

1) Débrancher le conducteur de la dynamo.
2) Mettre le moteur en marche et mesurer la tension générée par l'unique dynamo.

Norme de référence
20V en c.a. ou plus lorsque la dynamo tourne à 5200 tr/mn

2. DYNAMO UND REGULATOR

PRÜFUNGEN

❶ Überprüfung des Ladestroms der Batterie

1) Nach dem Anlassen des Motors, die + Zuleitung der Batterie entfernen und ein Amperemeter daran anschließen.
2) Den Ladestrom bei voller Belastung messen. (Licht und andere Belastungen einschalten)

(Anmerkungen für die Überprüfungen)

- **Das Amperemeter nur nach dem Anlassen des Motors anschließen.**
- **Bei zu geringer Belastung oder voll aufgeladener Batterie könnte der Vorschriftswert nicht erreicht werden.**

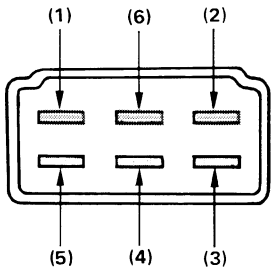
Richtwert
14 bis 15A bei einer Umdrehungszahl von 5200 Upm

(1) Batterie + Zuleitung

❷ Überprüfung der Nichtlastspannung des Wechselstromdynamos

1) Das Zuleitungskabel vom Dynamo entfernen.
2) Den Motor anlassen, und die vom Dynamo allein erzeugte Spannung messen.

Richtwert
Wechselstrom 20V oder höher bei einer Umdrehungszahl von 5200 Upm des Dynamos.



0076F022

❸ Regulator checking

1) Remove the regulator coupler.
2) Check with a tester whether the regulator is in optimum condition or not.

(Notes on checking)

- **Try to use a high-resistance tester as far as possible.**
- **The judgement should be as follows: "ON" if the indicator moves, otherwise "OFF".**

Check chart

Tester + terminal / Tester − terminal		Code colours					
		bule	blue	red	yellow	green	black
Code colours	blue		OFF	ON	OFF	OFF	OFF
	blue	OFF		ON	OFF	OFF	OFF
	red	OFF	OFF		OFF	OFF	OFF
	yellow	ON	ON	ON		OFF	ON
	green	OFF	OFF	OFF	OFF		OFF
	black	OFF	OFF	OFF	OFF	OFF	

(1) Blue
(2) Blue
(3) Red
(4) Yellow
(5) Green
(6) Black

❸ Vérification du régulateur

1) Retirer le connecteur du régulateur.
2) Vérifier l'état de fonctionnement du régulateur à l'aide d'un appareil d'essai.

(Notes concernant la vérification)

- **Essayer, autant que possible, d'employer un appareil d'essai à haute résistance.**
- **L'estimation devrait se faire comme suit: "CONTACT" (ON) si l'index bouge, sinon "COUPE" (OFF).**

Tableau de mise au point

Borne + de l'appareil d'essai / Borne − de l'appareil d'essai		Code des couleurs					
		bleu	bleu	rouge	jaune	vert	noir
Code des couleurs	bleu		COUPE	CONT.	COUPE	COUPE	COUPE
	bleu	COUPE		CONT.	COUPE	COUPE	COUPE
	rouge	COUPE	COUPE		COUPE	COUPE	COUPE
	jaune	CONT.	CONT.	CONT.		COUPE	CONT.
	vert	COUPE	COUPE	COUPE	COUPE		COUPE
	noir	COUPE	COUPE	COUPE	COUPE	COUPE	

(1) Bleu
(2) Bleu
(3) Rouge
(4) Jaune
(5) Vert
(6) Noir

❸ Uberprüfung des Regulators

1) Die Regulatorenkupplung entfernen.
2) Mit einem Tester überprüfen, ob der Regulator einwandfrei arbeitet.

(Anmerkungen für die Überprüfungen)

- **Soweit wie möglich versuchen für diese Überprüfungen einen Hochwiderstandstester zu verwenden.**
- **Die Messungen sollten folgendermaßen bewertet werden: Wenn sich der Zeiger bewegt, ist der Regulator "EINGESCHALTET"; im anderen Falle ist er "AUSGESCHALTET".**

Überprüfungstabelle

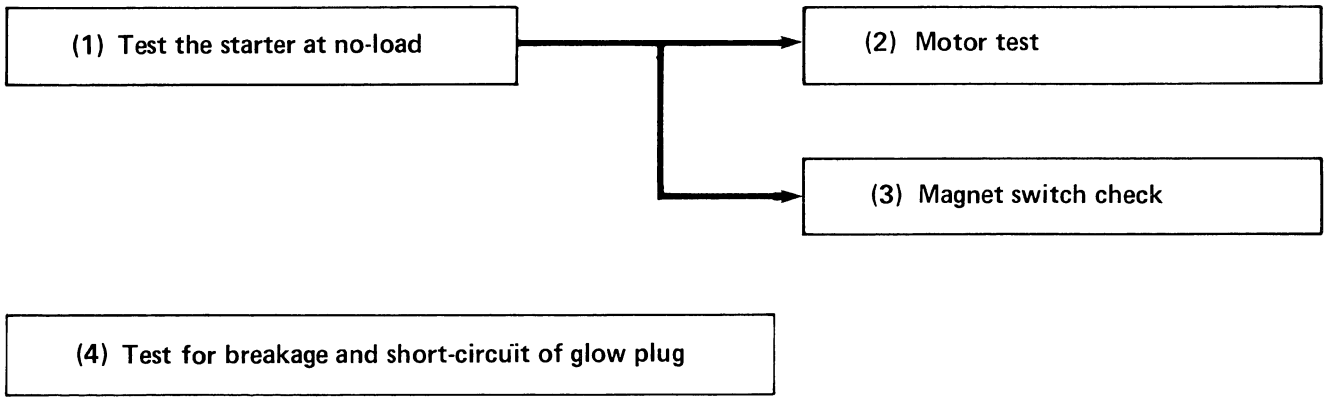
Testgerat am + Anschluß / Testgerat am − Anschluß		Farbmarkierungen					
		Blau	Blau	Rot	Gelb	Grün	Schwarz
Farbmarkierungen	Blau		AUS	EIN	AUS	AUS	AUS
	Blau	AUS		EIN	AUS	AUS	AUS
	Rot	AUS	AUS		AUS	AUS	AUS
	Gelb	EIN	EIN	EIN		AUS	EIN
	Grün	AUS	AUS	AUS	AUS		AUS
	Schwarz	AUS	AUS	AUS	AUS	AUS	

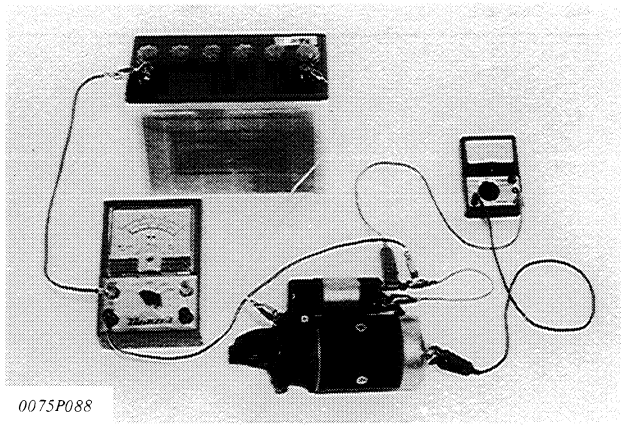
(1) Blau
(2) Blau
(3) Rot
(4) Gelb
(5) Grün
(6) Schwarz

3. STARTER AND GLOW PLUG

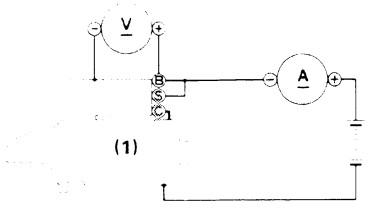
CHECKS

If the starter system malfunctions, do the following checks to locate the cause




0075P088

[A] Electrical connections for no-load testing.



C022F072

❶ No-Load Testing of Starter

1) Connect the ammeter's positive probe to the battery positive terminal and the negative probe to the starter's B terminal.
2) Connect the battery negative terminal to the starter body.
3) Connect the voltmeter's positive probe to the starter's B terminal and the negative probe to the starter body.
4) Set a tachometer.
5) Connect the starter's B terminal to the magnet switch's S terminal.
6) Check to see that the magnet switch actuation results in the specified speed, current and voltage.

(Note for checking)

- **Use a fully charged battery.**
- **Use an ammeter and lead of more than 200A capacity because strong current flows when the starter runs.**

Reference value	
Current	Less than 50A
Voltage	11V
Speed	More than 5000 rpm

(1) Starter

3. DEMARREUR ET BOUGIE INCANDESCENTE

VERIFICATIONS

Si le système de démarrage ne fonctionne pas de façon satisfaisante, en déterminer la cause en procédant comme suit.

(1) Essayer le démarreur à vide

(2) Essayer le moteur

(3) Essayer le disjoncteur (magnétique)

(4) Essayer la rupture et le court-circuit de la bougie incandescente

❶ Essai à vide du démarreur

1) Connecter l'extrémité positive de l'ampèremètre à la borne positive de la batterie et l'extrémité négative à la borne B du démarreur.
2) Connecter l'extrémité négative de la batterie au corps du démarreur.
3) Connecter l'extrémité positive du voltmètre à la borne B du démarreur et l'extrémité négative au corps du démarreur
4) Fixer un tachymètre.
5) Connecter la borne B du démarreur à la borne S du disjoncteur.
6) Vérifier que la mise en action du disjoncteur donne bien la vitesse, le courant et la tension spécifiés.

(Remarques pour la vérification)
- **Utiliser une batterie chargée au maximum.**
- **Utiliser un ampèremètre et une connexion d'une capacité supérieure à 200A, car un fort courant passe lors de la marche du démarreur.**

Norme de référence	
Courant	moins de 50A
Tension	11V
Vitesse	plus de 5000 tr/mn

[A] Connexions électriques pour test à vide
(1) Démarreur

3. STARTER UND GLÜHKERZE

PRÜFUNGEN

Falls Störungen im Startersystem auftreten sollten, gemäß den folgenden Punkten nach der Ursache suchen.

(1) Den Starter unter Nichtbelastung prüfen

(2) Motorentest

(3) Magnetschaltertest

(4) Auf Bruch und Kurzschluß der Glühkerze prüfen

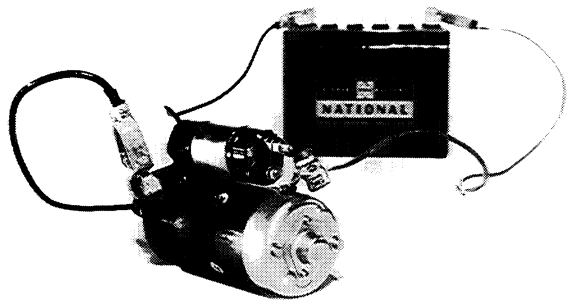
❶ Nichtbelastungstest des Starters

1) Das Positivkabel des Amperemeters mit dem Positivanschluß der Batterie verbinden, und das Negativkabel des Meßgerätes an die "B"-Klemme des Starters anschließen.
2) Den Negativanschluß der Batterie an das Startergehäuse anschließen.
3) Das Positivkabel des Voltmeters an die "B"-Klemme des Starters anschließen, und die Negativleitung an das Startergehäuse anschließen.
4) Einen Umdrehungszähler (Tachometer) einstellen.
5) Die "B"-Klemme des Starters mit der "S"-Klemme des Magnetschalters verbinden.
6) Prüfen, ob das Ansprechen des Magnetschalters in den vorgeschriebenen Umdrehungszahlen, Strömen und Spannungen erfolgt.

(Anmerkung für die Prüfungen)
- **Eine voll aufgeladene Batterie verwenden.**
- **Ein Amperemeter und Zuleitung mit einer Kapazität von mehr als 200A benutzen, da beim Laufen des Starters hohe Ströme fließen.**

Richtwert	
Strom	Weniger als 50A
Spannung	11V
Umdrehungszahl	Höher als 5000 Upm

[A] Elektrische Anschlüsse bei Nichtbelastungsprüfungen.
(1) Starter



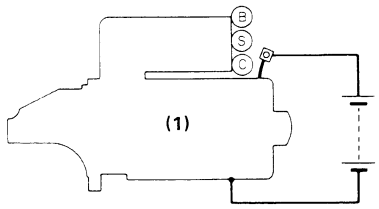
0075P089

❷ Motor Test

1) Remove the connecting lead from the starter's C terminal and connect it directly to the battery's positive terminal. Then connect the battery's negative terminal to the starter body.
2) If the starter runs normally, the magnet switch is faulty; if not, the motor is faulty.

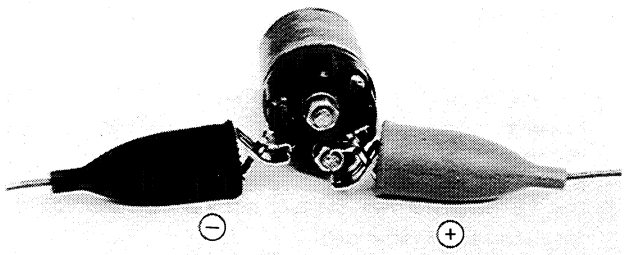
Reference value
The motor is O.K. if it rotates smoothly.

[A] Electrical connections for testing motor



C022F073

(1) Starter



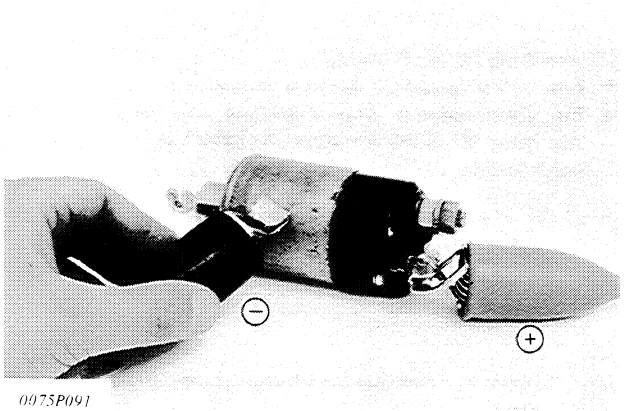
0075P090

❸ Checking Magnet Switch

(1) Pull-In Coil (Attraction Test)

1) Apply 1/2 the rated voltage across S terminal and C terminal.
2) If the plunger is attracted strongly, the pull-in coil is normal; if not, it is faulty.

Reference value
If the plunger is attracted strongly, the pull-in coil is normal; if not, it is faulty.



0075P091

(2) Holding Coil (Retention Test)

1) Apply 1/2 the rated voltage across S terminal and the body, push the plunger in by hand, and release your hand.
2) If the plunger is maintained in the attracted position, the holding coil is good; if not, it is faulty.

Reference value
If the plunger is maintained in the attracted position, the holding coil is good; if not, it is faulty.

❷ Essai du moteur

1) Retirer la connexion de la borne C du starter et la relier directement à la borne positive de la batterie. Ensuite, relier la borne négative de celle-ci au corps du démarreur.
2) Si le moteur tourne normalement, le disjoncteur est défectueux; sinon, c'est le moteur qui est défectueux.

Norme de référence
Une marche régulière indique un bon moteur.

[A] Connexions électriques pour essai du moteur
(1) Démarreur

❸ Vérification du disjoncteur

(1) Bobine d'entrée (test d'attraction)

1) Soumettre un demi de la tension nominale sur les bornes S et C.
2) Si le plongeur est fortement attiré, la bobine est normale; si l'attraction n' est pas forte, elle est anormale.

Norme de référence
Si le plongeur est fortement attiré, la bobine est normale. Sinon, elle est anormale.

(2) Bobine de maintien (test de maintien)

1) Soumettre un demi de la tension nominale sur la borne S et le culot, pousser à la main le plongeur puis relâcher celui-ci.
2) S'il est maintenu dans cette position, la bobine de maintien est bonne; sinon, elle est défectueuse.

Norme de référence
Si le plongeur est maintenu attiré, la bobine est normale, sinon il est défectueux.

❷ Motorentest

1) Das Anschlußkabel von der "C"-Klemme des Starters abtrennen, und dieses direkt an den Positivanschluß der Batterie anschließen. Den Negativanschluß der Batterie dann an das Startergehäuse anschließen.
2) Sollte der Starter bei diesem Anschluß normal laufen, ist der Magnetschalter defekt. Sonst ist der Motor defekt.

Richtwert
Der Motor funktioniert normal, wenn seine Drehung glatt und vibrationsfrei ist.

[A] Elektrische Anschlüsse für den Motorentest
(1) Starter

❸ Prüfung des Magnetschalters

(1) Einzugsspule (Ansprechtest)

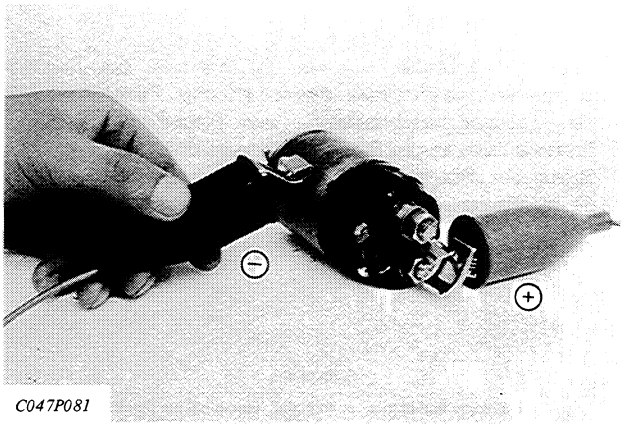
1) Über die "S" - und "C" - Klemmen 1/2 der Nennspannung anlegen.
2) Wenn die Tauchspule stark angezogen wird, ist die Einzugsspule normal. Falls dies nicht der Fall ist, ist sie defekt.

Richtwert
Wenn die Tauchspule stark angezogen wird, ist die Einzugsspule normal. Falls nicht, ist sie defekt.

(2) Haltespule (Rückhaltungstest)

1) Über die "S"-Klemme und das Gehäuse 1/2 der Nennspannung anlegen. Die Tauchspule mit der Hand eindrücken und dann loslassen.
2) Wird die Tauchspule in angezogener Stellung gehalten, ist die Haltespule normal. Ist dies nicht der Fall, ist sie defekt.

Richtwert
Wird die Tauchspule in angezogener Stellung gehalten, ist die Haltespule normal. Falls nicht, ist sie defekt.

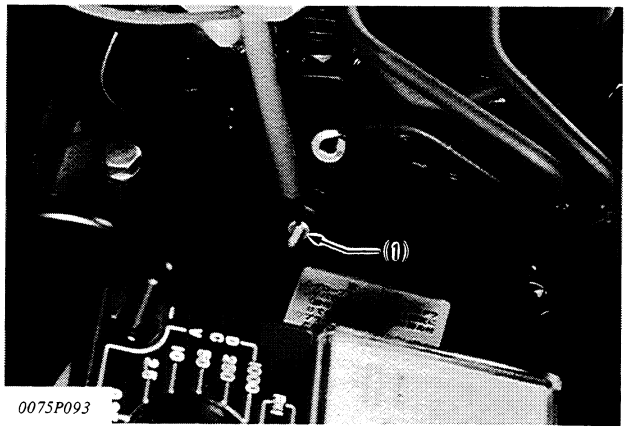


C047P081

(3) Plunger Return

1) Apply the rated voltage across C terminal and body, push the plunger in by hand, and release your hand.
2) If the plunger returns immediately, it is good; if not, it is faulty.

Reference value
If the plunger returns immediately, it is good; if not, it is faulty.



0075P093

❹ Checking for Breakage and Short-Circuit of Glow Plug

1) Disconnect the glow plug cable and lead.
2) Connect a circuit tester across the screw of the glow plug end and body.

- If the resistance is zero ohms, the glow plug is shorted.
- If the resistance is infinite, the glow plug coil is broken.

Reference value	Approx. 1.6Ω

(1) Glow plug

(3) Retour du plongeur

1) Soumettre la tension nominale sur la borne C et le culot, pousser le plongeur à la main et le relâcher.
2) S'il revient immédiatement, il est bon; sinon, il est défectueux.

Norme de référence
Si le plongeur revient immédiatement, il est bon; sinon, il est défectueux.

④ Vérification de la rupture et du court-circuit de la bougie incandescente

1) Déconnecter le câble de la bougie incandescente et la connexion.
2) Connecter un testeur de circuit entre la vis de bas de la bobine incandescente et le culot.
- Si la résistance est de 0Ω, la bougie est en court-circuit.
- Si la résistance est illimitée, la bobine de la bougie est rompue.

Norme de référence	env. 1,6Ω

(1) Bobine incandescente

(3) Tauchspulenrückführung

1) Über die "C"-Klemme und das Gehäuse die Nennspannung einleiten. Die Tauchspule mit der Hand eindrücken und dann loslassen.
2) Wenn die Tauchspule sofort zurückkehren kann, ist die Tauchspulenrückführung normal. Ist dies nicht der Fall, ist sie defekt.

Richtwert
Wenn die Tauchspule sofort zurückkehren kann, ist die Tauchspulenrückführung normal. Falls nicht, ist sie defekt.

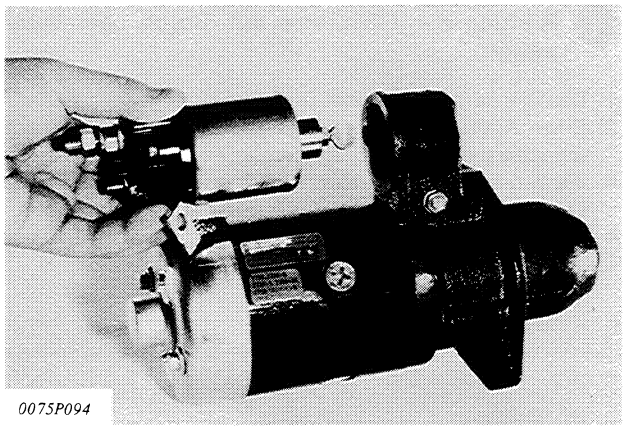
④ Prüfung der Glühkerze auf Bruch oder Kurzschluß

1) Das Glühkerzenkabel und Zuleitung abtrennen.
2) Einen Kreistester (Durchgangstester) über die Glühkerzenschraube und das Gehäuse anschließen.
- Wenn der Widerstand Null Ohm beträgt, ist die Glühkerze kurzgeschlossen.
- Wenn der Widerstand unendlich ist, ist die Glühkerze unterbrochen.

Richtwert	Ungefähr 1,6Ω

(1) Glühkerze

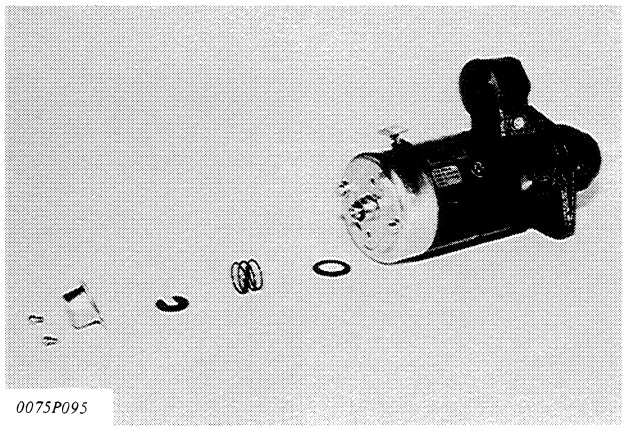
DISASSEMBLY



0075P094

❶ Removing Magnet Switch

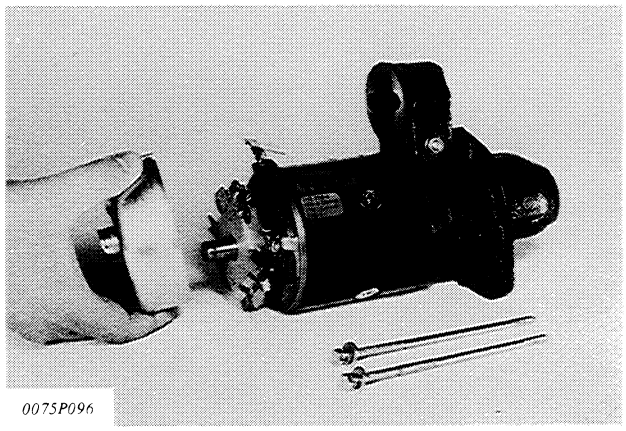
1) Remove the connecting lead.
2) Remove the set screws.
3) Detach the magnet switch by lifting it up while taking care that it does not contact the drive lever.



0075P095

❷ Removing Armature Brake

1) Remove the end frame cap.
2) Remove the washers.
3) Remove the brake spring.
4) Remove the packing.



0075P096

❸ Removing End Frame

1) Remove the through bolt.
2) Remove the end frame.

DEMONTAGE

❶ Retrait du disjoncteur

1) Retirer le câble de connexion.
2) Retirer les vis d'arrêt.
3) Détacher le disjoncteur en le soulevant, en veillant à ce qu'il ne touche pas le levier d'entraînement.

❷ Retrait du frein d'armature

1) Retirer le capuchon de culot.
2) Retirer les rondelles.
3) Retirer le ressort de frein.
4) Retirer la garniture.

❸ Retrait du culot

1) Retirer le boulon passant.
2) Retirer le culot.

ZERLEGEN

❶ Entfernen des Magnetschalters

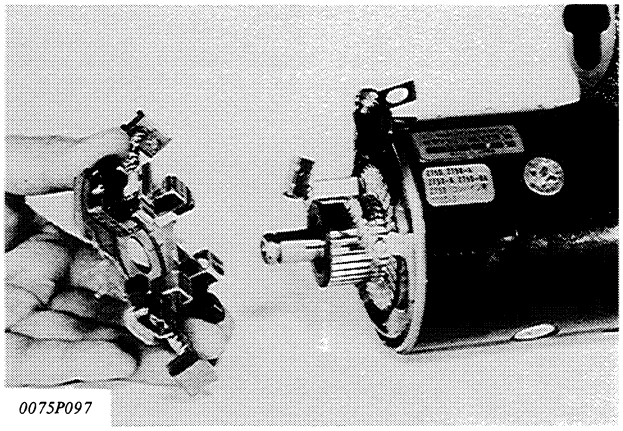
1) Die Anschlußkabel entfernen.
2) Die Befestigungsschrauben entfernen.
3) Den Magnetschalter vorsichtig herausheben, wobei darauf geachtet werden muß, daß er nicht gegen den Treibhebel stößt.

❷ Entfernen der Armaturbremse

1) Die Endrahmenkappe entfernen.
2) Die Unterlegscheiben entfernen.
3) Die Bremsspirale entfernen.
4) Die Dichtung entfernen.

❸ Entfernen des Endrahmens

1) Den Durchschraubebolzen entfernen.
2) Den Endrahmen entfernen.



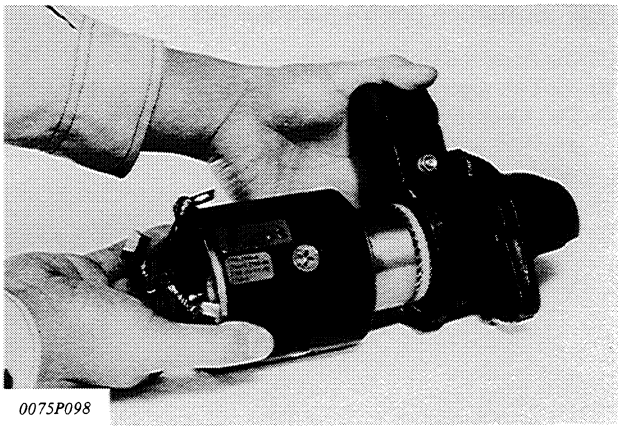
0075P097

❹ Removing Brush Holder

1) Draw out the brush from the holder while holding the spring up.
2) Take off the brush holder.

(Note for reassembling)

- **Be sure not to mistake the direction and position of the spring.**
- **Do not contact the body with the positive brush's lead.**



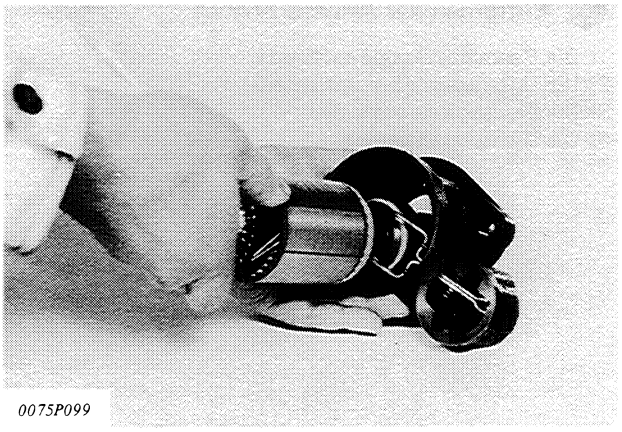
0075P098

❺ Removing Yoke

1) Draw out the yoke from the drive end frame.

(Note for reassembling)

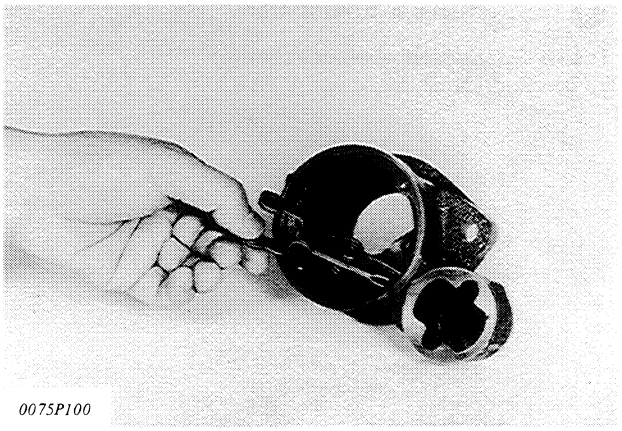
- **Take care yoke does not knock pin.**



0075P099

❻ Removing Armature

1) Remove the set bolt from the drive lever.
2) Draw out the armature from the drive end frame.
3) Detach the drive lever.



0075P100

(Important)

- **When reassembling, be sure not to mistake the installing direction of the drive lever.**

❹ Retrait du porte-balais

1) Retirer les balais de leur support en maintenant haut le ressort.
2) Retirer le porte-balais.

(Remarques pour le remontage)
- **Veiller à ce que la bonne direction et la bonne position du ressort soient gardées.**
- **Ne pas laisser le corps toucher la connexion positive des balais.**

❺ Retrait de la culasse

1) Retirer la culasse du bâti côté entraînement.

(Remarques pour le remontage)
- **Veiller à ce que la culasse ne heurte pas la goupille.**

❻ Retrait de l'armature

1) Retirer le boulon de fixation du levier d'entraînement.
2) Retirer l'armature du bâti côté entraînement.
3) Détacher le levier d'entraînement

(Important)
- **Au remontage, veiller à ce que la direction de levier soit correcte.**

❹ Entfernen der Bürstenhalter

1) Die Bürste aus dem Halter herausziehen, während dabei die Feder aufgehalten wird.
2) Den Bürstenhalter abnehmen.

(Anmerkung für den Zusammenbau)
- **Darauf achten, daß die Richtung und Position der Feder (Spirale) nicht verwechselt wird.**
- **Das Gehäuse nicht mit der positiven Bürstenzuleitung berühren.**

❺ Entfernen des Jochs

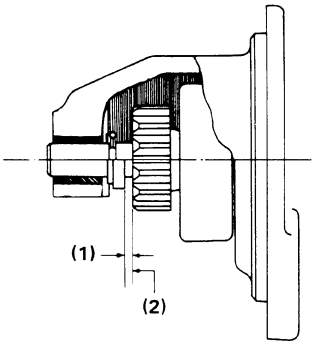
1) Das Joch aus dem Treibendrahmen herausziehen.

(Anmerkung für den Zusammenbau)
- **Darauf achten, daß das Joch den Bolzen nicht anstoßt.**

❻ Entfernen des Ankers

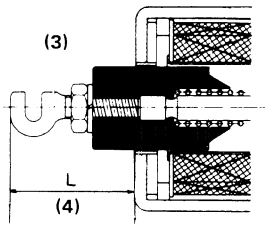
1) Die Befestigungsschrauben vom Treibhebel entfernen.
2) Den Anker aus dem Treibendrahmen herausziehen.
3) Den Treibhebel entfernen.

(Wichtung)
- **Darauf achten, daß die Einbaurichtung des Treibhebels nicht verwechselt wird.**



C022F075

[A] Adjustment of pinion gap



C022F076

❶ Checking and Adjusting Pinion Gap

1) Disconnect the connecting lead from C terminal.
2) Energize the magnet switch and measure the gap between the pinion tip and the stop collar.
3) To adjust the gap, change the length of the magnet switch joint to the specified one.

Reference value	0.1 to 5.0 mm 0.004 to 0.197 in.

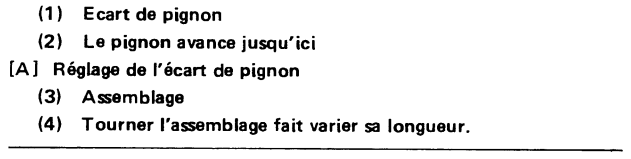
(1) Pinion gap
(2) Pinion juts out to this position
(3) Joint
(4) Turning the joint alters its length

ENTRETIEN

❶ Vérification et réglage de l'écart de pignon

1) Retirer la connexion de la borne C.
2) Actionner le disjoncteur et mesurer l'écart séparant le bout de pignon et la bague d'arrêt.
3) Pour régler l'écart, faire varier la longueur de l'assemblage du disjoncteur à la longueur spécifiée.

Norme de référence	0,1 à 5,0 mm



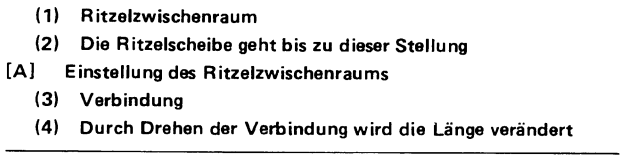
(1) Ecart de pignon
(2) Le pignon avance jusqu'ici
[A] Réglage de l'écart de pignon
(3) Assemblage
(4) Tourner l'assemblage fait varier sa longueur.

WARTUNG

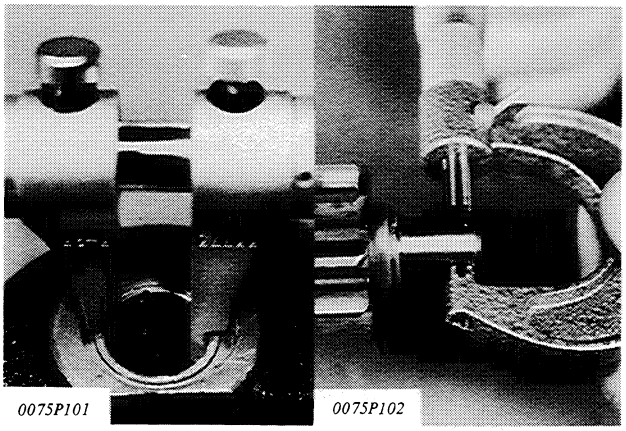
❶ Prüfung und Einstellung des Ritzelzwischenraums

1) Das Anschlußkabel von der "C"-Klemme abtrennen.
2) Den Magnetschalter unter Strom setzen, und den Zwischenraum zwischen der Ritzelspitze und der Stoppmanschette messen.
3) Zur Einstellung des Zwischenraums wird die Länge der Magnetschalterverbindung auf den vorgeschriebenen Wert verändert.

Richtwert	0,1 bis 5,0 mm



(1) Ritzelzwischenraum
(2) Die Ritzelscheibe geht bis zu dieser Stellung
[A] Einstellung des Ritzelzwischenraums
(3) Verbindung
(4) Durch Drehen der Verbindung wird die Länge verändert



0075P101 0075P102

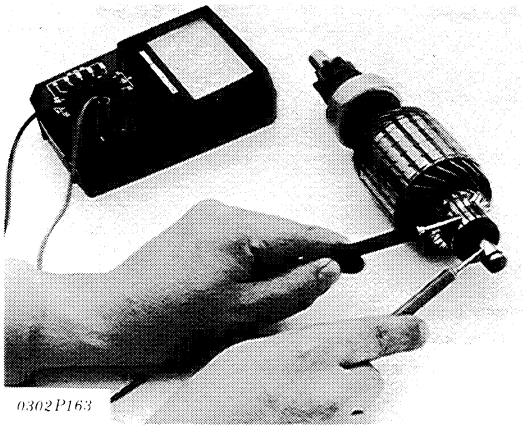
❷ Checking Gap between Shaft and Bush

1) Measure the inside diameters of the bearing bushings on the side of the drive and commutator.
2) Measure the drive-side and commutator-side shaft diameters and calculate the gap.

	Reference value	Allowable limit
Commutator side	0.03 to 0.10 mm 0.0012 to 0.0039 in.	0.20 mm 0.0079 in.
Drive side	0.05 to 0.10 mm 0.0020 to 0.0039 in.	

- **Diameters of shaft and bushing**

O.D. of drive shaft	12.50mm 0.4921 in.
O.D. of commutator shaft	12.50mm 0.4921 in.
I.D. of drive bushing	12.55 to 12.60 mm 0.4941 to 0.4961 in.
I.D. of commutator bushing	12.53 to 12.60 mm 0.4933 to 0.4961 in.

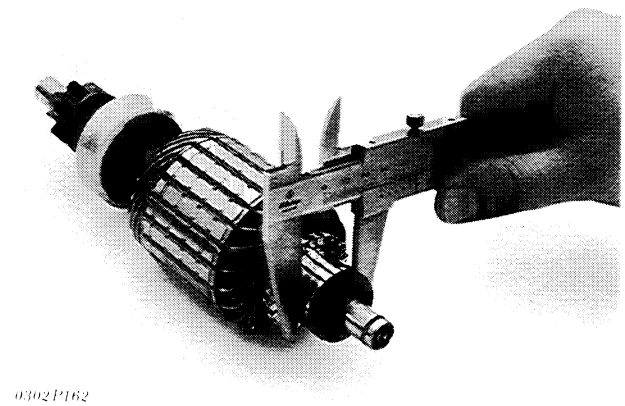


0302P163

❸ Grounding Armature Coil

1) Check conduction across the commutator and core shaft. If it is not conducting, the coil is good; if it is conducting, the coil is defective.
2) If conducting, replace armature coil.

Reference value
If it is not conducting, the coil is good; if it is, the coil is faulty.



0302P162

❹ Checking Commutator Wear

1) Check to see if the contact face of the brush is scored.
2) If scored, grind off with sand paper or on a lathe.
3) When the wear between the maximum and minimum diameters exceeds 0.4 mm, correct the wear to within 0.05 mm on the lathe. Allowable limit is not less than 2 mm smaller than the reference value of outside diameter.

Commutator diameter	
Reference value	Allowable limit
28.0 mm 1.1024 in.	27.0 mm 1.0630 in.

❷ Vérification de l'écart entre l'arbre et le coussinet

1) Mesurer les diamètres internes des coussinets de palier du côté de l'entraînement et du collecteur.
2) Mesurer les diamètres d'arbre côté entraînement et côté collecteur et calculer l'écart.

	Norme de référence	Limite autorisée
Côté collecteur	0.03 à 0.10 mm	0,20 mm
Côté commande	0.05 à 0.10 mm	

- **Diamètres d'arbre et de coussinet**

D.E. d'arbre de commande	12,50 mm
D.E. d'arbre de collecteur	12,50 mm
D.I. de coussinet de commande	12.55 à 12.60 mm
D.I. de coussinet de collecteur	12.53 à 12.60 mm

❸ Mise à la masse de la bobine d'induit

1) Vérifier la conduction entre le commutateur et l'arbre de noyau. La bobine est en bon état si elle est non-conductrice et défectueuse dans le cas contraire.
2) Remplacer la bobine d'induit, s'il y a conduction.

Norme de référence
La bobine est en bon état si elle est non-conductrice.

❹ Vérification d'usure du collecteur

1) Vérifier si la surface de contact de balai est marquée.
2) Si elle est marquée, corriger avec un papier de verre.
3) Si l'usure entre les diamètres maximum et minimum représente plus de 0,4mm, la rectifier au tour à 0,05mm près.
   La limite autorisée ne permet pas de descendre au-dessous de 2mm de moins que la valeur étalon du diamètre extérieur.

Diamètre du Collecteur	
Norme de référence	Limite autorisée
28,0 mm	27,0 mm

❷ Prüfung des Zwischenraums zwischen Achse und Buchse

1) Die Innendurchmesser der Lagerungsbuchsen auf den Kommutator und Treibseiten ausmessen.
2) Die Durchmesser der Achsen auf der Kommutatoren- und Treibseite ausmessen, und den Unterschied errechnen.

	Richtwert	Zugelassener Grenzwert
Kommutatorenseite	0.03 bis 0.10 mm	0,20 mm
Treibseite	0.05 bis 0.10 mm	

- **Durchmesser von Achse und Buchse**

Außendurchmesser der Treibachse	12,50mm
Außendurchmesser der Kommutatorenachse	12,50mm
Innendurchmesser derTreibbuchse	12.55 bis 12.60 mm
Innendurchmesser der Kommutatorenbuchse	12.53 bis 12.60 mm

❸ Isolationsprüfung der Ankerspule

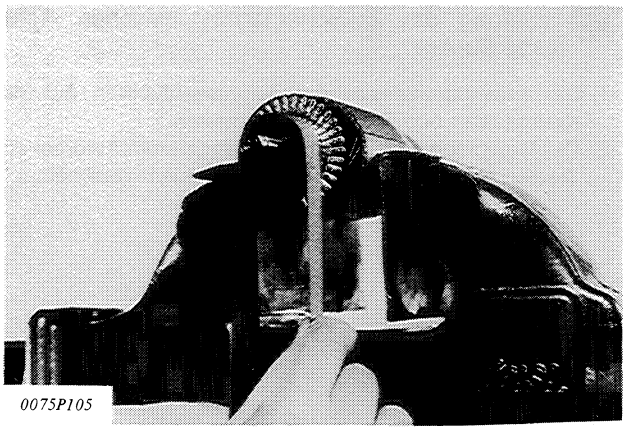
1) Durchgang über den Kommutator und Kernachse überprüfen.
   Wenn kein Durchgang vorhanden ist, ist die Spule normal.
   Falls Durchgang vorhanden ist, ist die Spule defekt.
2) Falls Leitungsdurchgang vorhanden ist, auswechseln.

Richtwert
Ist die Spule nicht leitend, ist sie normal. Falls sie leitend ist, ist die Spule defekt.

❹ Prüfung Kommutator-Abnutzung

1) Überprüfen, ob die Kontaktfläche der Bürste angekratzt ist.
2) Wenn die Oberfläche beschädigt ist, mittels Sandpapiers kratzen oder auf der Drehbank entfernen.
3) Falls die Abnutzung zwischen den Maximal- und Minimaldurchmessern einen Wert von 0,4mm übersteigt, die Abnutzung auf einer Drehbank auf einen Wert von innerhalb 0,05mm korrigieren.
   Der erlaubte Grenzwert ist nicht weniger als 2mm kleiner als der Referenzwert des Außendurchmessers.

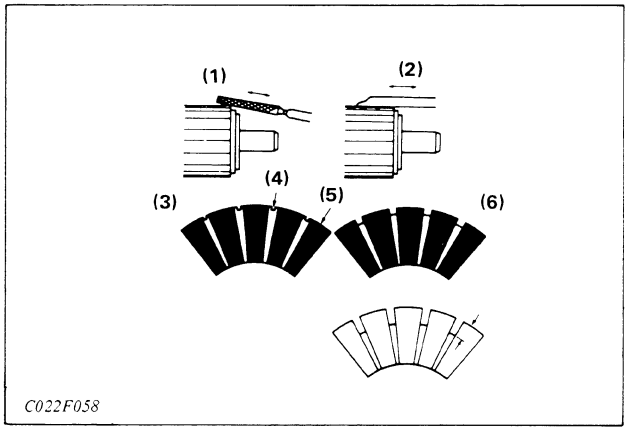
Durchmesser des Kommutators	
Richtwert	Zugelassener Grenzwert
28,0 mm	27,0 mm



0075P105

❺ Staining or Burning of Commutator

1) Check to see if the commutator surface is stained or burnt.
2) If it is locally burnt, correct with fine sandpaper.



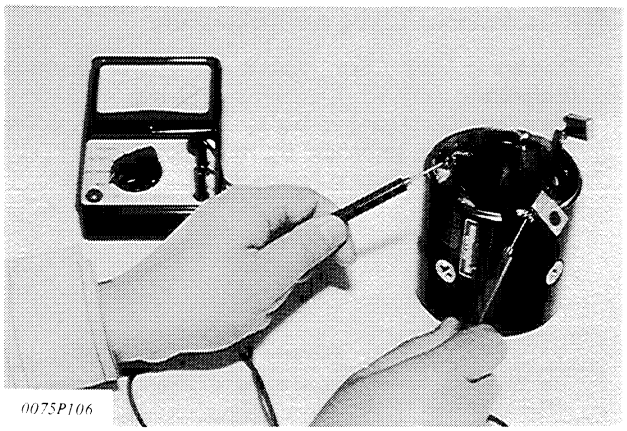
C022F058

❻ Checking Mica (Undercut)

1) Check to see if the mica has sunk below the allowable limit.
2) If it is below the allowable limit, correct with a saw blade. Since the correction produces burrs on the corner of the segment, chamfering should be executed.

Reference value	0.50 to 0.80 mm 0.0197 to 0.0315 in.
Allowable limit	Less than 0.20 mm (0.0079 mm in.)

(1) Bad
(2) Good
(3) Mica
(4) Segment
(5) Depth of mica

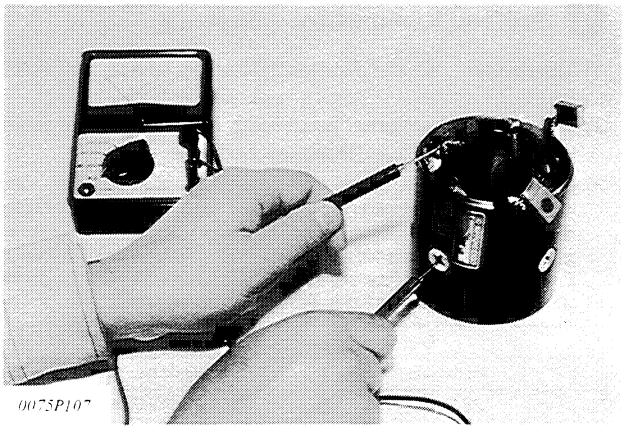


0075P106

❼ Checking for Field Coil Breakage

1) To check conduction, place the tester probes on the lead and brush.
2) If not conducting, replace.

Reference value
If it is conducting, the coil is good; if it is not, the coil is faulty.



0075P107

❽ Checking Insulation between Field Coil and Yoke

1) Place each tester probe on the field coil and yoke.
2) If conducting, replace.

Reference value
If it is not conducting, the insulation is good; if it is conducting, the insulation is defective.

❺ Collecteur souillé ou grillé

1) Vérifier si la surface du collecteur n'est pas souillée ou grillée.
2) Si elle l'est partiellement, la passer au papier de verre fin.

❺ Verschmutzung oder Brennflecken des Kommutators

1) Die Kommutatorenoberfläche auf Verschmutzungen und Brennflecke untersuchen.
2) Falls stellenweise Brennflecken vorhanden sein sollten, mit feinem Sandpapier korrigieren.

❻ Vérification du mica (évidé)

1) Vérifier si le mica est descendu en-dessous de la tolérance.
2) Dans ce cas, corriger à la lame de scie. La correction produisant des barbures sur le coin du segment, il convient de chanfreiner.

Norme de référence	0,50 à 0,80 mm
Limite autorisée	moins de 0,20 mm

(1) Mauvais **(4) Segment**
(2) Bon **(5) Profondeur de mica**
(3) Mica

❻ Prüfung des Glimmers (Unterlagen)

1) Prüfen, ob die Glimmerteilchen unter den erlaubten Grenzwert abgesunken sind.
2) Falls die Glimmerteilchen unter den erlaubten Grenzwert abgesunken sein sollten, mit einem Sägeblatt korrigieren. Da durch den Korrigierungsvorgang die Segmentecken vergratet werden, sollte eine Abschrägung ausgeführt werden.

Richtwert	0,50 bis 0,80 mm
Zugelassener Grenzwert	Weniger als 0,20 mm

(1) Schlecht **(4) Segment**
(2) Gut **(5) Glimmer-Tiefe**
(3) Glimmer

❼ Vérification de la rupture de bobine de champ

1) Pour vérifier la conduction, placer l'extrémité du testeur sur la connexion et le balai.
2) Si la conduction est nulle, remplacer.

Norme de référence
La conduction indique que la bobine est bonne, son absence qu'elle est défectueuse.

❼ Prüfung auf Feldspulenbruch

1) Zur Prüfung des Leitungsdurchgangs den Testfühler auf die Bürste und Zuleitung geben.
2) Falls kein Durchgang vorhanden ist, auswechseln.

Richtwert
Wenn die Spule Leitungsdurchgang hat, ist sie normal. Ist dies nicht der Fall, ist sie defekt.

❽ Vérification de l'isolation entre la bobine de champ et la culasse

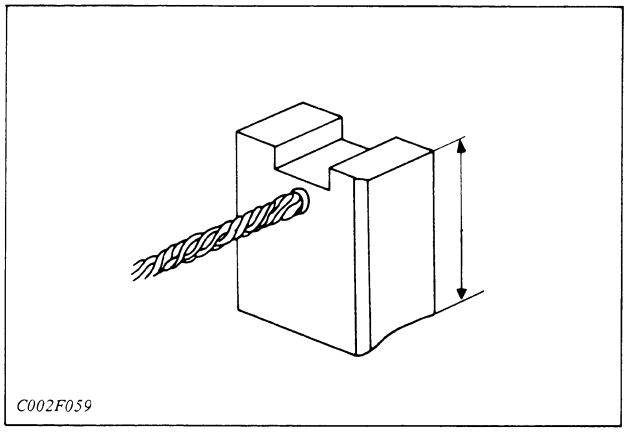
1) Placer chaque extrémité de testeur sur la bobine de champ et la culasse.
2) S'il y a conduction, remplacer.

Norme de référence
Si la conduction est nulle, l'isolation est bonne, et défectueuse s'il se produit une conduction.

❽ Prüfung der Isolation zwischen Feldspule und Joch

1) Jeden der Testfühler auf Feldspule und Joch legen.
2) Falls Durchgang vorhanden ist, auswechseln.

Richtwert
Wenn kein Durchgang vorhanden ist, ist die Isolation normal. Falls Durchgang vorhanden ist, ist die Isolation defekt.



C002F059

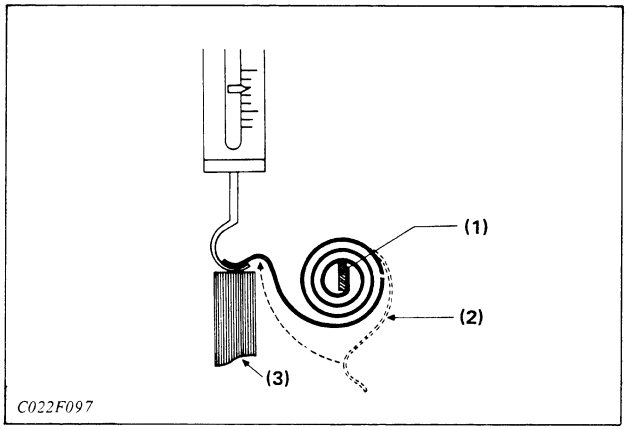
⑨ Checking for Brush Wear

1) Check to see that the brush has worn down more than 1/3 the standard dimensions.
2) If wear exceeds the allowable limit, replace.

Allowable limit
Longer than 10.5 mm (0.4134 in.)

- **Dimensions of starter brush**

Length	16.0 mm 0.6299 in.
Width	12.0 mm 0.4724 in.
Thickness	7.0 mm 0.2756 in.



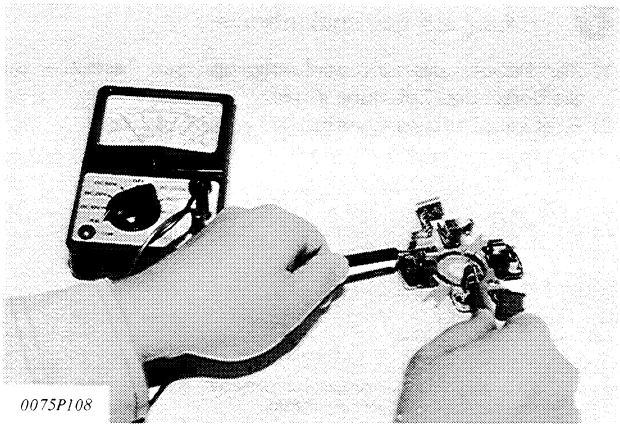
C022F097

⑩ Checking Brush Spring Tension

1) Measure the tension with a new spring in place.
2) Replace if the tension is under the reference value.

Reference value	
Spring tension	9.8N (1.0 kgf, 2.21 lbs)
Commutator diameter	32.70 mm (1.2874 in.).

(1) Spring hanger
(2) Install the brush and spring in this manner
(3) Brush



0075P108

⑪ Grounding of Brush Holder

1) Check the insulation of the positive brush holder.
2) Replace if faulty.

Reference value
If it is not conducting, the brush holder is acceptable; if it is conducting, the brush holder is faulty.

⑨ Vérification de l'usure du balai

1) Vérifier si l'usure de balai ne dépasse pas le. 1/3 des dimensions normales.
2) Si l'usure est supérieure à la limite autorisée, remplacer le balai.

Limite autorisée
Dune longueur supérieure à 10,5 mm

- **Dimensions du balai de starter**

Longueur	16,0 mm
Largeur	12,0 mm
Epaisseur	7,0 mm

⑩ Vérification de la tension du ressort de balai

1) Mesurer la tension avec un ressort neuf.
2) Remplacer, si la tension est inférieure à la tolérance.

Norme de référence	
Tension de ressort	9,8N (1,0 kgf)
Diamètre de collecteur	32,70 mm

(1) Bride de ressort
(2) Fixer balai et ressort
(3) Balai

⑪ Mise à la Masse du Porte-Balais

1) Vérifier l'isolation du porte-balais positif.
2) Remplacer s'il n'est pas satisfaisant.

Norme de référence
S'il n'y a pas conduction, le porte-balais est satisfaisant, non, s'il y a conduction.

⑨ Prüfung der Bürstenabnutzung

1) Prüfen, ob die Bürste mehr als 1/3 der Standardabmessung abgenutzt ist.
2) Wenn die Abnutzung diesen Wert übersteigt, auswechseln.

Zugelassener Grenzwert
Länger als 10,5 mm

- **Abmessungen der Starterbürste**

Länge	16,0 mm
Breite	12,0 mm
Dicke	7,0 mm

⑩ Prüfung des Bürstenfederdrucks

1) Den Druck mit einer neuen eingesetzten Spirale messen.
2) Auswechseln, falls der Druck unter dem Referenzwert liegt.

Richtwert	
Spiralendruck	9,8 N (1,0 kp)
Kommutatorendurchmesser	32,70 mm

(1) Spiralenhänger
(2) Bürste und Spirale auf diese Weise installieren
(3) Bürste

⑪ Erdschluß des Bürstenhalters

1) Die Isolation des positiven Bürstenhalters überprüfen.
2) Auswechseln falls defekt.

Richtwert
Wenn der Bürstenhalter keinen Leitungsdurchgang aufweist, ist er normal. Falls Durchgang vorhanden ist, ist er defekt.

SERVICE DIRECTIONS

SERVICE DIRECTIONS 238

DIRECTIONS D'ENTRETIEN

DIRECTION D'ENTRETIEN 242

WARTUNGSANWEISUNGEN

WARTUNGSANWEISUNGEN 246

CYLINDER HEAD

* R.V. : Reference Value A.L. : Allowable Limit

	D650-B	D750-B	D850-B	DH850-B	D950-B
Distortion of cylinder head surface	0.05 mm (0.0020 in.)/100 mm (4 in.) of cylinder head surface length.				
Thickness of gasket	When tightened 1.05 to 1.15 mm (0.0413 to 0.0453 in.)				
Thickness of gasket shim	0.2 mm (0.0079 in.)				
Top clearance	0.6 to 0.8 mm (0.0236 to 0.0315 in.)				
Tightness of head bolts and nuts	39.2 to 44.1 Nm (4.0 to 4.5 kgf·m / 28.9 to 32.5 ft-lbs)		64.7 to 69.6 Nm (6.6 to 7.1 kgf·m / 47.7 to 51.4 ft-lbs)		

VALVES

Valve seat width		2.1 mm (0.083 in.)
Valve seat angle		0.785rad. (45°)
O.D. of valve stems (Intake, Exhaust)		6.960 to 6.975 mm (0.2740 to 0.2746 in.)
I.D. of valve guides (Intake, Exhaust)		7.010 to 7.025 mm (0.2759 to 0.2765 in.)
Clearance between valve stems and guides	(R.V.)	0.035 to 0.065 mm (0.0014 to 0.0026 in.)
	(A.L.)	0.1 mm (0.004 in.)
Valve recessing	(R.V.)	0.9 to 1.1 mm (0.035 to 0.043 in.)
	(A.L.)	1.3 mm (0.051 in.)
Valve clearance (Intake, Exhaust)	Cold	0.145 to 0.185 mm (0.0057 to 0.0073 in.)

VALVE SPRINGS

Free length	(R.V.)	35.1 to 35.6 mm (1.382 to 1.402 in.)
	(A.L.)	34.8 mm (1.37 in.)
Fitted length		30.99 mm (1.2201 in.)
Load to compress to fitted length	(R.V.)	74N/31 mm (7.5 kgf/31 mm, 16.5 lbs/1.22 in.)
	(A.L.)	63N/31 mm (6.4 kgf/31 mm, 14.1 lbs/1.22 in.)
Squareness		1.3 mm (0.051 in.)

VALVE ROCKER ARMS

O.D. of rocker arm shafts		10.973 to 10.984 mm (0.4320 to 0.4324 in.)
I.D. of rocker arm bushings		10.997 to 11.038 mm (0.4330 to 0.4346 in.)
Clearance between rocker arm shafts and bushings	(R.V.)	0.013 to 0.065 mm (0.0005 to 0.0026 in.)
	(A.L.)	0.12 mm (0.0047 in.)
Adjustment of compression release		0.750 to 1.125 mm (0.0295 to 0.0443 in.)

CAMSHAFT

O.D. of camshaft bearing journal		32.934 to 32.950 mm (1.2966 to 1.2972 in.)
I.D. of camshaft bearing		33.000 to 33.025 mm (1.2992 to 1.3002 in.)
Clearance between camshaft bearing journals and bearings	(R.V.)	0.050 to 0.091 mm (0.0020 to 0.0036 in.)
	(A.L.)	0.15 mm (0.0059 in.)
Alignment of camshaft	(A.L.)	0.05 mm (0.0020 in.)

	D650-B	D750-B	D850-B	DH-850-B	D950-B

CAMSHAFT

Cam height	(Intake)	(R.V.)	26.88 mm (1.0583 in.)
		(A.L.)	26.83 mm (1.0563 in.)
	(Exhaust)	(R.V.)	26.88 mm (1.0583 in.)
		(A.L.)	26.83 mm (1.0563 in.)
Gear backlash		(R.V.)	0.042 to 0.115 mm (0.0017 to 0.0045 in.)
		(A.L.)	0.2 mm (0.0079 in.)

IDLE GEAR

O.D. of idle gear shaft		17.973 to 17.984 mm (0.7076 to 0.7080 in.)
I.D. of idle gear bushing		18.000 to 18.018 mm (0.7087 to 0.7093 in.)
Clearance between idle gear shaft and idle gear bushings	(R.V.)	0.016 to 0.045 mm (0.0007 to 0.0017 in.)
	(A.L.)	0.1 mm (0.0039 in.)

● **Engine serial number: 407507 and beyond (D650-B, D750-B, D850-B, DH850-B)**
393782 and beyond (D950-B)

O.D. of idle gear shaft		23.967 to 23.980 mm (0.9436 to 0.9441 in.)
I.D. of idle gear bushing		24.000 to 24.021 mm (0.9449 to 0.9457 in.)
Clearance between idle gear shaft and idle gear bushings	(R.V.)	0.020 to 0.054 mm (0.0008 to 0.0021 in.)
	(A.L.)	0.1 mm (0.0039 in.)

CYLINDER LINERS

I.D. of cylinder liner	(R.V.)	64.000 to 64.019mm (2.5197 to 2.5204 in.)	68.000 to 68.019 mm (2.6772 to 2.6779 in.)	72.000 to 72.019 mm (2.8346 to 2.8353 in.)	75.000 to 75.019 mm (2.9528 to 2.9535 in.)
	(A.L.)	+0.15 mm (+0.0059 in.)			

PISTON RINGS

Ring gap	Top ring	(R.V.)	0.25 to 0.40 mm (0.0098 to 0.0157 in.)	0.25 to 0.40 mm (0.0098 to 0.0157 in.)	0.20 to 0.35 mm (0.0079 to 0.0138 in.)
		(A.L.)	1.25 mm (0.0492 in.)		
	2nd ring	(R.V.)	0.25 to 0.40 mm (0.0098 to 0.0157 in.)	0.25 to 0.40 mm (0.0098 to 0.0157 in.)	0.30 to 0.45 mm (0.0118 to 0.0177 in.)
		(A.L.)	1.25 mm (0.0492 in.)		
	Oil ring	(R.V.)	0.20 to 0.40 mm (0.0079 to 0.0157 in.)	0.25 to 0.40 mm (0.0098 to 0.0157 in.)	0.25 to 0.40 mm (0.0098 to 0.0157 in.)
		(A.L.)	1.25 mm (0.0492 in.)		
Side clearance of ring in groove		(Top ring)	—		
		(2nd ring)	0.085 to 0.112 mm (0.0033 to 0.0044 in.)		
		(Oil ring)	0.020 to 0.055 mm (0.0008 to 0.0022 in.)		
Oversizes of piston and ring			0.5 mm (0.0197 in.)		

	D650-B	D750-B	D850-B	DH850-B	D950-B

PISTONS

I.D. of piston bosses	(R.V.)	20.000 to 20.013 mm (0.7874 to 0.7879 in.)
	(A.L.)	20.03 mm (0.7885 in.)
O.D. of piston pin		20.002 to 20.011 mm (0.7875 to 0.7878 in.)
I.D. of connecting rod small end bushings (fitted)		20.025 to 20.040 mm (0.7884 to 0.7890 in.)
Clearance between piston pin and small end bushings	(R.V.)	0.014 to 0.038 mm (0.0006 to 0.0015 in.)
	(A.L.)	0.15 mm (0.0059 in.)
Connecting rod alignment	(R.V.)	0.02 mm (0.0008 in.)
	(A.L.)	0.05 mm (0.0020 in.)

CRANKSHAFT

Crankshaft alignment	(R.V.)	0.02 mm (0.0008 in.)
	(A.L.)	0.08 mm (0.0031 in.)
O.D. of crankshaft journals		43.934 to 43.950 mm (1.7297 to 1.7303 in.)
I.D. of crankshaft bearing 1		43.984 to 44.040 mm (1.7317 to 1.7339 in.)
I.D. of crankshaft bearing 2		43.984 to 44.026 mm (1.7317 to 1.7339 in.)
Clearance between crankshaft journal and bearing 1	(R.V.)	0.034 to 0.106 mm (0.0013 to 0.0042 in.)
	(A.L.)	0.20 mm (0.0079 in.)
Clearance between crankshaft journals and bearing 2	(R.V.)	0.034 to 0.092 mm (0.0013 to 0.0036 in.)
	(A.L.)	0.20 mm (0.0079 in.)
Undersizes of crankshaft bearing 1		0.2 mm (0.0079 in.) 0.4 mm (0.0157 in.)
Undersizes of crankshaft bearing 2		0.2 mm (0.0079 in.) 0.4 mm (0.0157 in.)
O.D. of crankpins		36.959 to 36.975 mm (1.4551 to 1.4557 in.)
I.D. of crankpin bearings		37.004 to 37.050 mm (1.4569 to 1.4587 in.)
Clearance between crankpins and bearings	(R.V.)	0.029 to 0.091 mm (0.0011 to 0.0036 in.)
	(A.L.)	0.20 mm (0.0079 in.)
Undersizes of crankpin bearings		0.2 mm (0.0079 in.) 0.4 mm (0.0157 in.)
End play of crankshaft	(R.V.)	0.15 to 0.31 mm (0.0059 to 0.0122 in.)
	(A.L.)	0.5 mm (0.0197 in.)
Oversizes of crankshaft side metal 1.2		0.2 mm (0.0079 in.) 0.4 mm (0.0157 in.)

FUEL INJECTION NOZZLES

Opening pressure	13.7 to 14.7 MPa. (140 to 150 kgf/cm^2, 1990 to 2133 psi)
Fuel tightness of nozzle valve seat	Dry nozzle at 12.7 Mpa. (130 kgf/cm^2, 1848.6 psi)

INJECTION PUMP

Fuel tightness of plunger	(R.V.)	60 seconds or more; initial pressure from 39.23 to 34.32 MPa. (400 to 350 kgf/cm^2, 5689 to 4978 psi)
	(A.L.)	30 seconds
Fuel tightness of delivery valve	(R.V.)	10 seconds or more; initial pressure from 21.57 to 20.59 MPa. (220 to 210 kgf/cm^2, 3129 to 2987 psi)
	(A.L.)	5 seconds

	D650-B	D750-B	D850-B	DH850-B	D950-B

INJECTION PUMP

Injection timing	0.401 to 0.436 rad (23° to 25°) before TDC

OIL PUMP

Oil pressure	At rated speed	(R.V.)	196 to 441 kPa. (2.0 to 4.5 kgf/cm^2, 28 to 64 psi)
		(A.L.)	196 kPa. (2.0 kgf/cm^2, 28 psi)
	At idle speed	(A.L.)	69 kPa. (0.7 kgf/cm^2, 10 psi)
ROTOR TYPE	Rotor lobe clearance	(R.V.)	0.11 to 0.15 mm (0.0043 to 0.0059 in.)
		(A.L.)	0.20 mm (0.0079 in.)
	Radial clearance between outer rotor and pump body	(R.V.)	0.07 to 0.15 mm (0.0028 to 0.0059 in.)
		(A.L.)	0.25 mm (0.0098 in.)
End clearance between rotor and cover		(R.V.)	0.08 to 0.13 mm (0.0031 to 0.0051 in.)
		(A.L.)	0.2 mm (0.0079 in.)

RADIATOR

Opening pressure of cap	88.3 kPa. (0.9 kgf/cm^2, 12.8 psi)
Test pressure	88.3 kPa. (0.9 kgf/cm^2, 12.8 psi)

THERMOSTAT

Opening temperature	(beginning)	80.5°C to 83.5°C (176.9°F to 182.3°F)
	(full-open)	95°C (203°F)
Distance of lift		8 mm (0.3150 in.)

FANBELT

Belt sag under load of 58.8 to 68.6 N (6 to 7 kgf, 13.2 to 15.4 lb.)	7 to 9 mm (0.7256 to 0.3543 in.)

AC DYNAMO

Charging current	14 V max./8.5 A min or 14.0 to 15.5 V/0.5 to 8.5 A
No-load voltage	AC Voltage 20V
Insulation resistance	3 MΩ min.

STARTER MOTOR

No-load test	Current	50 A or less
	Voltage	11 V
	Speed	5000 rpm or more
O.D. of commutator	(R.V.)	28.0 mm (1.1024 in.)
	(A.L.)	27.0 mm (1.0630 in.)
Mica undercutting	(R.V.)	0.5 to 0.8 mm (0.0197 to 0.315 in.)
	(A.L.)	0.2 mm (0.0079 in.)
Brush length	(R.V.)	16 mm (0.6299 in.)
	(A.L.)	10.5 mm (0.4134 in.)

GLOW PLUG

Resistance	Approx. 1.6 Ω

CULASSE

* N.R.: Norme de Référence L.A.: Limite Autorisée

	D650-B	D750-B	D850-B	DH850-B	D950-B
Deformation de la surface de la culasse	0,05 mm/100 mm de longueur de la surface de culasse				
Épaisseur de joint de la culasse	1,05 à 1,15 mm				
Épaisseur d'une cale de joint	0,2 mm				
Jeu du point mort haut	0,6 à 0,8 mm				
Couple de serrage des boulons et des écrous	39,2 à 44,1 Nm (4,0 à 4,5 kgf·m)		64,7 à 69,6 Nm (6,6 à 7,1 kgf·m)		

SOUPAPES

Largeur du siège de soupape		2,1 mm
Angle du siège de soupape		45°
D.E. de la queue de soupape (Admission, échappement)		6,960 à 6,975 mm
D.I. du guide de soupape (Admission, échappement)		7,010 à 7,025 mm
Jeu entre le siège et la queue de soupape	(N.R.)	0,035 à 0,065 mm
	(L.A.)	0,1 mm
Tassement de soupape	(N.R.)	0,9 à 1,1 mm
	(L.A.)	1,3 mm
Jeu de soupape		0,145 à 0,185 mm

RESSORT SOUPAPE

Longueur libre du ressort de soupape	(N.R.)	35,1 à 35,6 mm
	(A.L.)	34,8 mm
Longueur du ressort en montant		30,99 mm
Poids pour presser le ressort	(N.R.)	74 N/31mm (7,5 kgf/31 mm)
	(L.A.)	63 N/31mm (6,4 kgf/31 mm)
Verticalité du ressort		1,3 mm

CULBUTEURS DE SOUPAPE

D.E. de l'axe de culbuteur		10,973 à 10,984 mm
D.I. de la bague de culbuteur		10,997 à 11,038 mm
Jeu entre l'axe et la bague de culbuteur	(N.R.)	0,013 à 0,065 mm
	(L.A.)	0,12 mm
Jeu de décompression		0,750 à 1,125 mm

ARBRE À CAME

D.E. de tourillon de l'arbre à came		32,934 à 32,950 mm
D.I. de palier de l'arbre à came		33,000 à 33,025 mm
Jeu entre le tourillon et le palier de l'arbre à came	(N.R.)	0,050 à 0,091 mm
	(L.A.)	0,15 mm

	D650-B	D750-B	D850-B	DH850-B	D950-B

ARBRE À CAME

Flexion de l'arbre à came			0,05 mm
Hauteur de came	(Admission)	(N.R.)	26,88 mm
		(L. A.)	26,83 mm
	(Échappement)	(N.R.)	26,88 mm
		(L.A.)	26,83 mm
Jeu du pignon		(N.R.)	0.042 à 0,115 mm
		(L.A.)	0,2 mm

PIGNON DE RENVOI

D.E. d'axe de pignon de renvoi		17,973 à 17,984 mm
D.I. de bague de pignon de renvoi		18,000 à 18,018 mm
Jeu entre l'axe du pignon de renvoi et les bagues du pignon de renvoi	(N.R.)	0,016 à 0,045 mm
	(L.A.)	0,1 mm

● **Numéro de série moteur: à partir de 407507 (D650-B, D750-B, D850-B, DH850-B)**
à partir de 393782 (D950-B)

D.E. d'axe de pignon de renvoi		23,967 à 23,980 mm
D.I. de bague de pignon de renvoi		24,000 à 24,021 mm
Jeu entre l'axe du pignon de renvoi et les bagues du pignon de renvoi	(N.R.)	0,020 à 0,054 mm
	(L.A.)	0,1 mm

CHEMISE DE CYLINDRE

D.I. de la chemise de cylindre	(N.R.)	64,000 à 64,019 mm	68,000 à 68,019 mm	72,000 à 72,019 mm	75,000 à 75,019 mm
	(L.A.)	+0,15 mm			

SEGMENTS DE PISTON

Inlervalle de segment	(Segment coup de feu)	(N.R.)	0,25 à 0,40 mm	0,25 à 0,40 mm	0,20 à 0,35 mm
		(L.A.)	1,25 mm		
	(Segment d'étanchéité)	(N.R.)	0,25 à 0,40 mm	0,25 à 0,40 mm	0,30 à 0,45 mm
		(L.A.)	1,25 mm		
	(Segment racleur)	(N.R.)	0,20 à 0,40 mm	0,25 à 0,40 mm	0,25 à 0,40 mm
		(L.A.)	1,25 mm		
Jeu de côté des segments dans la gorge des segments du piston	(Segment coup de feu)		—		
	(Segment d'étanchéité)		0,085 à 0,112 mm		
	(Segment racleur)		0,020 à 0,055 mm		
Sur-calibre du piston et des segments			0,5 mm		

PISTONS

D.I. du trou du piston	(N.R.)	20,000 à 20,013 mm
	(L.A.)	20,03 mm

	D650-B	D750-B	D850-B	DH850-B	D950-B

PISTONS

D.E. de l'axe de piston		20,002 à 20,011 mm
D.I. de la bague de pied de bielle (monté)		20,025 à 20,040 mm
Jeu entre l'axe de piston et la bague de pied de bielle	(N.R.)	0,014 à 0,038 mm
	(L.A.)	0,15 mm
Distorsion et flexion de la bielle	(N.R.)	0,02 mm
	(L.A.)	0,05 mm

VILEBREQUIN

Flexion du vilebrequin	(N.R.)	0,02 mm
	(L.A.)	0,08 mm
D.E. du tourillon de vilebrequin		43,934 à 43,950 mm
D.I. du palier 1 de vilebrequin		43,984 à 44,040 mm
D.I. du palier 2 de vilebrequin		43,984 à 44,026 mm
Jeu d'huilage entre le tourillon et le palier 1	(N.R.)	0,034 à 0,106 mm
	(L.A.)	0,20 mm
Jeu d'huilage entre le tourillon et le palier 2	(N.R.)	0,034 à 0,092 mm
	(L.A.)	0,20 mm
Sous-calibre du palier 1		0,2 mm 0,4 mm
Sous-calibre du palier 2		0,2 mm 0,4 mm
D.E. du maneton de vilebrequin		36,959 à 36,975 mm
D.I. de la bague de tête de bielle		37,004 à 37,050 mm
Jeu d'huilage entre le maneton et la bague de tête de bielle	(N.R.)	0,029 à 0,091 mm
	(L.A.)	0,20 mm
Sous-calibre de la bague de maneton		0,2 mm 0,4 mm
Jeu latéral de vilebrequin	(N.R.)	0,15 à 0,31 mm
	(L.A.)	0,5 mm
Sur-calibre de la bague de butée latérale 1, 2		0,2 mm 0,4 mm

INJECTEUR DE CARBURANT

Pression d'ouverture d'injecteur	13,7 à 14,7 MPa. (140 à 150 kgf/cm^2)
Resserrement du siège d'injecteur	L'injecteur doit être sec lorsque la pression est de 12,7 MPa. (130 kgf/cm^2)

POMPE D'INJECTION

Resserrement du plongeur de pompe d'injection	(N.R.)	Plus de 60 secondes, avec une pression initiale de 39,23 à 34,32 MPa. (400 à 350 kgf/cm^2)
	(L.A.)	30 secondes
Resserrement de la soupape d'injecteur	(N.R.)	Plus de 10 secondes, avec une pression initiale de 21,57 à 20,59 MPa. (220 à 210 kgf/cm^2)
	(L.A.)	5 secondes
Temps d'injection		23° à 25° avant TDC

	D650-B	D750-B	D850-B	DH850-B	D950-B

POMPE A HUILE

Pression d'huile		(N.R.)	196 à 441 kPa. (2,0 à 4,5 kgf/cm^2)
		(L.A.)	196 kPa. (2,0 kgf/cm^2)
		(L.A.)	69 kPa. (0,7 kgf/cm^2)
TYPE A ROTOR	Jeu entre les saillies de rotor	(N.R.)	0,11 à 0,15 mm
		(L.A.)	0,20 mm
	Jeu entre le rotor extérieur et le boîtier	(N.R.)	0,07 à 0,15 mm
		(L.A.)	0,25 mm
Jeu entre le rotor et le couvercle		(N.R.)	0,08 à 0,13 mm
		(L.A.)	0,2 mm

RADIATEUR

Pression du bouchon de radiateur	88,3 kPa. (0,9 kgf/cm^2)
Pression de contrôle	88,3 kPa. (0,9 kgf/cm^2)

THERMOSTAT

Température d'ouverture	(Commencer à ouvrir)	80,5°C à 83,5°C
	(Ouvrir complètement)	95°C
Distance d'ouverture		8 mm

COURROIE DE VENTILATEUR

Fléchissement de la courroie sous la pression de 6 à 7 kgf.	7 à 9 mm

DYNAMO C.A.

Courant de charge	14V max./8,5A min. ou 14,0 à 15,5V/0,5 à 8,5A
Tension à vide	Tension c.a. 20V
Résistance d'isolement	3MΩ min.

MOTEUR DE DÉMARREUR

Contrôle de non-chargement	Courant	Moins de 50 A
	Voltage	11 V
	Vitesse	Plus de 5000 t/min.
D.E. du commutateur	(N.R.)	28,0 mm
	(L.A.)	27,0 mm
Sous-cave du mica	(N.R.)	0,5 à 0,8 mm
	(L.A.)	0,2 mm
Longueur de balai	(N.R.)	16 mm
	(L.A.)	10,5 mm

BOUGIE DE PRÉ-CHAUFFAGE

Résistance	Approx. 1,6 Ω

ZYLINDERKOPF

* R.W. : Richtwert Z.G. : Zugelassener Grenzwert

	D650-B	D750-B	D850-B	DH850-B	D950-B
Verformung der Zylinderkopf Oberfläche	0,05 mm/100 mm der Oberfläche des Zylinderkopfes				
Stärke der Dichtungen	1,05 bis 1,15 mm				
Stärke der Ausgleichsscheiben	0,2 mm				
Oberes Spiel	0,6 bis 0,8 mm				
Anzugskraft für Schrauben und Muttern	39,2 bis 44,1 Nm (4,0 bis 4,5 kp·m)		64,7 bis 69,6 Nm (6,6 bis 7,1 kp·m)		

VENTILE

Ventilsitzweite		2,1 mm
Ventilsitzwinkel		45°
Außendurchmesser der Ventilstößel (Ansaugung und Abgase)		6,960 bis 6,975 mm
Innendurchmesser der Ventilführungen (Ansaugung und Abgase)		7,010 bis 7,025 mm
Spiel zwischen Ventilstößel und Sitz	(R.W.)	0,035 bis 0,065 mm
	(Z.G.)	0,1 mm
Ventileinstiche	(R.W.)	0,9 bis 1,1 mm
	(Z.G.)	1,3 mm
Ventilspiel (Ansaugung und Abgase) kalt		0,145 bis 0,185 mm

VENTILFEDERN

Freie Länge	(R.W.)	35,1 bis 35,6 mm
	(Z.G.)	34,8 mm
Eingepaßte Länge		30,99 mm
Belastung um die eingepaßte Länge zu erreichen	(R.W.)	74 N/31 mm (7,5 kp/31 mm)
	(Z.G.)	63 N/31 mm (6,4 kp/31 mm)
Winkligkeit		1,3 mm

VENTILSTEUERHEBEL

Außendurchmesser Ventilsteuerhebelachsen		10,973 bis 10,984 mm
Innendurchmesser Ventilsteuerhebelachsen		10,997 bis 11,038 mm
Spiel zwischen Ventilsteuerhebelachsen und Büchse	(R.W.)	0,013 bis 0,065 mm
	(Z.G.)	0,12 mm
Einstellung Dichtungsnachlaßdruck		0,750 bis 1,125 mm

NOCKENWELLE

Außendurchmesser Nockenwellenende		32,934 bis 32,950 mm
Innendurchmesser des Nockenwellenlagers		33,000 bis 33,025 mm
Spiel zwischen Nockenwellenende und Lager	(R.W.)	0,050 bis 0,091 mm
	(Z.G.)	0,15 mm

	D650-B	D750-B	D850-B	DH850-B	D950-B

NOCKENWELLE

Abgleichung Nockenwelle			0,05 mm
Nockenscheibenhöhe	(Ansaugung)	(R.W.)	26,88 mm
		(Z.G.)	26,83 mm
	(Ausstoß)	(R.W.)	26,88 mm
		(Z.G.)	26,83 mm
Getriebeendspiel		(R.W.)	0,042 bis 0,115 mm
		(Z.G.)	0,2 mm

LEERLAUFGETRIEBE

Außendurchmesser der Leerlaufachse		17,973 bis 17,984 mm
Innendurchmesser der Leerlaufbuchse		18,000 bis 18,018 mm
Spiel zwischen Leerlaufachse und Leerlaufbuchse	(R.W.)	0,016 bis 0,045 mm
	(Z.G.)	0,1 mm

●**Seriennummer des Motors: 407507 und höher (D650-B, D750-B, D850-B, DH850-B)**
393782 und höher (D950-B)

Außendurchmesser der Leerlaufachse		23,967 bis 23,980 mm
Innendurchmesser der Leerlaufbuchse		24,000 bis 24,021 mm
Spiel zwischen Leerlaufachse und Leerlaufbuchse	(R.W.)	0,020 bis 0,054 mm
	(Z.G.)	0,1 mm

ZYLINDERAUSKLEIDUNGEN

Innendurchmesser der Zylinder-a	(R.W.)	64,000 bis 64,019 mm	68,000 bis 68,019 mm	72,000 bis 72,019 mm	75,000 bis 75,019 mm
	(Z.G.)	+0,15 mm			

KOLBENRINGE

Ringspalt	Oberer Ring	(R.W.)	0,25 bis 0,40 mm	0,25 bis 0,40 mm	0,20 bis 0,35 mm
		(Z.G.)	1,25 mm		
	2 Ring	(R.W.)	0,25 bis 0,40 mm	0,25 bis 0,40 mm	0,30 bis 0,45 mm
		(Z.G.)	1,25 mm		
	Ölring	(R.W.)	0,20 bis 0,40 mm	0,25 bis 0,40 mm	0,25 bis 0,40 mm
		(Z.G.)	1,25 mm		
Seitenspiel der Ringkerben		Oberer Ring	—		
		2 Ring	0,085 bis 0,112 mm		
		Ölring	0,020 bis 0,055 mm		
Übermaße von Kolben und Ringen			0,5 mm		

	D650-B	D750-B	D850-B	DH850-B	D950-B

KOLBEN

Innendurchmesser der Kolbennaben	(R.W.)	20,000 bis 20,013 mm
	(Z.G.)	20,03 mm
Außendurchmesser der Kolbenzapfen		20,002 bis 20,011 mm
Innendurchmesser Plevelstangenbuchse, kurzes Ende (aufgezogen)		20,025 bis 20,040 mm
Spiel zwischen Kolbenzapfen und Endbuchsen	(R.W.)	0,014 bis 0,038 mm
	(Z.G.)	0,15 mm
Abgleichung Pleuerstange	(R.W.)	0,02 mm
	(Z.G.)	0,05 mm

KURBELWELLE

Abgleichung Kurbelwelle	(R.W.)	0,02 mm
	(Z.G.)	0,08 mm
Außendurchmesser Kurbelwellenende		43,934 bis 43, 950 mm
Innendurchmesser Kurbelwellenlager 1		43,984 bis 44,040 mm
Innendurchmesser des Kurbelwellenlagers 2		43,984 bis 44,026 mm
Spiel zwischen Kurbelwellenende und Lager 1	(R.W.)	0,034 bis 0,106 mm
	(Z.G.)	0,20 mm
Spiel zwischen Kurbelwellenende und Lager 2	(R.W.)	0,034 bis 0,092 mm
	(Z.G.)	0,20 mm
Untermaß-Kurbelwellenlager 1		0,2 mm 0,4 mm
Untermaß-Kurbelwellenlager 2		0,2 mm 0,4 mm
Außendurchmesser der Kurbelwellenzapfen		36,959 to 36,975 mm
Innendurchmesser der Kurbelwellenlagerzapfen		37,004 bis 37,050 mm
Spiel zwischen Kurbelwellenzapfen und Lager	(R.W.)	0,029 bis 0,091 mm
	(Z.G.)	0,20 mm
Untermaß der Kurbelwellenlagerzapfen		0,2 mm 0,4 mm
Endspiel der Kurbelwelle	(R.W.)	0,15 bis 0,31 mm
	(Z.G.)	0,5 mm
Übermaß-von Kurbelwellen-Seitenmetall 1, 2		0,2 mm 0,4 mm

KRAFTSTOFFEINSPRITZDÜSE

Öffnungsdruck	13,7 bis 14,7 MPa. (140 bis 150 kp/cm^2)
Kraftstoffdichte der Düsenventildichtung	Trockene Düse 12,7 MPa. (130 kp/cm^2)

	D650-B	D750-B	D850-B	DH850-B	D950-B

EINSPRITZPUMPE

Kraftstoffdichte am Kolben	(R.W.)	60 Sekunden oder länger, Ausgangsdruck vonn 39,23 bis 34,32 MPa. (400 bis 350 kp/cm^2)
	(Z.G.)	30 Sekunden
Kraftstoffdichte am Zylinderventil	(R.W.)	10 Sekunden oder länger, Ausgangsdruck 21,57 bis 20,59 MPa. (220 bis 210 kp/cm^2)
	(Z.G.)	5 Sekunden
Einspritzmoment		23° bis 25° vor TDC

ÖLPUMPEN

Öldruck		(R.W.)	196 bis 441 kPa (2,0 bis 4,5 kp/cm^2)
		(Z.G.)	196 kPa. (2,0 kp/cm^2)
		(Z.G.)	69 kPa. (0,7 kp/cm^2)
Rotortyp	Rotorflügelspiel	(R.W.)	0,11 bis 0,15 mm
		(Z.G.)	0,20 mm
	Radialspiel zwischen Außenrotor und Pumpengehäuse	(R.W.)	0,07 bis 0,15 mm
		(Z.G.)	0,25 mm
Endspiel zwischen Rotor und Abdeckung		(R.W.)	0,08 bis 0,13 mm
		(Z.G.)	0,2 mm

KÜHLER

Öffnungsdruck am Verschluß	88,3 kPa. (0,9 kp/cm^2)
Prüfdruck	88,3 kPa. (0,9 kp/cm^2)

TEMPERATURREGLER

Öffnungstemperatur	(anfangs)	176,9°F bis 182,3°F
	(völlig offen)	203°F
Abhebestrecke		8 mm

KEILRIEMEN

Keilriemenspiel unter einem Druck von 6 bis 7 kgf	7 bis 9 mm

WECHSELSTROMDYNAMO

	D650-B	D750-B	D850-B	DH850-B	D950-B
Ladestrom	14V max./7,5 min, oder 14,0 bis 15,5V/0,5 bis 8,5A				
Nichtlastspannung	Wechselstromspannung 20V				
Isolationswiderstand	3MΩ min.				

ANLASSERMOTOR

Nicht-Ladeprüfung	(Strom)	50 A oder weniger
	(Spannung)	11 V
	(Umdrehungszahl)	5000 Upm oder mehr
Außendurchmesser des Kommutators	(R.W.)	28,0 mm
	(Z.G.)	27,0 mm
Glimmerschrämer	(R.W.)	0,5 bis 0,8 mm
	(Z.G.)	0,2 mm
Bürstenlänge	(R.W.)	16 mm
	(Z.G.)	10,5 mm

ZÜNDKERZE

Widerstand	Ungef. 1,6 Ω

WORKSHOP MANUAL INTRODUCTION
INTRODUCTION AU MANUEL D'ATELIER
EINFÜHRUNG WERKSTATTANLEITUNG

The following Workshop Manuals are available through your local Kubota Distributor.

NOTE
- Letters in parentheses after the code numbers represent the language used for the manuals.(e: English, f: French, d: German, a: Arabic, s: Spanish, c: Chinese, r: Russian)
- * Engine section included.

Les manuels d'atelier suivants sont disponibles chez votre fournisseur local KUBOTA.

NOTA
- Les lettres entre parenthèses, après les numéros de référence, représentent la langue dans laquelle est écrit le manuel.(e: Anglais, f: Français, d: Allemand, a: Arabe, s: Espagnol, c: Chinois, r:Russe)
- * Comprend la partie du moteur.

Die folgenden Werkstattanleitungen stehen bei Ihrem örtlichen KUBOTA-Händler zur Verfügung:

ANMERKUNG
- Die nach den Code-Nr. angegebenen Buchstaben weisen auf die Sprache der Handbücher hin.(z.B.:e: Englisch, f: Französisch, d: Deutsch, a: Arabisch, s : Spanisch, c: Chinesisch, r:Russisch).
- * Der Motorteil ist enthalten.

Model / Modèle / Modell	Code No. / Référence / Code-Nr.	Model / Modèle / Modell	Code No. / Référence / Code-Nr.

[Diesel Engine / Moteur diesel / Dieselmotor]

Z751-B·Z851-B	07909-70070-4 (e)	ZB500C-1-B·ZB600C-1-B	07909-70075-2(e,f,d)
DH1101-B·D1301-B V1501-B·V1701-B S2200-B·S2600-B		ZB400-B	07909-60158-0(e,f,d)
D1102-B·D1302-B·D1402-B V1502-B·V1702-B·V1902-B	07909-70073-5(e,f,d)	GA·ER·KND·ET·EA SERIES	07909-70090-3 (e)
D650-B·D750-B·D850-B DH850-B·D950-B	07909-70076-6(e,f,d)	ER650DI SERIES·ER750DI SERIES ER850DI SERIES·ER950DI SERIES	07909-70114-0 (e)
Z500-B·Z600-B·ZH600-B	07909-70101-6(e,f,d)	ER1200 SERIES·KND1200 ER1400 SERIES	07909-70105-2 (e,f)
Z751-B·Z851-B	07909-70102-0(e,f,d)	ER1500 SERIES·KND1500 ER1700DI SERIES·KND1700DI ER1900DI SERIES·KND1900DI ER2200DI SERIES·KND2200DI	07909-70106-2 (e,f)
D3000-B·D3200-B V4000-B·V4300-B	07909-70103-5(e,f,d)	KND2800·KND3200	07909-70104-1 (e,a)
V4300-T TURBOCHARGER	07909-70113-0 (e)	KND2000	07909-60185-0 (e)
V1100-B·VH1100-B·V1200-B	07909-70107-3(e,f,d)	EA300 SERIES·EA400 SERIES	07909-60132-0(e,f,d)
S2200-B·S2600-B·S2800-B	07909-70108-2(e,f,d)	RK50 SERIES·RK60 SERIES RK70 SERIES·RK80 SERIES RK95 SERIES·RK105 SERIES RK125 SERIES	07909-60133-0 (e)
Z400-B·Z430-B·D600-B D640-B·V800-B	07909-70109-2(e,f,d)	RK SERIES(U.S.A.) RK301·RK351·RK401 RK451·RK501·RK551·RK601	07909-60195-0 (e)
F2302-DI-B	07909-60180-0 (e)		
Z600-BG·D850-BG·D950-BG V1200-BG·D1400-BG·V1902-BG S2800-BG·D3200-BG·V4300-BG	07909-60181-0 (e)		

[Gasoline Engine / Moteur à essence / Benzinmotor]

GS130·GS160·GS200·GS280 GN2900-H·GN4000-H	07909-70074-2(e,f,d)	WG600-B	07909-60172-0 (e)
GS160-3 SERIES·GS200-3 SERIES	07909-70117-1(e,f,d)		

[Kerosene Engine / Moteur à kérozène / Kerosinmotor]

KS160·KS200·KS300	07909-60129-0 (e)		

[Gas Engine / Moteur à gaz / Gasmotor]

KNG1600E	07909-60162-0 (c)	KNG1600·3200(E)	07909-60184-0 (e,f)
KNG3200E	07909-60163-0 (c)	ER16G·32G	07909-60196-0 (e,f)

[Tractor / Tracteur / Traktor]

(† Engine workshop manual / Manuel d'atelier du moteur / Motorteil Werkstattanleitungen)

G SERIES (For U.S.A.) ..... 07909-70314-3 (e,f)
SERIE G (Destiné au Canada)
† Z400-B·Z430-B·D600-B ..... 07909-70109-2(e,f,d)
D640-B·V800-B

G SERIES (For Europe) ..... 07909-70315-0 (e,f)
SERIE G (Destiné en Europe)
† Z400-B·Z430-B·D600-B ..... 07909-70109-2(e,f,d)
D640-B·V800-B

* B5100·B6100·B7100 ..... 07909-70010-9 (e,f)

* B5100·B6100·B7100 ..... 07909-60325-0 (s)

B7100HST (For Europe) ..... 07909-70303-0 (e,f)
† D650-B·D750-B·D850-B ..... 07909-70076-6(e,f,d)
DH850-B·D950-B

* B7100HST·B6100HST (For U.S.A.) ..... 07909-70306-4 (e)

* B5200·B6200·B7200 ..... 07909-70319-2 (e)
B6200HST·B7200HST

* B5200·B6200·B7200 ..... 07909-70323-0 (f)
B6200HST·B7200HST

B8200 ..... 07909-70302-3 (e,f)
(Including BF300)
† D650-B·D750-B·D850-B ..... 07909-70076-6(e,f,d)
DH850-B·D950-B

B8200HST ..... 07909-70320-0 (e,f)
† D650-B·D750-B·D850-B ..... 07909-70076-6(e,f,d)
DH850-B·D950-B

* B9200HST·B9200DC ..... 07909-60339-1 (e)

* B4200 ..... 07909-60342-0 (e)
(Including RC44-42)

* L185·L245·L295 ..... 07909-70020-9 (e,f)

* L185·L245·L295 ..... 07909-60324-0 (s)

L245H ..... 07909-70021-2 (e,f)
† Z751-B·Z851-B ..... 07909-70070-4 (e)
DH1101-B·D1301-B
V1501-B·V1701-B
S2200-B·S2600-B

* L175·L225 ..... 07909-70022-1 (e,f)

L345·L345-II ..... 07909-70023-2 (e,f)
† Z751-B·Z851-B ..... 07909-70070-4 (e)
DH1101-B·D1301-B
V1501-B·V1701-B
S2200-B·S2600-B
† D1102-B·D1302-B·D1402-B ..... 07909-70073-5(e,f,d)
V1502-B·V1702-B·V1902-B

L235·L275 ..... 07909-70301-1 (e,f)
† D1102-B·D1302-B·D1402-B ..... 07909-70073-5(e,f,d)
V1502-B·V1702-B·V1902-B

L355SS ..... 07909-70305-0 (e,f)
† D1102-B·D1302-B·D1402-B ..... 07909-70073-5(e,f,d)
V1502-B·V1702-B·V1902-B

L405 ..... 07909-70313-0 (e)
† D1102-B·D1302-B·D1402-B ..... 07909-70073-5(e,f,d)
V1502-B·V1702-B·V1902-B

* L2050 ..... 07909-60350-0 (e)

* L2250·L2550(GST)·L2850 ..... 07909-60329-4 (e)

* L2250·L2550·L2850 (Destiné en France) ..... 07909-60336-0 (f)

* L2250·L2550·L2850 (Destiné au Canada) ..... 07909-60337-0 (f)

* L3350·L3750·L4150·L4150(N) ..... 07909-70321-6 (e)

* L3750·L4150 (Destiné en France) ..... 07909-60331-0 (f)

* L3750·L4150 (Destiné au Canada) ..... 07909-60335-0 (f)

L4150-N ..... 07909-60340-0 (e)

M4000·M4500·M5500 ..... 07909-70030-7 (e)
M6500·M7500
† S2200-B·S2600-B·S2800-B ..... 07909-70108-2(e,f,d)
† D3000-B·D3200-B ..... 07909-70103-5(e,f,d)
V4000-B·V4300-B

M4500·M5500 ..... 07909-70309-0 (e)
M7500(A/AC Type)
† S2200-B·S2600-B·S2800-B ..... 07909-70108-2(e,f,d)
† D3000-B·D3200-B ..... 07909-70103-5(e,f,d)
V4000-B·V4300-B

M4500·M5500 ..... 07909-70322-0 (s)
M7500(Tipo A/AC)
† S2200-B·S2600-B·S2800-B ..... 07909-70108-2(e,f,d)
† D3000-B·D3200-B ..... 07909-70103-5(e,f,d)
V4000-B·V4300-B

M4950·M5950 (For U.S.A.) ..... 07909-70310-1 (e)
M6950·M7950
† S2200-B·S2600-B·S2800-B ..... 07909-70108-2(e,f,d)
† D3000-B·D3200-B ..... 07909-70103-5(e,f,d)
V4000-B·V4300-B

M4950·M5950 (For Canada) ..... 07909-70311-1 (e)
M6950·M7950
† S2200-B·S2600-B·S2800-B ..... 07909-70108-2(e,f,d)
† D3000-B·D3200-B ..... 07909-70103-5(e,f,d)
V4000-B·V4300-B

M4950·M5950 (Destiné au Canada) ..... 07909-60333-0 (f)
M6950·M7950
† S2200-B·S2600-B·S2800-B ..... 07909-70108-2(e,f,d)
† D3000-B·D3200-B ..... 07909-70103-5(e,f,d)
V4000-B·V4300-B

M4950·M5950 (For Oceania) ..... 07909-70312-1 (e)
M6950·M7950
† S2200-B·S2600-B·S2800-B ..... 07909-70108-2(e,f,d)
† D3000-B·D3200-B ..... 07909-70103-5(e,f,d)
V4000-B·V4300-B

M4950·M5950 (For North Europe) ..... 07909-70318-0 (e)
M6950·M7950
† S2200-B·S2600-B·S2800-B ..... 07909-70108-2(e,f,d)
† D3000-B·D3200-B ..... 07909-70103-5(e,f,d)
V4000-B·V4300-B

* M8950 ..... 07909-60326-1 (e)

* M8950 (Destiné au Canada) ..... 07909-60334-0 (f)

* M4030·M5030·M6030 ..... 07909-60338-1 (e)
M7030·M8030
(Including Manual Shuttle Transmission)

IC69·79·89 ..... 07909-60332-1 (e)
INTEGRAL CABIN

[Tractor Implement / Outils de Tracteur / Anbaugerät für Traktor]

BF300 ..... 07909-70701-1 (e,f)

BF300A·BF400 ..... 07909-70702-0 (e,f)

BF900 ..... 07909-60705-0 (e,f)

RC40-G(E)·RC40-GR·RC44-G(E) ..... 07909-70703-0 (e)
RC48-G·RC48-62-F·RC60-71H
RC60-71HR·RC60-72·RCB-60-1(E)
RC60-82H·RC60-27(E)

RC40-G(E)·RC40-GR·RC44-G(E) ..... 07909-70704-0 (f)
RC48-G·RC48-62-F·RC60-71H
RC60-71HR·RC60-72·RCB-60-1(E)
RC60-82H·RC60-27(E)

[Tiller, Power Tiller / Motoculteur / Einachsschlepper]

* T120·T320·T420 ..... 07909-70080-0 (e,f)
T420C·T620·T720

* T250·T350 ..... 07909-70081-0 (e,f)

T450·T550·T650·T750 ..... 07909-70082-0(e,f,d)
† GS130·GS160·GS200·GS280 ..... 07909-70074-2(e,f,d)
GN2900-H·GN4000-H

* AT25 ..... 07909-60601-0 (e)

* AT25 ..... 07909-60607-0 (f)

* AT55 ..... 07909-60602-0 (e)

* AT55 ..... 07909-60608-0 (f)

* AT70S ..... 07909-60603-0 (e)

* AT60·AT70SE ..... 07909-60605-0 (e)

* AT60·AT70S·AT70SE ..... 07909-60609-0 (f)

* TF40·TF45·TF55 ..... 07909-60604-0 (f)

* AD70 ..... 07909-60610-0 (e)

* TF65·TF75 ..... 07909-60611-0(e,f,d)

K75M·K75R·K80M ..... 07909-70100-0 (e)
K80MB·K80R
† GA·ER·KND·ET·EA SERIES ..... 07909-70090-3 (e)

[Front Mower / Tondeuse Avant / Aufsitz-Sichelmäher]

* F2000 ..... 07909-60343-1 (e)

* F2000 ..... 07909-60346-0 (f)

[Lawn Tractor, Riding Mower / Tondeuse autoportée / Rasentraktor]

* T1400·T1400H ..... 07909-60347-0 (e)

* T1400·T1400H ..... 07909-60348-0 (e)

* T1400·T1400H ..... 07909-60349-0 (f)

[Walk Behind Mower / Tondeuse poussée autotractée / Benzin Rasenmäher]

* W4019·W4021 ..... 07909-60613-0(e,f,d)

[Combine / Moissonneuse-batteuse / Kombinieren]

RX2750 ..... 07909-60175-0 (e)
† V1100-B·VH1100-B·V1200-B ..... 07909-70107-3(e,f,d)

[Reaper / Moissonneuse / Ablegemäher]

AR120 ..... 07909-60606-0 (e)
† GS130·GS160·GS200·GS280 ..... 07909-70074-2(e,f,d)
GN2900-H·GN4000-H

[Rice Transplanter / Planteuse à riz / Pflanzgerät]

NSR85 ..... 07909-60612-0 (e)
† GS130·GS160·GS200·GS280 ..... 07909-70074-2(e,f,d)
GN2900-H·GN4000-H

[Generator / Générateur / Stromerzeuger]

* A450(A400)·A1000(A800) A1400(A1200)·A2100(A1800) A3000(A2500)·A3500(A3050) 07909-70118-1 (e,f)

* A4300(B)·A5000(B) 07909-60130-1 (e)

* A4300-3-220-FR A4300B-3-220-FR 07909-60134-0 (f)

* A3700K(B) 07909-60135-0 (e)

* A3700K(B) 07909-60136-0 (a)

* A500(U.S.A.) A650(U.S.A.) 07909-60137-0 (e)

* A4300·A4300(B) 07909-60143-0 (c)

* A2200(U.S.A.) A2200X(U.S.A) 07909-60144-0 (e)

* A3000(U.S.A.) A3200·A3200X(U.S.A.) A3500·A3500X(U.S.A.) 07909-60145-0 (e)

* A800-3·A1200-3 07909-60148-0 (c)

* A1200KS·A1200K·A1800K A2500K·A3050K 07909-60150-0 (e)

* A2500KB·A3050KB 07909-60152-0 (e)

* ASK SERIES 07909-60138-0 (e)

* ASK-G120·ASK-G130·ASK-G150 ASK-G165·ASK-G180·ASK-G335 ASK-G350·ASK-G380·ASK-G3100 07909-60139-0 (a)

* ASK-3100GV-50-B-4-R ASK-3150-50-B-4-R 07909-60170-0 (e,f)

* ASK-G125-50-4-R 07909-60173-0 (e,f)

* ASK-G350-50-B-4-R 07909-60174-0 (e,f)

* AE SERIES 07909-60188-0 (e)

* ASK-R SERIES 07909-60189-0 (e)

G-3100S 07909-70123-0 (e)

† D650-B·D750-B·D850-B DH850-B·D950-B 07909-70076-6(e,f,d)

G-8500SD 07909-70125-0 (e)

† D650-B·D750-B·D850-B DH850-B·D950-B 07909-70076-6(e,f,d)

* G5500S 07909-60149-0 (e)

* GV-3150-50-B GV-3170-60-B 07909-60141-1 (e)

* GV-3150-50-B GV-3170-60-B 07909-60142-0 (a)

* GV-3120-60-B(U.S.A.) GV-3170-60-B 07909-60159-1 (e)

* GV-3200-50-B GV-3240-60-B 07909-60183-0 (e)

* NA500-3J(-3Y)(STANDARD) NA600-3J(-3Y)(STANDARD) 07909-60153-0 (e)

* NA500·NA600 07909-60151-0 (c)

* NA500-3Y-SA-2(-SA-110-2) NA600-3Y-SA-2(-SA-110-2) 07909-60157-0 (e)

* NA500-3J-KTE NA600-3J-KTE 07909-60171-0 (f)

* NA500-3J(GER)·NA600-3J(GER) 07909-60179-0 (d)

* NA1900-3(FR)·NA1900X-3(FR) 07909-60154-0 (f)

* NA1900-3(-3-H2)(STANDARD) 07909-60155-0 (e)

* NA2600-3(-3-H2)(STANDARD) NA3050-3(-3-H2)(STANDARD) 07909-60156-0 (e)

* NA2600-3(FR) NA3050-3(FR) 07909-60177-0 (f)

* NA2600-X-3(GER)·NA3050-X-3(GER) 07909-60178-0 (d)

* F270S 07909-60701-0 (r)

[Welder / Machine à souder / Schweißer]

* FS-200(B)·FS-250(B) 07909-60146-1 (e)

* ES-150 07909-60147-0 (e)

* F-270·F-330 07909-60160-0 (e)

* F-230 07909-60166-0 (e)

[Pump / Pompe / Pumpe]

KGP SERIES·KDP SERIES KDP-S SERIES·KTP SERIES 07909-70111-2 (e)

† GS130·GS160·GS200·GS280 GN2900-H·GN4000-H 07909-70074-2(e,f,d)

† GA·ER·KND·ET·EA SERIES 07909-70090-3 (e)

SERIES KGP·SERIES KDP 07909-70124-0 (f)

SERIES KDP-S·SERIES KTP

† GS130·GS160·GS200·GS280 GN2900-H·GN4000-H 07909-70074-2(e,f,d)

† GA·ER·KND·ET·EA SERIES 07909-70090-3 (e)

* KGP-D30 07909-60140-1 (e)

* KHP-2000·KHP-3000 07909-60131-0 (e)

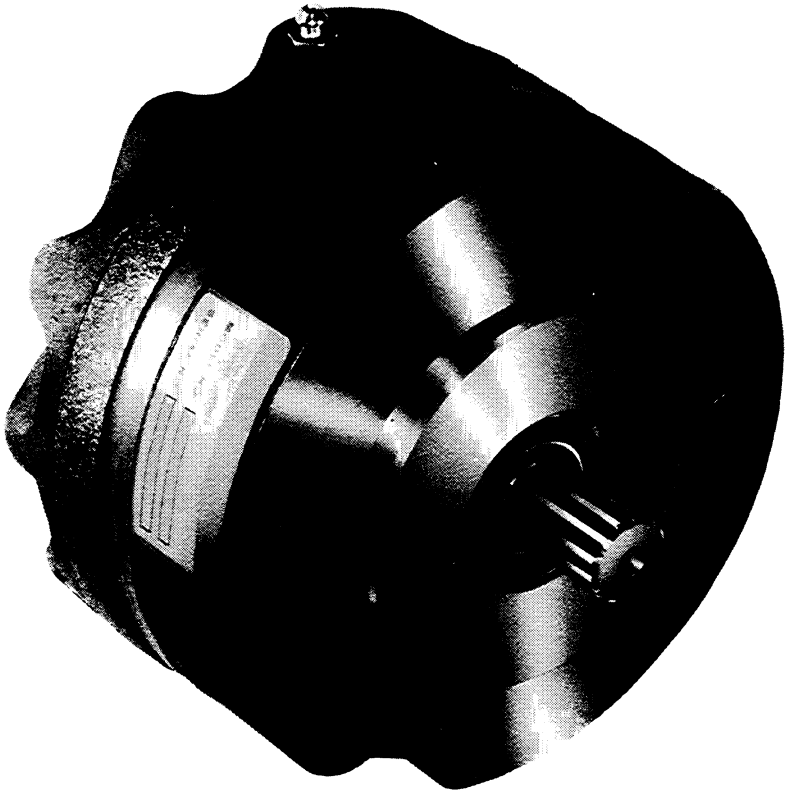
* KHP-1300 07909-60161-0 (e)

* GK SERIES·GKT SERIES MSK SERIES·DK SERIES 07909-60182-0 (e)

* KZP-20·KZP-201·KZP-30 07909-60186-0 (e)

Modular
MULTIPLE DISC BRAKE
(SAE B size)

SERVICE MANUAL



MICO INCORPORATED
1911 Lee Boulevard / P.O. Box 2118
North Mankato, Minnesota U.S.A. 56002-2118
Telex: 910-565-2444(MICO INC)
Fax: (507) 625-3212 / Phone: (507) 625-6426

MICO WEST DIVISION
701 East Francis Street / P.O. Box 9058
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Fax: (714) 947-6054
Phone: (714) 947-4077

Form No. 81-950-051 7/89

Printed in U.S.A.

TYPICAL BRAKE

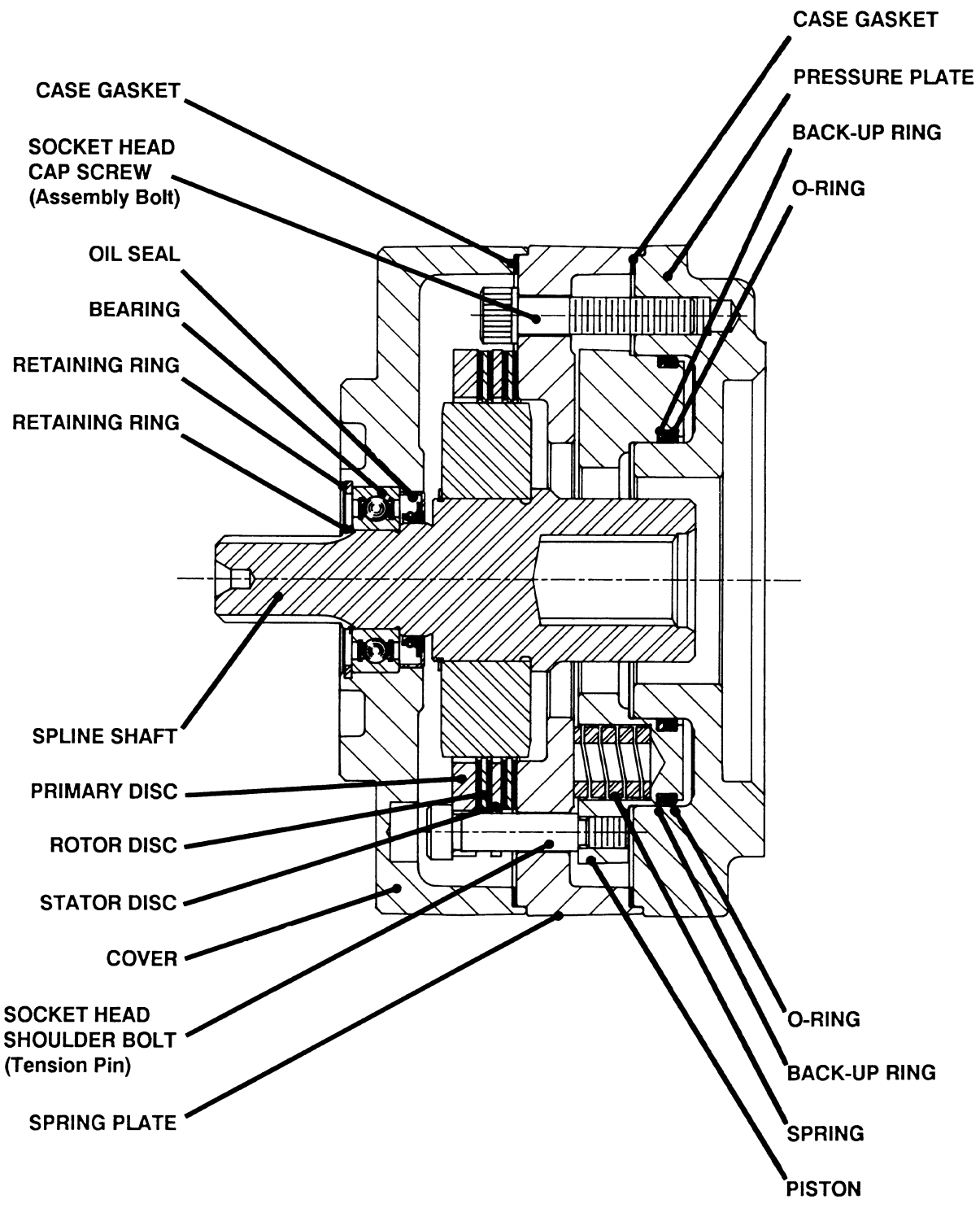


FIGURE 1

PRINCIPLES OF OPERATION

These brakes are spring-set, hydraulically released, multi-disc brakes. They are used primarily for holding loads, vehicles, conveyors, etc. in place when the hydraulic drive system is shut down or fails. Although the brakes are rated at 3000 psi they only require from 120 psi to 370 psi to make them function normally. The exact pressure required for operation is dependent upon the number of springs used to generate the torque necessary to hold the designed load. Thus, a brake with a full compliment of springs, will generate the highest level of torque and require approximately 370 psi to fully release the brake and provide adequate running clearance for the individual discs. A brake with 1/2 of the full spring compliment will have 1/2 as much torque and will require only 120 psi to fully release the brake. Consult catalog to choose the torque which best suits your design parameters.

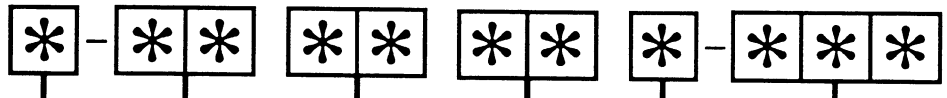
It is very important to remember that any pressure on the brake's release piston will directly effect the level of torque.

Two application examples:

1. The brake has a release pressure of 200 psi. The actuation pressure is provided by a charge pump. During certain phases of the machine's operation, the charge pump pressure dips from 200 psi to 100 psi. At 200 psi, the brake runs free (zero torque) but at 100 psi the brake will generate slightly less than half of its rated torque. The brake will drag - failure may occur. In this case, a brake should be selected which has a lower release pressure.
2. A brake has a release pressure of 200 psi. The system is set up to hold a load when a variable pump is shifted into neutral. Everything is running fine until the filter clogs, causing a build-up of back pressure in the return line to the tank. At a pressure of 60 psi, the brake will lose 25% of its holding torque; thus the load may slip. The situation can be corrected by replacing the filter or adding an extra margin of safety to your required brake torque in the initial design.

These brakes are designed to give thousands of trouble-free hours of service when set up correctly in the hydraulic circuit.

DESCRIPTION OF MODEL NUMBERS



OUTPUT FACE
B - SAE B-Mount 2-Bolt

OUTPUT SPLINE
13 - 13T 16/32
06 - 1.0 Dia. 6B
25 - 1.25 Dia. Keyed
10 - 1.0 Dia. Keyed
14 - 14T 12/24
15 - 15T 16/32

INPUT SPLINE
13 - 13T 16/32
06 - 1.0 Dia. 6B
25 - 1.25 Dia.6B Keyed
10 - 1.00 Dia. Keyed
14 - 14T 12/24
15 - 15T 16/32
12 - 12T 12/24
Used with L2 Input Face only
00 - Used with R Input Face only

TORQUE

1 psi = .06895 bar

Code	Standard (lbs. in.)	High (lbs. in.)	Initial Release Pressure (psi)	Full Release Pressure (psi)
90 *		9000	300	370
70 *		7000	250	300
56 *		5600	190	230
48 *		4800	150	180
40		4000 +	190	220
28	2800		190	220
35		3500 +	150	180
24	2400		150	180
29		2900 +	135	165
19	1900		135	165
25		2500 +	120	150
16	1600		120	150
18		1800 +	100	120
12	1200		100	120

OPTIONS
(Available separately or in combination)
D - Double Bearing
Z - Oil Cooled*
S - Speed Sensor - specified torque models only +
OS - Offset Bolt Pattern

INPUT FACE
B - SAE B-Mount 2-Bolt
M - MAB 4-Bolt and SAE A-Mount 2-Bolt
L2 - Char-Lynn Bearingless 2000
R - Closed
BOS - SAE B-Mount 2-Bolt offset

*** NOTE: On oil cooled models (Z - option) actual torque is 67% of value shown on torque code chart.**

DISASSEMBLY

1. Remove 2 flat head assembly bolts (1) and o-rings (2). A suitable holding fixture is useful to keep brake in position.
2. Tap female end of spline shaft assembly (9) and spring plate (15) with soft mallet to separate cover. If sections will not separate, use a screwdriver to carefully pry sections apart.
3. Remove case gasket (8) from cover (7).
4. Remove retaining ring (3) from spline shaft assembly (9).
5. Remove spline shaft assembly (9) from cover (7) by tapping male end of spline shaft assembly with soft mallet.
6. Remove retaining ring (4) from cover (7) and press out oil seal (6) and bearing (5) if required.
7. Remove four socket head shoulder bolts (11). A suitable holding fixture is useful to hold brake in position.

   CAUTION: Do not remove shoulder bolts without pressurization of brake (approx. 200 psi) or damage may result.

8. Remove primary disc (12), rotor discs (13) and stator discs (14).
9. Remove 2 socket head cap screws (10).
10. Remove spring plate (15).
11. Remove case gasket (8) from spring plate (15).
12. Before removing springs (16), note pattern and color for reassembly purposes.
13. Remove piston (17) by carefully exerting hydraulic pressure through brake release port on pressure plate (22).
14. Remove outside and inside o-rings (19 & 21) and outside and inside back-up rings (18 & 20) from piston (17).

    CAUTION: Care must be taken so as not to scratch or mar piston.

ASSEMBLY

LUBRICATE ALL RUBBER COMPONENTS FROM REPAIR KIT WITH CLEAN TYPE FLUID USED IN THE SYSTEM.

1. Clean all parts thoroughly before assembling.
2. Press oil seal (6) into bore until it is flush with bearing shoulder.
   DRY DESIGN BRAKE; oil seal (6) must be installed with open side facing pilot end of cover (7).
   LIQUID COOLED BRAKE; oil seal (6) must be installed with closed side facing pilot end of cover (7). Note direction of seal for Liquid Cooled Brakes
3. Press bearing (5) into position until it bottoms out on oil seal borestep.
4. Install retaining ring (4) into cover (7).
5. Press spline shaft assembly (9) into bearing (5) until shaft bottoms on shaft shoulder. Bearing inner race must be supported during this operation.
6. Install retaining ring (3) on spline shaft assembly (9).
7. Install back-up rings (18 & 20) on piston (17) toward spring pockets.
8. Install o-rings (19 & 21) on piston (17). Be sure o-rings are flat and all twists removed.

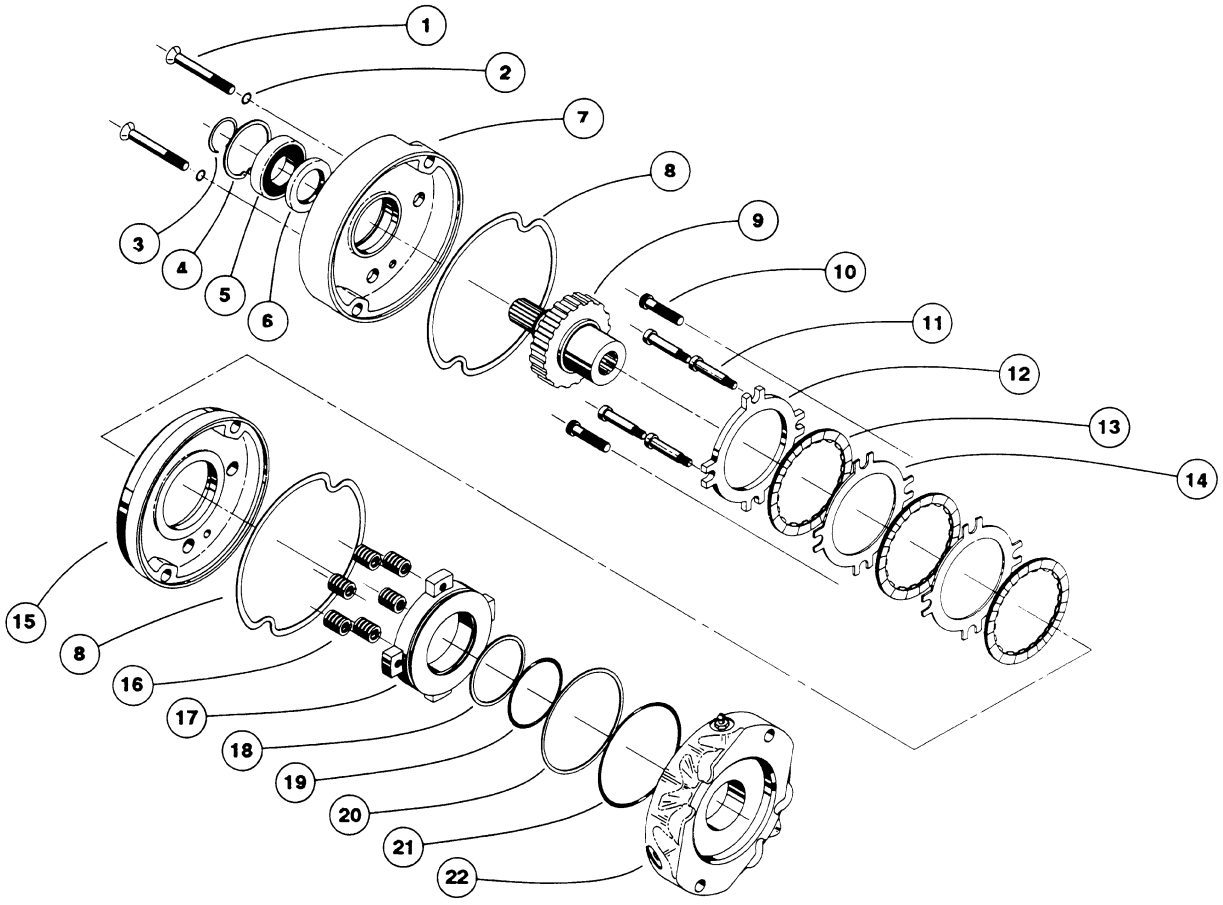
   CAUTION: Care must be taken so as not to scratch or mar piston.

9. Lubricate piston (17) with type fluid used in the system. Carefully press piston into pressure plate (22). Be sure piston is aligned correctly at all times and that there are no extrusions. Press piston until it bottoms on pressure plate (22).
10. Install springs (16) according to pattern and color noted during disassembly. Different colored springs must be alternated.
11. Affix case gaskets (8) to cover (7) and spring plate (15).
12. Place unit on a press. Using fixture, depress and install two socket head assembly bolts (10). **SEE NOTE BELOW.** Torque bolts to 40 ft. lbs. A suitable holding fixture is useful to hold brake in positon.
13. Install stator discs (14) and rotor discs (13). Begin with a rotor disc (13) and alternate with stator discs (14). For high torque models with 4 rotors and 4 stators the last stator should be assembled next to the primary disc (12).
14. Install primary disc (12).
15. Align discs and partially screw in four socket head shoulder bolts (10). **SEE NOTE BELOW.** Inspect for free movement of stack. Pressurize brake release port (approx. 200 psi) to release discs. Torque shoulder bolts to 15 ft. lbs. and release pressure. A suitable holding fixture is useful to hold brake in position.
16. Install cover (7) using flat head assembly bolts (1) and two o-rings (2). **SEE NOTE BELOW.** Torque bolts to 40 ft. lbs.

NOTE: Bolts should have one or two drops of Henkel Omnifit #1550 or Loctite #609 applied to threads.

FOR REPAIR KIT INFORMATION REFER TO PAGE 7.

FIGURE 2 **TYPICAL MODEL SHOWN**



PARTS LIST

ITEM	DESCRIPTION
1	FLAT HEAD ASSEMBLY BOLTS (2)
2	O-RING (2)
3	RETAINING RING
4	RETAINING RING
5	BEARING
6	OIL SEAL
7	COVER
8	CASE GASKETS (2)
9	SPLINE SHAFT ASSEMBLY
10	SOCKET HEAD CAP SCREWS (2) (Assembly Bolts)
11	SOCKET HEAD SHOULDER BOLTS (4) (Tension Pins)

ITEM	DESCRIPTION
12	PRIMARY DISC
13	ROTOR DISCS
14	STATOR DISCS
15	SPRING PLATE
16	SPRINGS
17	PISTON
18	BACK-UP RING
19	O-RING
20	BACK-UP RING
21	O-RING
22	PRESSURE PLATE

BLEEDING

1. Install brake in system and connect pressure lines.
2. Bleed pressure release section of brake by pressurizing side inlet port and allowing air to escape from top port. Pressure should not exceed 100 psi during bleeding.
3. Apply sufficient pressure to release brake and check for proper operation in system.

SERVICE DIAGNOSIS

PROBLEM	CAUSE	EXPLANATION	ACTION
Brake slips	A. Excessive pressure in hydraulic system	If there is back pressure in the actuation line of the brake, holding torque will be reduced.	Check filters, hose size, restrictions in other hydraulic components.
	B. Oil in brake if designed for dry use	Wet linings generate 67% of the dry torque rating. If the brake has oil in it, check the type of oil hydraulic or gearbox. 1. Gearbox oil 2. Hydraulic oil	Replace oil seal in brake Check motor seal Check piston seals Note: Internal components will need to be inspected, cleaned and replaced as required.
	C. Disc plates worn	The thickness of the disc stack sets the torque level. A thin stack reduces torque.	Check disc thickness
	D. Springs broken or have taken a permanent set	Broken or set springs can cause reduced torque - a rare occurrence.	Check release pressure (See spring replacement)
Brake drags or runs hot	A. Low actuation pressure	The brake should be pressurized to minimum of 20 psi over the full release pressure under normal operating conditions. Lower pressures will cause the brake to drag thus generating heat.	Place pressure gauge in bleed port & check pressure with system on
	B. Bearing failure	If the bearing should fail, a large amount of drag can be generated.	Replace bearing
	C. Oil in brake	Excess fill of oil in sump condition thru wet brakes can cause the unit to run hot. Also excessive rpm in sump condition.	Drain oil and refill as specified for brakes or Switch to flow thru cooling.
Brake will not release	A. Stuck or clogged valve	Brakes are designed to come on when system pressure drops below stated release pressure. If pressure cannot get to brake, the brake will not release.	Place pressure gauge in bleed port - check for adequate pressure - Replace defective line or component
	B. Bad o-rings	If release piston will not hold pressure, brake will not release.	Replace o-rings
	C. Discs frozen	These brakes are designed for only limited dynamic braking. A severe emergency stop or prolonged reduced release pressure operation may result in this type of damage.	Replace disc stack

REPAIR KITS
(Refer to Page 5 for item numbers)

NUMBER	DESCRIPTION	INCLUDES
12-501-058	O-ring and Back-up Ring Kit	Case Gaskets (8) Back-up Rings (18 & 20) O-rings (19 & 21) O-rings (2) Loctite
12-501-060	High Torque Lining Kit	Case Gaskets (8) Primary Disc (12) Stator Discs (14) Rotor Discs (13) O-rings (2) Loctite
12-501-062 (Use with 13 & 15 Code Shafts)	Bearing Kit	Case Gaskets (8) Oil Seal (6) Bearing (5) O-rings (2) Loctite
12-501-064	Spring Kit	Case Gaskets (8) Springs - red (16) Springs - blue (16) O-rings (2) Loctite
12-501-090	Standard Lining Kit	Case Gaskets (8) Primary Disc (12) Stator Discs (14) Rotor Discs (13) O-rings (2) Loctite
12-501-228 (Use with 48, 56, 70 and 90 Torque Codes)	High Torque Lining Kit	Case Gaskets (8) Primary Disc (12) Stator Discs (14) Rotor Discs (13) O-rings (2) Loctite
12-501-229 (Use with 06, 10 and 25 Code Shafts)	Bearing Kit	Case Gaskets (8) Oil Seal (6) Bearing (5) O-rings (2) Loctite
12-501-230 (Use with 14 Code Shafts)	Bearing Kit	Case Gaskets (8) Oil Seal (6) Bearing (5) O-rings (2) Loctite

NOTE: All repair kits include mounting face gaskets and o-rings.

110 Series

Service and Parts List

High Torque, Low Speed Hydraulic Motor with Thru-Shaft Option

The 110 Series High Torque Low Speed (HTLS) hydraulic orbit motors are designed to provide long life while operating with limited radial load. Refer to catalog radial load limits. However, should maintenance be required, the instructions below should be used for disassembly, replacement of parts, cleaning and assembly.

Note: Prior to any motor disassembly, plug the open ports and clean all dirt from the outside of the motor. Prior to assembly lightly oil all seals, the rollers and the threaded bolt ends.

Part I—Installation Requirements

1. The motor may be mounted in any secure position.
2. If the system minimum downstream pressure exceeds 1000 psi on a continuous basis, the external case drain (9) should be vented to a low pressure area.
3. The standard motor seals are suitable for use with petroleum base oils. Consult the factory for use with other fluids.
4. A minimum of 25 micron filtration with B ratio of 2 is recommended.
5. For maximum system pressure refer to catalog.
6. Shaft may not turn freely after assembly. A short running break in period may be required.

Part II—Motor Disassembly

A. Disassembly of Cover Section of Motor

1. Remove the key (11) from the shaft if there is a key.
2. Mount the motor in a vise or other holding device with the shaft facing down.
3. Remove the eight 5/16-24 bolts (10). If motor has bolt washers, remove and discard them.
4. Remove the cover/bearing assembly (17) or (18) and the square ring (8).
5. Remove the IGR set components (6) starting with the outer locating ring and rollers. Note that the innermost IGR component and rotary valve (4) are retained on the shaft by the snap ring (7). Do **not** remove this snap ring.
6. Remove the two check valve balls (5). Note that the check balls may fall into the body tapped holes or into the body valve ports during disassembly. Be sure that the check balls are removed.
7. Remove the shaft (12) or (13), the IGR inner element, and the rotary valve (4) as one assembly.
8. With the shaft assembly removed from the body, inspect the IGR inner component, the rotary valve (4), and the shaft (12) or (13) for wear or other damage. The shaft should have smooth polished surfaces in the bearing and seal areas. If any of these components are damaged, the snap ring (7) must be removed and the appropriate components replaced. If the snap ring (7) is removed, **discard** it.
9. Check IGR tip clearance. Replace the IGR assembly if the clearance between the inner-most rolls and outer contour exceeds .010 inches.

B. Main Shaft Seal Replacement

1. If the motor body shaft seal has shown signs of leakage during operation, the quad ring seal (3) and back-up ring (2) must be replaced with the motor completely disassembled per Part II, Section A above.
2. The quad ring seal (3) and the back-up ring (2) can be removed using a dull pointed object such as a pencil point or the end of a paperclip. Do **not** use a sharp object such as a knife because the sealing surface in the body or cover can be damaged.
3. With the old quad ring seal and back-up ring removed, install a new back-up ring first and push it against the sealing surface toward the outside of the motor. The back-up ring can be seated with a dull object.
4. Next install the new quad ring seal on the inboard side of the back-up ring and push it against the back-up ring.
5. Lubricate the inside diameter of the quad ring and back-up ring with oil.

C. Thru Cover Shaft Seal Replacement

1. If the motor body thru cover shaft seal has shown signs of leakage during operation, the seals must be replaced with the motor completely disassembled per Part II, Section A above.
2. The lip seal (19) can be removed using a dull pointed object such as a pencil point or the end of a paperclip. Do **not** use a sharp object such as a knife because the sealing surface in the cover can be damaged. **Note:** models pre-January 1, 1986, Serial Number A6 and earlier, contain quad rings and back-up rings.

Parker

3. With the old seal removed, install the new lip seal into the bore with the rubber lips facing the inboard side (the flat seal back against the bore floor). **Note:** models pre-January 1986, Serial Number A6 and earlier, require quad rings and back-up rings as the replacement seals (see Note 3, page 3). Install the back-up ring into the cover bore and push it against the sealing surface toward the outside of the motor. Put the quad ring in next on the inboard side of the back-up ring and push it against the back-up ring.
4. Press the dust seal into the bore on the outboard side of the cover. Make sure that the rubber lips are facing the outside of the motor. The dust seal's back should be flush with the bottom of the bore.
5. Lubricate the inside diameter of the seals with oil.

Part III—Motor Assembly

A. Shaft, IGR Inner, and Rotary Valve Assembly

1. If the shaft assembly has been disassembled intact according to Part II, Section A, step 7; proceed to Part III, Section B.
2. Place the rotary valve (4) on the shaft spline with the "T" shaped slots on first.
3. Next put the IGR inner member on the shaft spline with the semi-circular roll pockets between the rotary valve ports.
4. Now install the new snap ring (7) which holds the inner and valve on the shaft. Be sure not to over-extend the snap ring during assembly. The snap ring should be snug in the groove when finally assembled.

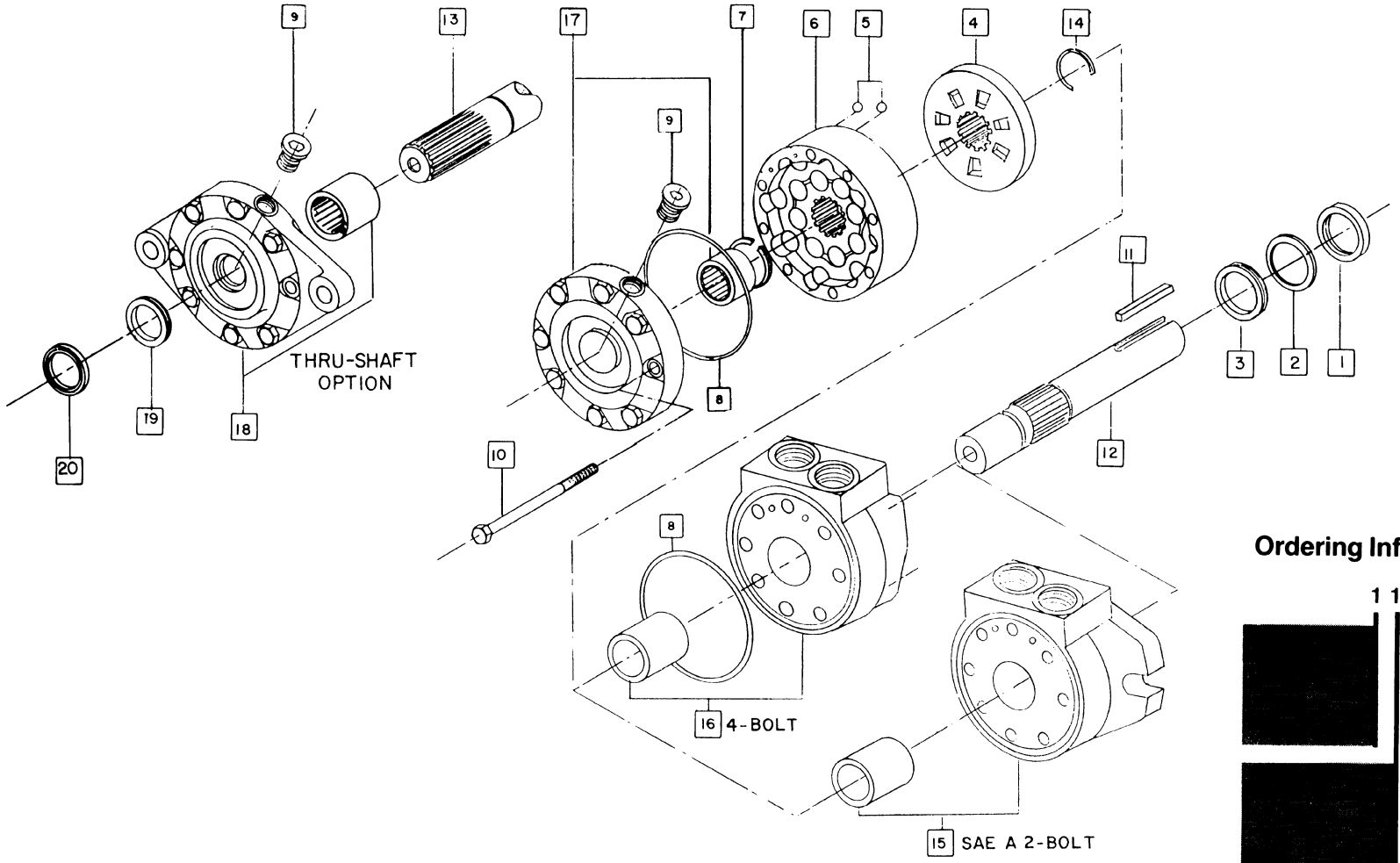
B. Assembly of Complete Motor

1. Prior to assembly, all parts must be cleaned with a suitable solvent and be free of nicks and burrs.
2. Mount the body with the pilot and bearing down in a vise or other holding mechanism.
3. Check the output shaft end for burrs and scratches, especially on a used keyed shaft. De-burr if necessary. The shaft end must be free of burrs because it slides through the quad ring and can cut it. Install the shaft assembly into the body.
4. Place the contour member of the IGR over the inner and insert the seven rolls into the inner pockets (larger in diameter than the eight rollers).
5. Lightly oil the square ring seal (8) and place in the body groove.
6. Place the check balls (5) over the two ⅛ inch diameter holes in the body. Be sure the check balls do not fall into the tapped holes.
7. Place the locating ring section (4.5 inch diameter) of the IGR (6) onto the body with the check ball holes facing downward over the balls. Align the eight bolt holes in the locating ring with the eight holes in the body. The holes align in only one position.

   Note: Be sure not to dislodge the body square ring seal while moving the locating ring.
8. Install the eight locating ring rollers into their pockets and oil lightly.
9. Place the other lightly oiled square ring seal (8) into the groove in the cover and place the cover over the shaft end and align the bolt holes.
10. If the motor had bolt washers, install the bolts with new washers, Part #1047. Install the eight bolts with lightly oiled thread ends into the bolt holes. Tighten diagonally to 15 lbs. ft. Turn the shaft by hand through several rotations. Increase the torque of each bolt by 5 lbs. ft. in a diagonal pattern. Turn the shaft by hand through several rotations. Repeat this procedure until the torque of each bolt has reached 27 lbs. ft.

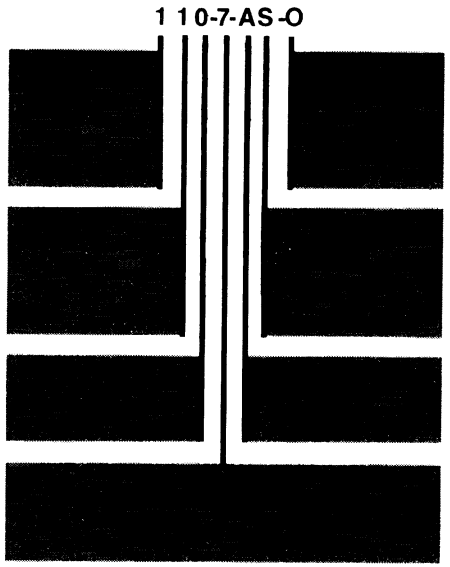
Parker Hannifin Corporation
Gray Division
Box 900, Gray, ME 04039 (207) 657-3343
Telex: 9102407421 FAX: (207) 657-2498

12/88 5M



Ordering Information

1 10-7-AS-O



Item	Part No.	Part Description	Model No.	Quantity Per Motor
1	1061	Dust Seal 1.0	All Models	1
2	1142-14	Back Up Ring 1.0		1
3	1062-15	Quad Ring Seal 1.0		1
4	1007	Rotary Valve 7110		1
5	1021	Check Valve Ball .25		2
6	1004-1	IGR Assembly W/Ring 7110-3.6 cu. in./rev.		1
	1004-2	IGR Assembly W/Ring 7110-5.4 cu. in./rev.		1
	1004-3	IGR Assembly W/Ring 7110-7.1 cu. in./rev.		1
	1004-4	IGR Assembly W/Ring 7110-8.8 cu. in./rev.		1
	1004-5	IGR Assembly W/Ring 7110-10.6 cu. in./rev.		1
	1004-6	IGR Assembly W/Ring 7110-12.9 cu. in./rev.		1
	1004-7	IGR Assembly W/Ring 7110-16.4 cu. in./rev.		1
7	1135	Snap Ring Shaft		1
	1296	Snap Ring Shaft[4]		
8	1046	Square Ring Seal 046		2
9	1019-4	Vent Plug W/O-Ring, 7/16		1
10	1114-X	Bolts, Hex 5/16-24, Displacements 1-5		8
	1014-2	Bolts, Hex 5/16-24, Displacement 6		
	1014-4	Bolts, Hex 5/16-24, Displacement 7		
11[5]	1020-1	Key, Straight .25 x 1.00	110-X-XX-X	1
	1655	Key, Woodruff .25x1.00	110-X-XX-X	1
12	1110-X	Shaft, Key Straight	110-X-XX-0	1
	1115-X	Shaft SAE 6B	111-X-XX-0	1
	1113-X	Shaft 13T Spline	116-X-XX-0	1
	1685	Shaft, Key Woodruff[6]	110-X-XX-0	1
13	1150-X	Shaft, Key Straight Thru	110-X-XX-1	1
	1152-X	Shaft SAE 6B Thru	111-X-XX-1	1
	1151-X	Shaft 13T Spline Thru	116-X-XX-1	1
	1758	Shaft, Key Woodruff Thru[6]	110-X-XX-1	1
14	1157	Snap Ring Valve (For Thru Shaft Only)	11X-X-XX-1	1
15[2]	M110B-1	Body/Bearing Assembly SAE 2 Bolt	11X-X-AS-X	1
	M110B-3	Body/Bearing Assembly SAE A 2 Bolt-Manifold	11X-X-AM-X	1
	M110B-5	Body/Bearing Assembly SAE A 2 Bolt-Pipe	11X-X-AP-X	1
	M110B-7	Body/Bearing Assembly SAE B 2 Bolt	11X-X-BS-X	1
	M110B-9	Body/Bearing Assembly SAE B 2 Bolt-Manifold	11X-X-BM-X	1
	M110B-10	Body/Bearing Assembly SAE B 2 Bolt-Pipe	11X-X-BP-X	1
16[2]	M110B-2	Body/Bearing Assembly 4 Bolt	11X-X-FS-X	1
	M110B-4	Body/Bearing Assembly 4 Bolt-Manifold	11X-X-FM-X	1
	M110B-6	Body/Bearing Assembly 4 Bolt-Pipe	11X-X-FP-X	1
17[2]	M110C-1	Cover/Bearing Assembly	XXX-X-XX-0	1
18[2]	M110C-2	Cover/Bearing Assembly Thru	XXX-X-XX-1	1
19[3]	1391	Lip Seal .875	XXX-X-XX-1	1
20	1141	Dust Seal .875		1
—	1158	Body Seal Kit	All Models	1
	1386	Body Seal Kit, Viton		1
—	1166	Cover Seal Kit (Thru)	Thru Shafts	1
	1387	Cover Seal Kit (Thru), Viton		1

NOTES:

[1]"X" in the Part No. refers to the displacement dash number which follows the Model Number on the nameplate, (i.e., 100-1-AS-0: X=1). The displacements are shown above under item #6.

[2]Body Assemblies (Items #15 and #16) and Cover Assemblies (Items #17 and #18) include respective bearings and seal components.

[3]Models pre-January 1, 1986 (S/N A6 and earlier) require quad ring P/N 1062-13 and back up ring P/N 1142-12 as replacements.

[4]Date codes Feb. '87 and later.

[5]Motors with date code L8 and later may have woodruff key.

[6]Date code L8 and later.

FIELD ADJUSTMENT INSTRUCTIONS

Proportional High Current
Dual Coil

Wire the Controller as shown in Figure 1.

Adjustments are provided to set Threshold current and Maximum Output current. By setting the following adjustments correctly you can obtain FULLY PROPORTIONAL VALVE CONTROL over the entire handle deflection.

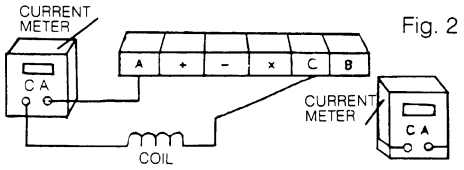


Fig. 2

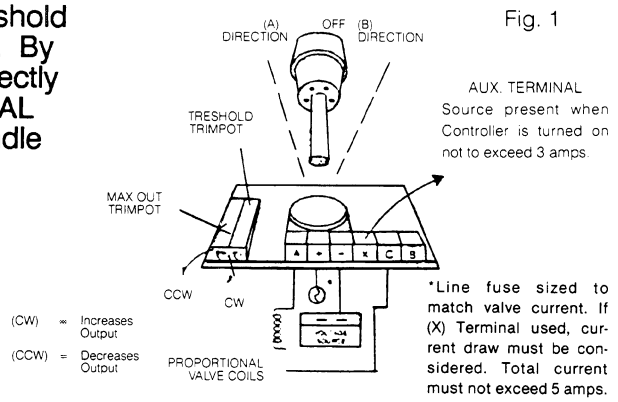


Fig. 1

A current averaging meter, such as the Beckman TECH 330, should be used to adjust "THRESHOLD" and "MAX OUT" to predetermined current levels. The meter must be in series with the valve coil. Refer to Figure 2.

"THRESHOLD" ADJUSTMENT

This adjusts Threshold current when the Controller first comes on. This should be done first. Deflect the handle approximately 1". Turn the "THRESHOLD" Trimpot screw (CW) until the function starts to respond, then turn the screw (CCW) one turn. This provides a smooth start. If the function starts to move too soon, turn the "THRESHOLD" adjustment (CCW). If more deadband is desired, continue to turn (CCW). By using a current meter as shown in Figure 2, a predetermined Threshold current can be obtained. (CW) increases current. (CCW) decreases current.

"MAX OUT" ADJUSTMENT

This adjusts the Maximum Output current when the Controller handle is fully deflected. The Controller is factory set to deliver full Valve Manufacturer's recommended output current at full handle deflection (unless otherwise requested). To adjust, deflect the handle fully. Turn the "MAX OUT" Trimpot (CCW) until the function begins to slow down. Now turn the Trimpot one to two turns (CW). If slower maximum function speed is desired, turn the "MAX OUT" adjustment (CCW) until the desired maximum function speed is obtained. By using a current meter as shown in Figure 2, a predetermined maximum current can be obtained. (CW) increases current. (CCW) decreases current. At the point the current stops increasing when the Trimpot is rotated (CW), the maximum current is obtained.

Important Notes

1. The TRIMPOTS ARE 15 TURN end to end devices . It may be necessary to turn the adjusting screw a number of turns (five or more) to observe a change in function response.

2. As a safety feature, when the Controller handle is returned to the center rest position, all electronics are turned off by the ON/OFF (S1) microswitch.

FIELD ADJUSTMENT INSTRUCTIONS

Proportional High Current
Single Coil

Wire the controller as shown in Fig. 1

Adjustments are provided to set Threshold current and Maximum Output current. By setting the following adjustments correctly you can obtain **FULLY PROPORTIONAL VALVE CONTROL** over the entire handle deflection.

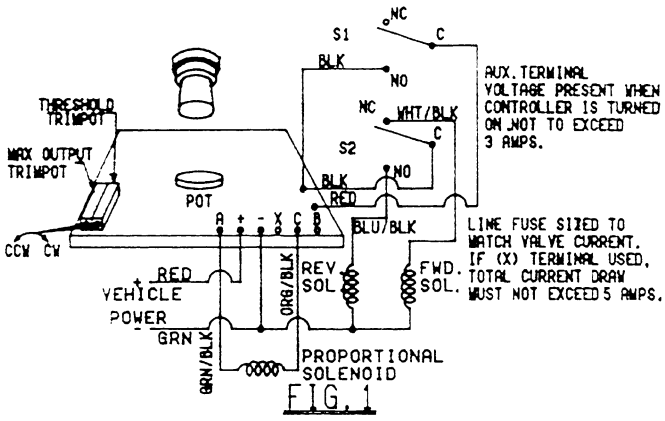


FIG. 1

"THRESHOLD" ADJUSTMENT

To be done first. This adjusts threshold current as the controller first turns on. Move the handle so the controller just turns on. Turn the "THRESHOLD" Trimpot screw clockwise until the function starts to respond, then turn the screw counter-clockwise one turn. This provides minimum dead band. If the function starts to move too soon when the handle is moved, turn the "THRESHOLD" adjustment further counter-clockwise.

"MAX-OUT" ADJUSTMENT

This adjusts the Maximum Output current (maximum output to that function) when the Controller handle is fully deflected. The controller is factory set to deliver full valve manufacturer's recommended output current at full handle deflection (unless otherwise requested). To adjust, deflect the handle fully in either direction. Turn the "MAX-OUT" Trimpot counter-clockwise until the function begins to slow down. Now turn the Trimpot one to two turns clockwise. If slower maximum function speed is desired, turn the "MAX-OUT" adjustment counter-clockwise until the desired maximum function speed is obtained. By using a current meter as shown in Figure 2, a predetermined maximum current can be set. Clockwise increases, counter-clockwise decreases current output.

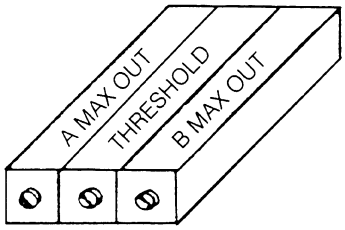
Important Notes

1. The TRIMPOTS require 15 turns to travel from end to end. It may be necessary to turn the adjusting screw a number of turns (five or more) before a change in the output is noticeable. A clutch mechanism in the pot prevents damage due to over-rotation.

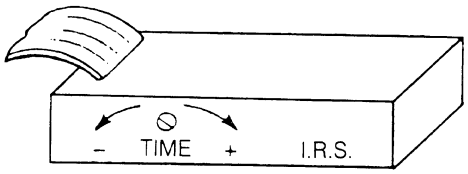
2. As a safety feature, when the controller handle is returned to the center rest position, all electronics are turned off by the "on/off (S1)" microswitch.

OPTIONS

"DUAL MAX" Threshold should be adjusted first.
Dual Max output allows for separate maximum output adjustments for each direction of handle deflection. "A MAX OUT" trimpot adjusts the current from Terminal "A" in respect to ground when the handle is deflected in the direction "A". "B MAX OUT" trimpot adjusts the current from Terminal "B" in respect to ground when the handle is deflected in the "B" direction.



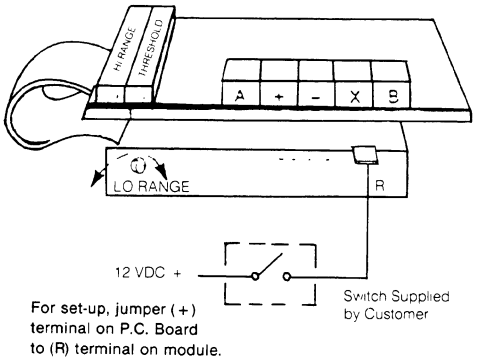
"IRS" (Integrated Ramp System)
An "IRS" is provided to smooth out function responses when reacting to an abrupt change in handle deflection. To slow the ramp speed, turn the adjusting screw "CW" one or two turns (Time +), then move the controller handle abruptly noting function response. If function response is too slow, turn the adjusting screw "CCW" (Time -). This adjustment should be made until the desired ramp speed is obtained.



"DUAL RANGE" Threshold should be adjusted first.
A separate module is provided to give two separate flow rates. When a 12/24VDC signal, supplied by the customers' remote contact switch, is present on Terminal "R" of the module, the maximum valve current and, therefore, output is limited by the "Hi Range" Trimpot. When the 12/24VDC signal is removed, the maximum valve current and output is limited by the "Lo Range" Trimpot.

HI RANGE ADJUSTMENT
Apply voltage to Terminal "R" by jumpering the (+) terminal on the controller Terminal Board to the "R" Terminal on the module. Deflect the handle fully and adjust the "HI RANGE" pot. Adjust for maximum desired function speed as described in "MAX OUT" Adjustments.

LO RANGE ADJUSTMENT
Remove the voltage signal on Terminal "R" of the module. Deflect the handle fully. Adjust the "LO RANGE" trimpot adjustment for desired "LO RANGE" speed. Refer to "MAXOUT" Adjustments. (The Lo-Range Adjustment is located on the Dual Range Module)



"DUAL MAX" AND "DUAL RANGE"
This is a combination of two features, "Dual Max" and "Dual Range". The only difference in set up is that the "Hi Range" adjustment is now the "A MAX OUT" adjustment when the handle is deflected in the direction of the "A" terminal; and the "B MAX OUT" adjustment when the handle is deflected in the direction of the "B" terminal.

TROUBLE SHOOTING PROCEDURES

Two (2) LED's (Light Emitting Diodes) are provided on the Circuit Board to use as diagnostic aides. When the Controller Lever is deflected in the direction of the "A" Terminal, the corresponding LED should light. When the Lever is deflected toward the "B" Terminal, that corresponding LED should light.

Problem	Possible Cause	Things to Check
1. Function will not operate when Handle is deflected.	1. No power to Controller.	1. If the LED's do not light when the Handle is deflected, check the following: a. Check supply (Battery Voltage) at Controller Terminals (+) and (-) using a V.O.M. Refer to Figure 1A. b. Check line fuse. Replace if needed.
	2. Defective ON/OFF Micro Switch (S1).	2. Check voltage at Aux. (X) Terminal with a V.O.M. Refer to Figure 1B. When the Handle is deflected approx. 1", supply voltage must be present at the (X) Terminal. If not, replace (S1).
	3. Output of Controller shorted to the ground	3. Remove coil wire from the "B" Terminal. Deflect Handle in the direction the "B" Terminal. If the corresponding LED lights, the Controller is functioning. The coil or associated wire is probably grounded. If voltage is present on Terminal "X" and LED's fail to light, replace the circuit board.
	4. Open circuit between Controller and coil.	4. If the LED's light, the Controller is functioning. Check for an open coil or open circuit between Controller and coil.
	5. Max Output Trimpot out of adjustment.	5. Refer to "Field Adjustment Instructions" for proper adjustment. Remember Trimpots are 15 turn end to end devices. Turn the Max Out Trimpot adjustment at least eight turns (CW). Refer to Figure 2.
2. Function jumps or lurches on turn on.	1. Threshold Trimpot out of adjustment.	1. Refer to "Field Adjustment Instructions". Be sure that Threshold Trimpot is turned 1 to 2 turns (CCW) after function just starts to move.
3. Function speed remains constant regardless of the degree of Handle deflection.	1. Trimpots out of adjustment.	1. Turn the Threshold Trimpot 15 turns (CCW); turn the Max Out Trimpot 15 turns (CW). 2. Refer to Field Adjustment Instruction for proper adjustments.

Fig. 1A

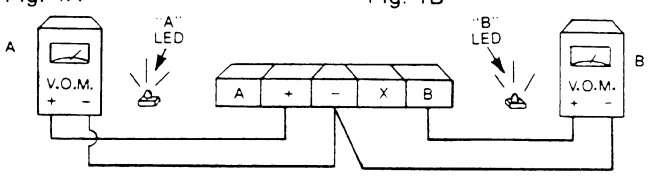
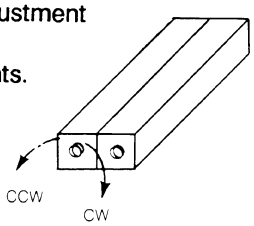


Fig. 1B

Fig. 2



OHM controls, inc.

OPTIONS

Dual Max

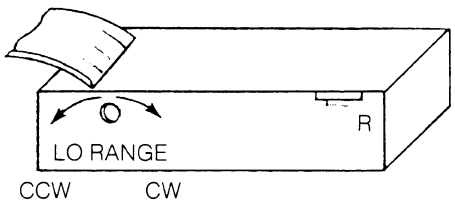
Trouble shoot the same as the standard U.F.O. on the reverse side of the page, except "A Max Out" Trimpot adjusts the maximum output current in respect to the "A" Terminal when the Handle is deflected in the direction of the "A" Terminal.

The "B Max Out" Trimpot adjusts the maximum output current in respect to the "B" Terminal when the Handle is deflected in the direction of the "B" Terminal.

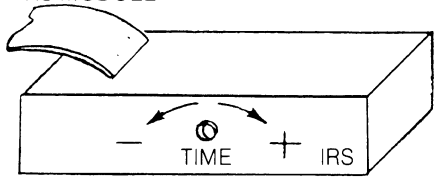
I.R.S.

Problem	Possible Cause	Things to Check
1. Function speed reacts too slow or too fast, in respect to Handle motion.	1. IRS module misadjusted	1. Refer to "Field Adjustment Instructions Options". The "Time +/-", Adjust is a 15 turn end to end device. Rotate the "Time +/-" Adjustment 15 turns (CCW). Deflect the Handle to full on. Note function response time. Release Handle. Now rotate the "Time +/-" Adjustment 15 turns (CW). Deflect the Handle to full on. There must be a noticeable change in function response time. If not, replace Circuit Board and I.R.S. module.
DUAL RANGE		
2. Controller will not switch between "Hi" and "Lo" Range.	1. 12/24VDC not switched ON and OFF at Terminal (R).	1. Place a V.O.M. ((-) or common) probe to (-) Terminal on the Circuit Board. The (+) lead on the V.O.M. to the wire coming from customer's Limit Switch. Actuate switch, 12/24VDC must be switched ON and OFF.
	2. "Hi" and "Lo" Range Trimpots out of adjustment.	2. Refer to "Field Adjustment Instructions" "Options", for proper adjustment. The "Hi" and "Lo" Range Trimpots are 15 turn end to end devices. It may be necessary to turn them 8 to 10 turns before the desired function response is observed.
	3. Damaged module	3. Rotate the "Hi" Range Trimpot 15 turns (CW). Rotate the "Lo" Range Trimpot 15 turns (CCW). When 12VDC is switched ON and OFF, a change in function response must be observed. If not, replace Circuit Board and module.

DUAL RANGE MODULE



IRS MODULE

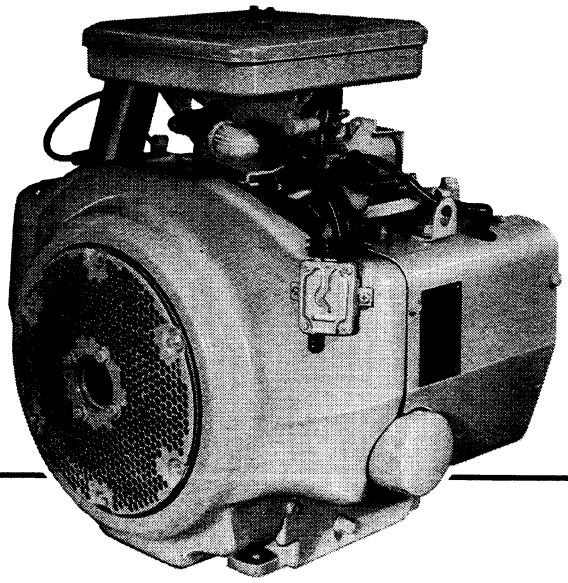


OEM controls, inc.

Onan

Operator's Manual

T-260G
Engine



965-0160
T-260G
10-88
Printed in U.S.A.

Safety Precautions

It is recommended that you read your engine manual and become thoroughly acquainted with your equipment before you start the engine.

⚠DANGER ***This symbol if used warns of immediate hazards which will result in severe personal injury or death.***

⚠WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that can result in serious, personal injury. Take care in following these recommended procedures. All local, state and federal codes should be consulted and complied with.

⚠WARNING ***This engine is not designed or intended for use in any type of aircraft. Use of this engine in aircraft can result in engine failure and causes serious personal injury or death.***

General

- Provide appropriate fire extinguishers and install them in convenient locations. Use an extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the engine are secure and accurately torqued. Keep guards in position over fans, driving belts, etc.
- If it is necessary to make adjustments while the engine is running, use extreme caution when close to hot exhausts, moving parts, etc.

Protect Against Moving Parts

- Do not wear loose clothing in the vicinity of moving parts, such as PTO shafts, flywheels, blowers, couplings, fans, belts, etc.
- Keep your hands away from moving parts.

Batteries

- Before starting work on the engine, disconnect batteries to prevent inadvertent starting of the engine.
- DO NOT SMOKE while servicing batteries. Lead acid batteries give off a highly explosive hydrogen gas which can be ignited by flame, electrical arcing or by smoking.
- Verify battery polarity before connecting battery cables. Connect negative cable last.

Fuel System

- DO NOT fill fuel tanks while engine is running.
- DO NOT smoke or use an open flame in the vicinity of the engine or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping for flexible lines as copper will work harden and become brittle enough to break.
- Be sure all fuel supplies have a positive shutoff valve.

Exhaust System

- Exhaust products of any internal combustion engine are toxic and can cause injury, or death if inhaled. All engine applications, especially those within a confined area, should be equipped with an exhaust system to discharge gases to the outside atmosphere.
- Do not use exhaust gases to heat a compartment.
- Make sure that your exhaust system is free of leaks. Ensure that exhaust manifolds are secure and are not warped by bolts unevenly torqued.

Exhaust Gas is Deadly!

Exhaust gases contain carbon monoxide, a poisonous gas that can cause unconsciousness and death. It is an odorless and colorless gas formed during combustion of hydrocarbon fuels. Symptoms of carbon monoxide poisoning are:

- Dizziness
- Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

If you experience any of these symptoms, get out into fresh air immediately, shut down the unit and do not use until it has been inspected.

The best protection against carbon monoxide inhalation is proper installation and regular, frequent inspections of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

Cooling System

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator pressure cap when coolant temperature is above 212°F (100°C) or while engine is running.

Keep the Unit and Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and present a potential fire hazard.

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⚠WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS CAN RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

Introduction

KNOW YOUR ENGINE

Read this manual carefully, observing all *WARNINGS* and *CAUTIONS*. Operating instructions, adjustments and periodic maintenance procedures are given so you . . . the owner, can keep your unit running like new and expect many years of dependable service from it. Remember . . . any machine, regardless of design or type, will perform only in relation to the service it receives. Regularly scheduled maintenance lowers operating costs.

ENGINE MODEL REFERENCE

Identify your model by referring to the *MODEL* and *SPEC* (specification) *NO.* as shown on the unit nameplate. Always use this number and the engine serial number when making reference to your engine.

If a major repair or an overhaul is necessary, Onan recommends that a competent mechanic either do the job or supervise and check the work of the mechanic assigned to do the job to ensure that all dimensions, clearances and torque values are within the specified tolerances.

An engine service manual and complete parts catalog are available at additional cost. Contact your nearest authorized dealer or Onan Parts and Service Center.

REFERENCE MANUALS

Parts Catalog	965-0260
Major Service Manual	965-0760

This manual contains the SI metric equivalents following immediately in parentheses after the U.S. customary units of measure.

SPECIFICATIONS

Engine Design	Opposed two cylinder, four cycle, and air cooled
Bore	3.56 inch (90.48 mm)
Stroke	3.0 inch (76 mm)
Displacement	59.8 CID (980 cm^3)
Horsepower (3600 RPM)	24.0 BHP (17.9 kW)
Oil Capacity	2.5 qt (2.4 litre)
Oil Capacity with filter change	3.0 qt (2.8 litre)
Compression Ratio	7.0 to 1

TUNE-UP SPECIFICATIONS

Spark Plug Gap	0.025 inch (0.635 mm)
Valve Lash	
Intake	0.005 inch (0.13 mm)
Exhaust	0.013 inch (0.33 mm)
Ignition Timing (static setting)	20°BTC

Engine Set-Up

Inspect the engine visually. Check for loose or missing parts and any damage that may have occurred in shipment.

⚠CAUTION ***Starting engine without oil will result in severe engine damage. Add oil prior to starting engine.***

BATTERY

The battery and battery cables used for starting the engine should be of sufficient size to provide prompt starting. Undersized battery will result in poor starter operation and a very short starter service life.

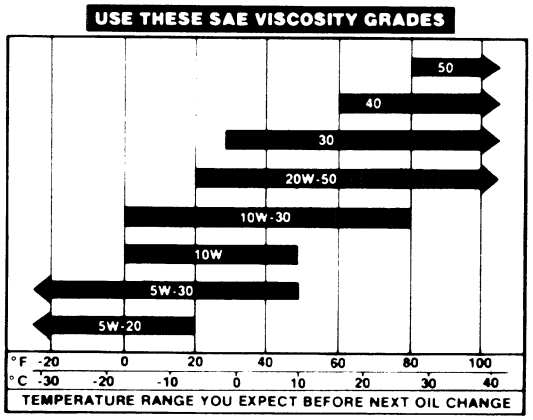
⚠WARNING ***Ignition of explosive battery gases can result in severe personal injury. Do not smoke or allow any ignition source near the battery.***

⚠CAUTION ***Reversing positive and negative battery connections or allowing engine to run without being connected to the alternator will result in engine electrical system damage. Do not switch battery connections or allow engine to run without being connected to the alternator.***

CRANKCASE OIL RECOMMENDATIONS

Fill crankcase with correct amount of oil. Refer to *Specifications* for crankcase capacity. Use oils meeting the API classification SF, SF/CC, or SF/CD. Refer to chart below to determine the proper viscosity grade of oil to use. Straight weight oils are recommended for severe duty use and at temperatures above 32°F (0°C) for minimum oil consumption.

⚠WARNING ***Crankcase pressure can blow out hot oil, which can cause severe personal injury. Do not check oil while the engine is running.***



LS-1170

⚠CAUTION ***Excess oil can cause high oil consumption, high operating temperatures, and oil foaming. Do not overfill crankcase.***

Oil Level

Check oil level at least every 8 hours of operation. Check more frequently on a new or reconditioned engine as oil consumption is higher until the piston rings seat properly.

When adding oil between oil changes, it is preferable to use the same brand, as various brands of oil may not be compatible together. Refer to *MAINTENANCE* for recommended oil change intervals and procedures.

FUEL RECOMMENDATIONS

⚠WARNING ***Ignition of fuel can result in severe personal injury or death. Do not smoke or allow any spark, pilot light, or arcing equipment near the fuel system.***

Use clean, fresh, unleaded gasoline. Regular leaded gasoline may also be used but is not a preferred fuel. Do not use highly leaded premium gasoline. Use of unleaded gasoline results in less maintenance.

⚠CAUTION ***Gasoline de-icers and fuel containing alcohol can cause poor engine performance and engine damage. Do not use fuel system de-icers. Do not use gasoline containing alcohol concentrations greater than ten percent.***

If regular leaded gasoline is used continually, carbon and lead deposits should be removed from the cylinder heads as required because of engine power loss. Unleaded gasoline may be used safely after lead deposits have been removed.

⚠WARNING ***Ignition of fuel can result in severe personal injury or death. Thoroughly clean up any spilled fuel.***

EXHAUST SYSTEM

Exhaust products of any internal combustion engine are toxic and can cause injury, or death if inhaled. All engine applications, especially those within a confined area, should be equipped with an exhaust system to discharge gases to the outside atmosphere.

⚠WARNING ***Breathing exhaust gases can result in severe personal injury or death. Use extreme care during installation to ensure a leak-free exhaust system.***

Operation

STARTING

Most engines are equipped with a start-stop switch and cable controlled choke and throttle.

1. Place the throttle control in the *SLOW* position and the choke into the *FULL* choke position.
2. Turn the ignition switch on and engage starter. If engine fails to start after 30 seconds determine the cause. Wait one minute before recranking. If the engine fails to start at first attempt, rust inhibitor oil used at the factory may have fouled the plugs. Remove the plugs, clean in a suitable solvent, dry thoroughly and reinstall. Heavy exhaust smoke when the engine is initially started is normal and usually caused by rust inhibitor oil.
3. When the engine starts, gradually push the choke lever in until the engine runs smoothly. Black smoke from the exhaust and a rough running engine usually indicate over-choking.
4. To stop the engine, turn the ignition switch to the *OFF* position.

BREAK-IN PROCEDURE

Controlled break-in is the ideal fitting of all internal moving metal parts. Using the proper oil and applying a conscientious maintenance program during this period helps assure satisfactory service from your Onan engine.

Maintain the proper cooling and lubrication during break-in. Run the engine at half load for the first three hours with intermittent periods of full load to control engine break-in.

⚠CAUTION ***Using the wrong grade and weight of oil and high engine operating temperatures during break-in can cause engine damage. Use correct oil grade and weight and provide adequate engine cooling during engine break-in.***

Check the oil level at least every five operating hours. Add oil to keep it at the proper level, but never overfill as overfilling may cause the oil to foam and enter the breather system, resulting in high oil consumption and oil accumulation in air cleaner housing.

HOT WEATHER OPERATION

When operating the engine in temperatures above 100°F (38°C), pay particular attention to the following items to prevent damage:

1. Keep the engine cooling fins clean and free of obstruction.

⚠CAUTION ***Plugged or clogged cooling fins can cause overheating and engine damage. Ensure cooling fins are kept clean and debris does not accumulate.***

⚠WARNING ***Contact with rotating machinery can result in severe personal injury or death. Stay clear of rotating components and ensure protective shields and guards are in place and secured before operating machinery.***

2. See that nothing obstructs air flow to and from the engine.
3. Ensure that you are using the proper grade and weight of oil for ambient temperatures. Check the oil level each time you fill the fuel tank.
4. Check the battery water more frequently. High temperatures cause faster evaporation.
5. Change crankcase oil and filter more frequently.

COLD WEATHER OPERATION

When the engine is being used in temperatures below 32°F (0°C), check the following items closely:

1. Use the correct grade and weight of oil for the temperature conditions. Change the oil only when the engine is warm. If an unexpected temperature drop occurs when the engine is filled with summer oil, before starting the engine, move it to a warm location until the oil will flow freely.
2. Use fresh fuel. Fill the fuel tank after each day's use to protect against moisture condensation.
3. Keep the battery in a well-charged condition.

DUST AND DIRT

1. Keep unit clean. Keep cooling system clean.
2. Service air cleaner as frequently as required.
3. Change crankcase oil and filter more often.

OUT-OF-SERVICE PROTECTION

Protect an engine that will be out-of-service for more than 30 days as follows:

1. Run the engine until it reaches normal operating temperature.
2. Turn off the fuel supply and run the engine until it stops.
3. Drain oil from oil base while the engine is still warm. Refill with fresh crankcase oil and attach a tag stating viscosity used.

4. Remove spark plugs. Pour 1 ounce (2 tablespoons or 28 grams) of rust inhibitor or SAE #50 oil into the cylinders. Crank the engine over a few times. Reinstall spark plugs.
5. Service air cleaner as outlined in *MAINTENANCE.*
6. Clean governor linkage and protect by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of moisture, dirt, bugs, etc.
8. Wipe entire unit. Coat rustable parts with a light film of grease or oil.
9. Provide a suitable cover for the entire unit.
10. If battery equipped, disconnect and follow standard battery storage procedure.

RETURNING UNIT TO SERVICE

1. Remove cover and all protective wrapping. Remove plug from exhaust outlet.
2. Check tag on oil base and verify that oil viscosity is still correct for existing ambient temperatures.
3. Clean and check battery. Measure specific gravity (1.260 at 77°F [25°C]) and verify level to be at split ring. If specific gravity is low, charge until correct value is obtained. If the level is low, add distilled water and charge until specific gravity is correct.
4. Check that fuel filter and fuel lines are secure, with no leaks.
5. Check that carburetor throttle lever and governor linkage move freely.
6. Connect battery.
7. Start Engine. Exhaust smoke is normal when the engine is started and is usually caused by the rust inhibitor oil.

⚠WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases from all fuels (including diesel, gasoline, liquid propane, natural gas) contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- ***Dizziness***
- ***Nausea***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Throbbing in Temples***
- ***Muscular Twitching***
- ***Vomiting***
- ***Inability to Think Coherently***

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Protection against carbon monoxide inhalation includes proper installation, ventilation and regular, frequent visual and audible inspections of the complete exhaust system.

Maintenance

⚠WARNING ***Accidental starting of the engine can result in severe personal injury or death. Disconnect the negative battery cable and spark plug wires while servicing engine, controls, or associated equipment.***

DAILY CHECKS OR EVERY 8 HOURS

The operator should daily make a complete visual and audible inspection of the engine. Check the following before starting the engine for the first time each day:

1. Check all fuel lines and fittings for possible leakage.
2. Inspect exhaust system for possible leakage and cracks. Locate leaks in muffler and piping while the engine is operating. Repair all leaks immediately after they are detected for personal safety.
3. Inspect air cleaner system for leaks. Make certain all clamps and fittings are tight and free of potential leaks.

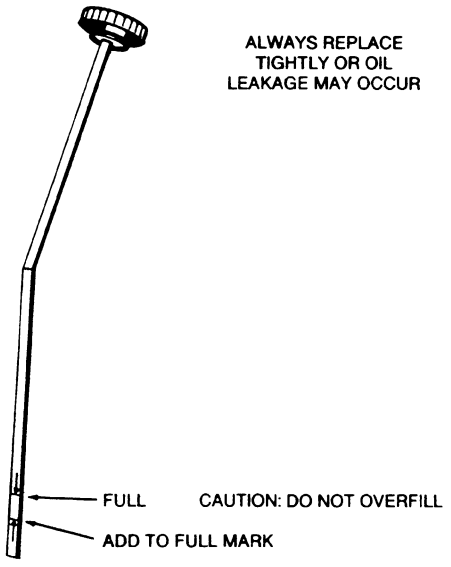


FIGURE 1. CRANKCASE OIL FILL

4. Check crankcase oil level with the engine off. If engine has been run, allow a minimum of 10 minutes for the oil to drain down before checking. If oil level is at or below ADD mark on dipstick (Figure 1), add sufficient oil of the proper viscosity as specified in *ENGINE SET-UP* to bring oil level to the FULL mark. Do not operate engine with oil level below the ADD mark.

OIL CHANGE

Refer to the *Periodic Maintenance Schedule* for oil change intervals.

Run engine until thoroughly warm before draining oil. Stop the engine, place a pan under the drain outlet and remove the oil drain plug or open the drain valve. After the oil is completely drained, replace the drain plug or close the drain valve. Refill with oil of the correct API classification and appropriate SAE viscosity grade for the temperature conditions (refer to *ENGINE SET-UP*).

⚠WARNING ***Hot crankcase oil can cause burns if it comes in contact with skin. Wear protective clothing and keep fingers and hands clear when draining oil.***

Oil level should be to the FULL mark of the dipstick. Start engine and run for a short time to check for oil leaks around the drain plug.

OIL FILTER CHANGE

Refer to the *Periodic Maintenance Schedule* for oil filter change intervals.

Spin off oil filter element and discard it. Thoroughly clean filter mounting surface and make sure new gasket is inserted in the element. Apply a thin film of oil to the gasket. Spin element down by hand until gasket just touches mounting pad and then turn down an additional 1/2-3/4 turn. Do not overtighten.

With oil in crankcase, start engine and check for leaks around filter element. Retighten only as much as necessary to eliminate leaks, but do not overtighten.

IGNITION

Spark Plugs

Refer to *Periodic Maintenance Schedule* for spark plug service interval. Replace spark plugs that show signs of fouling or electrode erosion. Refer to *Specifications* for spark plug gap.

Solid State Ignition

Ignition timing is set at the factory and is not adjustable. The solid state ignition components are not adjustable and require no routine maintenance.

COOLING SYSTEM

Refer to *Periodic Maintenance Schedule* for cooling system service interval. Clean cooling fins and chaff screen sooner if required. Remove any dust, dirt or oil which may have accumulated.

BATTERY

Disconnect negative ground strap from the battery before working on any part of the electrical system or engine.

Disconnect positive terminals before charging battery to avoid damaging ignition system alternator or regulator.

⚠WARNING ***Ignition of explosive battery gases can result in severe personal injury. Do not smoke or allow any ignition source near the battery.***

Cleaning Battery

Keep the battery clean by wiping it with a damp cloth whenever dirt appears excessive.

If corrosion is present around the terminal connections, remove battery cables and wash the terminals with an ammonia solution or a solution consisting of 1/4 pound of baking soda added to 1 quart of water.

Be sure the vent plugs are tight to prevent cleaning solution from entering the cells.

After cleaning, flush the outside of the battery, the battery compartment, and surrounding areas with clear water.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or non-conductive grease to retard corrosion.

Checking Specific Gravity

Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell.

Hold the hydrometer vertical and take the reading. Correct the reading by adding four gravity points (0.004) for every five degrees the electrolyte temperature is above 80° F (27°C) or subtracting four gravity points for every five degrees below 80°F (27°C). A fully charged battery will have a corrected specific gravity of 1.260. Charge the battery if the reading is below 1.215.

Checking Electrolyte Level

Refer to *Periodic Maintenance Schedule* for checking electrolyte level interval.

Fill the battery cells to the bottom of the filler neck. If cells are low on water, add distilled water and recharge. If one cell is low, check case for leaks. Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

⚠CAUTION ***Water added to battery electrolyte in freezing weather can damage the battery. Do not add water to battery unless the engine is run long enough (two or three hours) to ensure a thorough mixing of water and electrolyte.***

Storing Battery

If the engine is to be stored for more than 30 days, remove the battery. With the electrolyte level at the bottom of the split ring, charge the battery before storing it. After every 30 days the battery is in storage, bring it back up to full charge. To reduce self-discharge, store the battery in as cool a place as possible so long as the electrolyte does not freeze.

CRANKCASE BREATHER SERVICE

If the crankcase becomes pressurized as evidenced by oil leaks at the seals, use the following procedure to service.

⚠WARNING ***Most parts cleaning solvents are flammable and can cause severe personal injury or death if used improperly. Follow the manufacturer's recommendations when cleaning parts.***

Remove breather hose from cap and valve assembly. Remove cap and valve assembly and wash in solvent. Replace cap and valve assembly if balls do not move freely. Remove screen and pull baffle out and wash in solvent. Assemble components, assuring screen is positioned properly (Figure 2).

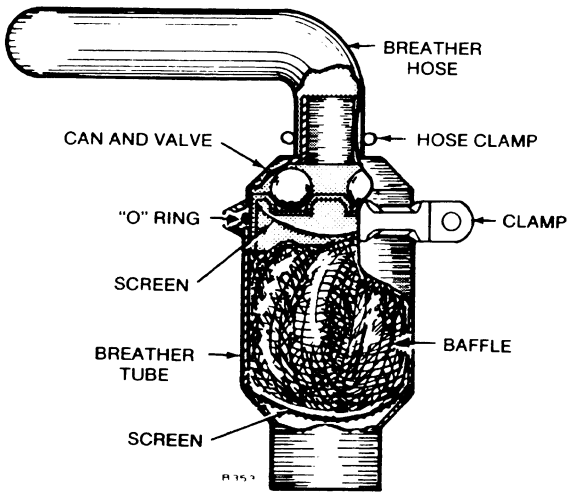


FIGURE 2. CRANKCASE BREATHER

EXHAUST SYSTEM

Make regular visual and audible inspections of the exhaust system throughout the entire life of the engine. Locate leaks in muffler and piping while the engine is operating. Repair all leaks immediately after they are detected for personal safety.

⚠WARNING ***Breathing exhaust gases can result in severe personal injury or death. Inspect exhaust system audibly and visually for leaks daily and repair leaks immediately.***

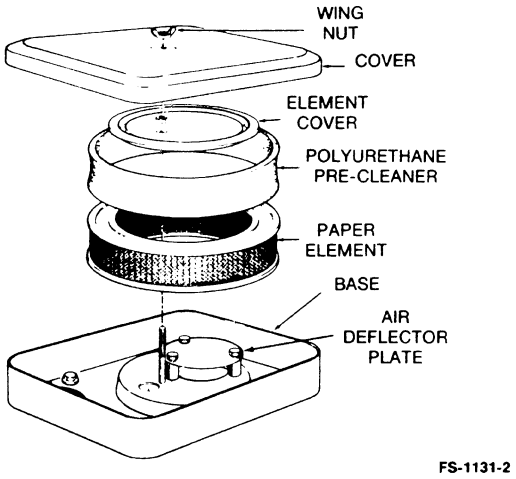
AIR CLEANER

Air Cleaner Element

Refer to *Periodic Maintenance Schedule* for air cleaner service and replacement interval. Service or replace more often when operating under severe operating conditions. Service by gently tapping element on a flat surface.

Element Wrapper (Pre-Cleaner)

Refer to *Periodic Maintenance Schedule* for element wrapper service interval. Wash in water and detergent and squeeze dry like a sponge. Rinse with water (Figure 3). Allow to dry, then coat evenly with two tablespoons (28 grams) of SAE 30 engine oil. Knead into and wring out excess oil from element wrapper. Failure to adequately wring out excess oil from the wrapper may cause drop in engine horsepower due to an increased restriction of inlet air. Install over air cleaner element.



1. WASH
2. SQUEEZE DRY
3. COAT WITH OIL
4. INSTALL OVER PAPER ELEMENT



FIGURE 3. AIR CLEANER ASSEMBLY

PERIODIC MAINTENANCE SCHEDULE

Follow a regular schedule of inspection and servicing, based on operating hours. Keep an accurate logbook of maintenance, servicing, and operating time. Use the factory recommended Periodic Maintenance Schedule (based on favorable operating conditions) to serve as a guide to get long and efficient engine life. Regular service periods are recommended for normal service and operating conditions. For continuous duty, extreme temperature, etc., service more frequently. For infrequent use, light duty, etc., service periods can be lengthened accordingly. Neglecting routine maintenance can result in engine failure or permanent damage.

For any abnormalities in operation, unusual noises from the engine or accessories, loss of power, overheating, etc., contact your nearest Onan Service Center.

PERIODIC MAINTENANCE SCHEDULE

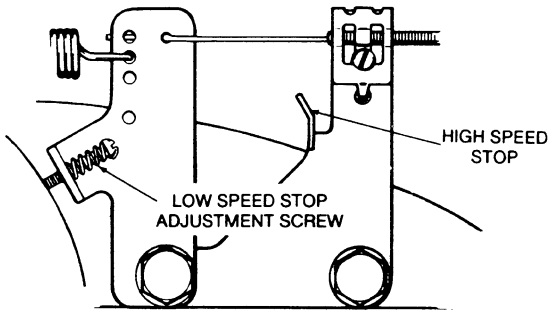
SERVICE THESE ITEMS	AFTER EACH CYCLE OF INDICATED HOURS				
	8	25	50	100	200
Inspect Engine Generally	X[1]				
Check Oil Level	X				
Service Air Cleaner		X[2]			
Change Crankcase Oil		X[3]	X[2]		
Replace Oil Filter		X[3]		X[2]	
Check Battery Electrolyte Level			X		
Clean Cooling Fins			X[2]		
Check Valve Clearance			X[3]		X[4]
Check or Replace Spark Plugs					X
Clean Breather Valve					X[2]
Replace Air Cleaner Element					X[2]
Compression Check					X[4]
Clean Carbon and Lead Deposits (Cylinder Head)					X[4,5]
Replace Fuel Filter					X

1 - Check for fuel leaks.With engine running, visually and audibly check exhaust system for leaks.
2 - Perform more often when running under severe operating conditions.
3 - Initial break-in check only.
4 - For detailed maintenance, contact an Onan Service Center or refer to the 965-0760 SERVICE MANUAL.
5 - For engines running on unleaded fuel this interval may be extended to 400 hours.

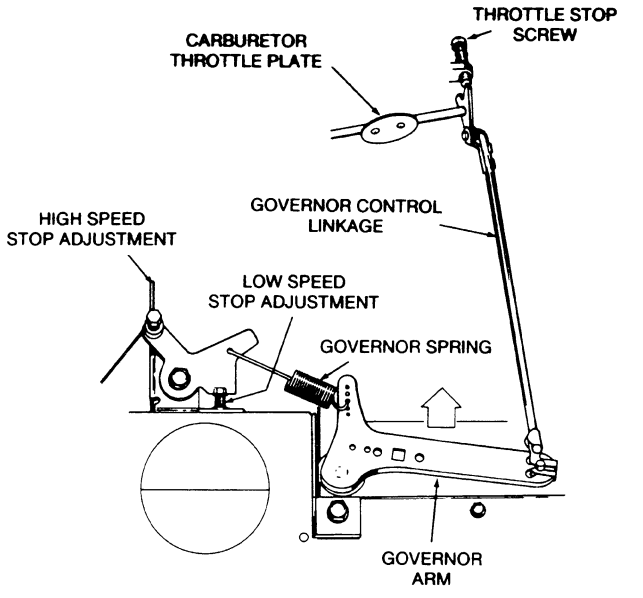
⚠WARNING ***Inhalation of exhaust gases can result in serious personal injury or death. Do NOT use the air cleaner or exhaust elbow as a supporting step. Damage to these and connecting parts can cause an exhaust leak.***

Adjustments

Carburetor mixture adjustments are set for maximum efficiency at the factory. Idle fuel adjustment is restricted to 1/4 of a turn by a limiting cap. There is no main fuel adjustment screw.



SIDE PULL GOVERNOR ASSEMBLY



FRONT PULL GOVERNOR ASSEMBLY

FIGURE 4. GOVERNOR SPEED ADJUSTMENT

1. Start the engine and allow it to warm up thoroughly (at least 10 minutes).

   Some equipment manufacturers may require higher throttle stop speed and governor low speed rpm settings. Refer to equipment manufacturer's Operator's Manual for the correct rpm settings. When rpm settings are not specified by the equipment manufacturer use the rpm settings listed in Steps 2 and 4.

2. Move the engine speed control to the slow position. Bend or turn the low speed stop on the governor so that the throttle stop screw on the carburetor controls engine speed. Adjust the throttle stop screw for 1000 rpm idle. (Figure 5)

3. Adjust the governor low speed screw for 1100 rpm idle. (Figure 4)

4. Move the engine speed control to the fast position. Bend the high speed stop on the governor so the engine runs at the vehicle manufacturer's recommended speed. (Figure 4)

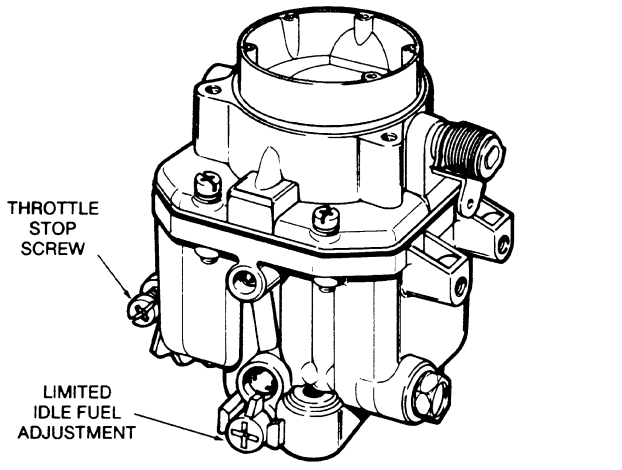
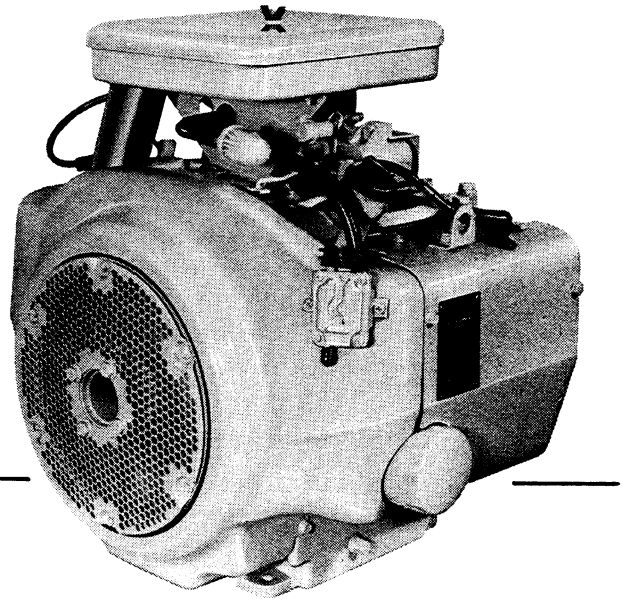


FIGURE 5. CARBURETOR ADJUSTMENTS

Onan

Service Manual

T-260G
Engine



965-0760
(Spec A-F)
6-87
Printed in U.S.A.

Safety Precautions

It is recommended that you read your engine manual and become thoroughly acquainted with your equipment before you start the engine.

⚠DANGER ***This symbol if used warns of immediate hazards which will result in severe personal injury or death.***

⚠WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that can result in serious, personal injury. Take care in following these recommended procedures. All local, state and federal codes should be consulted and complied with.

⚠WARNING ***This engine is not designed or intended for use in any type of aircraft. Use of this engine in aircraft can result in engine failure and causes serious personal injury or death.***

General

- Provide appropriate fire extinguishers and install them in convenient locations. Use an extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the engine are secure and accurately torqued. Keep guards in position over fans, driving belts, etc.
- If it is necessary to make adjustments while the engine is running, use extreme caution when close to hot exhausts, moving parts, etc.

Protect Against Moving Parts

- Do not wear loose clothing in the vicinity of moving parts, such as PTO shafts, flywheels, blowers, couplings, fans, belts, etc.
- Keep your hands away from moving parts.

Batteries

- Before starting work on the engine, disconnect batteries to prevent inadvertent starting of the engine.
- DO NOT SMOKE while servicing batteries. Lead acid batteries give off a highly explosive hydrogen gas which can be ignited by flame, electrical arcing or by smoking.
- Verify battery polarity before connecting battery cables. Connect negative cable last.

Fuel System

- DO NOT fill fuel tanks while engine is running.
- DO NOT smoke or use an open flame in the vicinity of the engine or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping for flexible lines as copper will work harden and become brittle enough to break.
- Be sure all fuel supplies have a positive shutoff valve.

Exhaust System

- Exhaust products of any internal combustion engine are toxic and can cause injury, or death if inhaled. All engine applications, especially those within a confined area, should be equipped with an exhaust system to discharge gases to the outside atmosphere.
- Do not use exhaust gases to heat a compartment.
- Make sure that your exhaust system is free of leaks. Ensure that exhaust manifolds are secure and are not warped by bolts unevenly torqued.

Exhaust Gas is Deadly!

Exhaust gases contain carbon monoxide, a poisonous gas that can cause unconsciousness and death. It is an odorless and colorless gas formed during combustion of hydrocarbon fuels. Symptoms of carbon monoxide poisoning are:

- Dizziness
- Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

If you experience any of these symptoms, get out into fresh air immediately, shut down the unit and do not use until it has been inspected.

The best protection against carbon monoxide inhalation is proper installation and regular, frequent inspections of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

Cooling System

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator pressure cap when coolant temperature is above 212°F (100°C) or while engine is running.

Keep the Unit and Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and present a potential fire hazard.

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⚠WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases from all fuels (including diesel, gasoline, liquid propane, natural gas) contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- *Dizziness*
- *Nausea*
- *Headache*
- *Weakness and Sleepiness*
- *Throbbing in Temples*
- *Muscular Twitching*
- *Vomiting*
- *Inability to Think Coherently*

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Protection against carbon monoxide inhalation includes proper installation, ventilation and regular, frequent visual and audible inspections of the complete exhaust system.

General Information

INTRODUCTION

This manual deals with specific mechanical and electrical information needed by engine mechanics for troubleshooting, servicing, repairing, or overhauling the engine.

Use the table of contents for a quick reference to the separate engine system sections.

Use the separate Parts Catalogs available at the dealer level, for parts identification and for establishing their proper location on assemblies.

The troubleshooting guide is provided as a quick reference for locating and correcting engine trouble.

The illustrations and procedures presented in each section apply to the engines listed on the cover. The flywheel-blower end of the engine is the front end so right and left sides are determined by viewing the engine from the front.

The disassembly section contains major overhaul procedures for step by step removal, disassembly, inspection, repair and assembly of the engine components.

If a major repair or an overhaul is necessary, a competent mechanic should either do the job or supervise and check the work of the mechanic assigned to do the job to ensure that all dimensions, clearances and torque values are within the specified tolerances.

The wiring diagram on the last page of the manual shows how the electrical components are interconnected.

A parts catalog (available at the dealer level) contains detailed exploded views of each assembly and the individual piece part numbers and their proper names for ordering replacement parts.

Use only Genuine Onan replacement parts to ensure quality and the best possible repair and overhaul results. When ordering parts, always use the complete Model and Spec number as well as the Serial number shown on the nameplate.

ENGINE MODEL REFERENCE

Identify your model by referring to the MODEL and SPEC (specification) NO. as shown on the unit nameplate. Always use this number and the engine serial number when making reference to your engine.

How to interpret MODEL and SPEC NO.



1. Factory code for general identification of basic engine series.
2. Number of cylinders.
3. Cubic inch displacement.
4. Engine duty cycle.
5. Fuel required (G=gasoline).
6. Cooling system description - (A=air-cooling-pressure).
7. BHP rating.
8. Factory code for designated optional equipment, if any.
9. Specification (spec letter) which advances with factory production modifications.

⚠WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS CAN RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

Specifications

This manual contains SI metric equivalents that follow immediately in parentheses after the U.S. customary units of measure.

SPECIFICATION	UNIT OF MEASURE	SERIES T-260G
Number of Cylinders		2
Bore	in (mm)	3.56 (90.48)
Stroke	in (mm)	3.0 (76)
Displacement	cu in (cm^3)	60 (983)
Compression Ratio		7.0 to 1
Rated Speed (Maximum)	RPM	3600
Power at Rated Speed	BHP (kW)	24 (17.9)
Oil Filter		Full Flow
Oil Capacity Without Filter	Qt (litre)	2.5 (2.4)
Oil Capacity With Filter Change	Qt (litre)	3.0 (2.8)
Crankshaft Rotation (viewed from flywheel)		Clockwise
Governor		Variable Speed Mechanical
Valve Clearance (Cold)		
Intake	in (mm)	.005 (0.13)
Exhaust	in (mm)	.013 (0.33)
Spark Plug Gap	in (mm)	.025 (0.64)
Breaker Point Gap - Static (Spec A-E) (Full Separation and Engine Cold)	in (mm)	.020 (0.51)
Ignition Timing	BTC	20°
Cylinder Compression	psi (kPa)	75 to 115 517 to 793

Dimensions and Clearances

All clearances given at room temperature of 70° F (21° C). All dimensions in inches (approximate millimetre dimensions in parentheses) unless otherwise specified.

DESCRIPTION	MINIMUM		MAXIMUM	
	Inches	(mm)	Inches	(mm)
CYLINDER BLOCK				
Cylinder Bore Honed Diameter	3.5625	(90.49)	3.5635	(90.51)
Maximum Allowable				
Taper			0.003	(0.08)
Out-of-Round			0.003	(0.08)
Main Bearing Inside Diameter (Without bearing)	2.187	(55.55)	(2.188	(55.58)
Main Bearing Inside Diameter (Installed)	2.0015	(50.84)	2.0040	(50.90)
Camshaft Bearing Bore (Bearing Installed)	1.3760	(34.95)	1.3770	(34.98)
Interference Stud Height from Top Surface of Block				
Spec C, D, E				
Top 2	2.00	(50.80)	(2.06	(52.32)
Middle 4	1.84	(46.74)	1.90	(48.26)
Bottom 4	1.16	(29.46)	1.22	(30.99)
CRANKSHAFT				
Main Bearing Journal Diameter	1.9992	(50.78)	2.0000	(50.80)
Main Bearing Clearance				
Spec A-E	0.0025	(0.064)	0.0038	(0.097)
Begin Spec F	0.0024	(0.061)	0.0042	(0.107)
Connecting Rod Journal Diameter	1.6252	(41.28)	1.6260	(41.30)
Crankshaft End Play	0.005	(0.13)	0.009	(0.23)
CONNECTING ROD				
Large Bore Diameter (Without bearing installed and rod bolts properly torqued	1.7505	(44.46)	1.7510	(44.48)
Connecting Rod Side Clearance	0.0020	(0.051)	0.0160	(0.406)
Piston Pin Bushing Bore (Without bearing)	0.8115	(20.61)	0.8125	(20.64)
Piston Pin Bushing Bore with Bearing, (Finished bore)	0.7504	(19.06)	0.7508	(19.07)
Bearing to Crankshaft Clearance				
Aluminum Rod	0.0020	(0.051)	0.0033	(0.084)
Iron Rod	0.0020	(0.051)	0.0033	(0.084)
CAMSHAFT				
Bearing Journal Diameter	1.3740	(34.90)	1.3745	(34.91)
Bearing Clearance	0.0015	(0.038)	0.0030	(0.076)
End Play				
Spec A-E	0.0030	(0.076)	0.0120	(0.305)
Begin Spec F	0.011	(0.28)	0.048	(1.22)
Camshaft Lift				
Intake				
Begin Spec A	0.286	(7.26)	0.294	(7.47)
Begin Spec E	0.285	(7.24)	0.293	(7.44)
Begin Spec F		0.305	(7.75)	
Exhaust				
Begin Spec A	0.291	(7.39)	0.299	(7.59)
Begin Spec E	0.283	(7.19)	0.291	(7.39)
Begin Spec F		0.295	(7.49)	

DESCRIPTION	MINIMUM Inches	(mm)	MAXIMUM Inches	(mm)
PISTON				
Clearance in Cylinder				
Measure 1.187 Below Top of Piston and 90° from pin	0.0070	(0.178)	0.0090	(0.229)
Piston Pin Bore	0.7502	(19.055)	0.7506	(19.065)
Ring Groove Width				
Top 1 Compression Ring	0.080	(2.032)	0.081	(2.057)
No. 2 Compression Ring	0.080	(2.032)	0.081	(2.057)
No. 3 Oil Control Ring	0.188	(4.775)	0.189	(4.801)
PISTON PIN				
Clearance in Piston	0.0001	(0.003)	0.0005	(0.013)
Clearance in Connecting Rod				
Aluminum Rod	0.0002	(0.005)	0.0008	(0.020)
Iron Rod	0.0002	(0.005)	0.0008	(0.020)
Diameter	0.7500	(19.05)	0.7502	(19.06)
PISTON RINGS				
Clearance				
Top Groove	0.002	(0.051)	0.008	(0.203)
Ring End Gap in Cylinder	0.010	(0.254)	0.020	(0.508)
INTAKE VALVE				
Stem Diameter	0.3425	(8.70)	0.3430	(8.71)
Clearance (Stem to Guide)	0.0010	(0.025)	0.0025	(0.064)
Valve Face Angle		44°		
INTAKE VALVE SEAT				
Seat Cylinder Head Bore Diameter	1.5645	(39.74)	1.5655	(39.76)
Seat Outside Diameter	1.5690	(39.85)	1.5700	(39.88)
Valve Seat Width	0.031	(0.787)	0.047	(1.194)
Valve Seat Angle		45°		
EXHAUST VALVE				
Stem Diameter	0.3410	(8.661)	0.3420	(8.687)
Clearance (Stem to Guide)	0.0025	(0.064)	0.040	(0.101)
Valve Face Angle		44°		
EXHAUST VALVE SEAT				
Seat Cylinder Head Bore Diameter	1.2510	(31.78)	1.2520	(31.80)
Seat Outside Diameter	1.2550	(31.88)	1.2560	(31.90)
Valve Seat Width	0.031	(0.787)	0.047	(1.194)
Valve Seat Angle		45°		
VALVE GUIDE				
Inside Diameter	0.344	(8.74)	0.346	(8.79)
TAPPET				
Body Diameter	0.7475	(18.99)	0.7480	(19.00)
Bore Diameter	0.7500	(19.05)	0.7515	(19.09)
Clearance in Bore	0.0015	(0.038)	0.003	(0.076)
VALVE SPRINGS INTAKE AND EXHAUST				
Valve Spring Free Length (Approx.)		1.662	(42.21)	
Valve Spring Length				
Valve Open		1.125	(28.58)	
Valve Closed		1.375	(34.93)	
Spring Load @ 1.375 inch (Valve Closed)	38 lb.	(17 kg)	42 lb.	(19 kg)
Spring Load @ 1.125 inch (Valve Open)	71 lb	(32 kg)	79 lb	(36 kg)

DESCRIPTION	MINIMUM		MAXIMUM	
	Inches	(mm)	Inches	(mm)
GEAR BACKLASH				
Timing Gear				
Spec A-E	0.002	(0.051)	0.003	(0.076)
Begin Spec F	0.001	(0.025)	0.005	(0.127)
Oil Pump Gear				
Spec A-E	0.002	(0.051)	0.005	(0.127)
Begin Spec F	0.001	(0.025)	0.008	(0.203)
GOVERNOR				
Dashpot to Governor Arm Bracket	0.040	(1.02)	0.060	(1.52)

Assembly Torques

The torque values given in Table 1 have been determined for the specific applications. Standard torque values must not be used where those listed in Table 1 apply. The engine assembly torques given here will assure proper tightness without danger of stripping threads. All threads must be clean and lubricated with new engine oil before torquing.

Check all studs, nuts, and capscrews, and tighten as required to keep them from working loose. Refer to the *PARTS MANUAL* for the location of washers and capscrews.

TABLE 1.

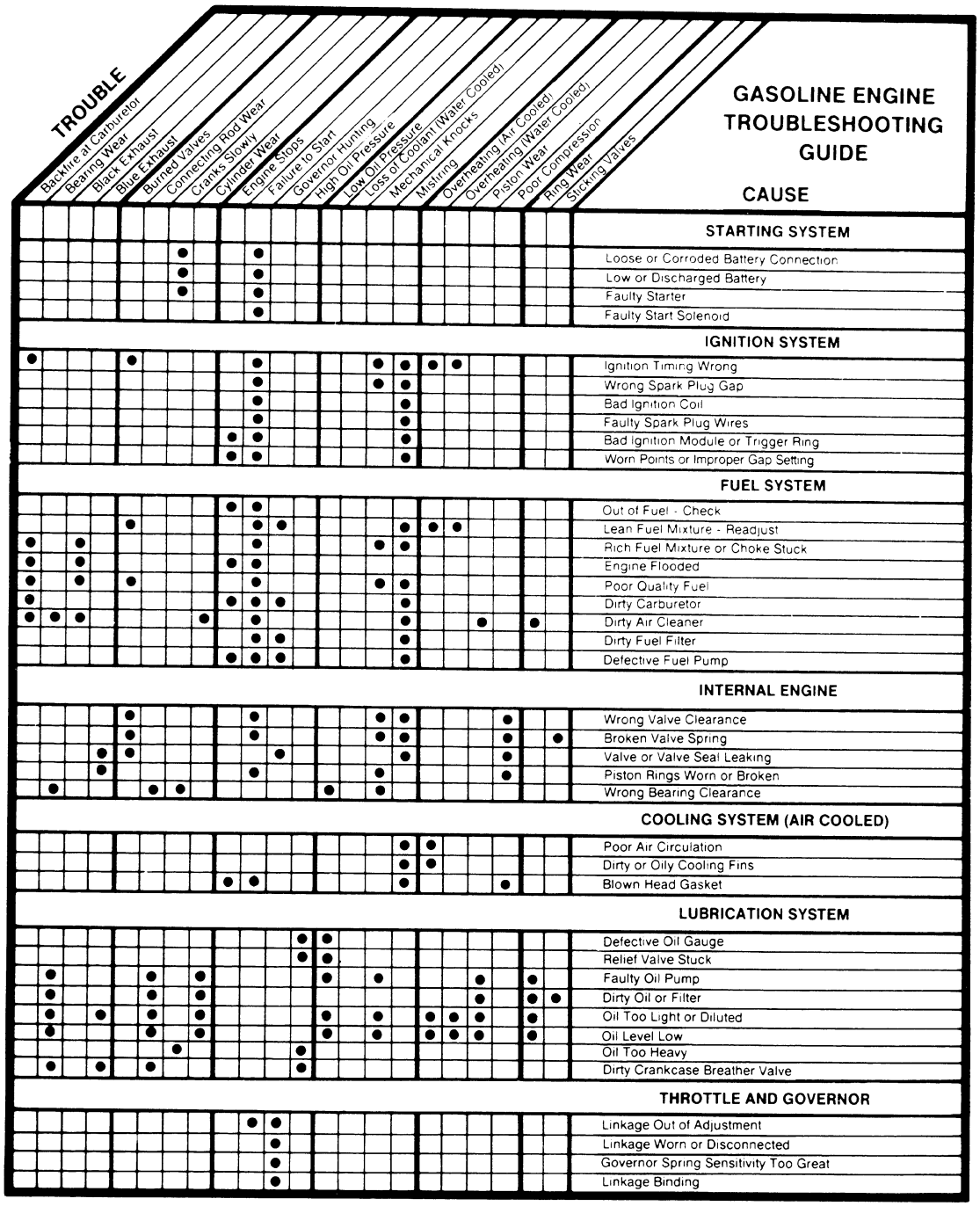
DESCRIPTION	TORQUE SPECIFICATION Ft.-Lb.	Nm	DESCRIPTION	TORQUE SPECIFICATION Ft.-Lb.	Nm
Cylinder Head Nuts (with Compression Washers)			Gear Case Cover	8-10	(11-14)
Spec A-E	11-13	(15-18)	Oil Pump	7-9	(10-12)
Begin Spec F	14	(19)	Intake Manifold Mounting Screws	20-23	(27-31)
Cylinder Head Nuts (without Compression Washers)			Valve Cover	4-8	(5-11)
Spec A-E	14-16	(19-22)	Exhaust Manifold Mounting Screws		
Begin Spec F	17	(23)	Spec A-E	20-23	(27-31)
Rear Bearing Plate	25-28	(34-38)	Begin Spec F	9-11	(12-15)
Connecting Rod Bolt			Other 1/4" Cylinder Block Studs and Nuts	7-9	(10-12)
Spec A-E	14-16	(19-22)	Other 5/16" Cylinder Block Studs and Nuts	8-10	(11-13)
Begin Spec F	27-29	(37-39)	Other 3/8" Cylinder Block Nuts	18-23	(24-31)
Flywheel Capscrew	50-55	(67-75)			
Starting Mounting Bracket to Oil Base Screws	24-26	(33-35)			

Special Tools

The following special tools are available from Onan. For further information see *TOOL CATALOG 900-0019.*

Valve Seat Driver
Valve Guide Driver
Oil Guide and Driver
Combination Bearing Remover (Main and Cam)
Combination Bearing Driver (Main and Cam)
Flywheel Puller

Engine Troubleshooting



M-1686-1

Oil System

CRANKCASE OIL

Refer to engine nameplate or *Periodic Maintenance Schedule,* located in the Operator's Manual, for oil change interval. If operating in extremely dusty, high ambient, or low ambient conditions change oil more often.

Run engine until thoroughly warm before draining oil. Stop the engine, place a pan under the drain outlet and remove the oil drain plug or open the drain valve. After the oil is completely drained, replace the drain plug or close the drain valve. Refill with oil of the correct API classification and appropriate SAE viscosity grade for the temperature conditions.

Oil must meet or exceed the API designation SF, SF/CC or SF/CD. Refer to the chart to determine the proper viscosity grade of oil to use. Straight weight oils are recommended for severe duty use and at temperatures above 32° F (0°C) for minimum oil consumption.

⚠WARNING ***Crankcase pressure can blow out hot oil and cause serious burns. Do NOT check oil while the engine is operating.***

⚠WARNING ***Hot crankcase oil can cause burns if it is spilled or splashed on skin. Keep fingers and hands clear when removing the oil drain plug and wear protective clothing.***

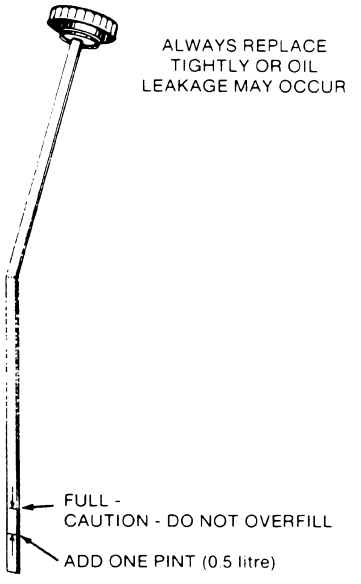
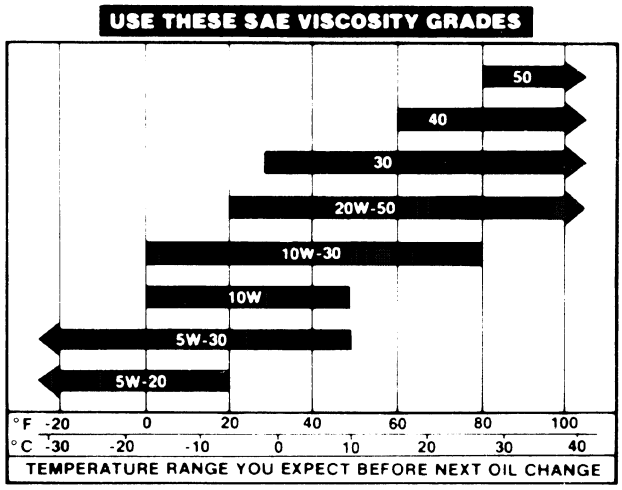
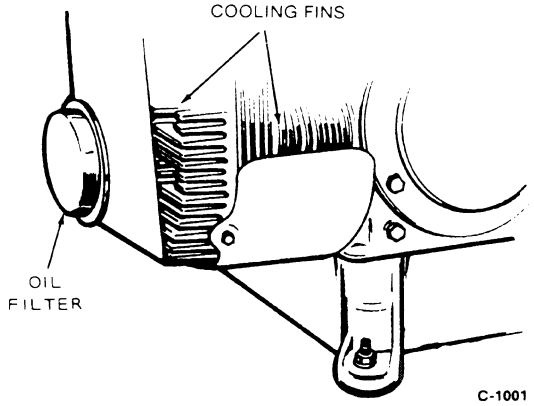


FIGURE 1. CRANKCASE OIL FILL

⚠CAUTION ***Do not overfill crankcase. Excess oil causes higher operating temperatures and may cause foaming.***

Oil level should be to the FULL mark of the dipstick. Start engine and run for a short time to check for oil leaks around the drain plug.





FILTER 2. OIL FILTER

OIL FILTER CHANGE

Refer to engine nameplate or *Periodic Maintenance Schedule,* located in the Operator's Manual, for oil filter change interval. If operating in extremely dusty, high ambient, or low ambient conditions change oil more often.

Spin off oil filter element and discard it. Thoroughly clean filter mounting surface and make sure new gasket is inserted in the element.

Apply a thin film of oil to the gasket. Spin element down by hand until gasket just touches mounting pad and then turn down an additional 1/2-3/4 turn. Do not overtighten.

With oil in crankcase, start engine and check for leaks around filter element. Retighten only as much as necessary to eliminate leaks; do not overtighten.

CRANKCASE BREATHER

The crankcase breather prevents pressure from building up in the crankcase. It also prevents oil contamination by removing moisture or gasoline vapors and other harmful blow-by materials from the crankcase. These vapors are routed to the carburetor where they are mixed with incoming air and burned in the combustion chamber. A sticky breather valve can cause leaks, high oil consumption, rough idle, reduced engine power and a rapid formation of sludge and varnish within the engine.

Crankcase Breather Service

This engine uses a crankcase breather valve for maintaining crankcase vacuum. If the crankcase becomes pressurized as evidenced by oil leaks at the seals, clean baffle and valve in a suitable solvent.

Clean or replace crankcase breather baffle periodically. Be sure baffle material doesn't come apart and work into the manifold.

To disassemble, remove breather hose from cap and valve assembly. Remove cap and valve assembly and wash in a suitable solvent. Replace cap and valve if balls do not move freely. Pull baffle out and wash in solvent. To allow free operation of the valve, screens must be positioned as shown in Figure 3.

PRESSURE LUBRICATION

All engines use an oil pump to provide a constant flow of oil to the engine parts. The oil supply collects in the oil base where it is picked up by the oil pump pick-up cup. A by-pass valve is used to control oil pressure. Drain oil before removing oil base and always use a new gasket when replacing the oil base.

Oil Pump

The oil pump (Figure 4) is mounted behind the gear cover and is driven by the crankshaft gear. Inlet pipe and screen assembly are attached directly to the pump body. A discharge passage in pump cover registers with a drilled passage in the crankcase. Parallel passages distribute oil to the front main bearing, rear main bearing, and pressure control bypass valve.

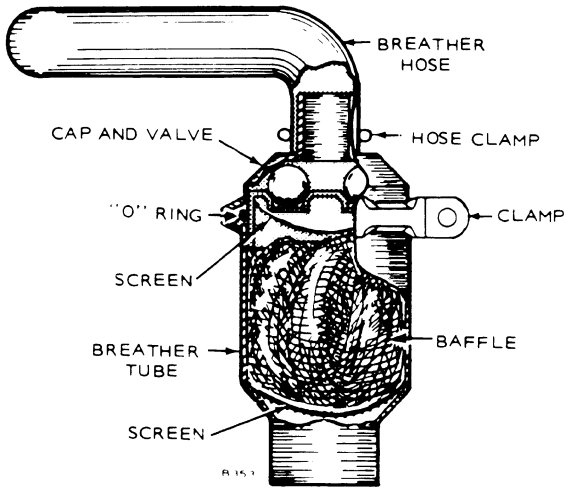


FIGURE 3. CRANKCASE BREATHER

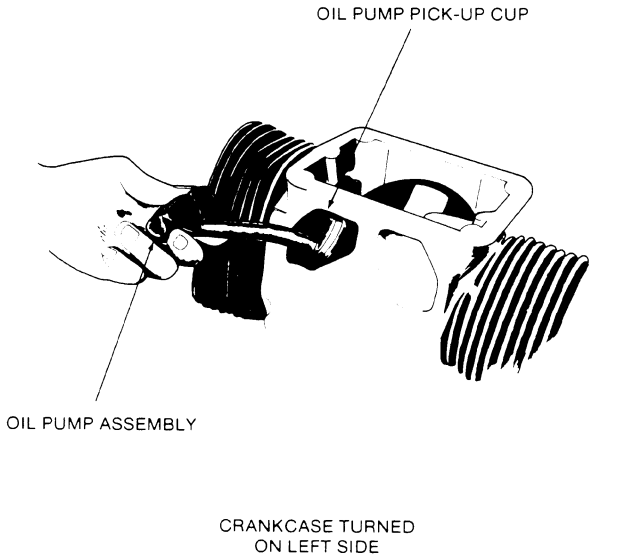


FIGURE 4. OIL PUMP ASSEMBLY

Circumferential grooves in the main bearings supply oil to connecting rod bearings through drilled passages from each main journal. A drilled passage connects the front main bearing oil supply to the front camshaft bearing; rear cam bearing is splash lubricated. Oil overflow from the bypass valve provides lubrication to the camshaft drive gears.

Normal oil pressure should be 30 psi (207 kPa) or higher when the engine is at normal operating temperature. If pressure drops below this value at governed speed, inspect oil system for faulty components.

Check oil pump thoroughly for worn parts. Oil pump to prime it before reinstalling. Except for gaskets and pick-up cup, component parts of the pump are not available individually. Install a new pump assembly if any parts are worn.

Oil By-Pass Valve

The by-pass valve (located to the right and behind gear cover, Figure 5) controls oil pressure by allowing excess oil to flow directly back to the crankcase. Normally the valve begins to open about 20 psi (138 kPa).

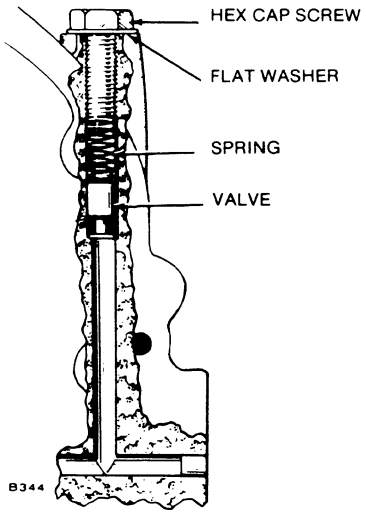


FIGURE 5. BY-PASS VALVE

The valve is non-adjustable and normally does not need maintenance. Determine if valve is operating normally by inspecting plunger action as follows:

1. Remove the 3/8 x 24 x 7/8 cap screw located behind gear cover and under governor arm.

2. Remove spring and plunger with a magnet tool.

3. Determine proper valve operation by checking the spring and plunger according to the following measurements.

   Plunger Diameter..... 0.3105 to 0.3125 in. (7.89 to 7.94 mm)

   Spring
   Free Length..... 1.00 inch (25.4 mm)
   Load ..... 2.6±0.2 lbs. (11.6±0.9 N) when compressed to 0.5 inch (12.7 mm)

4. Check the valve seat and clean away any accumulation of metal particles which could cause erratic valve action. Verify that the valve seat is not damaged.

5. Clean plunger and spring in parts cleaning solvent and install.

Fuel System

CARBURETOR

The carburetor mixture screw settings were set for maximum efficiency at the factory and should normally not be disturbed. If adjustments seem necessary, first be sure the ignition system is working properly and governor sensitivity is properly adjusted.

If adjustment is needed, refer to Figures 1 and 2 and proceed as follows:

⚠CAUTION ***Forcing the mixture adjustment screw tight will damage the needle and seat. Turn in only until light tension can be felt.***

1. **Walbro mixture screw settings:**

   Turn both mixture screws in until lightly seated (Figure 1), then back the idle mixture screw out 1/2 turn and the main mixture screw out 1-3/4 turns.

   Nikki limited idle adjustment mixture screw settings:

   The carburetor has a limited idle adjustment range between stops of ± 1/8 turn. The screw should only be adjusted within these limits; in to lean the mixture, out to richen. There is no main mixture adjustment.

   When replacing the idle mixture screw, turn in until lightly seated, then back screw out 1-1/2 turns. Replace limiter cap so the tab is approximately centered.

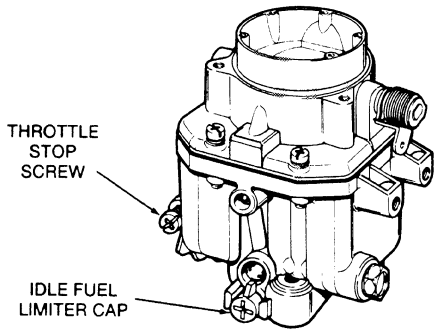
2. Start the engine and allow it to warm up thoroughly (at least 10 minutes).

   Some equipment manufacturers may require higher throttle stop speed and governor low speed rpm settings. Refer to equipment manufacturer's Operator's Manual for the correct rpm settings. When rpm settings are not specified by the equipment manufacturer use the rpm settings listed in Steps 3 and 5.

3. Move the engine speed control to the slow position. Back out the low speed screw on the governor so the throttle stop screw on the carburetor controls engine speed (Figure 2). Adjust the throttle stop screw for 1000 rpm idle.

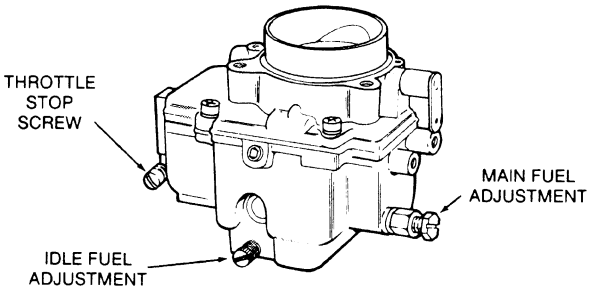
4. Determine the best idle mixture setting by first turning the idle adjustment screw in until engine speed drops and then outward until engine speed drops again. Over a narrow range between these two settings, engine speed remains at its highest.

   Set the adjustment screw about 1/8 turn outward (rich) from the midpoint of this range. On Nikki carburetors the idle adjustment is limited to ± 1/8 turn. Do not go beyond these limits.



FS-1406-2

NIKKI CARBURETOR WITH SEMI-AUTOMATIC CHOKE AND LIMITED IDLE MIXTURE SCREW.



FS-1002

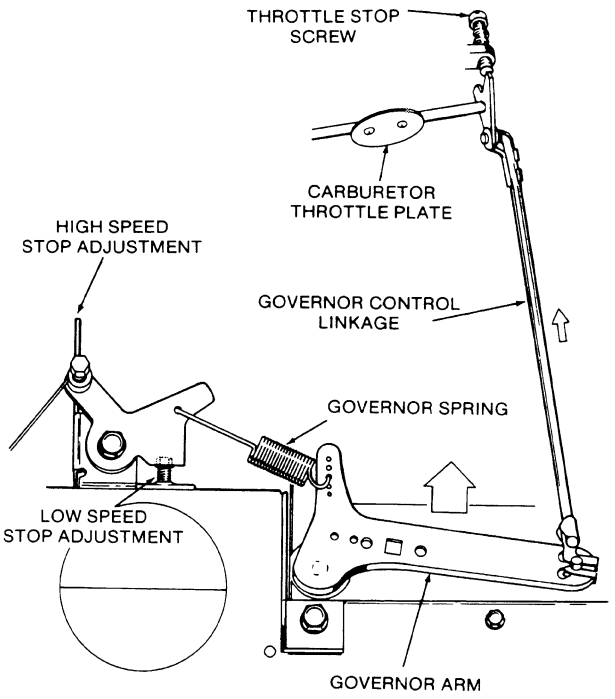
WALBRO CARBURETOR

FIGURE 1. CARBURETOR ADJUSTMENT

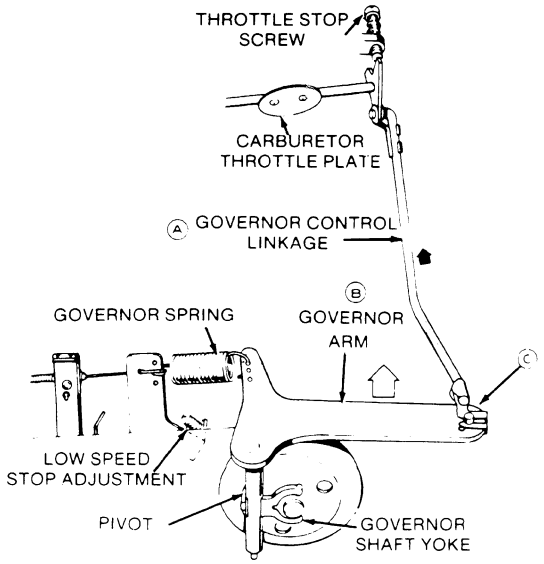
5. Readjust the throttle screw for 1000 rpm idle, then adjust the governor low speed screw for 1100 rpm idle.

6. Move the engine speed control to the fast position. Bend the high speed stop on the governor so the engine runs at the vehicle manufacturer's recommended speed (Figure 2.)

7. Check the main mixture adjustment (Walbro carburetors only) by rapidly accelerating the engine from idle to full speed. The engine should accelerate evenly and without hesitation. If it does not, turn the main adjustment screw out in 1/8 turn increments until the engine accelerates smoothly, but do not turn it out more than 1/2 turn beyond the original setting.



FRONT PULL GOVERNOR



SIDE PULL GOVERNOR

FIGURE 2. GOVERNOR SPEED ADJUSTMENT

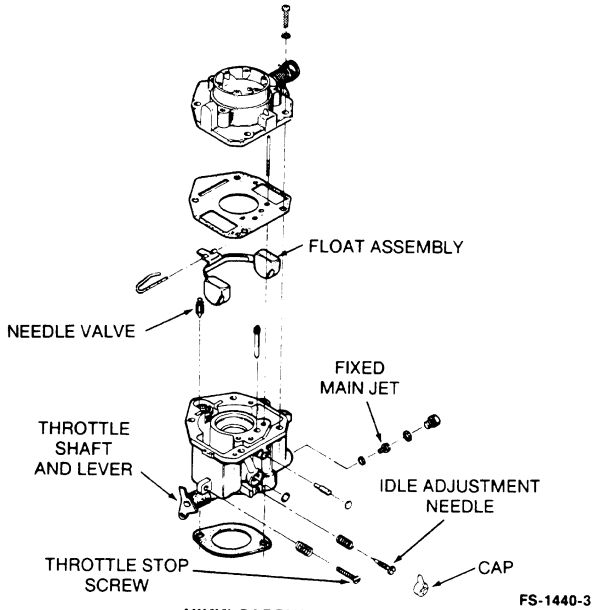
CARBURETOR OVERHAUL

Carburetion problems that are not corrected by mixture adjustments are usually a result of gummed-up fuel passages or worn internal parts. The most effective solution is a carburetor overhaul.

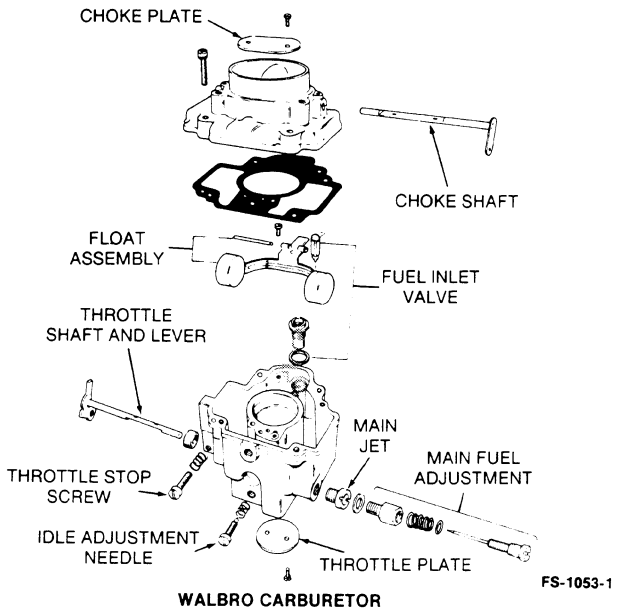
In general, overhauling a carburetor consists of disassembly, a thorough cleaning, and replacement of worn parts. Carburetor repair parts are available.

General instructions for overhauling a carburetor are given below. Carefully note the position of all parts while removing to assure correct placement when reassembling. Read through all the instructions before beginning for a better understanding of the procedures involved. Carburetor components are shown in Figure 3.

⚠WARNING ***Ignition of fuel can cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, or other igniter near the fuel system.***



NIKKI CARBURETOR



WALBRO CARBURETOR

FIGURE 3. CARBURETOR ASSEMBLY

Removal

1. Remove air cleaner and hose.
2. Disconnect governor and throttle linkage, choke control and fuel line from carburetor.
3. Remove the four intake manifold cap screws and lift complete manifold assembly from engine.
4. Remove carburetor from intake manifold.

Disassembly (Walbro)

1. Remove throttle and choke plate retaining screws, then plates. Pull out throttle and choke shafts.
2. Remove main jet and idle adjustment needle.
3. Remove attaching screws and separate upper and lower carburetor sections.
4. Carefully note position of float assembly parts, then pull out retaining pin and float assembly.
5. Remove needle and unscrew needle valve seat.

Disassembly (Nikki limited idle adjustment)

1. Remove main jet and idle adjustment needle.
2. Remove attaching screws and separate upper and lower carburetor sections.
3. Carefully note position of float assembly parts, then pull out retaining pin and float assembly.
4. Remove needle valve.

Cleaning and Repair

1. Soak all metal components not replaced in carburetor cleaner. Do not soak non-metal floats or other non-metal parts. Follow the cleaning manufacturer's recommendations.
2. Clean all carbon from the carburetor bore, especially where the throttle and choke plates seat. Be careful not to plug the idle or main fuel ports.
3. Dry out all passages with low pressure air (35 PSI). Avoid using wire or other objects for cleaning which may increase the size of critical passages.
4. Check the condition of the adjustment needle; replace if damaged. Replace float if loaded with fuel or damaged.
5. Check the choke and throttle shafts for excessive play in their bore. This condition may necessitate replacement of the carburetor.
6. Replace old components with new parts.

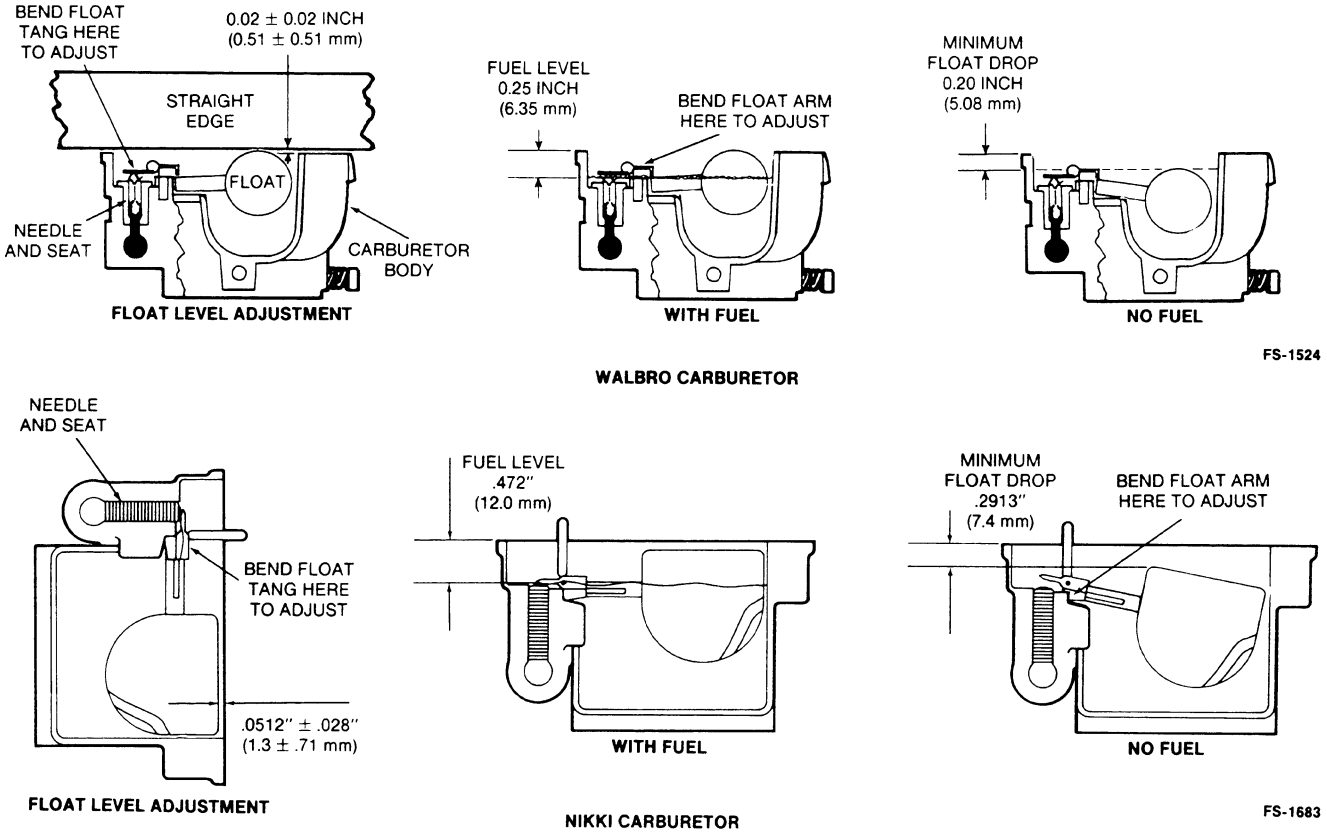


FIGURE 4. CARBURETOR FLOAT LEVEL ADJUSTMENTS

Reassembly and Installation (Walbro)

1. Install needle valve and seat, main jet and float assembly. Make sure that float pivot pin is properly placed and that float moves freely without binding.
2. Gently push float tang down until needle **just** seats. (Figure 4). Measure float level; adjust if necessary. Release float tang and measure float drop; adjust if necessary. When checking float level and drop, measure to float body, not seam.
3. Position gasket on carburetor and attach carburetor sections together with screws.
4. Slide in throttle shaft and install plate using new screws. Before tightening the screws, the plate must be centered in the bore. To do so, back off the throttle stop screw as necessary and completely close the throttle lever. Seat the plate by tapping with a small screwdriver, then tighten screws. Install the choke shaft and plate in the same manner.
5. Install idle adjustment screw, throttle stop screw, and main fuel adjustment needle.
6. Mount carburetor on intake manifold and install assembly on engine.
7. Mount air cleaner assembly. Connect air intake hose, breather hose, fuel line, vacuum line, and throttle linkage.
8. Adjust carburetor and governor according to directions given in this section.

Reassembly and Installation (Nikki limited idle adjustment)

1. Install needle valve, main jet, and float assembly. Make sure float pivot pin is properly placed and float moves freely without binding.
2. Turn carburetor on its side and measure float level (Figure 4). Adjust float level only if necessary. Measure float drop (the distance from the top of carburetor body to top of float). Adjust only if necessary.
3. Position gasket on lower carburetor section and install upper carburetor section.
4. Install idle adjustment screw, throttle stop screw, and fixed main jet plug.
5. Mount carburetor on intake manifold and install assembly on engine.
6. Mount air cleaner assembly. Connect air intake hose, breather hose, fuel line, vacuum line, and throttle linkage.
7. Adjust carburetor and governor according to directions given in this section.

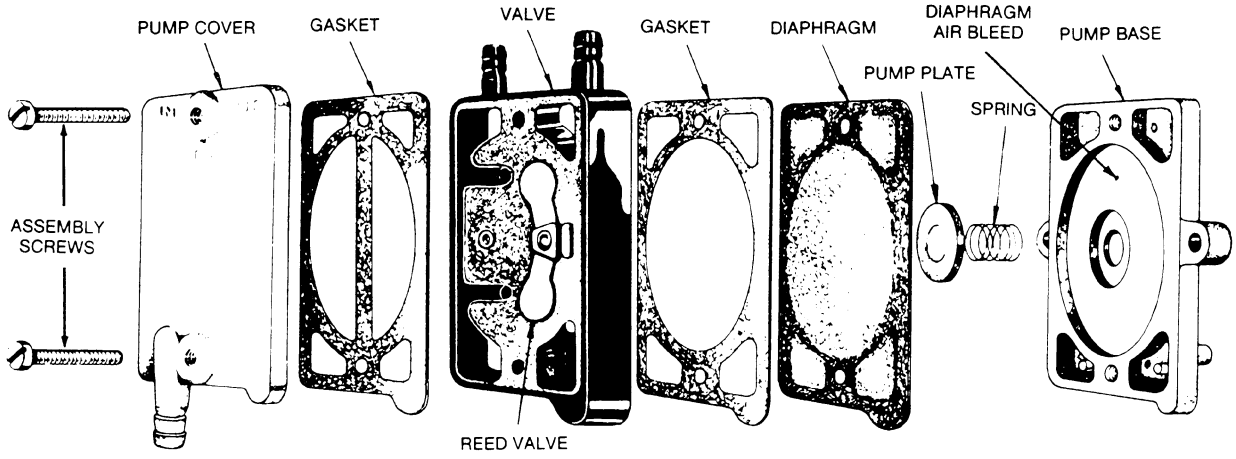


FIGURE 5. EXPLODED VIEW OF FACET FUEL PUMP

PULSATING-DIAPHRAGM FUEL PUMP

Pulsating-diaphragm fuel pumps, or pulse pumps, rely on changes in crankcase vacuum to create a pulsating movement of the pump diaphragm. As the engine's pistons move outward, a vacuum is created. This vacuum is transmitted to the pump diaphragm, causing it to pull back and suck fuel into the pump. As the engine's pistons move inward, crankcase vacuum is reduced and the diaphragm return spring pushes the pump diaphragm forward, forcing fuel through the pump outlet.

Fuel Pump Test Procedure

Before testing make certain that fuel pump vacuum line connections are tight and free of leaks.

1. Operate engine at an idle for five minutes to ensure that carburetor is full of fuel.
2. Shut engine off and remove fuel inlet line from fuel pump.

⚠WARNING ***Spilled fuel can ignite and cause serious personal injury or death. Thoroughly clean-up any spilled fuel.***

3. Connect a vacuum gauge to fuel pump inlet using a piece of fuel hose with clamps.

4. Start engine and allow to idle for at least five seconds. Record vacuum gauge reading.

5. Move throttle control to high idle position. Wait at least five seconds and record vacuum gauge reading.

6. Shut engine off and remove vacuum gauge hose from fuel pump inlet. Connect fuel inlet line to fuel pump.

7. Remove fuel outlet line from fuel pump.

⚠WARNING ***Spilled fuel can ignite and cause serious personal injury or death. Thoroughly clean-up any spilled fuel.***

8. Connect a pressure gauge to fuel pump outlet using a piece of fuel hose with clamps.

9. Start engine and allow to idle for at least five seconds. While holding pressure gauge level with pump outlet, record pressure gauge reading.

10. Move throttle control to high idle position and allow engine to run for at least five seconds. While holding pressure gauge level with pump outlet, record pressure gauge reading.

11. Shut engine off and remove pressure gauge hose from fuel pump outlet. Connect fuel outlet line to fuel pump.

Repair or replace the fuel pump if test readings are not within the values specified in TABLE 1.

TABLE 1
PULSE PUMP TEST SPECIFICATIONS

Engine Speed	Pump Inlet Vacuum (Minimum)	Pump Outlet Pressure (Minimum)
Low Idle	2.6 inches of mercury	1.7 psi
High Idle	2.6 inches of mercury	1.7 psi

Fuel Pump Repair

This section applies only to Facet fuel pump. The Nikki fuel pump is not repairable; replace unit if test readings are not within the values specified in TABLE 1.

1. Remove the vacuum and fuel lines. Inspect the lines for wear, cracking or brittleness. Replace as necessary.
2. To insure correct alignment when reassembling, scribe a line across the outer pump parts on each end of the pump.
3. Holding the pump carefully, remove the assembly screws (Figure 5).
4. Carefully pull apart the pump sections and check for worn or damaged parts. Replace with new parts where necessary or install pump repair kit.
5. Check and unclog if necessary the small diaphragm air bleed hole located behind the pump diaphragm in the pump base.

⚠CAUTION ***A clogged diaphragm air bleed hole can cause diaphragm wear and seal damage while inhibiting pump operation.***

6. Replace gaskets and reassemble pump. Reinstall assembly screws, checking the scribe marks for proper alignment. Reinstall fuel and vacuum lines and clamps.

⚠WARNING ***Use care when reassembling and reinstalling the pump. Improper parts alignment or misconnected fuel lines can result in leaking fuel, creating a serious fire hazard.***

AIR CLEANER

⚠CAUTION ***If air cleaner becomes too dirty, engine will not receive sufficient air to run properly. Symptoms: Loss of power, flooding, hard starting and overheating.***

Engine is equipped with a paper element. If the engine is equipped with polyurethane precleaner, it must be removed, cleaned and oiled every 25 hours of operation, or more under extremely dusty conditions.

1. To clean precleaner, wash in water and detergent (Figure 6). Remove excess water by squeezing like a sponge and allow to dry thoroughly. Distribute two tablespoons of SAE 30 engine oil evenly around the precleaner. Knead into and wring excess oil from precleaner.

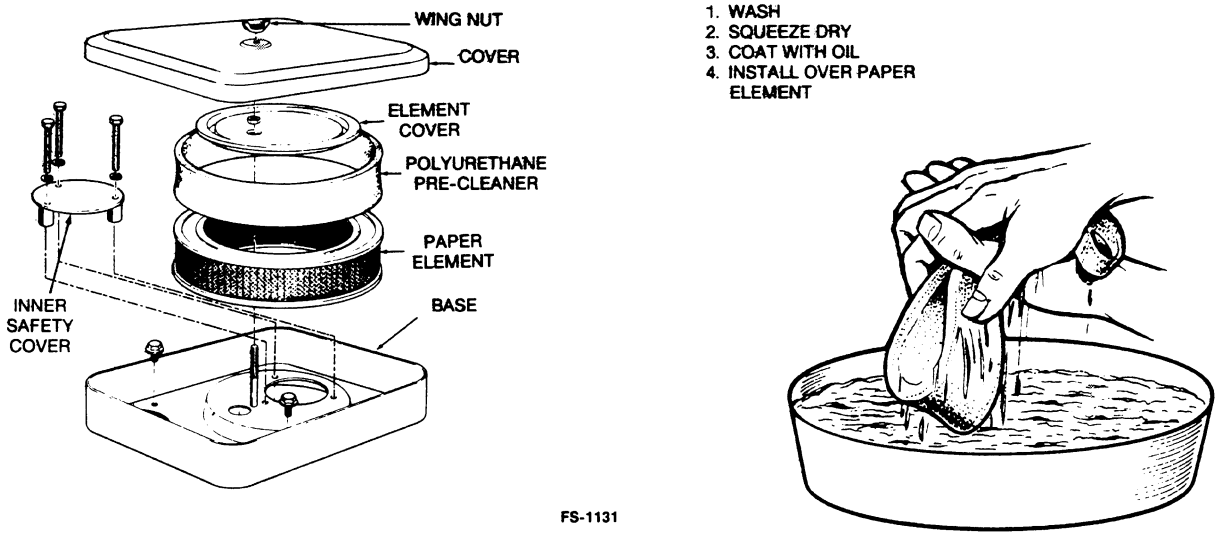


FIGURE 7. AIR CLEANER ASSEMBLY

2. Depending on conditions in which the engine is operating, the inner paper element should be replaced whenever it becomes excessively dirty or oily.

⚠CAUTION ***Never run engine with air cleaner removed. Dirt will enter engine and wear out rings causing excessive blow-by.***

DASHPOT ADJUSTMENT

On engines equipped with a dashpot, adjust as follows:

1. Pull governor arm and linkage (away from carburetor) until throttle stop contacts throttle stop screw.
2. Holding throttle against throttle stop screw, adjust dashpot to obtain 0.050 inch (1.27 mm) clearance (Figure 8).
3. Secure dashpot to air cleaner support bracket with hex nut.

⚠CAUTION ***Do not grip dashpot with a pliers; internal damage may occur. If necessary hold dashpot by hand when tightening hex nut.***

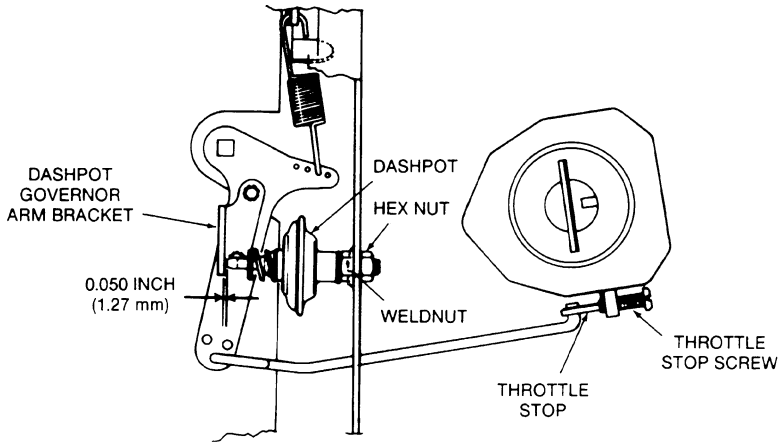


FIGURE 8. DASHPOT CLEARANCE

GOVERNOR ADJUSTMENT

These engines are adapted for use where a wide range of speed settings is desired. Engine speed is controlled at any given point between minimum and maximum by simply shifting the throttle lever on the dash panel until the desired speed is reached.

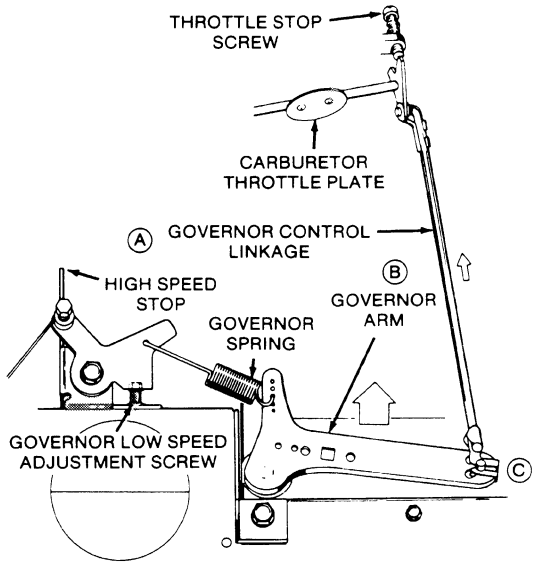
A reliable instrument for checking engine speed is required for accurate governor adjustment. Engine speed can be checked with a tachometer.

Check the governor arm, linkage, throttle shaft, and lever for a binding condition or excessive slack and wear at connecting points. A binding condition at any point will cause the governor to act slowly and regulation will be poor. Excessive looseness may cause a hunting condition and regulation could be erratic. Work the arm back and forth several times by hand while the engine is stopped to check for above conditions.

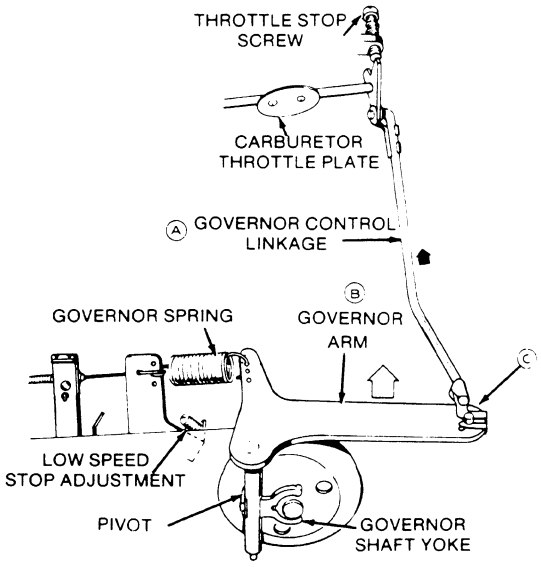
If the governor is hunting or not operating properly, adjust as follows (Figure 9).

1. Disconnect linkage (A) from one of holes (C).
2. Push linkage (A) and governor arm (B) as far back (toward carburetor) as they will go.
3. Holding linkage and governor arm toward direction of carburetor, insert end of linkage into whichever hole (C) in governor arm lines up the closest. If between two holes, insert in next hole out. Install clip to secure rod to arm.

On side pull governor the governor spring is set by the factory in the third hole of the governor arm. (Third hole from pivot). On front pull governors the governor spring is set by the factory in the second hole of the governor arm adapter. (Second hole from pivot.) To increase sensitivity, move spring loop into a hole closer to the pivot. To decrease sensitivity, move spring loop into a hole farther away from the pivot. After sensitivity has been set, recheck the low speed rpm setting. Adjust if necessary.



FRONT PULL GOVERNOR



SIDE PULL GOVERNOR

FIGURE 9. VARIABLE SPEED GOVERNOR ADJUSTMENTS

Ignition and Battery Charging

BREAKER POINT IGNITION SYSTEM

This section applies to those engines equipped with an automotive type battery ignition system. Both spark plugs fire simultaneously, thus the need for a distributor is eliminated. To maintain maximum engine efficiency, change the breaker points every 200 hours of operation.

IGNITION TIMING

The timing is preset at the factory. Slight timing changes can be made by adjusting the point gap.

Breaker Point Replacement and Adjustment

1. Remove spark plugs.
2. Remove breaker box cover. Rotate crankshaft clockwise (facing flywheel) until points are fully open.
3. Remove condenser (screw A) and detach condenser lead and coil lead (screw B). See Figure 1.
4. Remove two Allen screws (C) and lift breaker assembly from engine.
5. Replace condenser and point assembly with new parts and reinstall using above procedure in reverse order of removal.
6. Adjust point gap by rotating crankshaft clockwise (facing flywheel) by hand until the points are fully open. Set the point gap (using flat feeler gauge) at 0.020 inch (0.51 mm) by adjusting the socket head screw (D) inward or outward (Figure 1). A 0.020 inch point gap is equivalent to 20° BTC. Make sure feeler gauge is clean and free of any grease, oil or dirt.

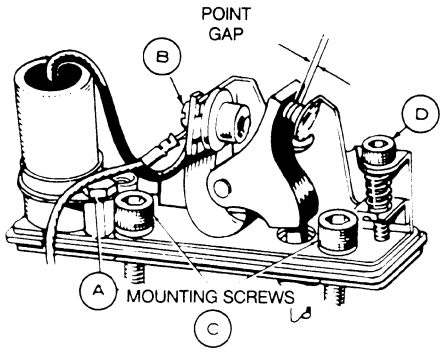


FIGURE 1. SETTING POINT GAP

7. Replace breaker box cover, coil wire, spark plugs, and spark plug cables.

Continuity Test

As a check for proper ignition timing a continuity test may be performed:

1. Adjust breaker points.
2. Remove blower housing to expose timing marks on top of gearcase cover and flywheel (Figure 2).

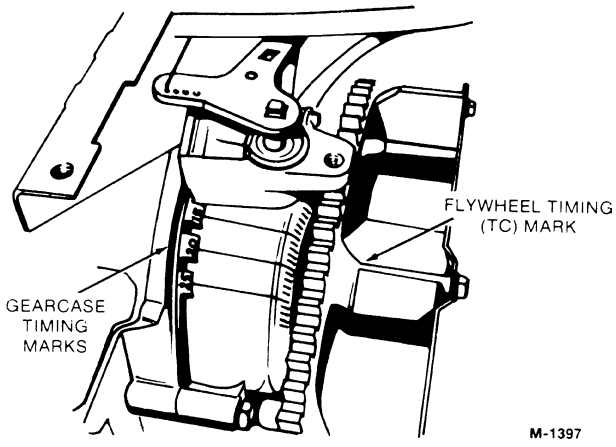


FIGURE 2. TIMING MARKS

3. Rotate flywheel clockwise until timing mark is aligned with the proper timing mark (Figure 2) located on top of gearcase cover. Refer to *SPECIFICATIONS* for proper number of timing degrees.
4. Connect an ohmmeter or a continuity test lamp set across the ignition breaker points. Touch one test prod to the coil lead terminal (screw B, Figure 1).
5. Touch the other test prod to a good ground on the engine.
6. Turn crankshaft against rotation (counterclockwise) until the points close. Then slowly turn the crankshaft with rotation (clockwise).
7. The lamp should go out or continuity lost just as the points break which is where ignition occurs. If timing is early (advanced) the point gap is too large. If timing is late (retarded) the point gap is too small. Adjust point gap accordingly.

ELECTRONIC IGNITION SYSTEM

This section applies to those engines equipped with an electronic battery ignition system. Both spark plugs fire simultaneously, thus the need for a distributor is eliminated. The electronic ignition module is located on the engine gear cover behind the flywheel. The module receives a timing signal from the magnets located within a trigger ring which rotates on the engine crankshaft (Figure 3). If the electronic ignition is suspected of malfunctioning, proceed as follows:

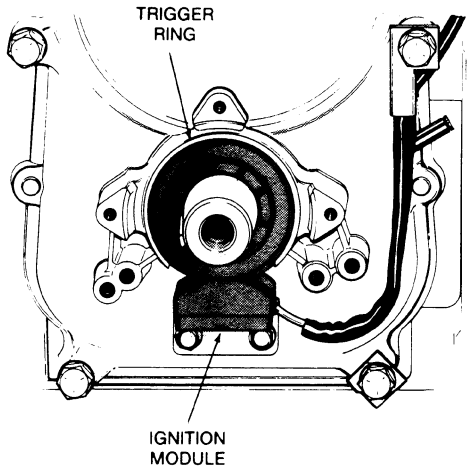


FIGURE 3. IGNITION MODULE AND TRIGGER RING

1. Check all electrical connections to be sure they are clean and tight. If all connections are good and wiring is intact, go to step 2.

⚠WARNING ***The electronic ignition will deliver full voltage to the spark plugs even when rotated by hand. Care should be taken to avoid an electrical shock.***

⚠WARNING ***Failure to remove spark plugs before turning engine over may result in engine starting, which may cause severe personal injury.***

⚠WARNING ***Failure to ground spark tester away from spark plug hole may result in ignition of cylinder gases and may cause severe personal injury.***

2. Pull spark plug wires off spark plugs and remove spark plugs. Connect an approved spark tester to each of the spark plug wires and ground them away from spark plug hole. Turn key on and crank engine over for 5 seconds while watching for spark. If a spark occurs regularly, the problem is not in the ignition system. If no spark occurs, go to step 3.

⚠CAUTION ***Never put jumper lead to the coil negative terminal. This will cause failure of the electronic ignition module.***

3. Connect a jumper lead directly from the positive battery terminal to the positive (+) coil terminal (smaller diameter of the two threaded posts). Crank engine over while watching for spark. If spark occurs, the problem is in the low oil pressure cut out switch or related wiring, the lubricating system (low oil pressure), or in the other circuitry bringing voltage to the coil. If no spark occurs, go to step 4.

4. Refer to IGNITION COIL section to test coil for proper resistance. If coil checks out good, go to step 5.

5. Connect positive side of voltmeter to negative (-) coil terminal (larger diameter of the two threaded posts) and negative side of voltmeter to engine ground. Turn key on and rotate flywheel slowly by hand while observing voltmeter. Voltage should switch back and forth between battery voltage and 1-1.5. If voltage does not switch properly, replace ignition module.

6. Install spark plugs and wires. If ignition module is being replaced, be sure to connect red lead from new ignition module to positive (+) terminal of coil, black lead from module to negative (-) terminal of coil.

⚠CAUTION ***Never put B+ lead to the coil negative terminal. This will cause failure of the electronic ignition module.***

IGNITION TIMING

The ignition timing is preset at the factory and is not adjustable. For troubleshooting purposes, it is possible to make an approximate check of the ignition timing by removing blower housing and using the gearcase timing marks.

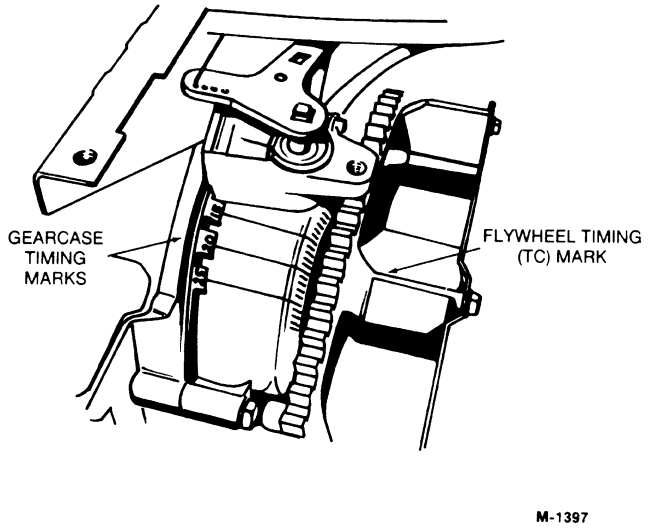


FIGURE 4. IGNITION TIMING MARKS

Continuity Test

1. Pull spark plug wires off spark plugs and remove spark plugs and blower housing.

   ⚠CAUTION ***Failure to remove spark plugs before turning engine over may result in engine starting, which may cause severe personal injury.***

2. Turn ignition on.

3. Connect a voltmeter between the negative (-) coil terminal (larger diameter of the two threaded posts) and a good engine ground.

   ⚠WARNING ***The electronic ignition will deliver full voltage to the spark plugs even when rotated by hand. Care should be taken to avoid an electrical shock from the spark plugs.***

4. Rotate the flywheel slowly by hand in the clockwise direction until the voltmeter reading jumps from approximately 1 volt to battery voltage. At this point the flywheel timing mark should line up with the proper timing degree (see *SPECIFICATIONS*) mark located on the gearcase timing marks. To recheck timing, the flywheel must be rotated another complete revolution in the clockwise direction. Moving the flywheel back and forth across the timing marks will not activate the electronic ignition control.

5. Install spark plugs, wires, and blower housing.

BREAKER POINT AND ELECTRONIC IGNITION COILS

To test primary and secondary windings within the ignition coil first make sure the ignition power is off and coil is at room temperature of 70°F (21°C).

1. Use a Simpson 260 VOM or equivalent.

2. Place a black lead on the negative (-) coil terminal and a red lead on the positive (+) coil terminal. Primary resistance should read between 3.87-4.73 ohms for breaker point coils, and between 2.90-3.60 for electronic ignition coils.

3. Change resistance setting on ohmmeter. Place ohmmeter leads inside on spark plug cable holes (Figure 5). Secondary resistance should read between 12,600-15,400 ohms for breaker point ignition coils, and between 14,500-19,800 ohms for electronic ignition coils.

4. If any of the above conditions are not met, replace coil.

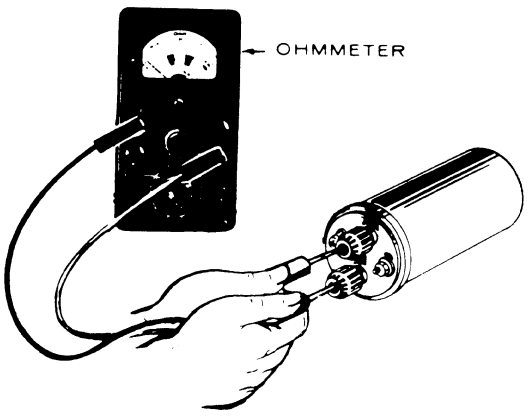


FIGURE 5. COIL TEST

SPARK PLUGS

Check and regap spark plugs every 100 hours of operation (Figure 6). Replace spark plugs that show signs of fouling or electrode erosion.

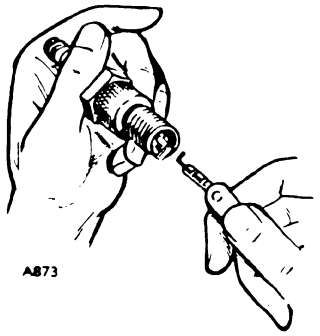


FIGURE 6. SPARK PLUG GAP

BATTERY INSPECTION

Check battery cells with a hydrometer. (Figure 7). The specific gravity reading should be approximately 1.260 at 77°F (25°C).

If one or more cells are low on water, add distilled water and recharge. Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

Keep the battery terminals clean and tight. Push the cable terminal down flush with or slightly below the top of the battery post (Figure 8). After making connections, coat the terminals with a light application of petroleum jelly or grease to retard corrosion.

Poor contact at the battery cable connections is often a source of trouble. Make sure battery cables are in good condition and that contacting surfaces are clean and tightly connected. Do not reverse battery leads. Use recommended battery tools when disconnecting leads to avoid mechanical battery damage.

⚠WARNING ***Ignition of explosive battery gases can cause severe personal injury. Do not smoke while servicing batteries.***

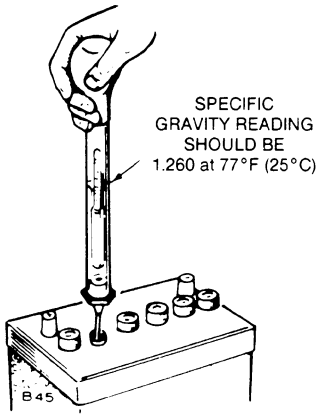


FIGURE 7. SPECIFIC GRAVITY TEST

BATTERY JUMP STARTING

Occasionally, it may be necessary to jump start (charge) a weak battery using a charged booster battery. If jump starting is necessary, the following procedure is recommended in order to prevent starter damage, battery damage and personal injuries.

⚠CAUTION ***Do not engage starter for periods longer than 30 seconds without allowing 5 minutes for starter to cool. Starter failure may result if these guidelines are not followed.***

1. Disconnect engine load.
2. Use only a battery of the same voltage (12V) as is used with your engine.
3. Attach one end of the positive booster cable (red) to the positive (+) terminal of the booster battery. Attach the other end of the positive cable to the positive (+) terminal of your engine battery.
4. Attach one end of the negative (-) booster cable (black) to negative (-) terminal of booster battery. Attach other end of negative cable to a solid chassis ground on your engine.

⚠WARNING ***Do not allow the positive and negative cable ends to touch each other because it will short the battery causing hazardous arcing, which can cause severe personal injury.***

5. Jump starting in any other manner may result in damage to the battery or the electrical system.
6. Turn ignition switch to ON to start engine.

⚠WARNING ***Never jump start a frozen battery. To do so can cause the battery to explode. Never expose the battery to an open flame or an electrical spark because a battery generates highly explosive hydrogen gas.***

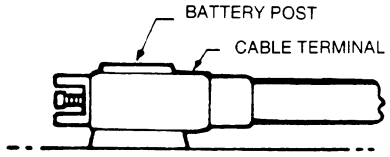


FIGURE 8. BATTERY CABLE CONNECTION

FLYWHEEL ALTERNATOR

This unit is equipped with a permanent magnet flywheel alternator and solid-state voltage regulator-rectifier (output control). See Figure 9. As with all solid-state electrical units, precautions are necessary when servicing. Observe the following:

⚠CAUTION ***This engine uses a 12 volt, negative ground system. Alternator must be connected to battery at all times when engine is running. Do not reverse battery cables.***

Weak ignition spark or a discharged battery indicates trouble in the charging system. But before testing the engine's charging system, always check the battery for serviceability.

Keep these points in mind when testing or servicing the flywheel alternator:

1. Be sure engine is being run long enough and fast enough to recharge battery after each start. Charging system tests require a full charged battery. Alternator output is reduced in direct proportion to engine rpm. Also, power required for accessories reduces power available to recharge battery.
2. The regulator-rectifier has built in protection against open circuits or short circuits on the alternator output (B+) terminal. Either condition will cause the regulator-rectifier to shut off and appear as if it is not functioning. Prior to checking the regulator-rectifier, check all wiring between the regulator-rectifier B+ terminal and the battery positive (+) terminal to assure it is free of open circuits, resistances or short circuits. Also, if the battery is extremely discharged it may have insufficient power to "turn on" the regulator-rectifier.
3. Be sure regulator-rectifier plug (connector) is inserted properly. Plug must bottom in receptacle; this eliminates any resistance due to a poor connection. Keep clean and tight.
4. Make sure alternator stator leads are not shorted together.
5. Be sure regulator-rectifier has a good ground connection. Mating surface for mounting must be clean and fasteners tightened properly.
6. Never reverse the battery leads.

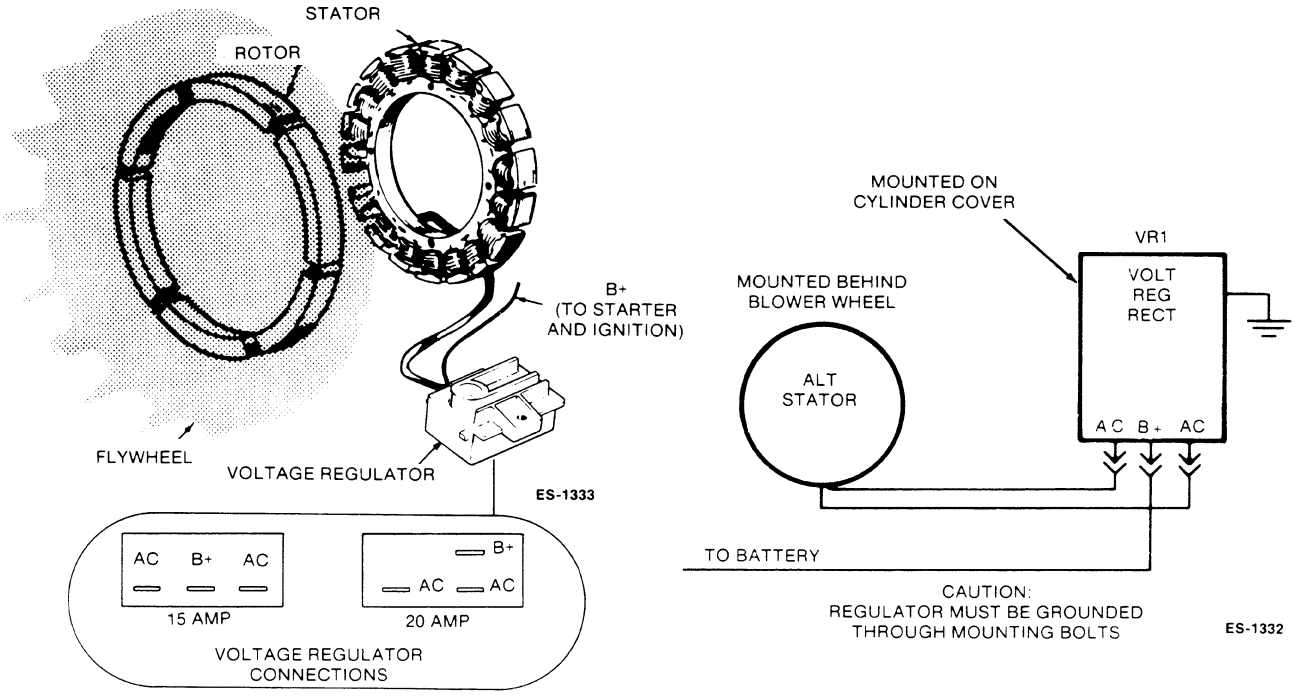


FIGURE 9. FLYWHEEL ALTERNATOR SYSTEM

With the engine running between 1800 to 2600 rpm, observe the panel ammeter (if not already equipped, connect a test ammeter). If no charging is evident, proceed with the *Alternator Output Test.*

ALTERNATOR OUTPUT TEST

Use a volt-ohmmeter such as the Simpson 270, when testing the charging system.

1. With the engine running, check the battery terminal voltage (regulator output) using a DC voltmeter. Voltage output should be within the values specified in Table 1. If voltage is greater than specified replace regulator-rectifier assembly. If voltage is less than specified, proceed to step 2.

2. Examine all wires for loose, corroded, broken connections, short circuits, etc. Check fuses. Repair as needed to assure complete circuits from regulator-rectifier B+ terminal to battery positive (+) terminal and from battery negative (-) terminal to regulator-rectifier case. If battery voltage remains low with engine running, proceed to step 3.

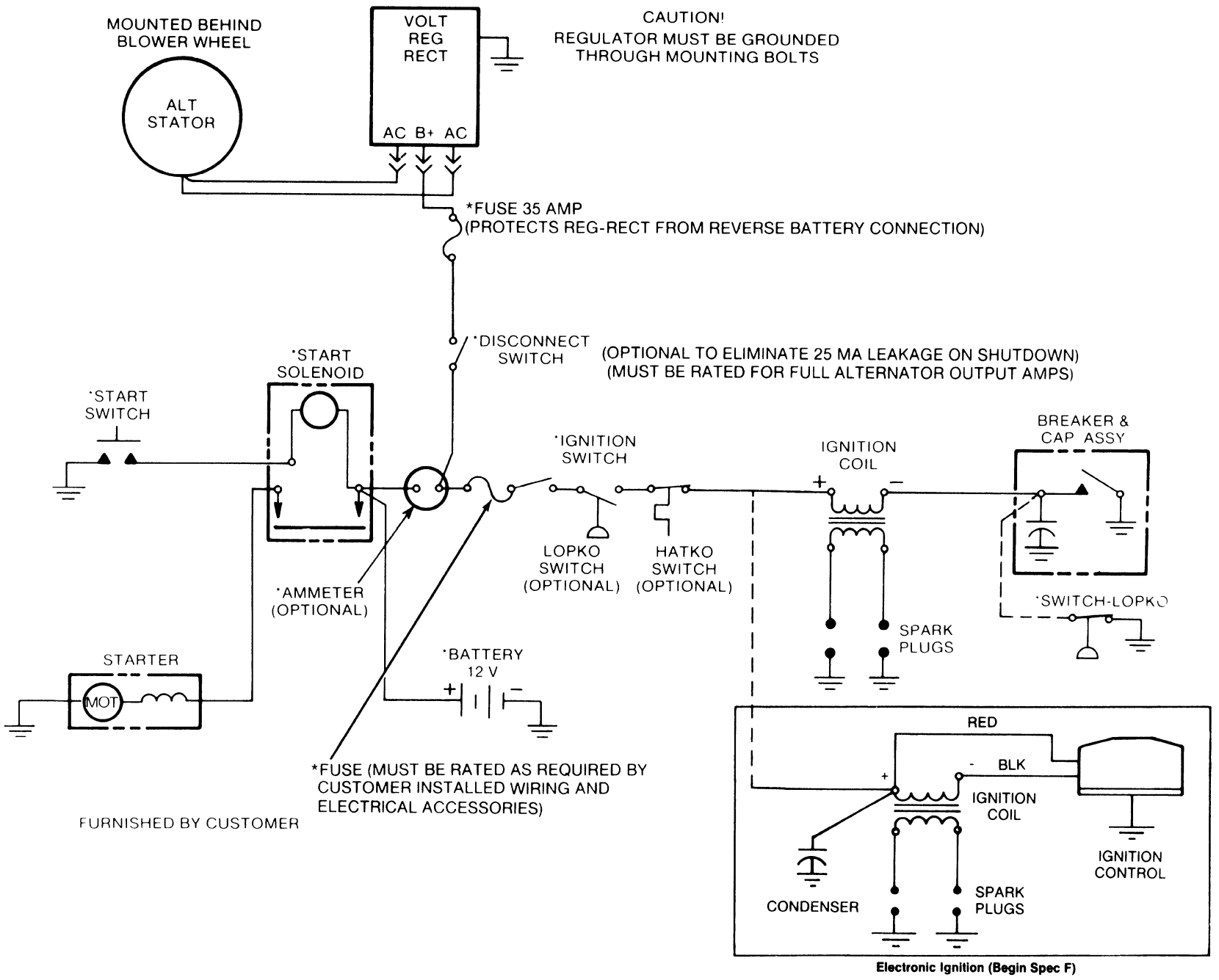
3. Disconnect plug from regulator-rectifier and test the AC voltage at the plug with engine running near 3600 rpm. If AC voltage reads more or less than specified in Table 1, proceed to step 4. If AC voltage is as specified but DC voltage is low, replace regulator-rectifier.

4. Use the Rx1 scale on the ohmmeter for detecting opens in the stator (unit not running). Disconnect plug from regulator-rectifier. Connect ohmmeter test leads to wires coming from stator. Refer to Table 1 for resistance specifications. If resistance is not as specified, replace stator. If stator resistance readings are as specified and windings are not shorted to ground, low AC voltage may be due to loss of magnetism. If so, blower wheel assembly must be replaced. Check for magnetism with steel tool blade. Next, connect one ohmmeter test lead to stator wire, connect the other test lead to ground. If the ohmmeter reading is low the stator is grounded and must be replaced.

TABLE 1. TESTING 15- AND 20-AMPERE SYSTEMS

BASIC TEST	PROCEDURE	TEST VALUES	
		15A. SYSTEM	20A. SYSTEM
1. Battery	Battery Voltage — unit not running.	12 VDC	12 VDC
2. Regulator	Battery Voltage after unit is running 3 to 5 minutes.	13.6 to 14.7 VDC	13.6 to 14.7 VDC
3. Alternator Stator and Wiring	Ohmmeter reading from stator output — unit not running. Check at plug.	0.1 to 0.2 Ohms	0.3 to 0.5 Ohms
4. Alternator and Wiring	Measure AC open circuit stator voltage with unit running. Measure between two stator leads with plug disconnected and unit running at approximately 3600 rpm.	40 VAC minimum 60 VAC maximum	31 VAC minimum 51 VAC maximum

ENGINE WIRING DIAGRAM
(Inertia Type Starter)

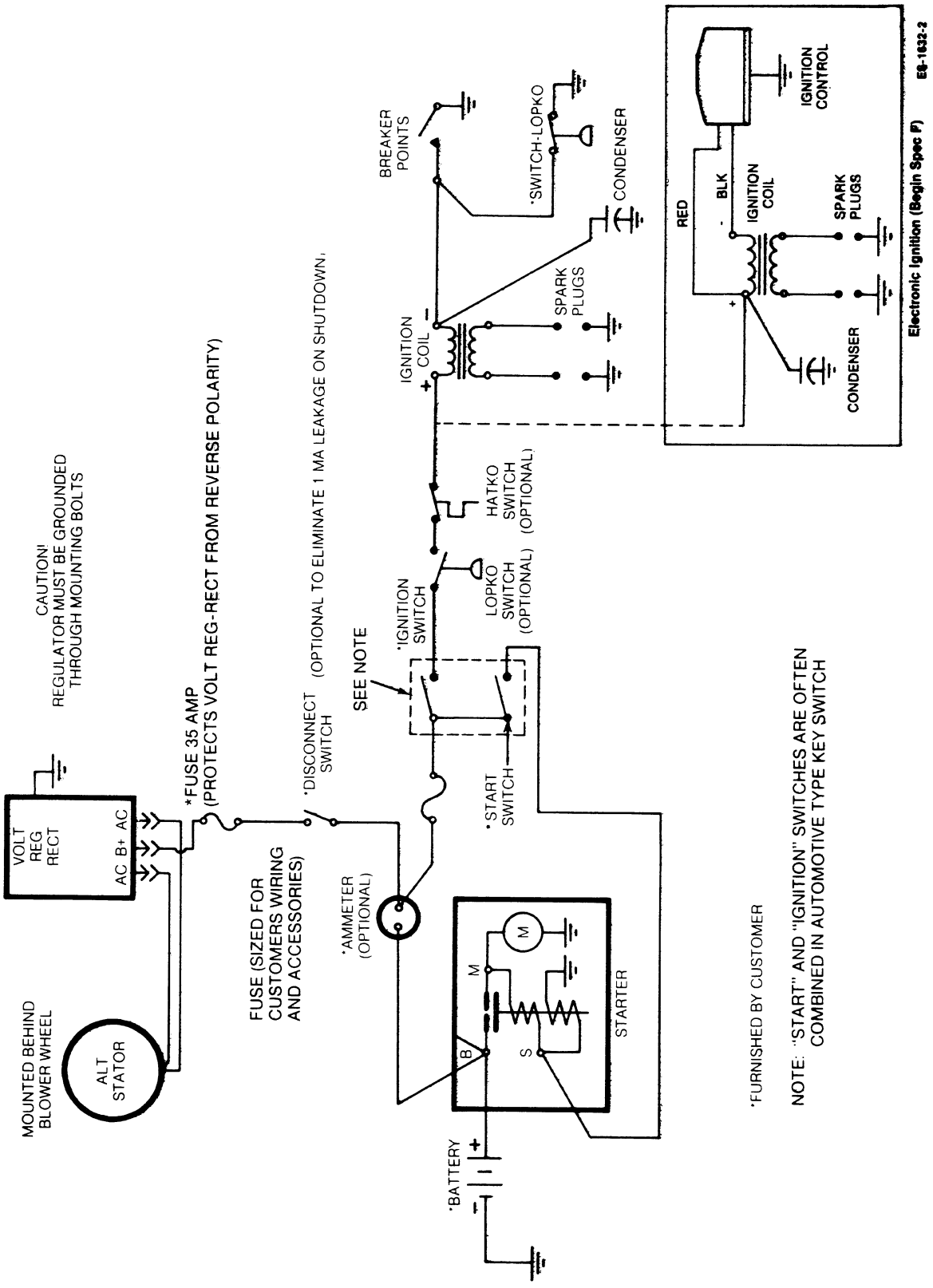


Electronic Ignition (Begin Spec F)

ES-1631-2

ENGINE WIRING DIAGRAM

(Solenoid Shift Type Starter)



Starting System

ELECTRIC STARTER

Normally the starter will require little or no service other than possible brush replacement. However, if through accident or misuse, the starter requires service or overhaul, the following information will provide the information necessary to perform this service.

Service

When starting engine, note starter motor action. The pinion gear should mesh quickly with flywheel ring gear and spin engine. Once engine starts and solenoid opens, the starter should disengage and stop. If starter cranks engine slow, or not at all, check start circuit components. Failure to crank is normally caused by low battery charge, defective battery cables, corroded or poor connections, or low temperatures. If after checking these variables, starter continues to crank slowly, starter must be removed and repaired.

Starter Removal

⚠WARNING ***Accidental starting of the engine can cause severe personal injury of death. Disconnect the battery cables when repairs are made to the engine, controls, or housings.***

1. Remove both battery cables from battery. Disconnect ground cable first.
2. Disconnect battery cable and electrical lead wires from starter.
3. Remove blower housing and cylinder air housing.
4. Remove flywheel and starter motor.

Starter Disassembly (Inertia Type)

1. Remove through-bolts and separate end cap, housing, and armature (Figure 1).
2. Disassemble drive assembly and drive end cap by loosening the self-locking stop nut.
3. Inspect starter for damaged or worn parts.
4. Repair or replace all damaged or worn parts, as needed.

Starter Assembly (Inertia Type)

1. Before reassembling the starter, wipe off any dirt from parts with a clean cloth or blow off with filtered, compressed air.

⚠CAUTION ***Do not immerse bearings in cleaning fluid. Use a brush dipped in clean engine oil for dirt removal.***

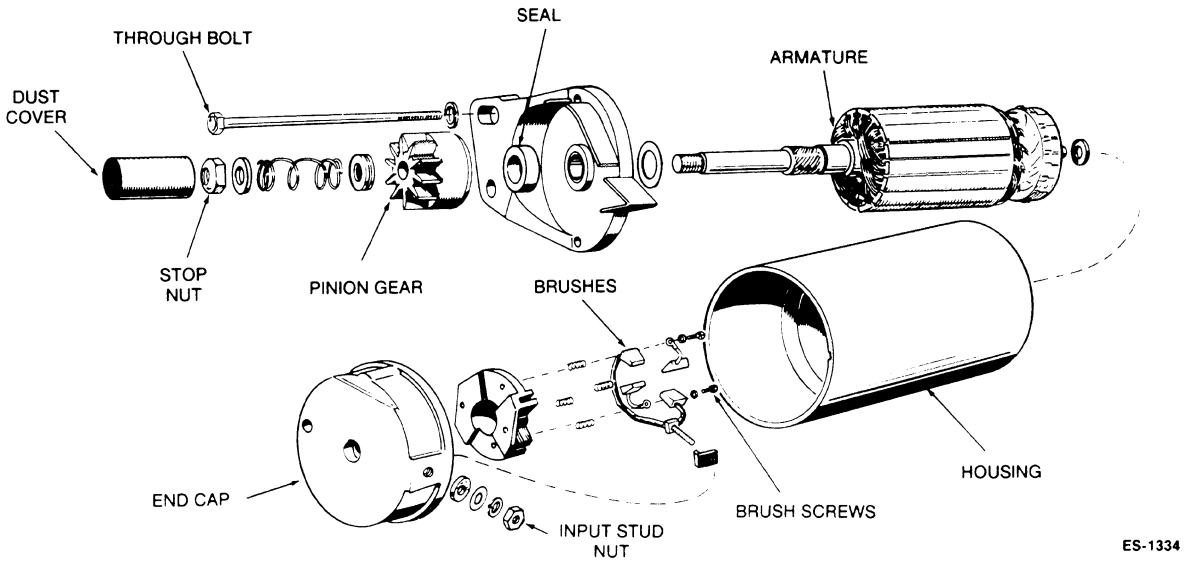


FIGURE 1. STARTER MOTOR (INERTIA TYPE)

2. Assemble brushes so that the chamfered side is away from the brush springs. Make sure brush wires do not rub against the commutaor or end cap.

3. Torque brush screws to a value of 3 to 3.5 ft-lbs (4 to 5 Nm).

4. Torque input stud nut to a value of 4 to 5 ft-lbs (5 to 7 Nm).

5. Apply a thin film of grease to the commutator end of the armature shaft and to the portion of the shaft that contacts the bearings. Apply a generous film of silicone base grease (GE Versilube 322-L) to the shaft threads.

6. Torque stop nut to a value of 20 to 25 ft-lbs (27 to 34 Nm).

7. Torque through bolts to a value of 4.5 to 6 ft-lbs (6 to 8 Nm).

8. Apply a small amount of a silicone based grease (GE Versilube 322-L) to armature shaft spline.

9. Install dust cap, pinion gear, dust cover spacer, anti-drift spring, stop nut washer, and stop nut.

10. Push dust cover on until it snaps into position.

Starter Disassembly (Solenoid Shift Type)

1. Remove "M" terminal nut and wire lead from solenoid (Figure 2).

2. Remove the two solenoid mounting screws and remove solenoid.

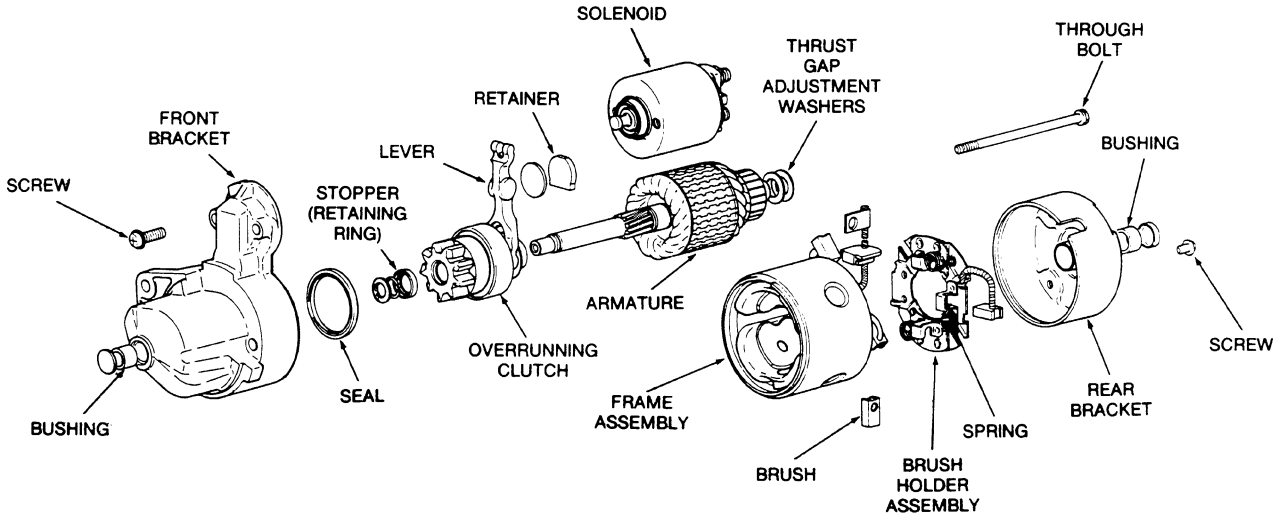
3. Scribe a mark across frame and rear bracket to aid in assembly. Remove the two through bolts.

4. Remove rear bracket and frame assembly.

5. Carefully remove armature and lever from front bracket. Note direction of lever and retainer.

6. Remove the two brush mounting screws, and remove the rear bracket.

7. Remove brush holder assembly from the frame by pulling the brushes out.



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FIGURE 2. STARTER MOTOR (SOLENOID SHIFT TYPE)

8. Push stopper toward pinion and remove snap ring (Figure 3).

9. Remove stopper and overrunning clutch from armature shaft.

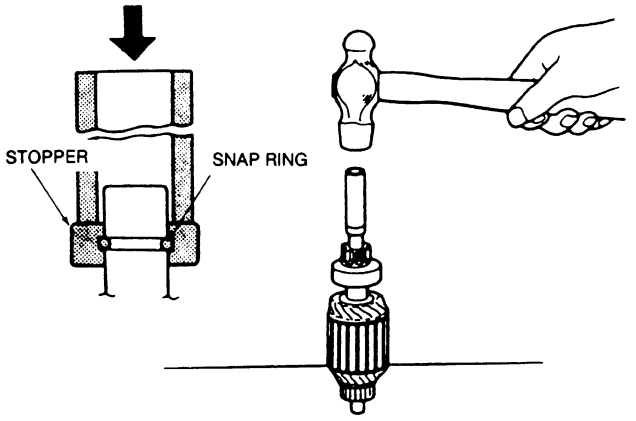


FIGURE 3. REMOVING OVERRUNNING CLUTCH

10. Inspect starter for damaged or worn parts.

11. Repair or replace all damaged or worn parts, as needed.

Starter Assembly (Solenoid Shift Type)

1. Install seal in nose housing. Install overrunning clutch on the armature shaft.

2. Slide stopper on the armature shaft. Position snap ring in groove in armature shaft.

3. Pull stopper all the way over snap ring (Figure 4). It may be necessary to tap snap ring into groove with a punch while maintaining tension on stopper.

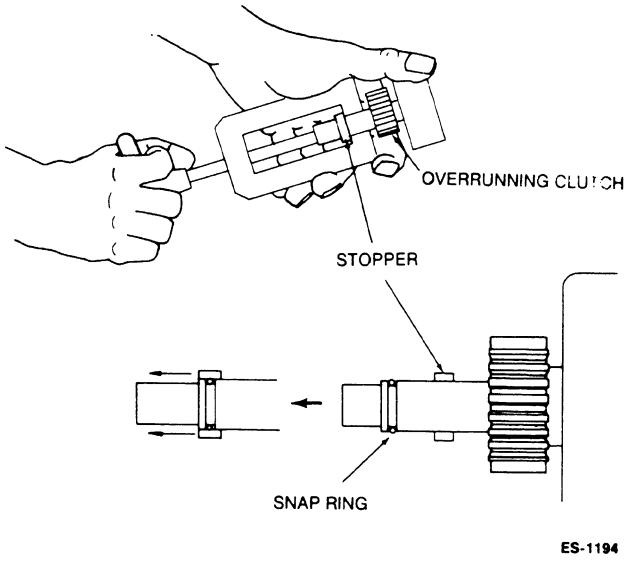


FIGURE 4. INSTALLING STOPPER

4. Lubrication: When starter motor is assembled apply grease to each of the following points (Recommended grade: Multemp PS No. 2):

   - Armature shaft spline
   - Both bushings (Both ends of armature)
   - Stopper on armature shaft
   - Pinion gear
   - Sliding portion of lever

5. Fit overrunning clutch into lever, and install with armature in the front bracket.

6. Install lever retainer and spacer. Position frame assembly over armature on the front bracket.

7. Install brush holder assembly. Position brushes in brush holder. Make certain positive lead wires are not grounded.

8. Install washers, as required, on the rear end of armature shaft to obtain an armature shaft thrust gap of 0.05 to 0.5 mm (0.002 to 0.02 inch). New washers are required if rear bracket is replaced.

Table 1. Starter Assembly Torques

Solenoid Screws	6 Nm	(54 in.-lb.)
Brush Retaining Screws	4 Nm	(33 in.-lb.)
Through Bolts	5.7 Nm	(51 in.-lb.)

9. Install rear bracket. Secure brush holder to rear bracket with two machine screws.

10. Install and tighten the two through capscrews.

11. Install solenoid plunger in lever. Secure solenoid to front bracket with two machine screws.

12. Install wire lead to the terminal "M" on solenoid.

13. After assembly, adjust pinion clearance. Pinion clearance should be 0.020 to 0.080 inch (0.5 to 2.0 mm); if not, check as follows. See Figure 5.

    A. Connect starter to a battery, as shown in Figure 5. Close switch. This will shift pinion into cranking position.

    B. Push pinion back by hand and measure pinion clearance. If clearance does not fall within the specified limits, adjust by adding or removing shims located between solenoid and front bracket. Adding shims decreases clearance; removing shims increases clearance. Shims are included with replacement solenoid.

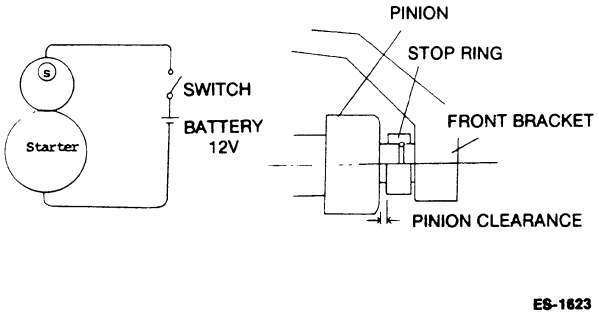


FIGURE 5. PINION CLEARANCE ADJUSTMENT

Inspection and Testing

Inspect the starter components for mechanical defects before testing for grounds or shorts.

Testing Armature for Grounds: Touch armature shaft or core and the end of each commutator bar with a pair of ohmmeter leads (Figure 6). A low ohmmeter reading indicates a grounded armature. Replace grounded armature.

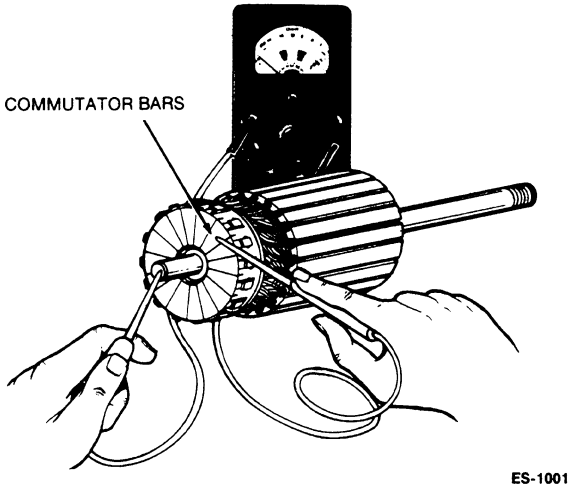


FIGURE 6. TESTING ARMATURE FOR GROUNDS

Inspecting for an Open Circuit in Armature: Using an ohmmeter, check for continuity between the commutator segments. If there is no continuity (high resistance), the segments are open and armature must be replaced.

Testing Armature for a Short Circuit: Use a growler for locating shorts in the armature. Place armature in growler and hold a thin steel blade (e.g. hacksaw blade) parallel to the core and just above it while slowly rotating armature in growler (Figure 7). A shorted armature will cause the blade to vibrate and be attracted to the core. If armature is shorted, replace with a new one.

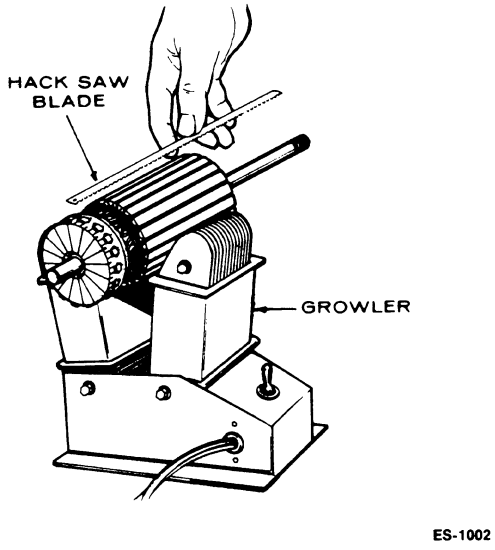


FIGURE 7. TESTING ARMATURE FOR SHORT CIRCUITS

Commutator Inspection: If commutator is dirty or discolored, clean with number 00 to 000 commutator paper. Blow grit out of armature after cleaning.

If commutator is scored, rough, or worn, turn it down in a lathe.

Inertia type starter inspection

Housing Inspection: Permanent magnets are glued to inside of the housing. Magnets must be secure and free of cracks.

Brush Inspection: If brushes are worn shorter than 1/4 inch (6.35 mm), replace them. Check to see that brushes move smoothly in the brush holders. See Figure 8.

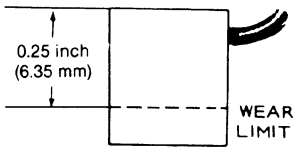


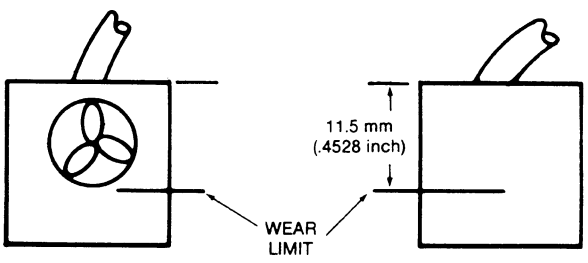
FIGURE 8. BRUSH WEAR LIMIT

Pinion Gear: If pinion gear is badly worn, has broken teeth, or pinion splined sleeve is damaged replace pinion gear and dust cover assembly. If pinion gear is in good condition, wipe armature shaft spline and pinion clean.

Solenoid shift type starter inspection

Field Coil: Use an ohmmeter to check for continuity between brushes. If there is no continuity, the field coil is open and must be replaced. With field coil mounted in the frame, check for continuity between the field coil and frame. Replace frame assembly if there is continuity.

Brushes: Clean around brushes and holders, wiping off all brush dust and dirt. If brushes are worn shorter than 11.5 mm (.4528 inch) replace them (Figure 9).



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FIGURE 9. BRUSH WEAR LIMIT

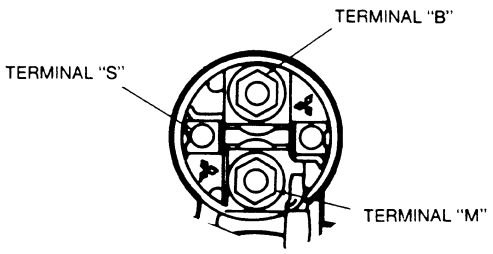
Check for shorts between positive side of brush holder and brush holder base. If there is continuity, replace holder assembly. Check for free movement of brushes. All brushes should move freely in the brush holders.

Overrunning Clutch: Inspect pinion and spline teeth for wear or damage.

If pinion gear is worn or damaged, inspect flywheel ring gear also. Rotate pinion. It should turn free when turned in one direction, and lock when turned in the opposite direction.

⚠CAUTION ***Do not clean overrunning clutch in in solvent or liquid cleaning solution. Washing the clutch will cause the grease to leak out.***

Solenoid: Push solenoid plunger in and release it. The plunger should return to its original position. While holding plunger all the way in, check for continuity between terminals "M" and "B". If there is no continuity, replace the solenoid (Figure 10). After replacing solenoid check pinion clearance.



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FIGURE 10. SOLENOID TERMINALS

Bushings: If either the front or rear bushing show signs of wear or damage, replace them. Bushing and rear bracket are replaced as an assembly. Check armature shaft thrust gap if rear bracket is replaced.

Remove front bushing by tapping bushing from inside with a 7/16 inch tap. Do not remove cap from front bracket. Thread capscrew, same size as tap, into bushing. Using a slide hammer remove bushing from front bracket. Press new bushing into front bracket. Use care not to distort inside diameter of bushing.

Brush Replacement: Cut old positive brush from pigtail at the brush. Be careful not to damage field coil. Clean 1/4 to 3/8 inch (6.5 to 9.5 mm) of brush end of pigtail with sandpaper or emery cloth (Figure 11).

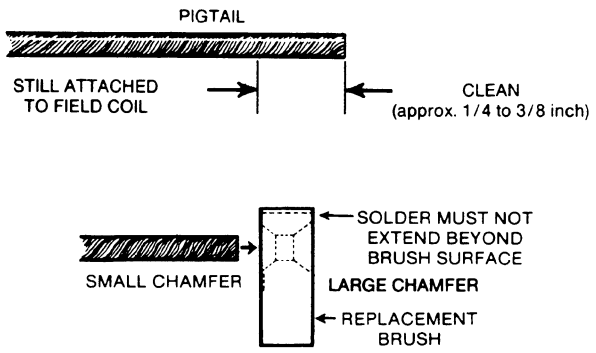


FIGURE 11. BRUSH REPLACEMENT

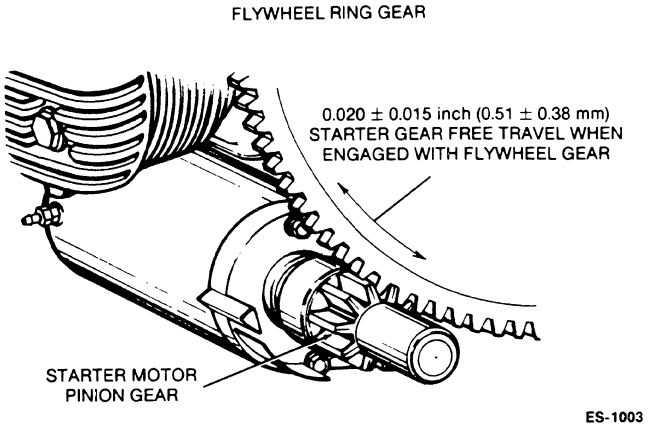


FIGURE 12. CHECKING STARTER GEAR LASH

Push prepared end of pigtail lead into hole in replacement brush from the small chamfered side. Solder pigtail lead to replacement brush on the large chamfered side, using 50/50 tin/lead, rosin core solder and a standard 240/325 Watt soldering iron. Use a file to remove any excess solder that may extend beyond brush surface.

⚠CAUTION ***Pigtail lead must not protrude from surface on the soldered side of brush. To prevent stiffening of pigtail lead to not use excessive amount of solder and heat.***

Starter Mounting

Before installing starter motor, make sure the starter mounting surface on the engine base is clean and free of oil.

To install starter on T-260G (Spec A) engines use the following procedure. On these engines starter pinion gear lash requires adjustment and must be checked when starter is installed.

1. Install starter motor and tighten mounting capscrews just enough to hold starter in place.
2. Remove spark plugs from the engine. This allows free movement of the flywheel.
3. Manually pull the starter pinion gear outward on its shaft until pinion gear teeth mesh completely with flywheel ring gear teeth. Energize solenoid on solenoid shift starter.
4. Measure the amount of free travel (lash) between the pinion gear teeth and the ring gear teeth. See Figure 12. If lash is too tight, causing binding and slow starter operation, or if lash is greater than 0.035 inch (0.889 mm), lash must be adjusted.
5. To adjust lash on starters without slotted mounting holes, remove starter. Use a 21/64 inch (8.334 mm) drill to enlarge one mounting hole in starter mounting bracket.
6. Install starter motor and adjust lash to 0.020 in. ± 0.015 in. (0.51 mm ± 0.38 mm).
7. Remove flywheel and torque starter mounting capscrews to 24 to 26 ft-lbs (33 to 35 Nm). Use Onan flangehead capscrews or SAE grade 8 capscrews with a hardened flatwasher. Do not use lockwashers.

⚠CAUTION ***Failure to torque starter bolts properly may cause starter failure and ring gear damage.***

8. Install flywheel spark plugs, blower housing, and cylinder air housings. For correct cylinder air housing installation (required on some models), refer to Cylinder Air Housing Clearance.
9. Connect battery cable and wires to starter. Connect battery cables to battery. Connect ground cable last.

To install starter on T-260G (Beginning Spec B) engines use the following procedure. On these engines starter pinion gear lash does not require adjustment.

1. Install starter motor and torque mounting capscrews to 24 to 26 ft-lbs (33 to 35 Nm).
2. Install flywheel, blower housing, and cylinder air housing. For correct cylinder air housing installations (required on some models), refer to Cylinder Air Housing Clearance.
3. Connect battery cable and wires to starter. Connect battery cables to battery. Connect ground cable last.

Engine Disassembly

DISASSEMBLY/ASSEMBLY

When complete engine disassembly is necessary, first remove all complete assemblies. Individual assemblies such as fuel pump and carburetor can be disassembled and repaired at another time.

Suggested Disassembly Order

1. Drain crankcase.
2. Disconnect all exhaust lines and electrical lines.
3. Remove engine from its mountings and place on a suitable bench or work stand.
4. Remove all housings, shrouds, blower housings, etc.
5. Remove flywheel, using a puller. Note position of chaff screen and venturi when removing to assure screw hole alignment on reassembly. See page 10-18 for further information.
6. Remove ignition trigger ring, if engine is equipped with electronic ignition.
7. Remove the gear cover, being careful to protect the oil seal from keyway damage.
8. Remove the crank gear, using a gear puller and ring.
9. Remove all accessories such as oil filter, starter, intake manifold, fuel lines, spark plugs, etc.
10. Remove breaker point box.
11. Remove oil base, oil pump and cylinder heads.
12. Remove valves, springs, lifters, etc.
13. Remove camshaft and gear assembly.
14. Remove connecting rods and pistons.
15. Remove rear bearing plate, crankshaft, and front bearing.

Keep all parts in their respective orders. Keep valve assemblies together. Return rod caps to their respective pistons. Analyze the reasons for parts failure.

Suggested Assembly Procedure

Engine assembly is normally the reverse of the disassembly procedure observing proper clearances and torques. use a torque wrench to assure proper tightness. Coat the internal engine parts with oil as they are assembled. After the internal engine parts are assembled, the engine should turn over by hand freely. Use only genuine Onan parts and special tools when reassembling your engine.

1. Use the proper bearing driver to install front main bearing after coating it with a light film of oil.
2. Insert rear main bearing in rear bearing plate.
3. Insert crankshaft, rear bearing plate, and crankshaft gear.
4. Install piston and connecting rods.
5. Install camshaft and gear assembly; align crank gear mark with cam gear mark.
6. Install valve assemblies, oil pump, oil base, and cylinder heads.
7. Install breaker point box.
8. Install all accessories such as oil filter, starter, fuel lines and spark plugs.
9. Install gear cover with oil seal, trigger ring (electronic ignition only) and flywheel.
10. Set breaker points (if equipped with points) to obtain proper timing.
11. Check valve clearance.
12. Install all housings and air cleaner.
13. Fill crankcase with oil.

Operation

Start engine and check oil pressure. Run for approximately 15 minutes to bring engine to operating temperature. Check for oil leaks, fuel leaks and exhaust leaks. Adjust carburetor and governor for speed and sensitivity.

Testing Compression

The compression tester is used to determine the condition of valves, pistons, piston rings and cylinders.

To check compression:

1. Run the engine until thoroughly warm.
2. Stop engine and remove spark plugs.
3. Remove air cleaner and place throttle and choke in the wide open position.
4. Insert the compression gauge in one spark plug hole.
5. Crank the engine and note the reading.

Refer to *SPECIFICATIONS* section for compression pressures. There may be variations due to equipment, temperature, atmospheric conditions and altitude. These pressures are for a warm engine at cranking speed (about 300 rpm).

Tappet Adjustment

The engine is equipped with adjustable valve tappets. The valve tappet clearance should be checked and adjusted, if necessary, at least every 200 operating hours or when poor engine performance is noticed. Adjust the valve clearance only when engine is at ambient temperature. Proceed as follows:

1. Remove ignition key to prevent accidental starting.
2. Remove all parts necessary to gain access to valve tappets.
3. Remove spark plugs to ease the task of turning the engine over by hand.
4. Place a socket wrench on the flywheel capscrew and rotate the crankshaft in a clockwise direction until the left intake valve (viewed from flywheel end) opens and closes. Continue turning the crankshaft until the TC mark on the flywheel is lined up with the TC mark on the gear cover. This should place the left piston (#1) at the top of its compression stroke. Verify that the left intake and exhaust valves are closed and there is no pressure on the valve lifters.
5. The correct feeler gauge for the valve adjustment (see *SPECIFICATIONS)* should pass freely between valve stem and tappet; a 0.002 inch (0.05 mm) thicker gauge should not (Figure 1).
6. To correct the valve clearance, use a 7/16-inch open end wrench to turn the adjusting screw to obtain the correct clearance. The screw is self-locking and will stay where it is set. A 9/16-inch (14 mm) open end wrench is required to hold the tappet while turning the adjusting screw.
7. To adjust valves on the right hand cylinder, turn engine one complete revolution and again line up mark on the flywheel and the TC mark on the gear cover. Then follow adjustment procedure given for left hand cylinder.
8. Replace all parts removed in Step 2. Tighten all screws securely. Torque manifold bolts to specified torque.

VALVE SYSTEM

A properly functioning valve system is essential for good engine performance. All engines utilize an L-head type valve design as shown in Figure 1. Access to the valve system can be obtained by removing the cylinder heads and the valve covers on top of the engine. A valve spring compressor must be used to remove valves from the cylinder block.

A valve stem seal is sometimes used on the intake valve guides of some engines. This seal must be replaced each time the valve is removed.

Place valves, springs, retainers, and tappets in a rack as they are removed from cylinder block so they can be identified and reinstalled in their original locations. Discard old valve stem seals and replace with new ones during assembly.

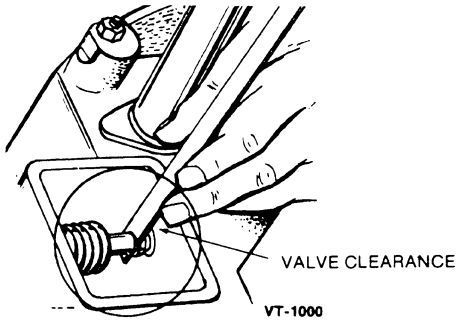
Use the following procedures to inspect and service the valve system.

Inspection

Clean carbon from the valves, valve seats, valve guides, and cylinder block.

Valves: Check the valve face for evidence of burning, warpage, out-of-round, and carbon deposits.

Burning and pitting are caused by the valve failing to seat tightly. This condition is often caused by hard carbon particles on the seat. It may also be due to weak valve springs, insufficient tappet clearance, warpage, and misalignment.



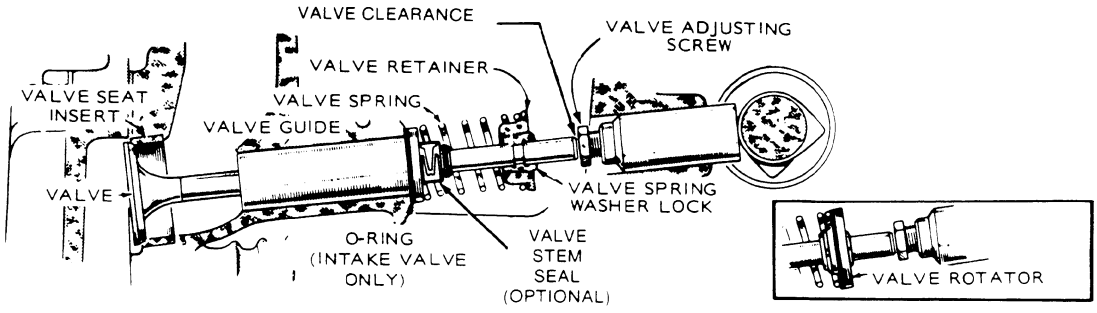


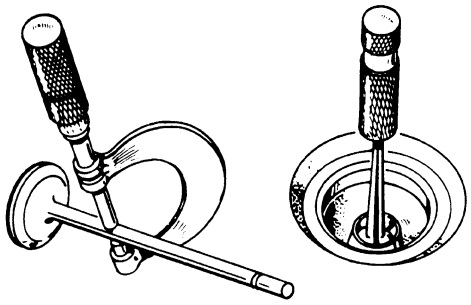
FIGURE 1. VALVE ASSEMBLY VT-1005

Warpage occurs chiefly in the upper stem due to its exposure to intense heat. Out-of-round wear follows when the seat is pounded by a valve whose head is not in line with the stem and guide. If a valve face is burned or warped, or if the stem is worn, install a new valve.

Too much clearance in the intake guide admits air and oil into the combustion chamber, upsetting carburetion, increasing oil consumption, and making heavy carbon deposits. Carbon reduces heat dissipation. Clean metal is a good heat conductor but carbon insulates and retains heat. This increases combustion chamber temperatures which causes warping and burning.

Unburned carbon residue gums valve stems and causes them to stick in the guide. Deposits of hard carbon with sharp points projecting become white hot and cause pre-ignition and pinging.

Refinish valves that are slightly pitted or burned on an accurate valve grinder. If valves are badly pitted or have a thin margin when refacing, replace them.



VT-1020

FIGURE 2. VALVE STEM AND VALVE GUIDE INSPECTION

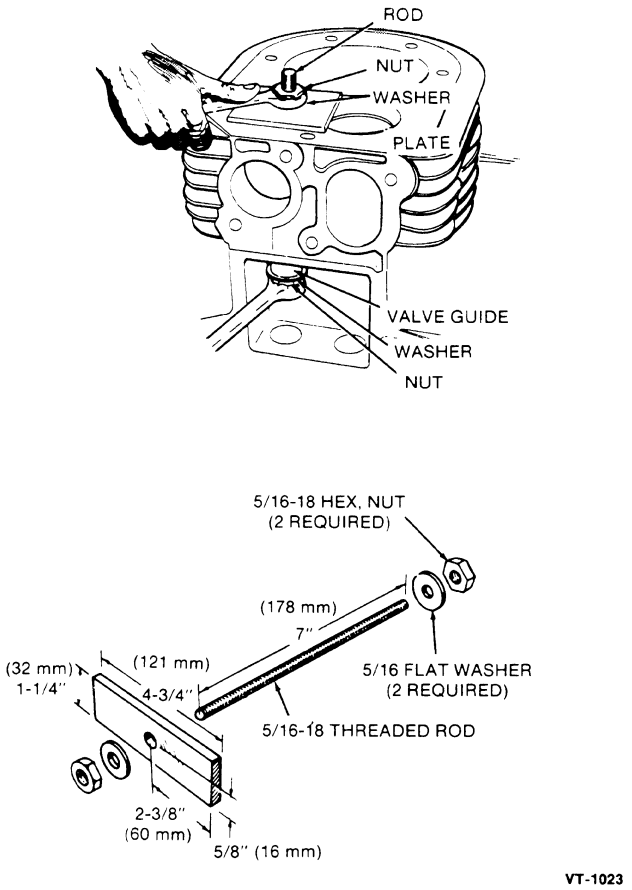
Stems And Guides: Always check valve stems and guides for wear (Figure 2). Use a hole gauge to measure the valve guide. When clearance with stem exceeds that specific in *DIMENSIONS AND CLEARANCES*, replace either valve or guide or both, as may be necessary. Always regrind seat to make concentric with the newly installed guide.

Worn valve stem guides can be replaced from inside the valve chamber (a seal is provided behind the intake valve guides only). The smaller diameter of the tapered valve guides must face toward the valve head. Tappets are also replaceable from the valve chamber after first removing the valve assemblies.

Valve Guide Removal: Before removing valve guides, use an electric drill with a wire brush to remove carbon and other foreign material from top surface of guides. Failure to perform this operation may result in damage to the guide bores. Drive the guides out with a hammer and valve guide driver.

⚠CAUTION ***Driving out old guides can damage the guide or tappet bores. Be careful not to strike guide bores with driver or allow guide to strike tappet bores during removal.***

Valve Guide Installation: Run a small polishing rod covered with crocus cloth through valve guide holes to clean out carbon and other foreign materials. Place a new gasket on the intake valve guide, and coat the outer edge of each new guide with oil. Place guide, notch-up, in cylinder block and press in until guide stops or protrudes 11/32 inch (8.7 mm) from rocker box side of block. A suggested method of installation is shown in Figure 3.



VT-1023

FIGURE 3. VALVE GUIDE INSTALLATION

Valve Stem Seals: Do not reuse valve stem seals. Each time the valves are removed from cylinder block, a new seal must be used when valve is reinstalled.

⚠CAUTION ***Do not remove valve after seal is installed. Valve can be withdrawn only as far as the groove in valve stem. Do not allow valve stem seal to come in contact with groove or seal damage will result.***

Valve Spring: Check valve springs for cracks, worn ends, distortion, and tension. If spring ends are worn, check valve spring retainer for wear. Check for spring distortion by placing spring on a flat surface next to a square. Measure height of spring and rotate it against square edge to measure distortion. If distortion exceeds 0.06 inch (1.5 mm) replace spring. Check spring tension at the installed height for both the valve open and closed position using an accurate valve spring tester. Replace any valve spring that is weak, cracked, worn, or distorted.

Valve Rotators: Positive type valve rotators prolong valve life and decrease valve repairs. When functioning properly, the valve is rotated a fraction of a turn each time it opens. While at open position, the valve must rotate freely. There is no easy way to determine if a valve rotator is good or bad. Onan recommends that valve rotators be replaced at each major overhaul or if a build-up of carbon is noted on valve face and valve seat.

Valve Seats: Inspect valve seat inserts. If seats are loose, cracked or severely pitted, new ones must be installed. Remove valve seat inserts using a valve seat removal tool. If valve seat insert bores in cylinder block are damaged or worn so that a press fit cannot be obtained when installing new standard size valve seat inserts, the bores must be machined for an oversize seat.

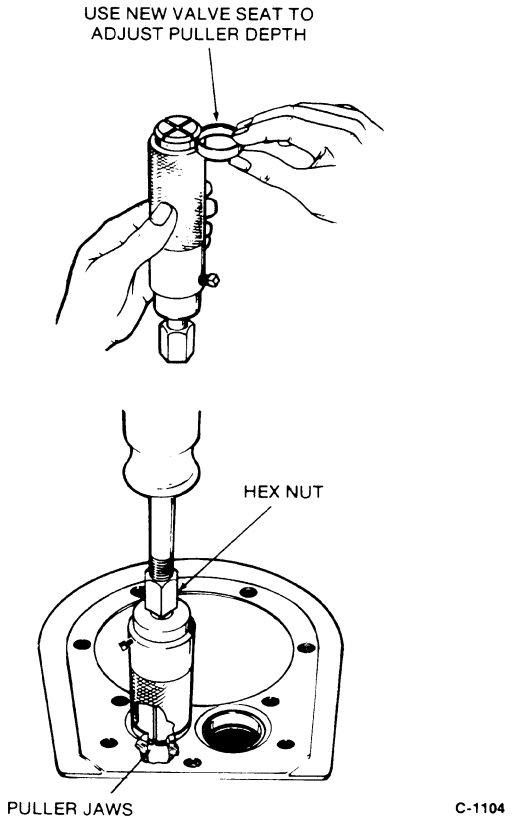


FIGURE 4. VALVE SEAT REMOVAL

Valve Seat Removal: Remove carbon and combustion deposits from valve seat. Select proper puller size determined by inside diameter of valve seat. On some pullers use a new seat as a guide to adjust puller depth (Figure 4). Puller jaws must expand into cylinder block at the point where bottom of valve seat insert rests on cylinder block. Position puller on valve seat and tighten hex nut. Clamp cylinder block to a solid bench. Attach slide hammer to puller. Tighten hex nut between each blow with the slide hammer.

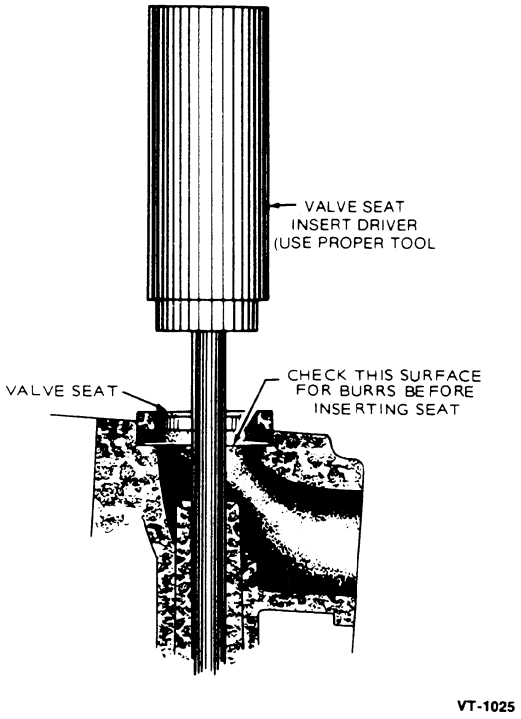


FIGURE 5. INSERTING NEW VALVE SEAT

Valve Seat Installation: After the old seat has been removed, clean out any carbon or metal burrs from the seat insert recess. Use a valve seat insert driver and hammer to install the insert (Figure 5). Drive the valve seat insert in so that the insert enters the recess evenly. Make certain that the valve seat insert rests solidly on the bottom of the recess all the way around its circumference.

To assure a tight valve seat fit and eliminate the danger of seat loosening in the bore, valve seat must be staked.

Insert valve seat staker into valve seat or guide in cylinder block. Using a lead hammer, strike the staking tool a sharp blow to wedge new valve securely in place. It will be necessary to refinish valve seat inserts before installing valves.

TAPPETS

Very little wear takes place on tappet diameters or in tappet bores. If the clearance between tappet and bore in cylinder block exceeds specifications, replace the tappet.

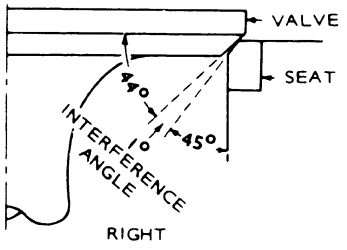
Inspect the tappet faces which contact camshaft lobes for roughness, scuffing, or concave wear. Replace any worn tappets. If tappets are worn, inspect camshaft for wear.

VALVE FACE AND SEAT GRINDING

Some engines are equipped with a premium valve package (aluminized intake valves). If the aluminized valve face does not clean-up using a wire brush, the valve face may be refinished. This removes the aluminized coating from the valve face. An aluminized valve that has been refinished will normally have a life expectancy equal to a standard valve. If longer valve life is required, worn or damaged valves should be replaced with new premium valves.

Before installing new valves or previously used valves, inspect valve seats for proper valve seating. If used valves are reinstalled, the valve stems should be cleaned and valve faces ground to their specified angles of 44°. Refinish valve seats to a 45° angle. When refacing valves and seats, remove all evidence of pitting and grooving. If end of valve stem is pitted or worn, true it and clean it up on the refacer wheel. A very light grind is usually enough to square stem and remove any pits or burrs. The valve guide should be thoroughly cleaned. If valve guide is worn, or valve is warped, the necessary parts must be replaced.

By grinding the valve face and seat at slightly different angles, a fine line of contact on face and seat is obtained, eliminating the need to lap the seating surfaces. The one degree difference in angles is defined as the interference angle (Figure 6). The seat angle is greater than that of the valve face. This assures contact at the maximum diameter on valve seat seating surface.

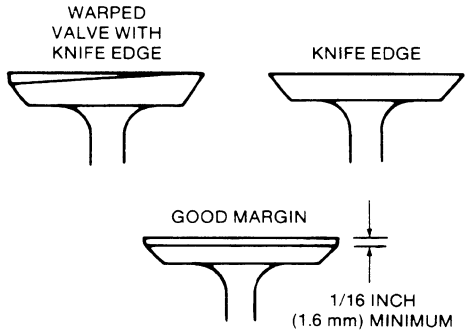


VT-1021

FIGURE 6. VALVE INTERFERENCE ANGLE

Refinish valve faces to a 44° angle on a valve refacing machine. The first cut from valve face must be a light grinding. Check if there is an unevenness of metal being removed. If only part of valve's face has been touched, check to see if valve is properly seated in machine or if valve is warped, worn, or distorted. When cut is even around the whole valve face, keep grinding until complete face is ground clean. Be sure the correct valve face angle is maintained. When valve head is warped, a knife edge will be ground (Figure 7) on part or all of the head due to the large amount of metal that must be removed to completely reface valve. Heavy valve heads are required for strength and good heat dissipation. Knife edges lead to breakage, burning, and pre-ignition due to heat localizing on the edge.

Replace any valve that cannot be entirely refaced while keeping a good valve margin (Figure 7) or is warped, worn, or damaged in any way. The amount of grinding necessary to true a valve indicates whether valve head is worn or warped.



M-1184

FIGURE 7. VALVE HEAD MARGIN

When new valve seats are installed, or previously used seats reground, refinishing must be done with a valve seat grinder used according to the manufacturer's directions.

Valve seats should be ground with a 45 degree stone and the width of the seat band should be 1/32 inch to 3/64 inch (0.79 to 1.2 mm) wide. Grind only enough to assure proper seating.

Place each valve in its proper location. Check each valve for a tight seat. Make several marks at regular intervals across the valve face using machinist's bluing. Observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat. The valve seat should contact the valve face evenly at all points. The line of contact should be at the center of the valve face.

FLYWHEEL

Removing the flywheel is a relatively simple process, but the following procedure must be followed to avoid damage to the gear case and possible injury to the operator.

1. Turn the flywheel mounting screw outward about two turns.

   ⚠WARNING ***Do not remove the screw completely since it acts as a restrainer when the flywheel snaps loose. If the flywheel is not held by the screw, the spring action in the wheel will cause it to fly off with great force which can cause injury to the operator.***

2. Install a puller bar on the flywheel (Figure 8).

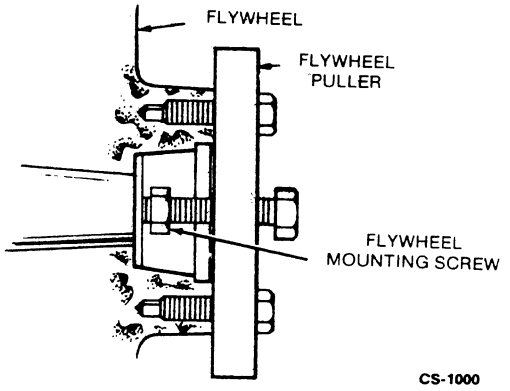


FIGURE 8. BLOWER WHEEL PULLEY

3. Turn the puller bar bolts in, alternately, until the wheel snaps loose on the shaft.

   ⚠CAUTION ***Do not use a screwdriver or similar tool or pry behind the flywheel against the gear case. The gear case cover is die-cast material and will break if undue pressure is applied in this manner.***

4. Unscrew the puller from the flywheel, remove the flywheel mounting screw and washer and pull the flywheel off the shaft. Take care not to drop the wheel. A bent or broken fin will destroy the balance. Always use a steel key for mounting the flywheel.

GEAR COVER

After removing the mounting screws, tap the gear cover gently with a soft faced hammer to loosen it.

When installing the gear cover, make sure that the pin in the gear cover engages the nylon lined (smooth) hole in the governor cup (Figure 9). Turn the governor cup so that the nylon lined hole is at the three o'clock position. Use a small amount of grease to assist in holding governor cup in position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal.

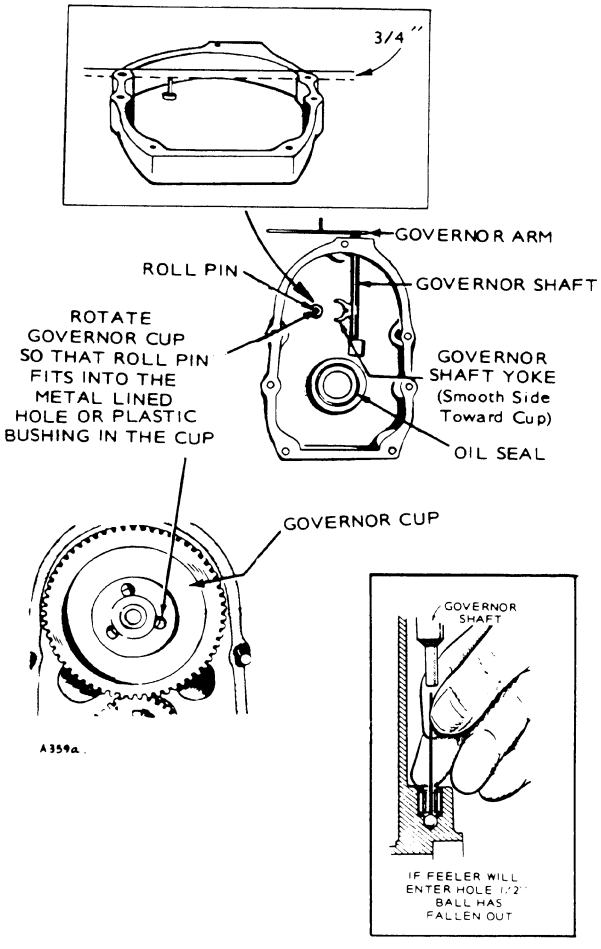


FIGURE 9. GEAR COVER ASSEMBLY

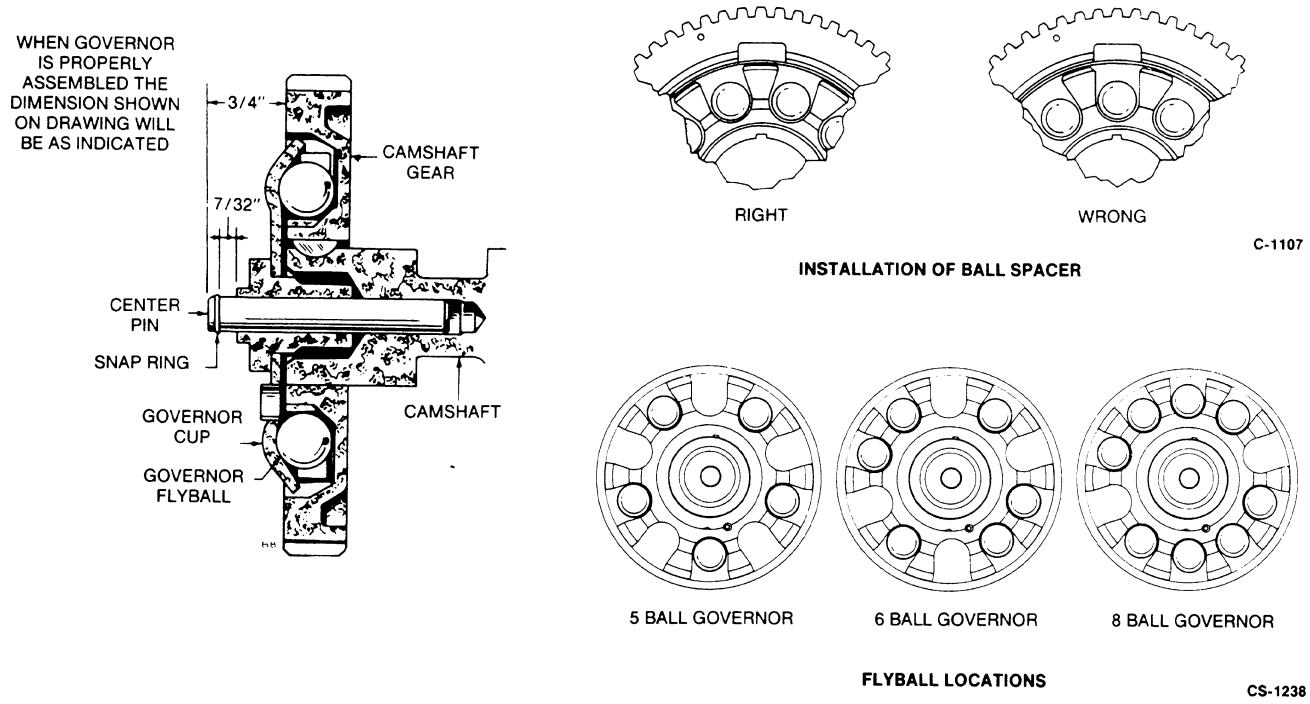


FIGURE 10. GOVERNOR CUP DETAILS

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the flyballs while sliding the cup off (Figure 10).

Replace with a new part any flyball which is grooved or has a flat spot; the ball spacer if its arms are worn or otherwise damaged; the gear/spacer assembly if loose on gear hub, and the governor cup if the race surface is grooved or rough. The governor cup must be a free-spinning fit on the camshaft center pin, but without any excessive play.

If replacing the ball spacer, be sure to position it so an arm is lined up with the space on the camshaft gear (if your camshaft gear does not have a space in it, disregard this paragraph). If the ball spacer arm is not lined up with the space in the camshaft gear, a flyball can slip into the space and cause engine racing and governing problems (Figure 10).

When installing the governor cup, tilt the engine so the gear is up, put the flyballs in place (Figure 10), and install the cup and snap ring on the center pin.

The camshaft center pin extends out 3/4 inch (19 mm) from the end of the camshaft. This distance provides an in-and-out travel distance of 7/32 inch (5.6 mm) for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. The camshaft center pin cannot be pulled outward or removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly. If the distance is less than 7/32" (5.6 mm), (the engine will race, especially at no load) remove the center pin and press in a new pin.

TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, always install both gears new.

The camshaft and gear must be replaced as an assembly. Before removing the camshaft and gear assembly, remove the cylinder head and valve assemblies. Then remove the operating plunger for the breaker points and tappets.

To remove the crankshaft gear, first remove the snap ring and retainer washer, then attach the gear pulling ring using two No. 10-32 screws (Figure 11). Tighten the screws alternately until both are tight. Attach a gear puller to the puller ring and proceed to remove the gear.

Each timing gear is stamped with "O" near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine. When installing the camshaft gear and shaft assembly, be sure that the thrust washer is properly in place behind the camshaft gear. Then install the crankshaft retaining washer and lock ring.

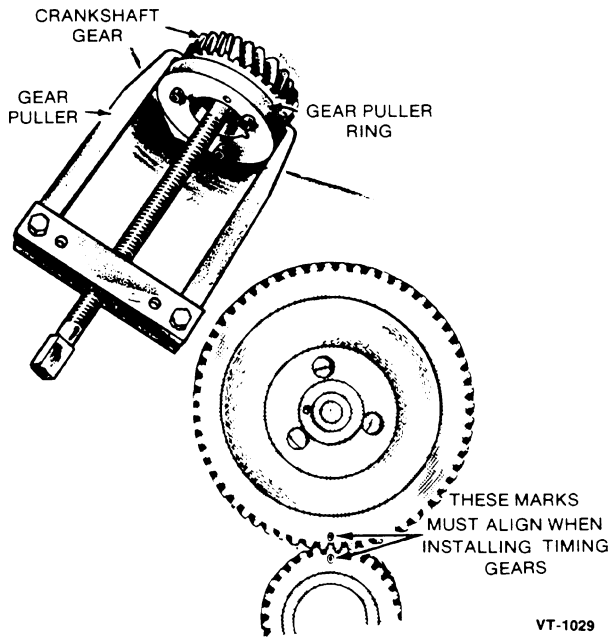


FIGURE 11. TIMING GEAR REMOVAL AND INSTALLATION

PISTONS AND CONNECTING RODS

Observe the following procedure when removing pistons and connecting rods from the engine.

1. Drain oil.
2. Remove the cylinder head and oil base pan from the engine.
3. Remove the ridge from the top of each cylinder with a ridge reamer before attempting piston removal (Figure 12).

⚠CAUTION ***Forcing the piston from the cylinder before reaming may cause damage to the piston lands and break rings.***

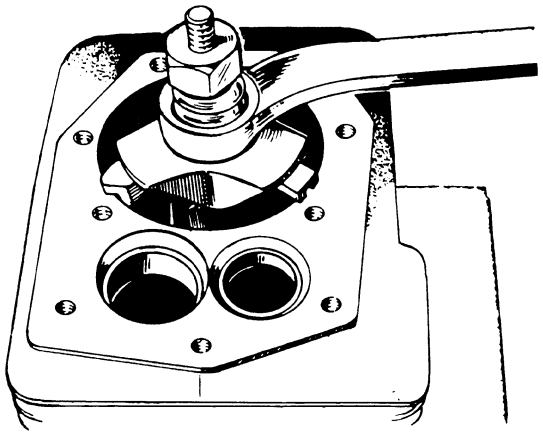


FIGURE 12. REMOVING RIDGE FROM CYLINDER

4. Turn the crankshaft until the piston is at the bottom of its stroke and remove the connecting rod nuts. Lift the rod bearing cap from the rod and push the rod and piston assembly out through the top of the cylinder using a hammer handle. Avoid scratching the crankpin and cylinder wall when removing the piston and rod.

5. Mark each piston and rod assembly so they can be returned to their respective cylinders after overhaul. Keep connecting rod bearing caps with their respective rods.

6. Remove the piston rings from the piston with a piston ring spreader (Figure 13). Remove the piston pin retainer and push the piston pin out.

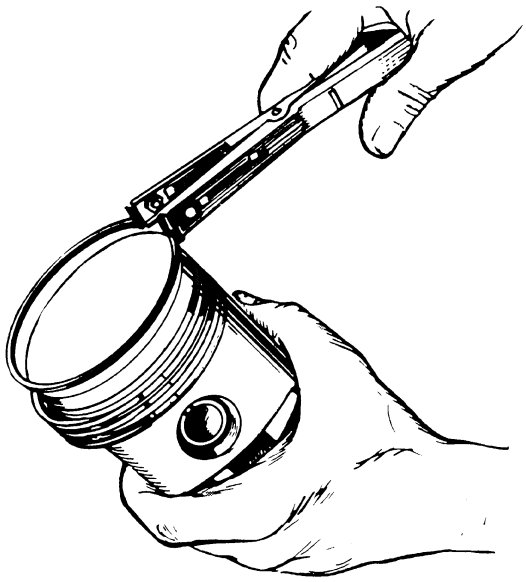


FIGURE 13. REMOVING PISTON RINGS

7. Remove dirt and deposits from the piston surfaces with an approved cleaning solvent. Clean the piston ring grooves with a groove cleaner or the end of a piston ring filed to a sharp point (Figure 14). Care must be taken not to remove metal from the groove sides.

⚠CAUTION ***Do not use a caustic cleaning solvent or wire brush for cleaning pistons. These materials will cause piston damage.***

When cleaning the connecting rods in solvent, be sure to include the rod bore. Blow out all passages with compressed air.

Engines that have been fitted with 0.005 inch (0.13 mm) oversize pistons at the factory are identified by the letter E after the serial number. Number is stamped on the cylinder block and on the unit nameplate.

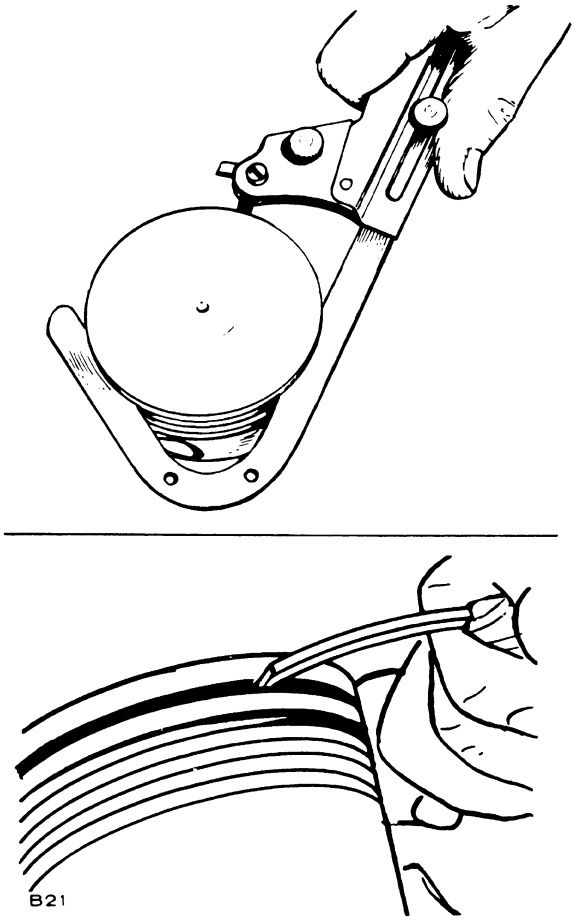


FIGURE 14. PISTON GROOVE CLEANING

Inspection

Follow the procedures given below when inspecting pistons and connecting rods.

Piston Inspection:

1. Inspect the pistons for fractures at the ring lands, skirts, and pin bosses. Check for wear at the ring lands using a new ring and feeler gauge (Figure 15). Replace the piston when the side clearance of the top compression ring reaches 0.008 inch (0.20 mm).

2. Replace pistons showing signs of scuffing, scoring, worn ring lands, fractures or damage from preignition. Excessive piston wear near the edge of the top ring land indicates preignition.

Connecting Rod Inspection:

1. Replace connecting rod bolts and nuts with damaged threads. Replace connecting rods with deep nicks, signs of fractures, scored bores or bores out of round more than 0.002 inch.

2. Use a new piston pin to check connecting rod for wear. A push fit clearance is required and varies from engine to engine. If a new piston pin falls through a dry rod pin bore as a result of its own weight, replace the rod.

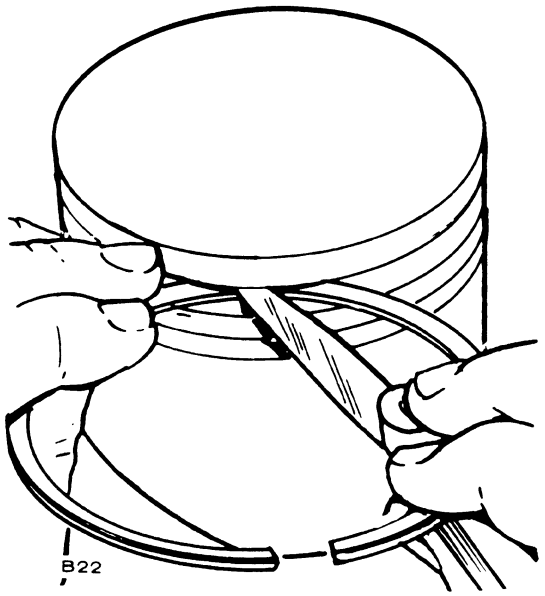


FIGURE 15. CHECKING RING SIDE CLEARANCE

Fitting Pistons:

1. Proper piston tolerances must be maintained for satisfactory operation.

2. Refer to *DIMENSIONS AND CLEARANCES* to determine where to measure piston to be sure the total clearance follows specifications.

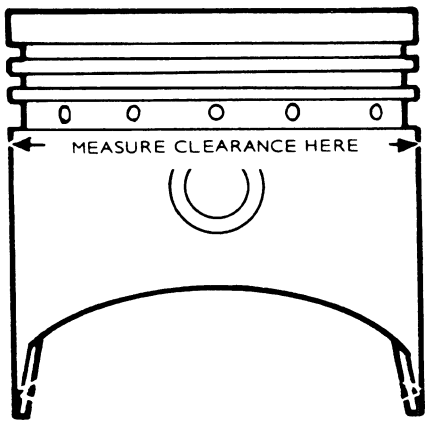


FIGURE 16. MEASURING PISTON CLEARANCE

Fitting Piston Rings:

1. Install the piston ring in the cylinder bore. Invert the piston and push the ring to the end of ring travel, about halfway into the bore, which trues the ring end gap. Check the gap with a feeler gauge (Figure 17).
2. The practice of filing ring ends to increase the end gap is not recommended. If the ring end gap does not meet specifications, check for the correct set of rings and the correct bore size A cylinder bore that is 0.001 inch (0.03 mm) under size will reduce the end gap 0.003 inch (0.08 mm).

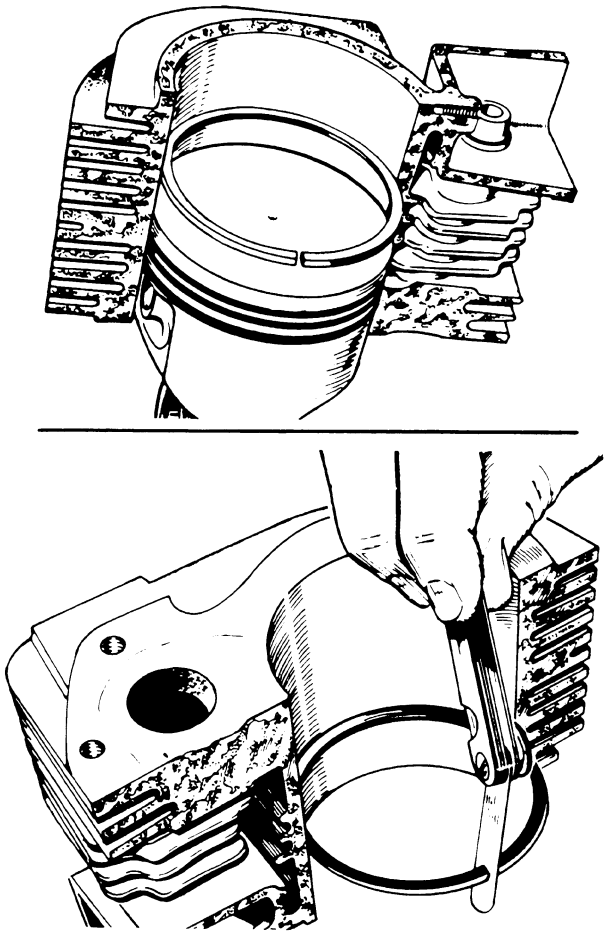


FIGURE 17. POSITIONING OF PISTON RING AND MEASURING OF END GAP

CYLINDER BLOCK

The cylinder block is the main support for all other basic engine parts. Crankshaft and camshaft are supported by the block, assuring alignment of the crankshaft and cylinder bores.

Cleaning

After removing pistons, crankshaft, cylinder heads, etc., inspect block for cracks and extreme wear. If block is still serviceable, prepare it for cleaning as follows:

1. Scrape all old gasket material from block. Remove oil by-pass to allow cleaning solution to contact inside of oil passages.
2. Remove grease and scale from cylinder block by agitating in a bath of commercial cleaning solution or hot soapy washing solution.
3. Rinse block in clean hot water to remove cleaning solution.

Inspection

When rebuilding the engine, thoroughly inspect block for any condition that would make it unfit for further use. This inspection must be made after all parts have been removed and block has been thoroughly cleaned and dried.

1. Make a thorough check for cracks. Minute cracks may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light motor oil. Wipe the part dry and immediately apply a coating of zinc oxide (white lead) dissolved in wood alcohol. If cracks are present, the white coating will become discolored at the defective area. Always replace a cracked cylinder block.
2. Inspect all machined surfaces and threaded holes. Carefully remove any nicks or burrs from machined surfaces. Clean out tapped holes and clean up any damaged threads.
3. Check top of block for flatness with a straight edge and a feeler gauge.

Cylinder Bore Inspection: Inspect cylinder bores for scuffing, scratches, wear, and scoring. If cylinder bores are scuffed, scratched, scored, or worn, they must be rebored and honed for the next oversize piston.

When the appearance of cylinder bores is good and there are no scuff marks, check cylinder bore for wear or out of roundness as follows:

1. Check cylinder bore for taper, out of round, and wear with a cylinder bore gauge, telescope gauge or inside micrometer. These measurements should be taken at four places, top and bottom of piston ring travel, parallel and perpendicular to axis of crankshaft.
2. Record measurements taken at top and bottom of piston travel as follows (Figure 18).

A. Measure and record as "A" the cylinder bore diameter (parallel to crankshaft) near the top of cylinder bore where greatest amount of wear occurs.

B. Also measure and record as "B" cylinder bore diameter (parallel to crankshaft) at the bottom of piston travel.

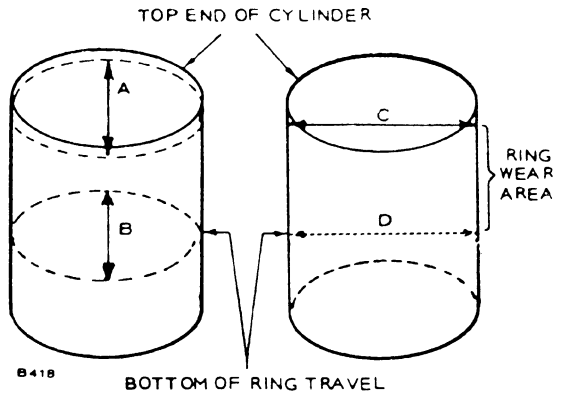
C. Measure and record as "C" cylinder bore diameter (perpendicular to crankshaft) near the top of cylinder bore where greatest amount of wear occurs.

D. Also measure and record as "D" cylinder bore diameter (perpendicular to crankshaft) at the bottom of piston travel.

E. Reading "A" subtracted from reading "B" and reading "C" subtracted from reading "D" indicates cylinder taper.

   If cylinder taper exceeds that specified in *DIMENSIONS AND CLEARANCES* rebore and hone cylinder to the next oversize.

F. Reading "A" compared to reading "C" and reading "B" compared to reading "D" indicate whether or not cylinder is out of round. If out of round exceeds that specified in *DIMENSIONS AND CLEARANCES* the cylinders must be rebored and honed to the next oversize. A reboring machine is used when going to oversize pistons.



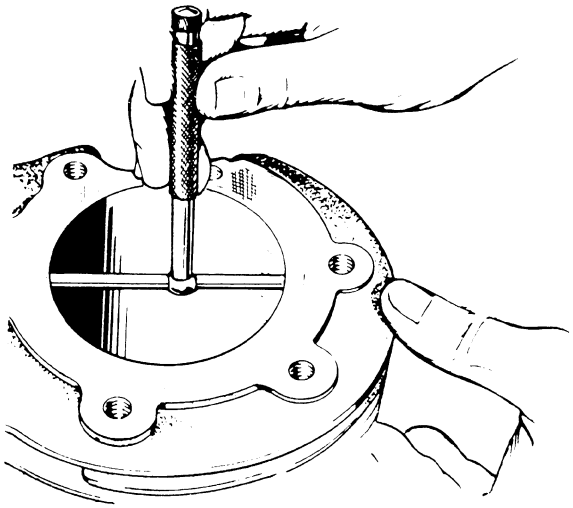


FIGURE 18. METHODS OF MEASURING THE DIAMETER OF A CYLINDER BORE

Reboring the Cylinder

Rebore and hone engine whenever cylinder bore is worn, damaged, out of round, or if cylinder taper exceeds specifications. A worn cylinder bore should be resized to the smallest standard oversize diameter at which it will clean up. The final finish and bore diameters should then be obtained by honing. Final bore diameter should equal the standard diameter added to the oversize.

⚠CAUTION ***If boring bar is operated incorrectly, it will produce a rough cylinder surface that may not clean up even when honed. Boring should be done only by qualified service personnel who are careful in their work.***

After boring to the correct oversize cylinder bore dimension piston and ring clearance should be appropriate. There is no need to adjust or "fit" pistons and rings.

When reboring cylinders, take the following precautions:

1. Make sure cutting tool is properly ground before using it.

2. Be sure top of engine block is smooth and deposit free.

3. Clean base of boring bar before bar is set up. Deposits under boring bar will cause it to tilt and the cylinder will be distorted after boring.

4. Make an initial rough cut, followed by a finish cut. Then hone cylinder bore to the specified oversize.

Honing Cylinders (Using Precision Hones)

Refer to hone manufacturer's recommended grit size to produce specified surface finish of 20 to 40 RMS. Too rough of a finish will wear out the rings and too smooth of a finish can retard piston ring seating.

1. Position block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at approximately 250 to 450 rpm.

2. Follow hone manufacturer's instructions for the use of oil or lubricant on stones. Do not use lubricants with a dry hone.

3. Insert hone in bore and adjust stones to fit snugly to the narrowest section. When adjusted correctly, the hone should not shake or chatter in cylinder bore, but will drag freely up and down when hone is not running.

4. Connect drill to hone and start drill. Feel out bore for high spots, which cause an increased drag on stones. Move hone up and down in bore with short overlapping strokes about 40 times per minute. Usually bottom of cylinder must be worked out first because it is smaller. As cylinder takes a uniform diameter, move hone up and down all the way through cylinder bore.

5. Check diameter of the cylindner regularly during honing. A dial bore gauge is the easiest method but a telescoping gauge can be used. Check size at six places in bore; measure twice at top, middle and bottom at 90-degree angles.

6. Crosshatch formed by the stones should form an included angle of 23 degrees. This can be achieved by moving the rotating hone (250 to 450 rpm) up and down in cylinder bore about 40 times per minute.

7. Clean cylinder bores thoroughly with soap, water and clean rags. A clean white rag should not become soiled on wall after cleaning is complete. Do not use a solvent or gasoline since they wash oil from the walls but leave the metal particles.

8. Dry crankcase and coat it with oil.

Deglazing Cylinder Bores

Deglaze the cylinder bores if there are no scuff marks and no wear or out of round beyond specifications before installing new rings. Deglazing gives a fine finish, but does not enlarge cylinder diameter, so the original pistons with new rings may still be used.

The reason for deglazing a cylinder is to provide cavities to hold oil during piston ring break-in.

1. Wipe cylinder bores with a clean cloth which has been dipped in clean, light engine oil.

2. Use a brush type deglazing tool with coated bristle tips to produce a crosshatch pattern in the cylinder bore.

3. Use a slow speed drill to drive the deglazing tool. Move deglazing tool up and down in cylinder (10 to 12 complete strokes) rapidly enough to obtain a crosshatch pattern (Figure 19).

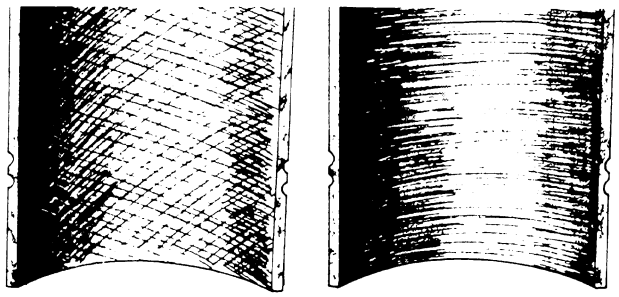


FIGURE 19. CROSS HATCHING

⚠CAUTION ***Never use gasoline or commercial cleaners to clean cylinder bores after deglazing or honing. These solvents will not remove abrasives from the walls. Abrasives not removed from engine will rapidly wear rings, cylinder walls, and bearing surfaces of all lubricated parts.***

4. Clean cylinder bore thoroughly with soap, water and clean rags. Continue cleaning until a clean white rag shows no discoloring when wiped through cylinder bore.

CRANKSHAFT

Clean crankshaft thoroughly and inspect journals for scoring, chipping, cracking, or signs of overheating. If crankshaft has overheated, is scored, or excessively worn, reconditioning or replacement will be required. Examine bearing journals for cracks if overheating has occurred.

Measure crankshaft main bearing and connecting rod journals at several places on their diameter to check for roundness and taper.

The only recommended method of reconditioning the crankshaft is regrinding, as required to accommodate undersize bearings. Metallizing of bearing journals is not recommended.

If regrinding of crankshaft journals is necessary, the work should be done by a reputable machine shop that has suitable equipment to handle precision work of this type. Undersize main bearings are available in sizes of 0.010, 0.020, and 0.030 inch. Undersize connecting rods are available in sizes of 0.010, 0.020, 0.030 and 0.040 inch.

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

BEARINGS

With camshaft and crankshaft removed, use a micrometer to measure diameter of bearing journals. Use a dial bore gauge or a telescopic gauge and micrometer to measure inside diameter of bearings. Refer to *DIMENSION AND CLEARANCE* to determine if clearances are within specifications.

Any bearing that is scored, chipped, pitted or worn beyond the specified limits must be replaced.

Removal of the camshaft bearings requires complete disassembly of the engine. Use a press or a suitable driver to remove bearings. Support casting to avoid distortion and to avoid damaging the bearing bore during removal and installation.

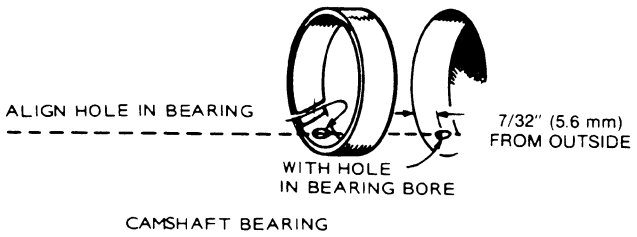


FIGURE 20. FRONT CAMSHAFT BEARING

Replacement camshaft bearings are precision type which do not require line reaming or line boring after installation. Clean outside of the bearing and bearing bore in the block. Before installing cam bearings use Locktite Bearing Mount on outside diameter of bearing. Use a combination bearing driver to install bearings. Place the bearing on the crankcase over the bearing bore with the lubricating hole (front only) in the proper position. Be sure to start the bearing straight. Press in the front bearing flush with the outside end of the bearing bore. Front cam bearing oil hole must line up with oiling hole in cylinder block (Figure 20). Press in the rear camshaft bearing until past the ignition plunger hole. Lubricate bearing surfaces with oil after installing.

New crankshaft main bearings are precision type which *do not* require line reaming or line boring after installation. Use a press or a suitable driver to remove bearings. Support casting to avoid distortion and to avoid damaging the bearing bore during removal and installation.

Before installing main bearings, expand bearing bore by placing the casting in an oven heated to 200°F (94°C). If practical, cool the precision bearing to shrink it.

Before installing the front main bearing, use the towelette included with the bearing kit to clean the outside of the bearing and bearing bore in the block.

⚠CAUTION ***Breathing vapor from towelette and prolonged contact with skin can be harmful. Be sure area is well ventilated.***

After allowing three to four minutes for drying, apply the Locktite from the small tube to the mating surfaces of the bearing and the bearing bore. Align the oil holes in the bearing with the oil holes in the bearing bore (Figure 22). The oil passage should be at least half open. Install the bearing flush with the block, using the combination driver. Wipe off excess Locktite around the bearing. Allow at least one hour for hardening at room temperature

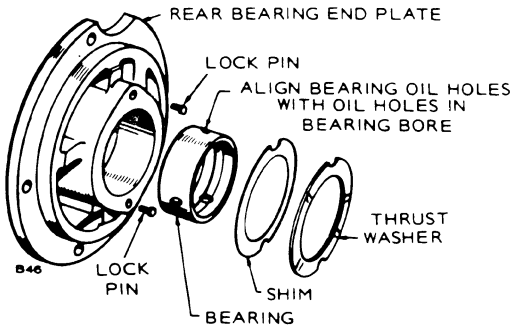


FIGURE 21. BEARINGS FOR REAR BEARING PLATE

In the rear bearing plate, install the bearing flush to 1/64 inch (0.40 mm) below the end of the bore. Be sure to align the oil holes in the bearing with the oil holes in the bearing bore (Figure 21). The oil passage must be at least half open. Lubricate bearing after installation.

If head of lock pin is damaged, use side cutters or Easy Out tool to remove and install new pin. Oil grooves in thrust washers must face the crankshaft, and washers must be flat (not bent). The two notches on each washer must fit over the two lock pins to prevent riding on the crankshaft (Figure 21).

Lubricate the front main bearing lightly with oil and insert the crankshaft. With the rear bearing plate gasket in place and the rear plate bearing lubricated, slide the thrust washer (grooves toward crankshaft) and plate over the end of the crankshaft. Line up notches of thrust washer with lock pins before tightening end plate or lock pins will be damaged.

Engines shipped from the factory have separate thrust washers and main bearings for both front and rear of engine. Front bearing replacement part is a one piece bearing (with attached thrust washer) as shown in Figure 22. Do not add an additional thrust washer to this front bearing.

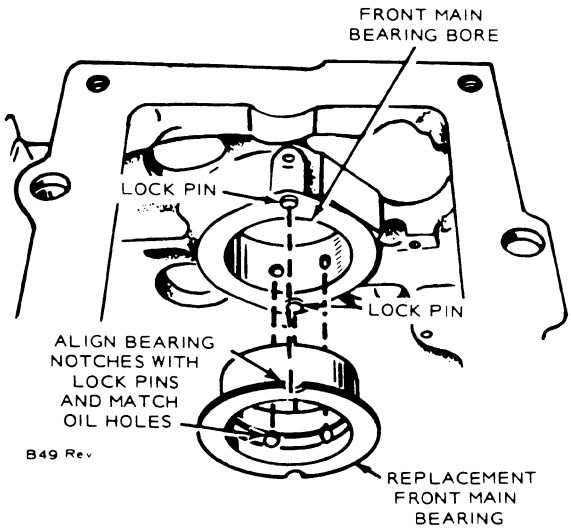


FIGURE 22. FRONT BEARING INSTALLATION

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened, using the torque recommended in *ASSEMBLY TORQUES AND SPECIAL TOOLS*, check the crankshaft endplay as shown in Figure 23. If there is too much endplay (see *DIMENSIONS AND CLEARANCES* for minimum and maximum endplay), remove the rear bearing end plate and add a shim (Figure 21) between the thrust washer and plate. Reinstall the end plate, making sure the thrust washer and shim notches line up with the lock pins. Torque and recheck endplay of the crankshaft.

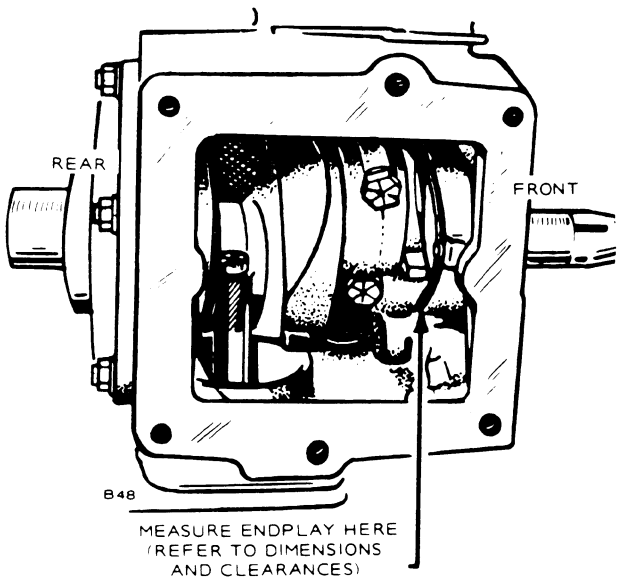


FIGURE 23. CRANKSHAFT ENDPLAY

CHECKING CONNECTING ROD BEARING CLEARANCE WITH PLASTIGAUGE

1. Make certain that all parts are marked or identified so that they are reinstalled in their original positions. Using a clean dry cloth, thoroughly clean all oil from crankshaft journal and connecting rod.

2. Place a piece of correct size Plastigauge in the bearing cap the full width of the journal surface and about 1/4 inch (6.35 mm) off center (Figure 24).

3. Rotate the crankshaft about 30 degrees from bottom dead center and reinstall the bearing cap; tighten rod bolts to the torque specified in *ASSEMBLY TORQUES AND SPECIAL TOOLS.* Do not turn the crankshaft.

4. Remove bearing cap. The flattened Plastigauge will be found adhering to either the bearing cap or crankshaft.

5. Compare flattened Plastigauge with the graduations on Plastigauge envelope to determine clearance.

   The number within the matching graduation on the envelope indicates total clearance in millimetres or thousandths of an inch.

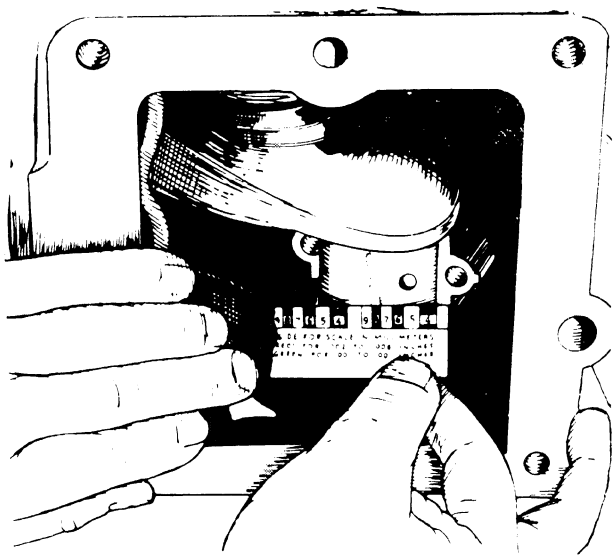


FIGURE 24. MEASURING BEARING CLEARANCE

OIL SEALS

The bearing plate must be removed to replace the oil seal (Figure 25). Drive the oil seal out from the inside.

Before installing seals, fill the space between lips with a multi-purpose grease. This will improve sealing.

When installing the gear cover oil seal, tap the seal inward until it is .645 inch (16.4 mm) from the front of the gear cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander or place a piece of heavy paper around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the paper as soon as the plate is in place.

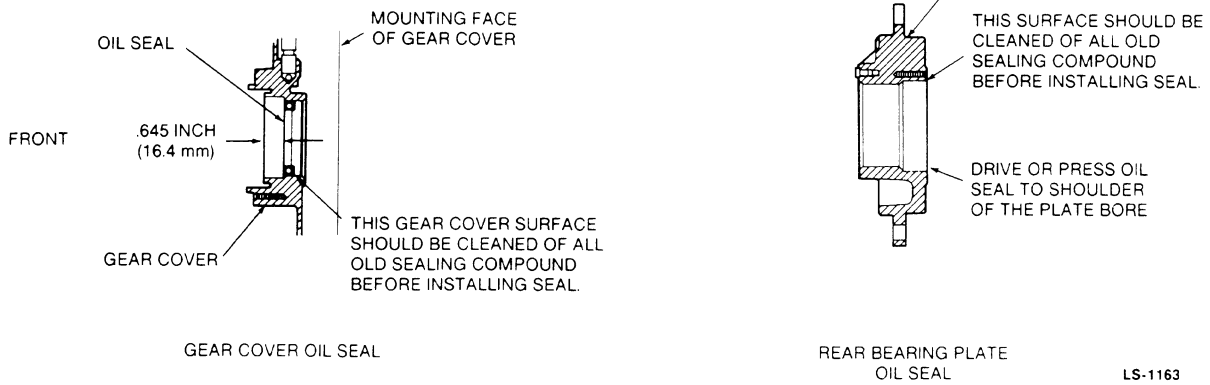


FIGURE 25. GEAR COVER AND REAR BEARING PLATE OIL SEALS

PISTON ASSEMBLY

1. Lubricate all parts with engine oil.

2. Position piston on its respective rod and install the pin.

3. Install the rings on the pistons starting with the oil control ring (Figure 26). Use a piston ring spreader to prevent twisting or excessive expansion of the ring. Compression rings have a dot or the word "top" on one side of the ring to indicate which side faces the top of the piston. Unmarked piston rings can be installed either way. The oil control ring has an expander; install the expander first and then close until the expander ends butt. The joint should be 180 degrees from the gap of that ring.

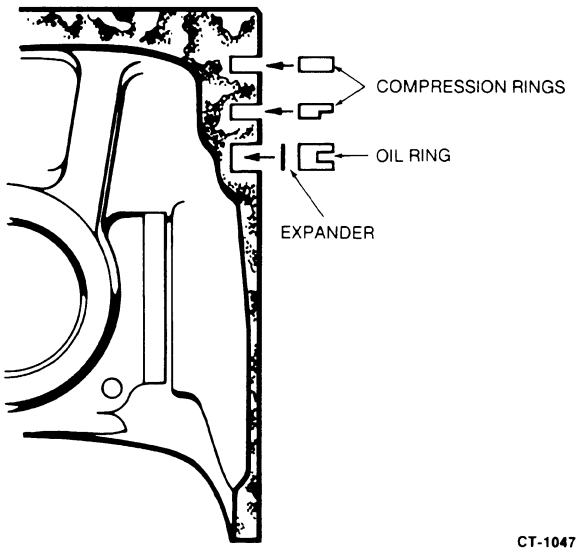


FIGURE 26. PISTON RINGS

INSTALLATION OF PISTON IN CYLINDER

1. Turn the crankshaft to position the number one rod bearing journal at the bottom of its stroke.

2. Lubricate the number one piston assembly and inside of the cylinder. Compress the rings with a ring compressor (Figure 27).

3. Position the piston and rod assembly in the cylinder block. Notched side of connecting rod must face camshaft; rod bolts must be off-set toward outside of block.

4. Tap the piston down into the bore with the handle end of a hammer until the connecting rod is seated on the journal (Figure 27). Install the bearing cap on the rod. Install and tighten the nuts evenly, in steps, to the specified torques.

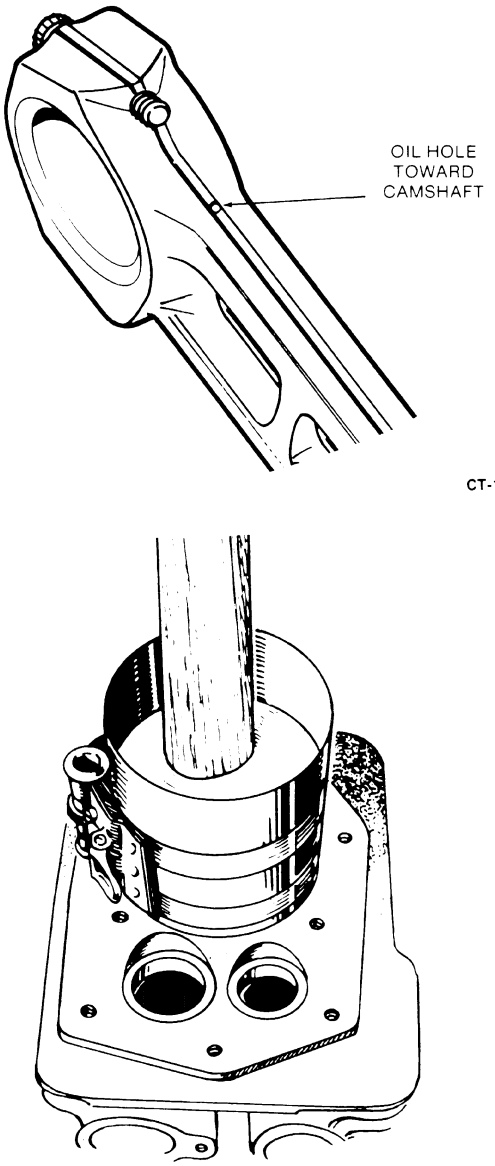


FIGURE 27. INSTALLING PISTON AND CONNECTING ROD

5. The bearing cap must be tapped to properly align it with the rest of the connecting rod. Clearance varies on the journal if this is not done.

6. Install the remaining piston and rod in the same manner. Crank the engine over by hand to see that all bearings are free.

7. Install the oil base with a new gasket.

8. Install the cylinder heads. See *Cylinder Head* section for torques and torquing procedure.

9. Replace oil and break in engine.

CYLINDER HEADS

Remove the cylinder heads for lead cleaning and gasket change at least every 250 hours, or when poor engine performance is noticed.

1. Use a 1/2 inch (13 mm) socket wrench to remove cylinder head nuts. Lift heads off.

⚠CAUTION ***Do not torque or remove heads when they are hot. Warpage may occur. The gasket surface must be below 100° F before removal. At temperatures above 100° F, the gasket will become gummy and difficult to remove from the surface of the block and cylinder head.***

2. After removing heads, clean out all carbon deposits. Be careful not to damage the outer sealing edges where gaskets fit. The heads are made of aluminum and can be damaged by careless handling.
3. Use new head gaskets and clean both the heads and the cylinder block thoroughly where the head gaskets rest.
4. Place a head gasket on the cylinder head and align the stud holes in the gasket with the stud holes in the cylinder head. While holding the gasket against the cylinder head, carefully install the cylinder head on the engine. Do not attempt to slide the gasket over the studs without the cylinder head behind it or the gasket may tear.
5. Install a flat washer, two compression washers, and nut on each of the top six studs (see Figure 28 for correct sequence). When properly installed, only the outside edges of the compression washers will be in contact with each other. Install a flat washer and nut on each of the four bottom studs.

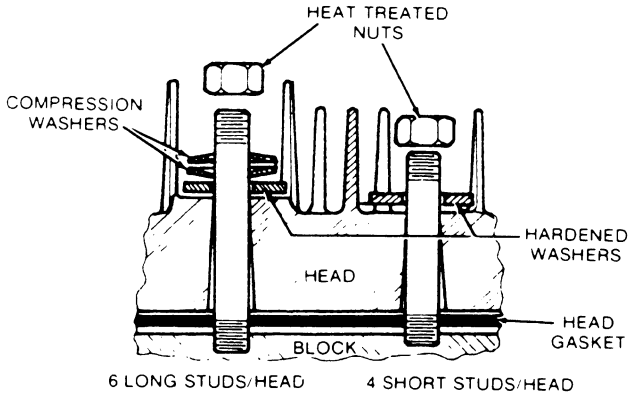


FIGURE 28. CYLINDER HEAD WITH COMPRESSION WASHERS

6. Follow the head torque sequence shown in Figure 29 tightening all nuts to 5 ft-lbs (7 Nm), then 10 ft-lbs (14 Nm), then to the torque specified in the *ASSEMBLY TORQUES* section. Recheck all nuts for correct torque.

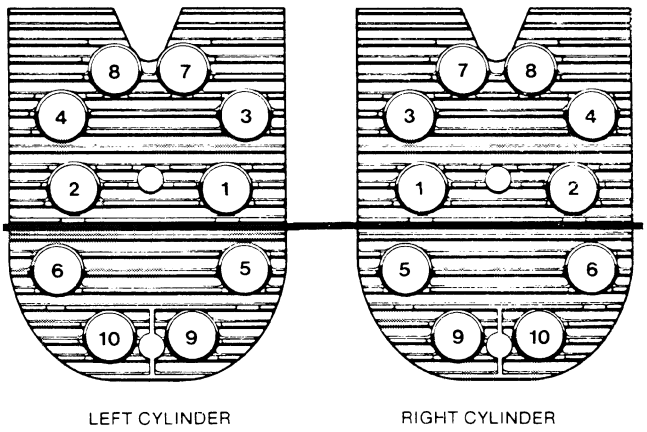


FIGURE 29. HEAD BOLT TIGHTENING SEQUENCE

⚠CAUTION ***Too much torque will flatten the compression washers and could result in engine damage.***

7. Recheck torque before engine has run a total of 50 hours.

⚠CAUTION ***Do not torque or remove heads when they are hot. Warpage may occur. The gasket surface must be below 100° F before removal. At temperatures above 100° F, the gasket will become gummy and difficult to remove from the surface of the block and cylinder head.***

CYLINDER HEAD STUD TEST AND REPLACEMENT PROCEDURE

This cylinder head stud replacement procedure should be used whenever replacing any of the top six studs on the block. The use of Helicoil is not a recommended repair procedure. If a Helicoil has been used, the cylinder block must be replaced. Graphoil head and intake manifold gaskets should also be used when replacing cylinder head studs.

Parts Required

Part No.	Description
520-0912	Step stud
110-2987	Head gasket
154-2219	Intake manifold gasket
420-0398	Drilling fixture (Reusable tool)

1. Disconnect the spark plug wires and remove the spark plugs and cylinder head air shrouds from each cylinder.

2. Remove the nuts and compression washers (do not remove the flatwashers) from the top six studs on each cylinder head (Figure 30). Each stud will have two compression washers and one flatwasher arranged in the sequence shown in Figure 31.

   Do not remove the nuts from the bottom four studs before the test procedure is completed.

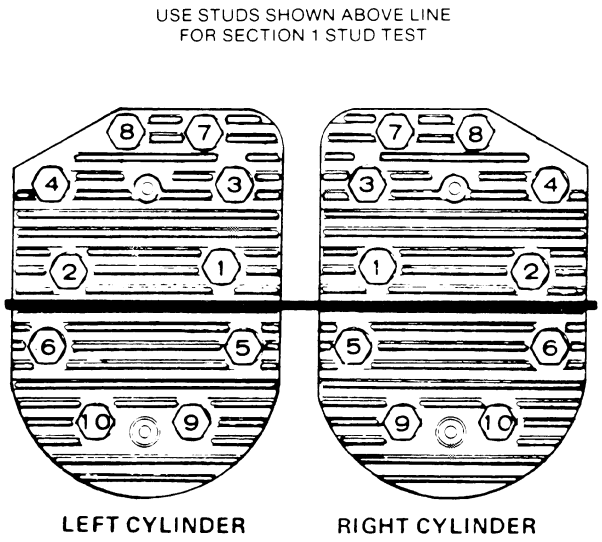


FIGURE 30. CYLINDER HEADS

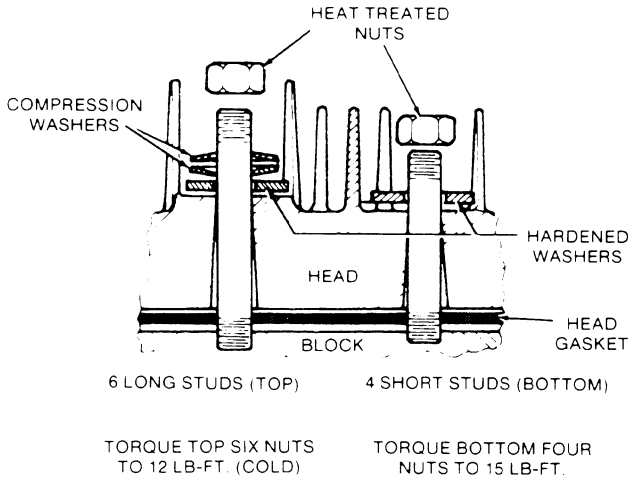


FIGURE 31. CYLINDER HEAD STUDS

3. Replace the nuts and then test the top six cylinder head studs by tightening (use an accurate torque wrench) each nut to 30 ft-lb (40 Nm) of torque. Make a note of any studs that cannot be tightened to 30 ft-lb of torque.

4. Remove the cylinder-head nuts, flatwashers, cylinder head, and head gasket. Discard the head gasket and remove any studs that could not be torqued to 30 ft-lb (40 Nm) without thread pull out.

5. Examine the gasket surfaces of the block and cylinder head for distortion or irregularities that could cause leakage. Check the head and block for warpage by laying a straight edge over the length of the gasket surface. If a 0.005 inch feeler gauge fits between the straight edge and gasket surface, the part must be replaced or milled flat. A maximum of 0.010 inch may be machined from the cylinder block or head.

On some engines, it is possible that a groove from the old head gasket fire ring may be impressed into the head and/or block. If this is the case, it is essential that the part be replaced or milled to remove the imperfection.

If all of the top six studs accepted 30 ft-lb of torque without pulling out, the new head gasket may be put on without replacement of the studs. If this is the case, skip steps 6 through 12.

6. Fit the special repair fixture (Onan Tool #420-0398) to the surface of the block. Use the studs shown in Figure 32 and two cylinder head nuts to secure fixture to head of block.

   Some applications may require that three or four flatwashers be placed over the studs between the block and fixture to space the fixture away from the block. This will be necessary if the fixture does not clear the sheet metal scroll backing plate.

7. Insert the small size bushing into the fixture over the hole(s) with damaged threads and lock it in place. With the bushing as a guide, drill out the damaged threads using a 27/64 size drill bit. If drilling out the holes on the SIDE of the block, drill through to the fourth fin (Figure 33). If drilling out the holes at the TOP of the block, it will be necessary to remove the corresponding intake or exhaust manifold. The drill bit should penetrate completely into the port but should not contact the opposite wall of the port (Figure 33).

8. Replace the small bushing with the large bushing and lock into place. Using a 1/2-13 tap, carefully form the threads, making sure there are full threads the entire length of the hole.

9. After all drilling and tapping is completed, remove the special fixture and repeat the same operation on the other cylinder if necessary.

10. Remove the ridge around all new holes using a flat file or a 45° chamfer tool. When using a chamfer tool, the depth of the chamfer should be 1/32 to 1/16 inch deep.

11. Apply screw thread retaining compound (Loctite 242) to the large end of each new step stud. Install the stepped replacement stud, making sure the entire stepped portion is below the gasket surface.

12. When putting a stepped stud into the hole that penetrates into the exhaust port, it will be necessary to cut approximately 3/16 to 1/4 inch (3 threads) off the stepped portion of the stud. No part of this stud may extend into the exhaust port or it will interfere with the exhaust manifold assembly.

13. Turn engine so that both valves are closed. Using a flat scraper and/or wire brush, remove all lead and carbon deposits from the top of the piston, valve area, and cylinder head combustion chamber.

14. Blow out all residual debris and metal chips using low pressure (35 PSI or less) air. If a hole was drilled into either the exhaust or intake port, open the valve on that port and blow it out thoroughly. Replace manifold if removed during the drilling and tapping operations.

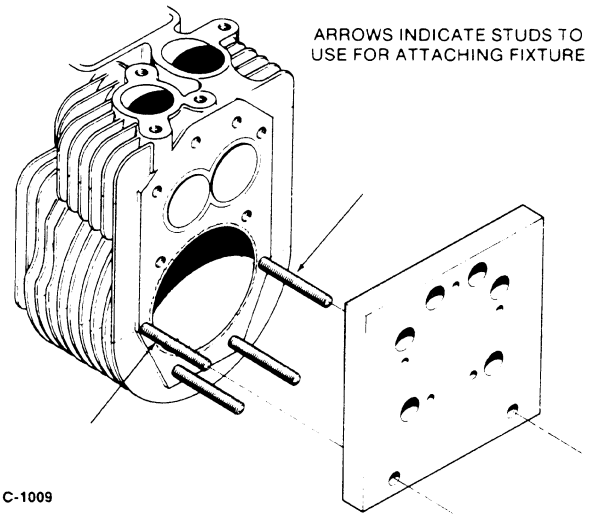


FIGURE 32. REPAIR FIXTURE

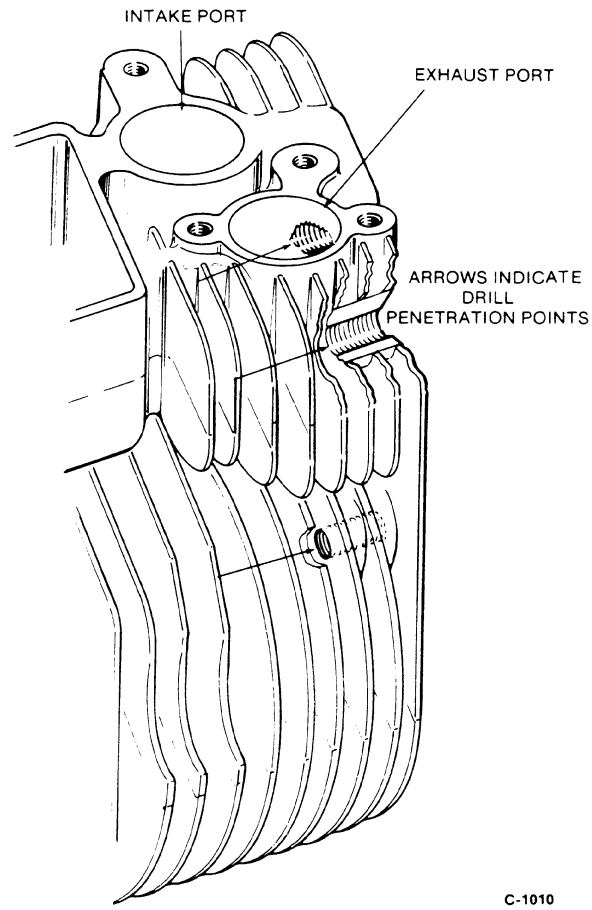


FIGURE 33. DRILLING PROCEDURE

ALIGNING BLOWER WHEEL, VENTURI AND CHAFF SCREEN

It may be difficult to line up the screw holes in the blower housing chaff screen with those in the venturi and those in the blower wheel if these parts are separated without noting their relative positions. The holes will match up if the parts are aligned as shown in Figure 34.

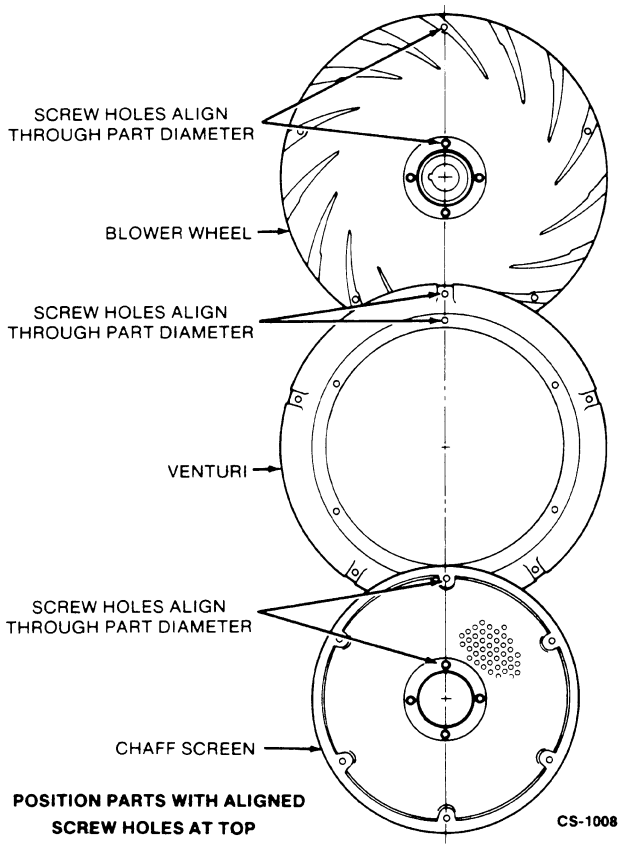
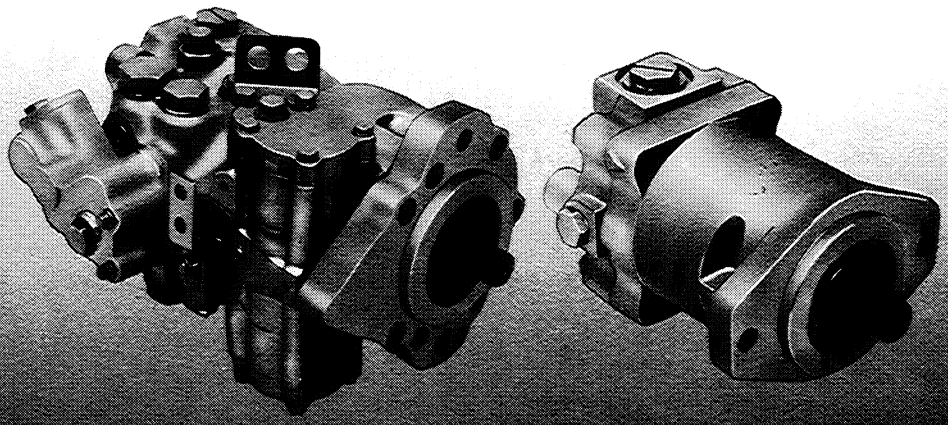


FIGURE 34. BLOWER WHEEL, VENTURI AND CHAFF SCREEN ALIGNMENT

SUNDSTRAND SAUER

Series 40

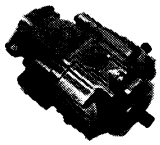


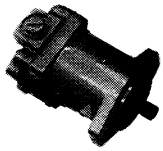
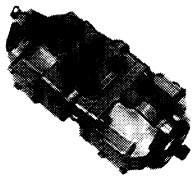
M46-Axial Piston Pumps and Motors Service Manual

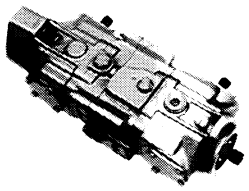
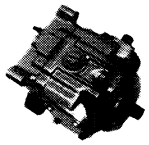
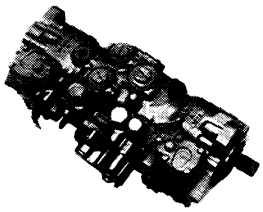
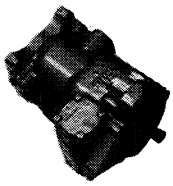
Series 40 Pumps and Motors

- 3 Sizes of Variable Displacement Pumps
- 3 Sizes of Tandem Pumps
- 3 Sizes of Fixed Displacement Motors
- 3 Sizes of Variable Displacement Motors
- High Performance at Low Cost
- Efficient Axial Piston Design
- Complete Family of Control Systems
- Proven Reliability and Performance
- Optimum Product Configurations
- Compact, Lightweight
- Worldwide Sales and Service





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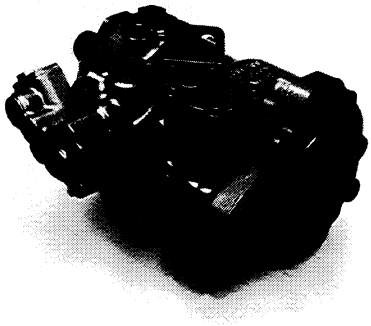
Introduction

The purpose of this manual is to provide information useful in the normal servicing of the Series 40 - M46 Medium Duty Hydrostatic Pumps and Motors. This manual includes unit and component description, troubleshooting, adjustment, and minor repair procedures. Following the procedures in this manual, the minor repairs may be performed without affecting the unit warranty.

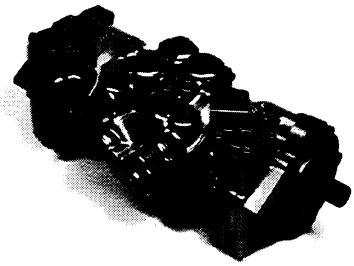
A Series 40 Transmission does occasionally require servicing, and these units have been designed with this in mind. Some repairs and adjustments can be accomplished without removing the unit from its installed location, provided that the unit is accessible and can be thoroughly cleaned before beginning any procedures. Since dirt or contamination is the greatest enemy of any hydraulic equipment, the greatest possible cleanliness is necessary.

Sundstrand-Sauer provides a complete repair service for its products. Contact any Sundstrand-Sauer Authorized Service Center for details. (See pages 43 and 44.)

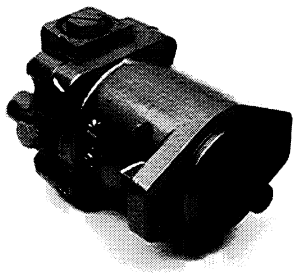
The torque values, pressures, and dimensions used throughout this manual are given in English and metric measurements.



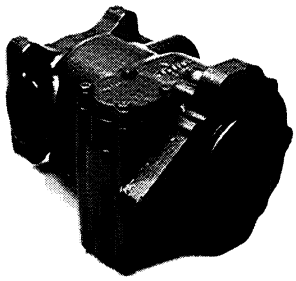
Variable Displacement Pump



Variable Displacement Tandem Pump



Fixed Displacement Motor



Variable Displacement Motor

General Description

Series 40 - M46 Medium Duty Hydrostatic Transmission

The Series 40 - M46 Medium Duty pumps and motors can be applied separately or combined in a system to transfer and control power. When combined in such a system, these units provide an infinitely variable speed range between zero and maximum, in both forward and reverse modes of operation.

Series 40 - M46 variable displacement pumps are a compact, state-of-the-art design, using the parallel axial piston / slipper design in conjunction with a tiltable swashplate to vary the pump's displacement. Reversing the direction of tilt of the swashplate reverses the flow of oil from the pump and thus reverses the direction of the motor output rotation.

The Series 40 - M46 variable displacement pump and tandem pump are controlled by a compact responsive hydro-mechanical, closed loop control system. A choice of manual, hydraulic, or electrical displacement controls are available.

A charge relief valve and charge check valves are included in the pump end cap to control the makeup and cooling oil flow for the system. The charge check valves also incorporate the high pressure relief valve function into their design.

The Series 40 - M46 variable displacement pump is available with a 0.85 in3/rev (13.9 cc/rev) integral gerotor type charge pump. The Series 40 - M46 tandem pump is available with a 1.40 in3/rev (22.9 cc/rev) integral gerotor type charge pump.

The fixed and variable displacement motors also incorporate the parallel axial piston / slipper design. Fixed displacement motors utilize a fixed swashplate angle. The variable displacement motors use a variable angle swashplate with a hydraulic control system, designed to provide two positions of the swashplate: a maximum displacement and a minimum displacement.

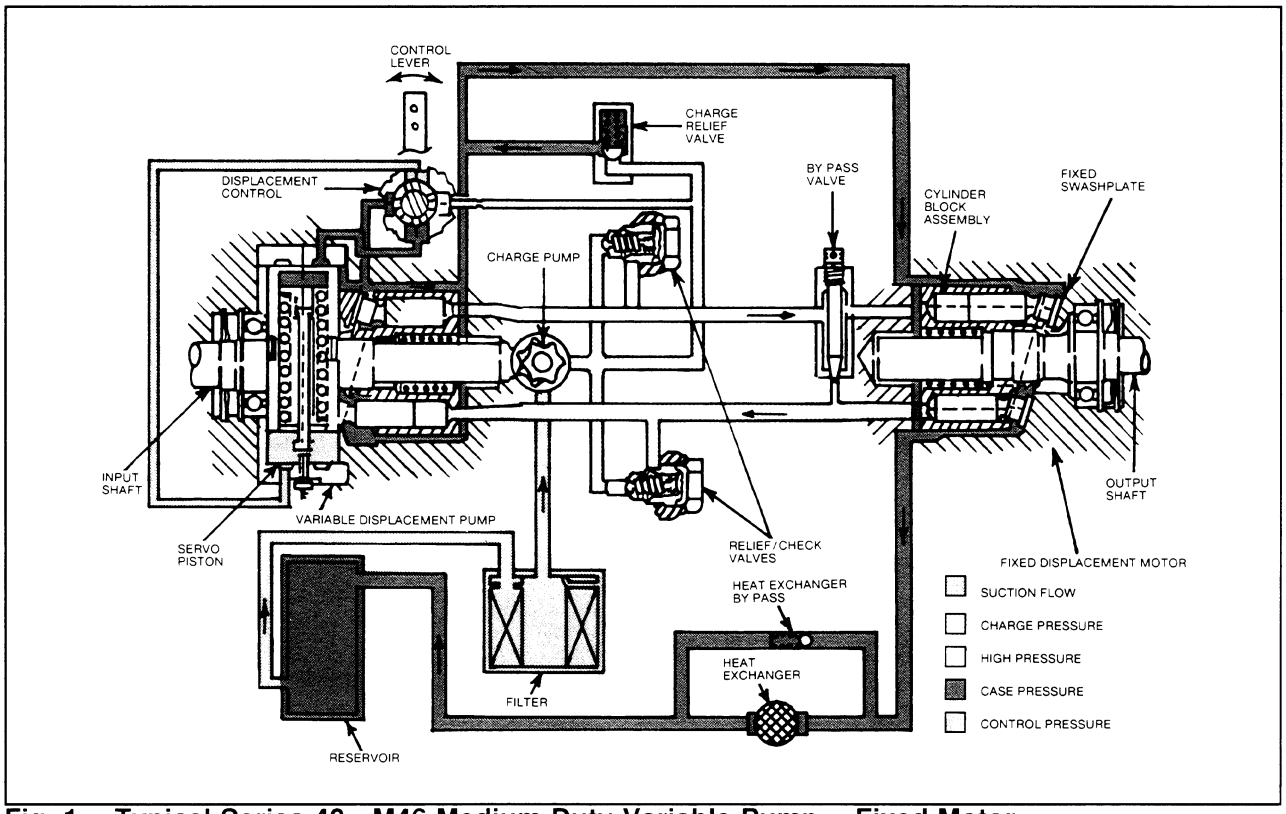


Fig. 1 - Typical Series 40 - M46 Medium Duty Variable Pump -- Fixed Motor Transmission Schematic

Transmission Hydraulic Support System

The Series 40 - M46 Pumps and Motors are easy to install, requiring no adjustments and few auxiliary components. They have their own hydraulic support system which is discussed in this section.

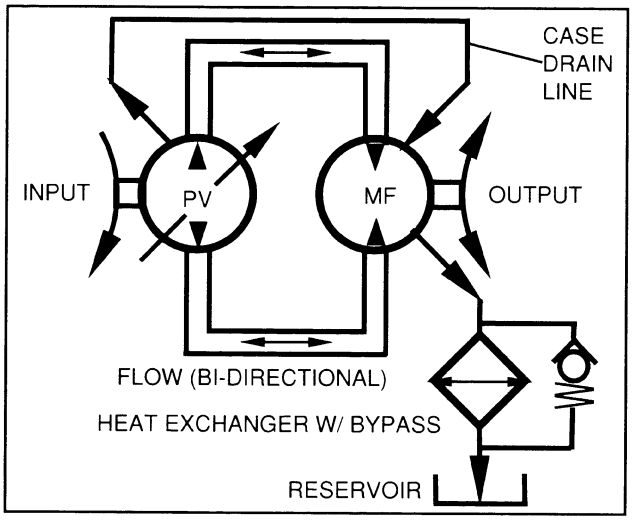


Fig. 2 - Basic Closed Circuit

Basic Closed Circuit

The main ports of the pump are connected by hydraulic lines to the main ports of the motor. Fluid flows, in either direction, from the pump to the motor then back to the pump in this closed circuit. Either of the hydraulic lines can be under high pressure. The direction and speed of fluid flow (and the motor output shaft rotation) depends on the position of the pump swashplate. The system pressure is determined by the machine load.

Case Drain and Heat Exchanger

The pump and motor require case drain lines to remove hot fluid from the system. The pump case should be drained from its upper drain port to insure the case remains full of fluid. The pump case drain is then connected to the lower drain port on the motor housing. The upper motor housing drain port is then connected to the reservoir.

A heat exchanger, with a bypass valve, may be required to cool the case drain fluid before it returns to the reservoir.

NOTE: When operating pump near rated speed, some case flow may have to be diverted around the motor to ensure pump case pressure remains within recommended limits.

CAUTION

Continuous case pressure should not exceed 25 PSI (1.7 BAR).

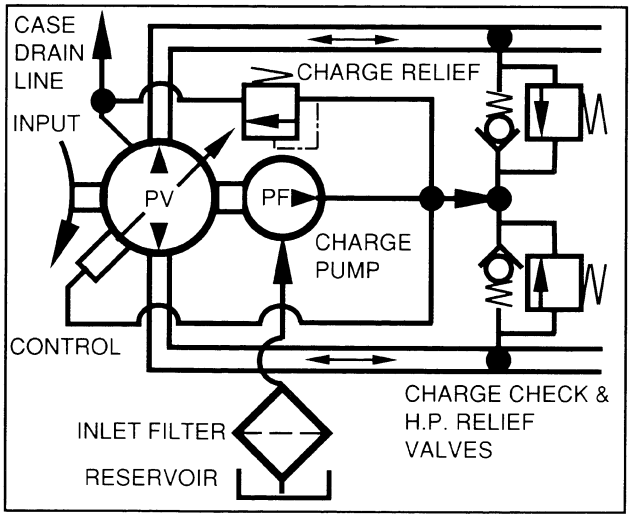


Fig. 3 - Charge System

Charge System and Inlet Filter

The charge pump supplies cool fluid to the system and keeps the closed loop charged to prevent cavitation. The charge pump draws its fluid from the system reservoir.

CAUTION

The inlet vacuum, measured at the charge pump inlet should not exceed 5 in. Hg (.8 BAR abs.), except during cold starts.

Since either of the main hydraulic lines can be high pressure, two (2) charge check valves are used to direct the charge supply into the low pressure line. These check valves are incorporated into the high pressure relief valves in the pump end cap. Any charge flow not being used for the closed circuit is discharged over a direct operating charge relief valve, through the pump and motor housings, and back to the system reservoir. The charge pressure relief valve is factory set for 220-240 ΔPSI (15.2-16.5 BAR) above case pressure under test conditions. Exact charge pressure may vary in various applications.

CAUTION

Charge Pressure must not be less than 220 PSI (15.2 BAR) for satisfactory operation. Pressure less than this may result in premature unit failure or loss of control.

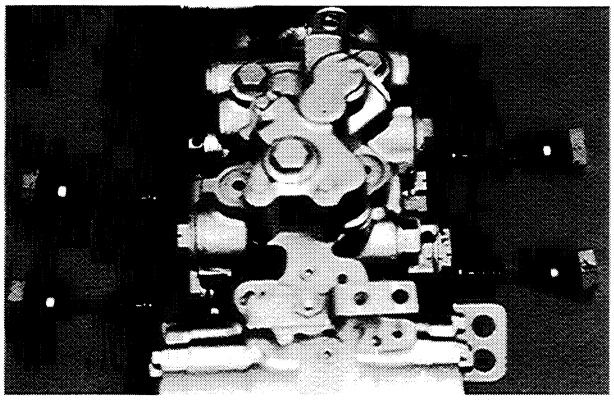


Fig. 4 - Charge Check and High Pressure Relief Valves (Tandem Pump Shown)

High Pressure Relief Valves

Two (2) optional combination check / high pressure relief valves may be provided in the pump end cap for overload protection. These cartridge type relief valves are factory set, and are not field adjustable. Changing the maximum system pressure can be accomplished by installing different cartridges with the desired setting.

Safety Precautions

- **The loss of hydrostatic drive line power in an acceleration, deceleration, or neutral mode may cause a loss of hydrostatic braking capacity. A braking system, redundant to the hydrostatic transmission must, therefore, be provided which is adequate to stop and/or hold the system should the condition develop.**

- **Certain service procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing them in order to prevent injury to the technician and bystanders.**

- **Use caution when dealing with hydraulic fluid under pressure. Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury. This fluid may also be hot enough to burn. Serious infection or reactions can develop if proper medical treatment is not administered immediately.**

- **Some cleaning solvents are flammable. To avoid possible fire, do not use cleaning solvents in an area where a source of ignition may be present.**

Technical Data - Variable Displacement Pump / Tandem Pump

Product Type		M46 Variable Pump	M46 Tandem Pump
Displacement			
In^3/Rev		2.8	2.8 (each section)
cc/Rev		46	46 (each section)
Input Speed			
Max - RPM (Full Angle)		5000	ALL UNITS
Continuous - RPM (Full Angle)		4000	
Input Mounting Flange (per SAE J744)			
		SAE B	SAE B
Input Shaft (Std. Spline)			
Number of Teeth		15	ALL UNITS
Pitch		16/32	
Weight			
LBS		73	131
KG		33	59
Pressure			
Maximum	PSI	5000	ALL UNITS
	BAR	345	
Continuous	PSI	3000	ALL UNITS
	BAR	210	
Case Pressure			
Continuous	PSI	25	ALL UNITS
	BAR	1.7	
Maximum	PSI	75	ALL UNITS
(Cold Start)	BAR	5.2	
Temperature at Hottest Point in Transmission (normally at case drain)			
Maximum	°F	220	ALL UNITS
	°C	104	
Continuous	°F	180	ALL UNITS
	°C	82	
Fluid Viscosity Limits -- SUS (CST)			
Optimum		70 (13)	
Min. Continuous		55 (9.0)	
Min. Intermittent		47 (6.4)	ALL UNITS
Max. Continuous		500 (110)	
Max. Cold Start		7500 (1600)	
Suggested Filtration			
Dedicated Reservoir		Beta 10 = 1.5 to 2.0	ALL UNITS
Common Reservoir		Beta 10 = 10 to 20	
Charge Inlet Vacuum at Sea Level			
Normal	in. Hg	5	
	BAR (abs.)	.8	ALL UNITS
Cold Start	in. Hg	10	
	BAR (abs.)	.7	

Technical Data - Fixed Displacement Motor / Variable Displacement Motor

Product Type		M46 Fixed Motor	M46 Variable Motor
Displacement			
In^3/Rev		2.8	2.8 (Maximum)
cc/Rev		46	46 (Maximum)
Output Speed			
Full Angle (17°)	Max - RPM	5000	5000
	Continuous - RPM	4000	4000
Low Angle (< 11°)	Max - RPM	----	6000
	Continuous - RPM	----	5000
Output Mounting Flange (per SAE J744)			
		SAE B	SAE B
Output Shaft (Std. Spline)			
Number of Teeth		15	ALL UNITS
Pitch		16/32	
Weight			
LBS		30	51
KG		14	23
Pressure			
Maximum	PSI	5000	ALL UNITS
	BAR	345	
Continuous	PSI	3000	ALL UNITS
	BAR	210	
Case Pressure			
Continuous	PSI	25	ALL UNITS
	BAR	1.7	
Maximum	PSI	75	ALL UNITS
(Cold Start)	BAR	5.2	
Temperature at Hottest Point in Transmission (normally at case drain)			
Maximum	°F	220	ALL UNITS
	°C	104	
Continuous	°F	180	ALL UNITS
	°C	82	
Fluid Viscosity Limits -- SUS (CST)			
Optimum		70 (13)	
Min. Continuous		55 (9.0)	
Min. Intermittent		47 (6.4)	ALL UNITS
Max. Continuous		500 (110)	
Max. Cold Start		7500 (1600)	
Suggested Filtration			
Dedicated Reservoir		Beta 10 = 1.5 to 2.0	ALL UNITS
Common Reservoir		Beta 10 = 10 to 20	

Controls and Options

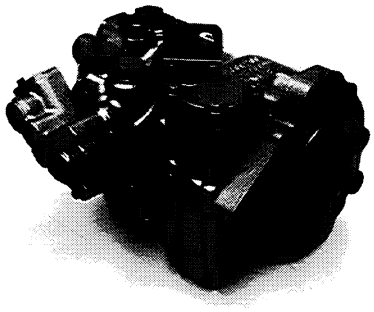


Fig. 5 - Variable Pump with Manual Displacement Control

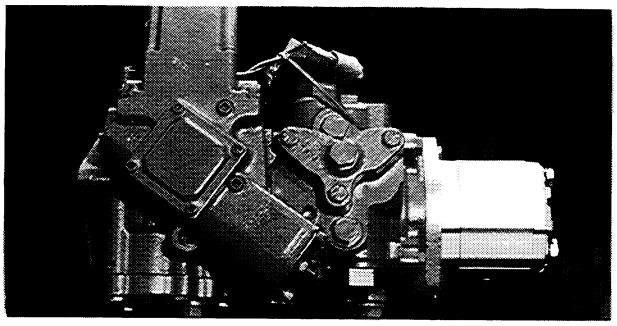


Fig. 6 - Variable Pump with Electric Displacement Control

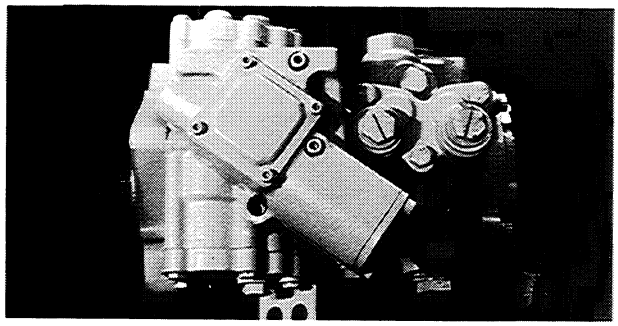


Fig. 7 - Variable Pump with Hydraulic Displacement Control

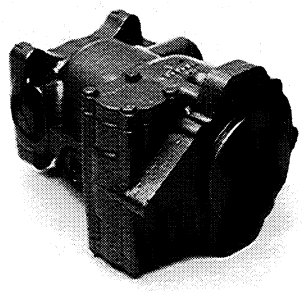


Fig. 8 - Variable Motor with Hydraulic Control

Manual Displacement Control

With the Manual Displacement Control (MDC), the pump displacement and output flow, in either direction, is approximately proportional to the angular movement of the control handle. The control will return to neutral if the pump control handle is released. the control centering mechanism is not sufficient to overcome external control linkage friction.

This control may have various sized orifices installed in the supply and drain passages for controlling maximum acceleration and deceleration (control response).

CAUTION

Torque on the control handle must not exceed 150 in.lbs. (17 Nm). Excessive torque may damage the control shaft.

Electric Displacement Control

With the Electric Displacement Control (EDC), the pump displacement and output flow, in either direction, is approximately proportional to an electrical input signal.

Orifices (various sizes available) are installed in the servo passages to control maximum acceleration and deceleration (control response).

Hydraulic Displacement Control

With the Hydraulic Displacement Control (HDC), the pump displacement and output flow, in either direction, is approximately proportional to a hydraulic pressure input signal.

Orifices (various sizes available) are installed in the servo passages to control maximum acceleration and deceleration (control response).

Bypass Valve

In some applications it is desirable to bypass fluid, allowing, for example, a vehicle to be moved short distances at low speeds without running the prime mover. This is accomplished by a manually operated bypass valve installed in the pump housing. When open (unscrewed 2 turns maximum), this valve connects both sides of the pump/motor closed circuit and allows the motor to turn. This valve must be fully closed for normal operation.

Variable Displacement Motor Hydraulic Control

The M46 Variable Motor Hydraulic Control is designed to provide two different positions of the swashplate: a maximum displacement and a minimum displacement. This control is available in several minimum displacement settings, including an infinitely adjustable stop.

Start-Up & Maintenance

Fluids

Hydraulic fluids used with Sundstrand-Sauer products should be carefully selected with assistance from a reputable supplier, following the guidelines presented in the "Fluid Quality Requirements" bulletin, BLN-9887.

Start-Up Procedure

The following start-up procedure should always be followed when starting-up a new Series 40 - M46 installation or when restarting an installation in which either the pump or motor had been removed from the system.

WARNING

The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders. Take necessary safety precautions before moving the vehicle/machine.

Prior to installing the pump and/or motor, inspect the units for damage incurred during shipping and handling. Make certain all system components (reservoir, hoses, valves, fittings, heat exchanger, etc.) are clean prior to filling with fluid.

Fill the reservoir with recommended hydraulic fluid, which should be passed through a 10 micron (nominal, no bypass) filter prior to entering the reservoir. The use of contaminated fluid will cause damage to the components, which may result in unexpected vehicle/machine movement.

The inlet line leading from the reservoir to the pump should be filled prior to start up. Check inlet line for properly tightened fittings and make sure it is free of restrictions and air leaks.

Be certain to fill the pump and/or motor housing with clean hydraulic fluid prior to start up. Fill the housing by pouring filtered oil into the upper case drain port.

Install a 0 to 500 PSI (35 BAR) pressure gauge in the charge pressure gauge port to monitor the charge pressure during start-up.

It is recommended that the external control input signal (linkage for MDC, hydraulic lines for HDC, or electrical connections for EDC) be disconnected at the pump control until after initial start-up. This will allow the pump to remain in its neutral position.

"Jog" or slowly rotate prime mover until charge pressure starts to rise. Start the prime mover and run at the lowest possible RPM until charge pressure has been established. Excess air may be bled from the high pressure lines through the high pressure gauge ports.

WARNING

Do not start prime mover unless pump is in neutral position (0° swashplate angle). Take precautions to prevent machine movement in case pump is actuated during initial start up.

Once charge pressure has been established, increase speed to normal operating RPM. Charge pressure should be approximately 220 PSI (15.2 BAR) minimum. If charge pressure is incorrect, shut down and determine cause for improper pressure.

WARNING

Inadequate charge pressure will affect the operator's ability to control the vehicle/machine.

Shut down prime mover and connect external control input signal. Start prime mover, checking to be certain pump remains in neutral. With prime mover at normal operating speed, slowly check for forward and reverse machine operation.

Charge pressure should remain at 220 to 240 PSI (15.2 to 16.5 BAR) minimum during forward or reverse operation. Continue to cycle slowly between forward and reverse for at least five (5) minutes.

Shut down prime mover, remove gauges, and plug ports. Check reservoir level and add fluid if necessary.

The transmission is now ready for operation.

Maintenance

To insure optimum service life on Series 40 - M46 products, regular maintenance of the fluid and filter must be performed.

Check the reservoir daily for proper fluid level, the presence of water (noted by a cloudy to milky appearance, or free water in bottom of reservoir), and rancid fluid odor (indicating excessive heat).

It is recommended that the fluid and filter be changed per the vehicle/machine manufacturer's recommendations or at the following intervals:

- System with a sealed type reservoir - 2000 hrs.
- System with a breathing type reservoir - 500 hrs.

It may be necessary to change the fluid more frequently than the above intervals if the fluid becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid has been subjected to temperature levels greater than the maximum recommended. Never reuse fluid.

The filter should be changed whenever the fluid is changed or whenever the filter indicator shows that it is necessary to change the filter.

Troubleshooting

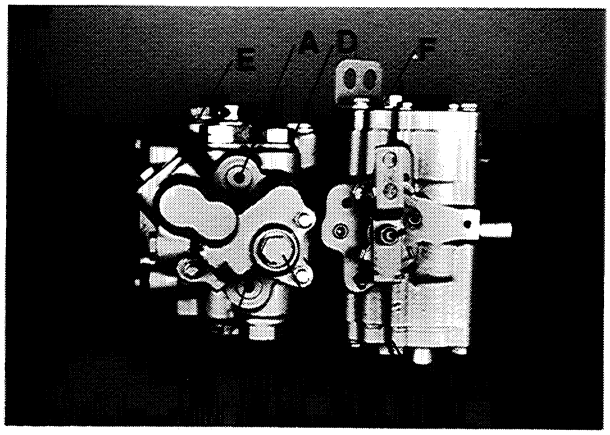


Fig. 9 - Gauge Connections -- Variable Pump with Suction Filtration

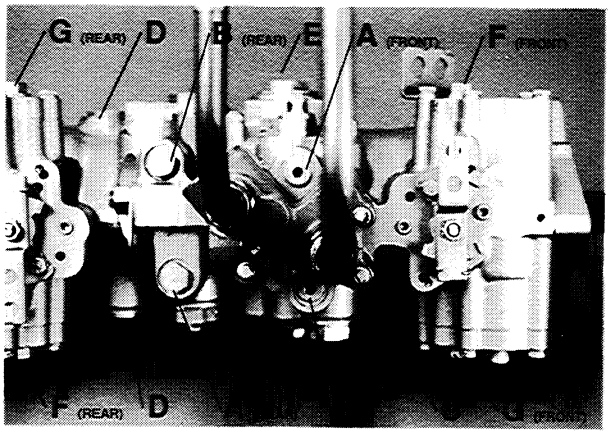


Fig. 10 - Gauge Connections -- Tandem Pump with Remote Pressure Filtration

Gauge Installation

Various pressure and vacuum gauge readings can be a great asset in troubleshooting problems with the Series 40 - M46 transmission or support system.

It will be necessary to install a high pressure gauge into the system pressure gauge ports to check the setting of the high pressure relief valves.

Measuring the charge pump inlet vacuum will help locate restrictions in the inlet lines, filter, etc.

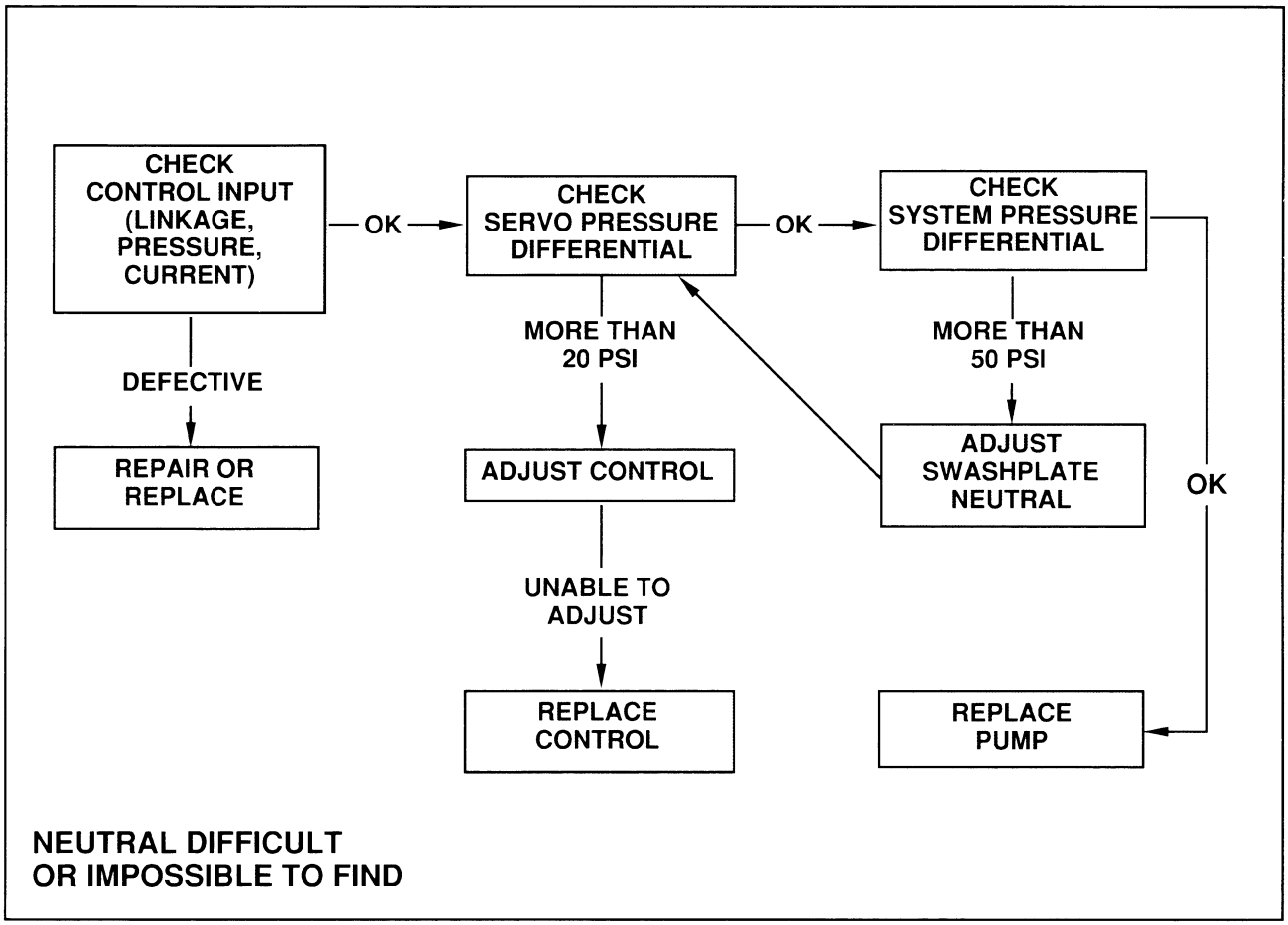
Case pressure readings can help locate restrictions in the return lines, oil cooler, and return filter.

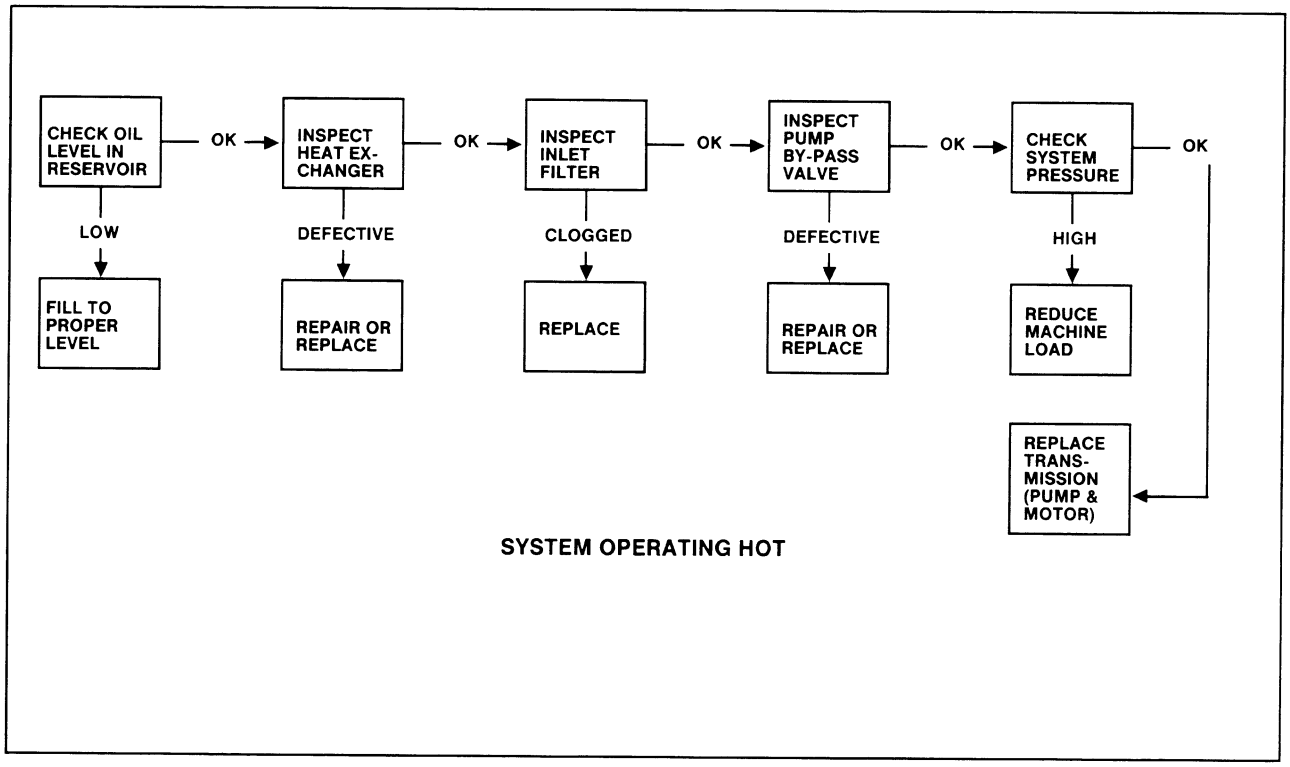
Gauge Information		
A	System Pressure Port "A"	10,000 PSI (690 BAR) Gauge 9/16–18 O-Ring Fitting
B	System Pressure Port "B"	10,000 PSI (690 BAR) Gauge 9/16–18 O-Ring Fitting
C	Charge Pressure Port "C"	500 PSI (35 BAR) Gauge 9/16–18 O-Ring Fitting or Tee into Charge Pressure Filter Outlet Line
D	Case Pressure	500 PSI (35 BAR) Gauge 1-1/16 –12 O-Ring Fitting
E	Charge Pump Inlet Vacuum	Vacuum Gauge Tee into Charge Pump Inlet Line
F	Servo Pressure	500 PSI (35 BAR) Gauge 9/16–18 O-Ring Fitting - Later Units 7/16–20 O-Ring Fitting - Earlier Units
G	Servo Pressure	500 PSI (35 BAR) Gauge 9/16–18 O-Ring Fitting - Later units 7/16–20 O-Ring Fitting - Earlier Units

NOTE: Tandem pumps have two (2) additional system pressure gauge ports (for system ports "C" and "D") in the rear section.

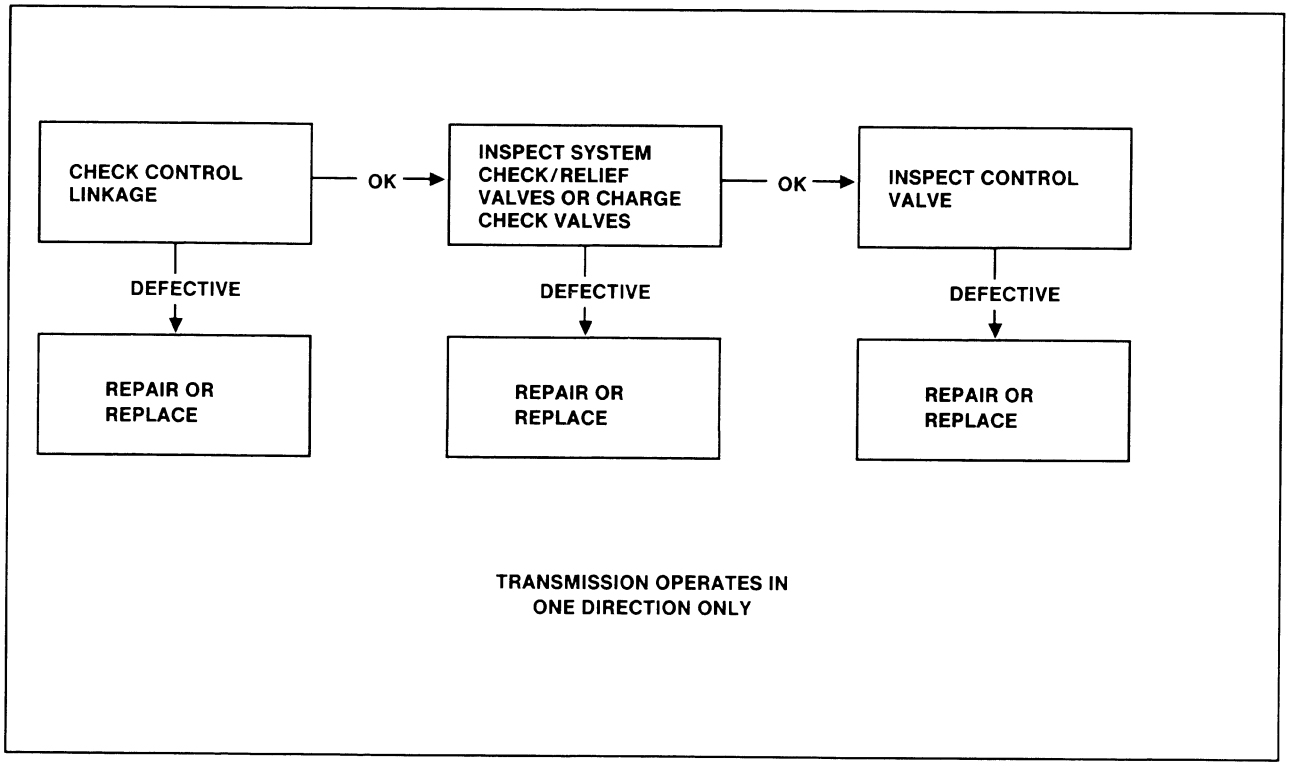
Snubbers are recommended to protect pressure gauges. Frequent gauge calibration is necessary to insure accuracy.

Fault-Logic Diagrams

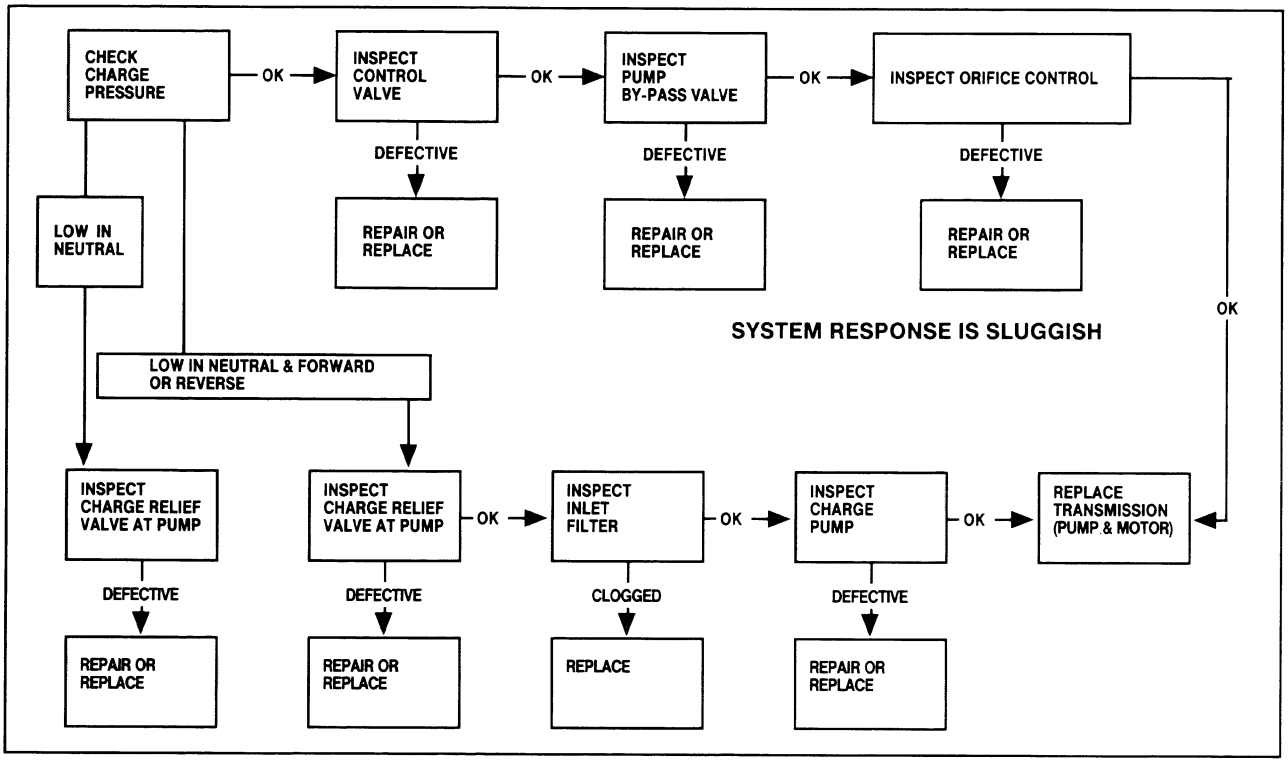


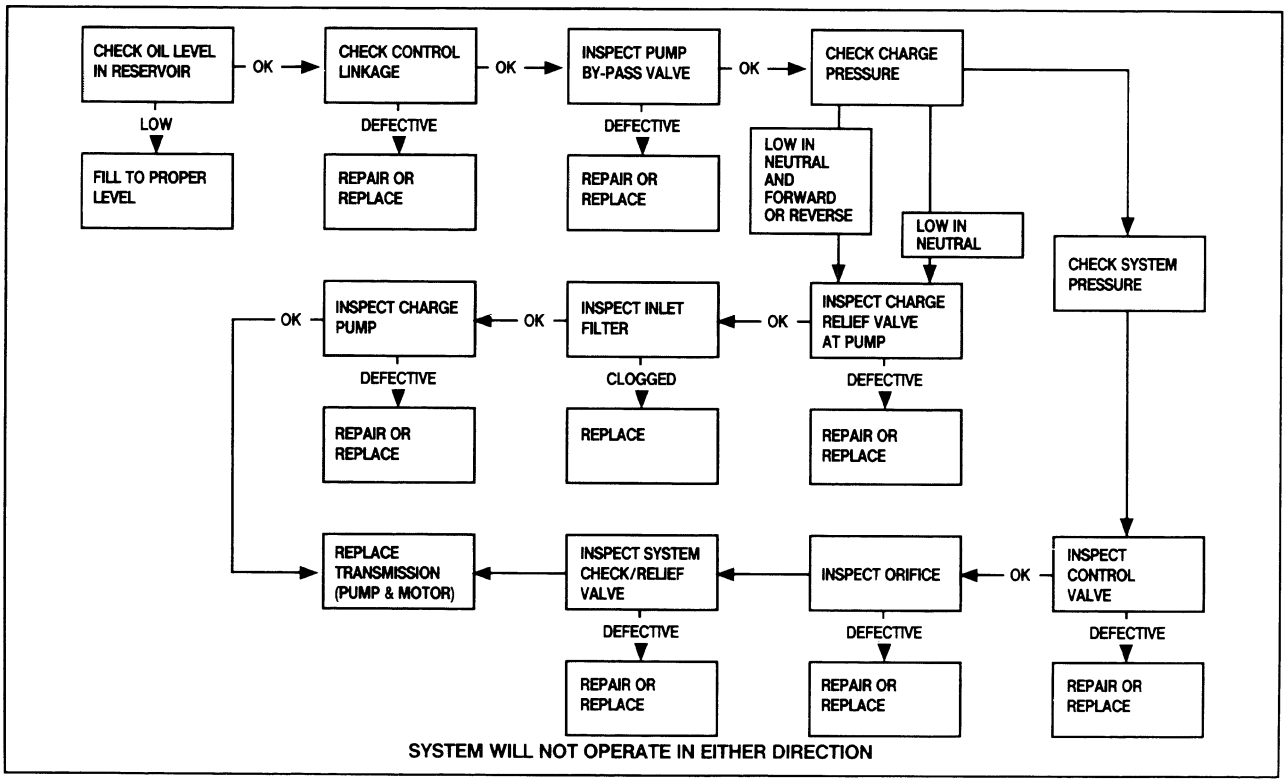


SYSTEM OPERATING HOT



TRANSMISSION OPERATES IN ONE DIRECTION ONLY


CHECK CHARGE PRESSURE
OK
INSPECT CONTROL VALVE
OK
INSPECT PUMP BY-PASS VALVE
OK
INSPECT ORIFICE CONTROL
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
LOW IN NEUTRAL
OK
SYSTEM RESPONSE IS SLUGGISH
LOW IN NEUTRAL & FORWARD OR REVERSE
INSPECT CHARGE RELIEF VALVE AT PUMP
INSPECT CHARGE RELIEF VALVE AT PUMP
OK
INSPECT INLET FILTER
OK
INSPECT CHARGE PUMP
OK
REPLACE TRANSMISSION (PUMP & MOTOR)
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
CLOGGED
REPLACE
DEFECTIVE
REPAIR OR REPLACE


CHECK OIL LEVEL IN RESERVOIR
OK
CHECK CONTROL LINKAGE
OK
INSPECT PUMP BY-PASS VALVE
OK
CHECK CHARGE PRESSURE
LOW
FILL TO PROPER LEVEL
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
LOW IN NEUTRAL AND FORWARD OR REVERSE
LOW IN NEUTRAL
CHECK SYSTEM PRESSURE
OK
INSPECT CHARGE PUMP
OK
INSPECT INLET FILTER
OK
INSPECT CHARGE RELIEF VALVE AT PUMP
DEFECTIVE
REPAIR OR REPLACE
CLOGGED
REPLACE
DEFECTIVE
REPAIR OR REPLACE
REPLACE TRANSMISSION (PUMP & MOTOR)
INSPECT SYSTEM CHECK/RELIEF VALVE
INSPECT ORIFICE
OK
INSPECT CONTROL VALVE
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
DEFECTIVE
REPAIR OR REPLACE
SYSTEM WILL NOT OPERATE IN EITHER DIRECTION

Inspections and Adjustments

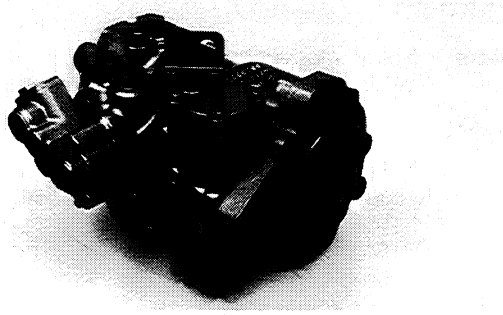


Fig. 11 - Pump with Manual Displacement Control

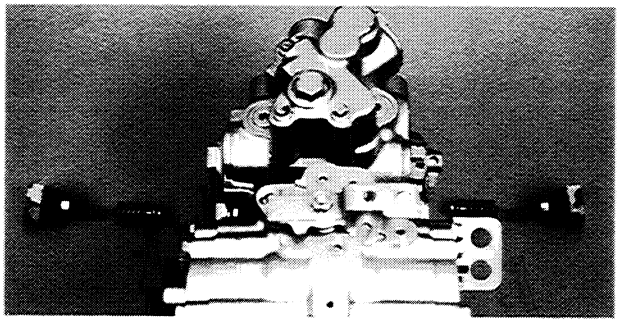


Fig. 12 - Check and High Pressure Relief Valves

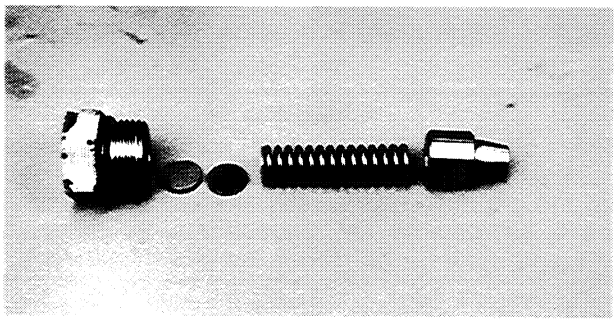


Fig. 13 - Pump Charge Relief Valve

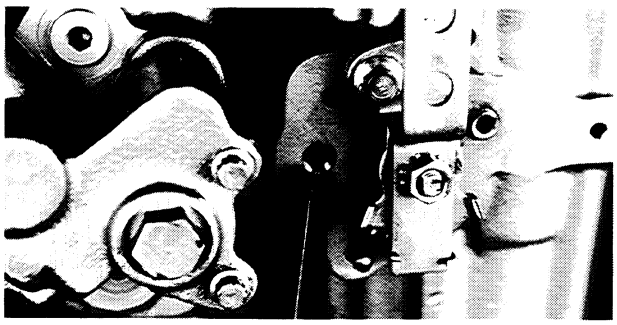


Fig. 14 - Manual Displacement Control Supply Orifice

Manual Displacement Control

Disconnect the external control linkage from the control handle and check for neutral by manually operating the control handle. Releasing the control handle should allow the pump to return to neutral. If operation is satisfactory with the external control linkage disconnected, the problem is not in the hydrostatic transmission.

If operation is not satisfactory with the external control linkage disconnected from the handle, the control may be incorrectly adjusted.

Check / High Pressure Relief Valves

The system check/relief valves have the dual purpose of providing make-up oil during by-directional rotation and providing protection from system over pressure. When the problem occurs in one direction only, interchange the check/relief valves to see if the problem changes to the other direction. If so, one check/relief valve cartridge is either malfunctioning or does not have the proper setting.

CAUTION

The relief valves are factory set and should not be tampered with except for replacing the entire cartridge. Disassembly may change the setting and cause erratic unit operation or premature failure.

Pump Charge Relief Valve

If charge pressure is low (less than 220 psi [15.2 BAR] above case pressure), the charge relief valve should be inspected. Inspect for foreign material holding the poppet open, and for scoring or wear on the poppet and seat in the housing.

Adjustment of the charge pressure is accomplished by changing the shim thickness behind the spring.

Manual Displacement Control (MDC) Supply Orifice

Note: Not all models have an orifice.

If the system is sluggish or will not operate in either direction, inspect the orifice. For pumps with serial number 02-XX-XX-XXXXX or below, remove the hex plug using a 9/16" wrench and remove the orifice with an 1/8" internal hex wrench. For pumps with serial number 03-XX-XX-XXXXX or above, remove the pipe plug with a 3/16" internal hex wrench and the orifice with a 5/32" internal hex wrench.

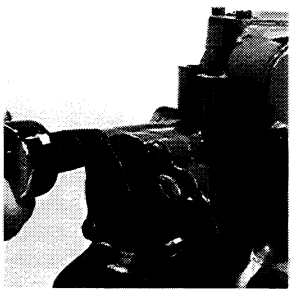


Fig. 15 - Remove Servo Cover (Opposite Neutral Adjustment)



Fig. 16 - Remove Control Orifice

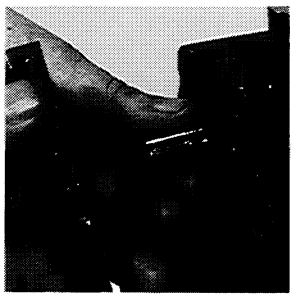


Fig. 17 - Install Spacer and Replace Cover

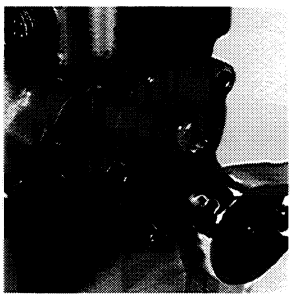


Fig. 18 - Remove Control Orifice (Neutral Adjustment Side)

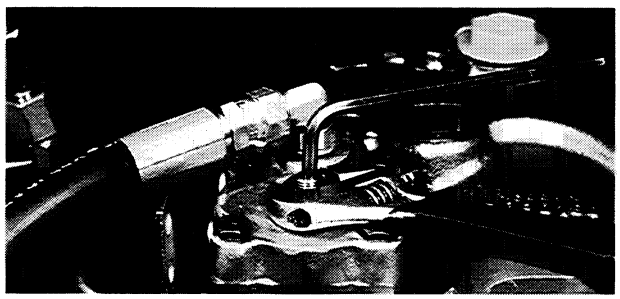


Fig. 19 - Install Servo Cross-Port Line

Hydraulic Displacement Control (HDC) and Electrical Displacement Control (EDC) Orifices

Note: Not all models have orifices. Pumps controlled by EDC or HDC should have a screen plug installed in place of the control inlet orifice installed in pumps with MDC. Pumps controlled by EDC or HDC have two (2) control orifices located under the servo covers.

With a 7/16" wrench, remove the five (5) cap screws from the servo cover opposite the neutral adjustment (cover without adjustment screw). With a 7/32" internal hex wrench, remove and inspect the orifice.

Remove the (5) cap screws from the servo cover on the neutral adjustment side. Install a spacer or socket, approximately 3/4" (19 mm) long, under the servo cover opposite the neutral adjustment, reinstall cap screws, and tighten until the servo cover on the neutral adjustment side of the pump separates 1/8" from the housing. Turn cover and remove and inspect orifice.

NOTE: On later production pumps, the displacement control may first have to be removed in order to rotate the servo cover.

Remove spacer, reinstall orifices, gaskets, and covers. Torque grade 5 cap screws to 8 to 11 ft.lbs. (10.8 to 14.9 NM) and grade 8 cap screws to 10 to 13 ft.lbs. (13.8 to 17.8 Nm).

Neutral Adjustment Procedure (PV and PT)

WARNING

The following procedures may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedures in order to prevent injury to the technician and bystanders.

Swashplate Neutral Adjustment

Using a low pressure line (500 PSI [35 BAR] min.), cross-port servo port "F" to servo port "B". This removes the effects of any control pressure on the servo piston.

Install pressure gauges (10,000 PSI [690 BAR]) in the system pressure gauge ports. Start the prime mover and slowly accelerate to normal operating RPM.

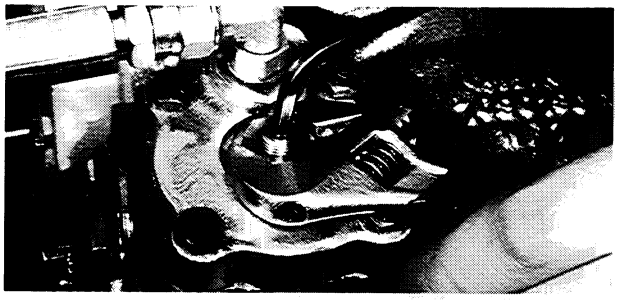


Fig. 20 - Loosen Neutral Adjustment Lock Nut

Remove the protective cap and loosen servo lock nut while holding the servo adjustment screw in position. Turn the servo adjustment screw until the two system pressure gauge readings are equal.

Turn the servo adjustment screw clockwise until one of the system pressures starts to increase. Noting the amount of rotation, turn the servo adjustment screw counter-clockwise until the other system pressure starts to increase.

Turn the servo adjustment screw clockwise half the amount of rotation noted above.

While holding the servo adjustment screw from turning, torque the servo lock nut to 13 to 18 ft.lbs. (17.6 to 24.4 Nm). Stop the prime mover, install a new protective cap, remove the servo cross-port line, and proceed to the appropriate control adjustment.

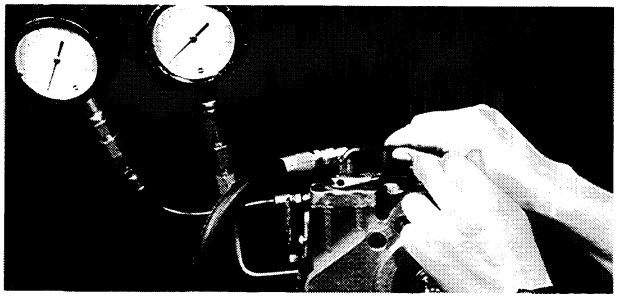


Fig. 21 - Adjusting Swashplate Neutral

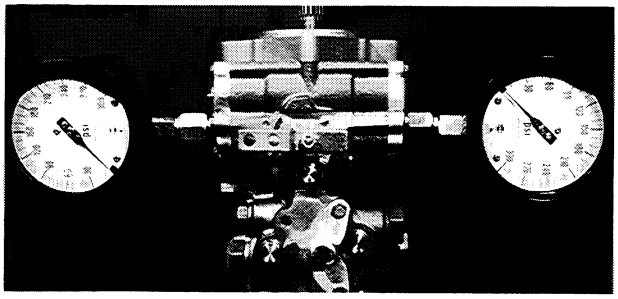


Fig. 22 - Install Servo Pressure Gauges

Manual Displacement Control (MDC) Neutral Bracket Adjustment

Remove the external control linkage from the control handle. Remove the servo cross-port line (installed while making the swashplate neutral adjustment) and install a 0 to 300 PSI (0 to 21 BAR) gauge in each servo gauge port.

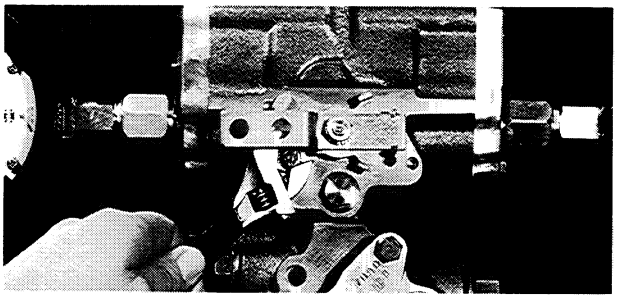


Fig. 23 - Loosen Neutral Bracket Retaining Screw

Loosen the washer head screw to allow the neutral bracket to move, but not freely.

WARNING

The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders.

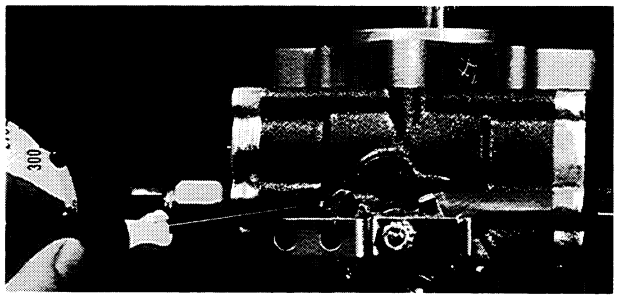


Fig. 24 - Rotate Neutral Bracket

Start the prime mover and slowly accelerate to normal operating RPM.

Insert a Phillips screwdriver into the 1/4" clearance hole and engage the slot of the neutral adjust bracket. Slowly rotate the neutral adjust bracket, using the Phillips screwdriver, until the pressure is equal on both servo gauges.

Slowly rotate the neutral adjust bracket until one of the servo gauges starts to increase in pressure. Mark the position of the neutral adjust bracket.

Slowly rotate the neutral adjust bracket in the opposite direction until the other servo gauge begins to increase in pressure. Mark the position of the neutral adjust bracket.

Rotate the neutral adjust bracket to a position between the two marks, and hold while torquing the washer head screw to 95 to 132 in.lbs. (10.8 to 14.9 Nm).

Stop the prime mover. Remove the gauges and install the gauge port plugs. Install and adjust, if necessary, the external control linkage.

Hydraulic Displacement Control (HDC) and Electrical Displacement Control (EDC) Neutral Adjustment

Remove the electrical connector at the EDC or the signal lines at the HDC. Remove the servo cross port line (installed while making the swashplate neutral adjustment) and install a 0 to 300 PSI (0 to 21 BAR) gauge in each servo port. (Refer to section on mechanical displacement control adjustment.)

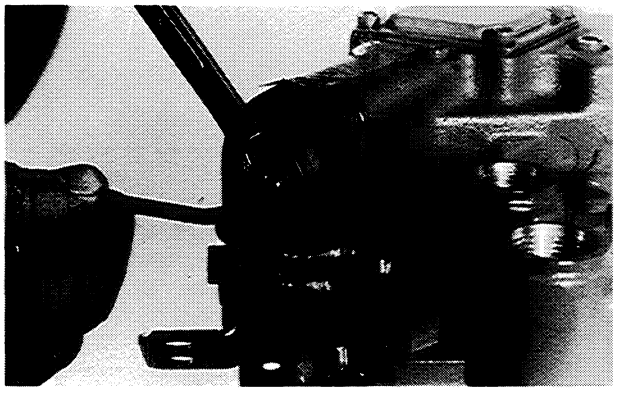


Fig. 25 - Adjusting Neutral for Hydraulic Displacement Control (HDC) or Electric Displacement Control (EDC)

WARNING

The following procedure may require the vehicle/machine to be disabled (wheels raised off the ground, work function disconnected, etc.) while performing the procedure in order to prevent injury to the technician and bystanders.

Start the prime mover and slowly accelerate to normal operating RPM.

Loosen lock nut with 1/2" wrench and slowly rotate the neutral adjustment screw, with 5/32" internal hex wrench, until the pressure is equal on both servo gages.

Slowly rotate the neutral adjust screw until one of the servo gauges starts to increase in pressure.

Noting the amount of rotation, slowly rotate the neutral adjust screw in the opposite direction until the other servo gauge begins to increase in pressure.

Turn the neutral adjust screw back one-half the amount noted above. Hold the neutral adjust screw and torque the lock nut to 25 to 30 in.lbs. (2.8 to 3.4 Nm).

Stop the prime mover. Connect the control input. Remove the servo pressure gages. Return the machine to normal operating condition. Restart prime mover and assure that hydrostatic system is in neutral.

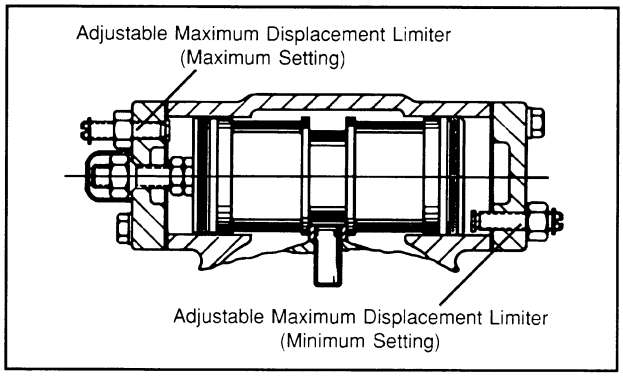


Fig. 26 - Displacement Limiter Adjustment (PV and PT)

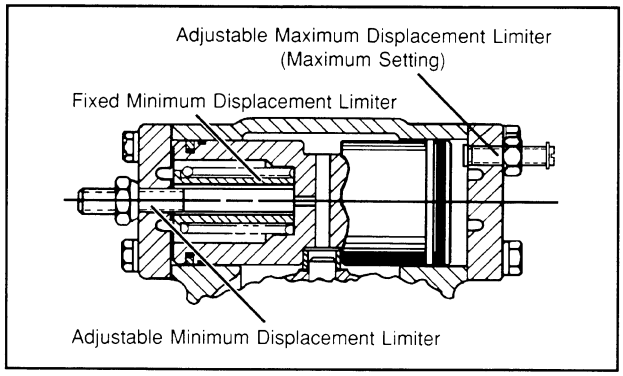


Fig. 27 - Displacement Limiter Adjustment (MV)

Displacement Limiters

The optional mechanical displacement (stroke) limiters are located in the servo covers of the variable pump and tandem pump. To adjust, remove the protective cap and loosen the sealing lock nut (with a 5/16" hex wrench), and adjust the displacement by rotating the screw with a screwdriver. Lock the adjuster by torquing the sealing lock nut to 4 to 7 lb.ft. (5.4 to 9.5 Nm) while holding the screw stationary. Install a new protective cap.

NOTE: One full revolution of the adjustment screw produces a change in displacement of approximately 9% of maximum (1.5° swash-plate angle). Full unit displacement is attained with the adjuster screw at its maximum extension from servo cover.

WARNING

Care should be taken in adjusting displacement limiters to avoid undesirable flow or speed conditions. The sealing lock nut must be retorqued after every adjustment to prevent an unexpected change in operating conditions and to prevent external leakage during unit operation. Use caution when adjusting minimum displacement on variable motors to avoid potential overspeed conditions during operation.

Minor Repair and Replacement

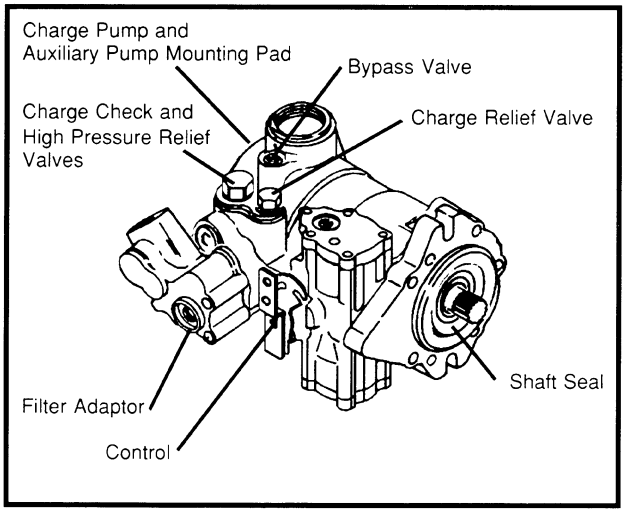
General

Minor Repairs may be performed, following the procedures in this section, without voiding the unit warranty.

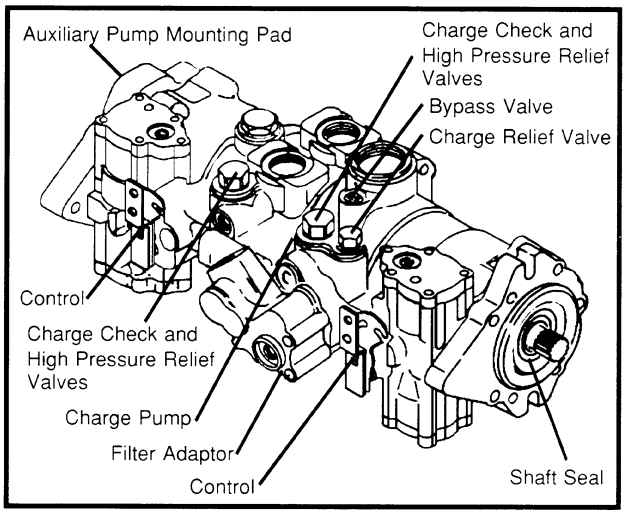
Cleanliness is a primary means of assuring satisfactory transmission life, on either new or repaired units. Cleaning parts by using a clean solvent wash and air drying is usually adequate. As with any precision equipment, all parts must be kept free of foreign materials and chemicals.

Protect all exposed sealing surfaces and open cavities from damage and foreign material.

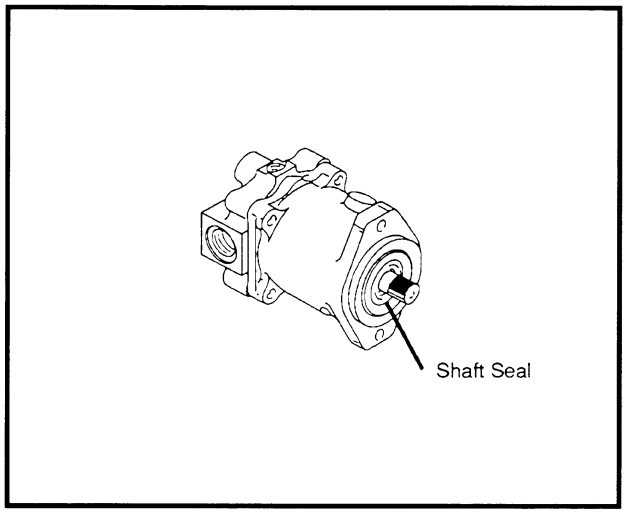
It is recommended that all gaskets and O-rings be replaced. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly. All gasket sealing surfaces must be cleaned prior to installing new gaskets.



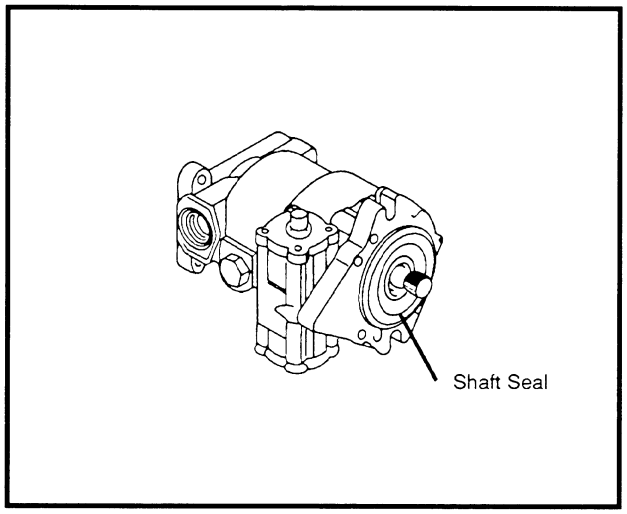
Variable Displacement Pump



Variable Displacement Tandem Pump



Fixed Displacement Motor



Variable Displacement Motor

Fig. 28 - Minor Repairs

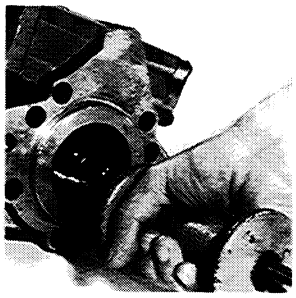


Fig. 29 - Removing Shaft Seal

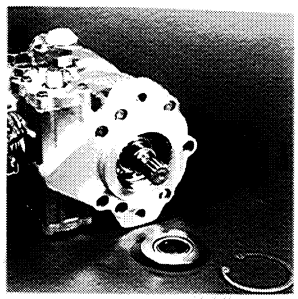


Fig. 30 - Shaft Seal Removed

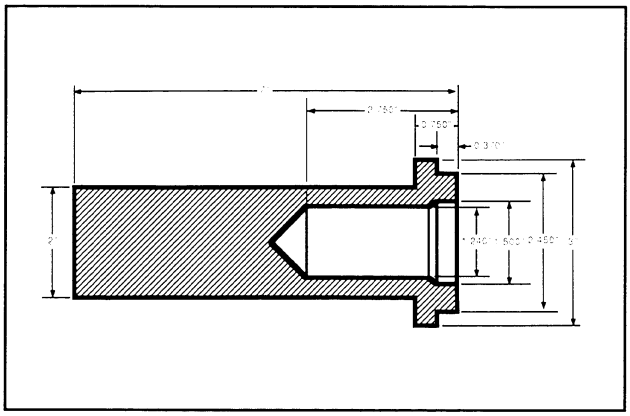


Fig. 31 - Shaft Seal Installation Tool Dimensions

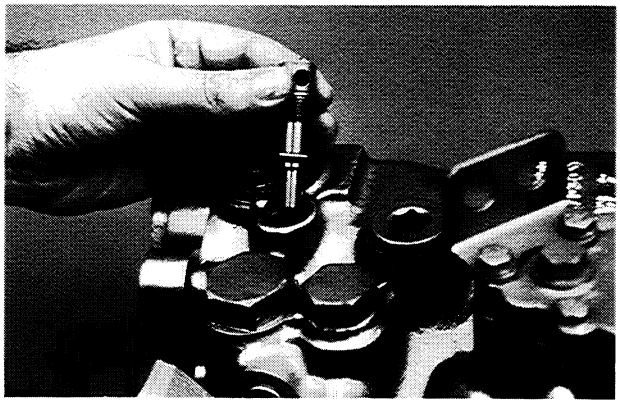


Fig. 32 - Bypass Valve

Shaft Seal

Lip type shaft seals are used on the Series 40 - M46 pumps and motors. These seals can be replaced without major disassembly of the unit. However, replacement of the shaft seal requires removal of the pump or motor from the machine.

Remove the retaining ring from the housing.

Carefully remove the seal from the housing bore. The face of the seal may be punctured with a sharp instrument (such as a screw driver) to aid in prying the seal out, or a slide hammer type puller may be used to remove the seal. Care must be taken so as not to damage the housing bore or shaft. Once removed, the seal is not reusable.

Prior to installing the new seal, inspect the sealing area on the shaft for rust, wear, or contamination. Polish the sealing area on the shaft if necessary.

Wrap the spline or key end of shaft with thin plastic to prevent damage to the seal lip during installation. Lubricate the inside diameter of the new seal with petroleum jelly.

Slide the new seal over the shaft and press it into the housing bore. Be careful not to damage seal. A seal installer tool can be made to aid in installing the seal. Dimensions for this tool are shown in the accompanying drawing.

Reinstall the seal retaining ring.

Bypass Valve (Pump)

Unscrew the bypass valve from the housing. Inspect the valve and mating seat for damage or foreign material. It is recommended that the O-ring and back up ring be replaced.

NOTE: Bypass valves are available with integral bypass orifices for specific applications. Refer to the appropriate Service Parts Manual for more information.

Reinstall the bypass valve into the housing. Torque to 7 to 10 ft.lbs. (9.5 to 13.6 Nm).

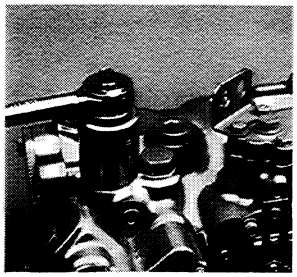


Fig. 33 - Removing Check and Relief Valve Plug

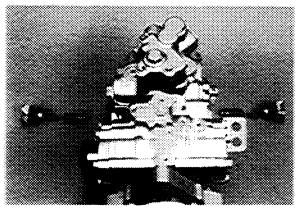


Fig. 34 - Remove Check and Relief Valves (PV Shown)

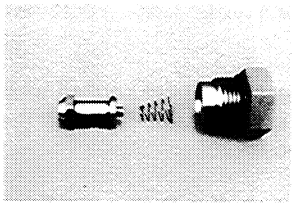


Fig. 35 - Charge Check Valve Components (Through 87-39)

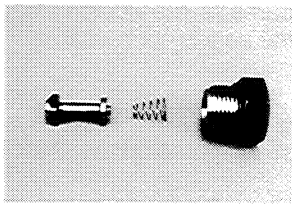
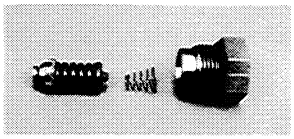


Fig. 36 - Charge Check Valve Components (From 87-40)



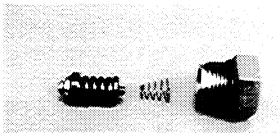


Fig. 37 - Charge Check and Relief Valve Components (Through 87-39)

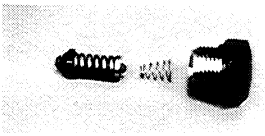


Fig. 38 - Charge Check and Relief Valve Components (From 87-40)

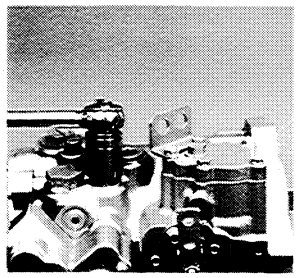


Fig. 39 - Removing Charge Relief Valve

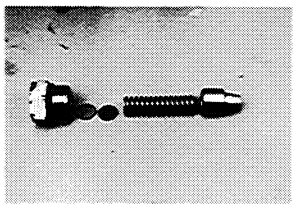


Fig. 40 - Charge Relief Valve Components

Charge Check and High Pressure Relief Valves

Remove the charge check and high pressure relief valve hex plug.

Remove the spring and check poppet or valve cartridge from the housing. Inspect the valve and mating seat in the housing for damage or foreign material. It will be necessary to replace the housing if the seat is damaged.

Several designs of charge check and high pressure relief valves have been used. Do not attempt to mix different vintage parts.

The appropriate check valve kit and/or check and relief valve kit should be used when servicing all units prior to date code 87-40. Refer to the appropriate Service Parts Manual for more information.

NOTE: Always replace ball type charge check valves with the poppet type.

The valve poppet or cartridge, spring, plug, and main housing were changed at date code 87-40, and are not individually interchangeable with earlier design parts.

NOTE: If the pump housing must be replaced on a unit with date code 86-14 through 87-39, the latest design charge check and high pressure relief valves must also be installed. Refer to the appropriate Service Parts Manual for more information.

Reinstall the valve cartridge, spring, and plug (with O-ring) into the housing. Torque the plug to 70 to 170 ft.lbs. (95 to 230 Nm).

CAUTION

The relief valves are factory set and should not be tampered with except for replacing the entire cartridge. Disassembly may change the setting and cause erratic unit operation or premature failure.

Charge Pressure Relief Valve

Remove charge relief valve hex plug.

Remove the spring and poppet from the housing. Do not alter the shims or interchange parts with another valve. Inspect the poppet and mating seat in the end cap for damage or foreign material.

Reinstall the poppet, spring, and plug (with shims and O-ring) into the housing. Torque the plug to 30 to 70 ft.lbs. (41 to 95 Nm).

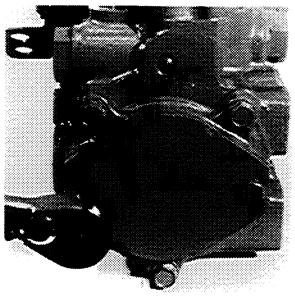


Fig. 41 - Remove Flange Cover

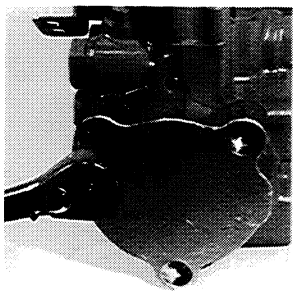


Fig. 42 - Remove Charge Pump Cover

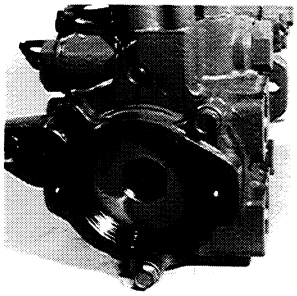


Fig. 43 - Remove Pad Adapter



Fig. 44 - Remove Temper Load Ring

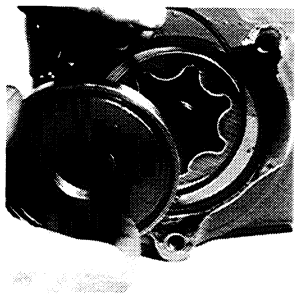


Fig. 45 - Remove Spacer Plate and O-Ring (Earlier Units)

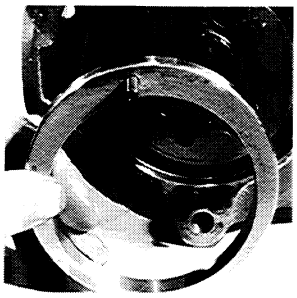


Fig. 46 - Remove Gerotor Ring and Pin (Earlier Units)



Fig. 47 - Remove Gerotor Cover (Later Units)

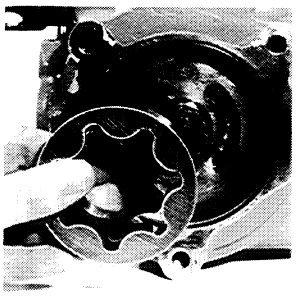


Fig. 48 - Remove Gerotor Assembly

Integral Charge Pump and Auxiliary Pump Mounting Pad (Variable Pump)

NOTE: Variable Pumps without an integral charge pump have no gerotor or drive parts installed in the charge pump cavity. Procedures for removing and installing the charge pump cavity cover or auxiliary mounting pad are similar to those for units with an integral charge pump.

If the unit is equipped with an auxiliary pump mounting pad, remove the two (2) hex head screws retaining the flange cover or auxiliary pump. Remove the flange cover or auxiliary pump and O-ring.

Using a 9/16" wrench, remove the three (3) hex head screws retaining the charge pump cover or adapter to the housing. Remove the cover or adapter.

Remove the temper load ring and discard. The temper load ring should always be replaced when the cover or adapter has been removed.

On earlier units, remove the O-ring, spacer plate, gerotor ring, and pin. On later units, remove the O-ring, gerotor cover, and pin.

NOTE: The gerotor ring and spacer plate are incorporated into a one (1) piece gerotor cover on pumps built after first quarter, 1986.

Note the orientation of the gerotor ring (or cover) and pin for reassembly.

Remove the gerotor assembly and woodruff key.

Each part should be inspected separately if they are to be reused. If either of the gerotor assembly parts needs to be replaced, they must both be replaced. Always replace the O-rings.

Inspect the woodruff key for damage or wear and replace it if necessary.

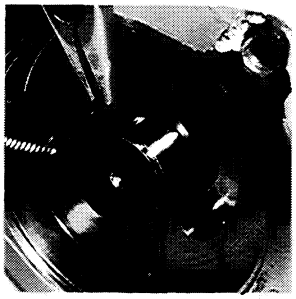


Fig. 49 - Install Drive Key

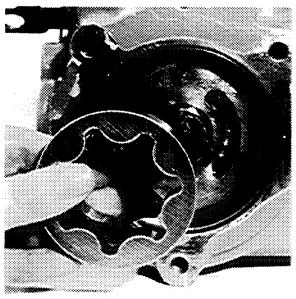


Fig. 50 - Install Gerotor Assembly

Prior to assembly, lubricate the gerotor assembly with clean hydraulic oil. Lubricate the O-rings with petroleum jelly.

Install the woodruff key into the drive shaft.

Slide the gerotor assembly into place in the pump housing. Be certain the gerotor engages the woodruff key in the drive shaft.

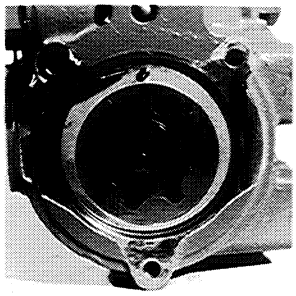


Fig. 51 - Orienting Gerotor Ring and Pin (CW) (Earlier Units Shown)

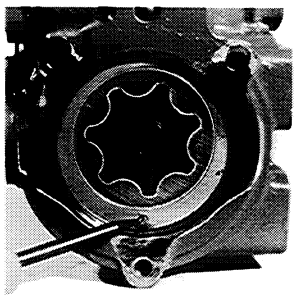


Fig. 52 - Orienting Gerotor Ring and Pin (CCW) (Earlier Units Shown)

NOTE: The charge pump rotation is determined by the position of the gerotor ring (earlier units) or gerotor cover (later units) and locating pin in the pump housing.

Install the gerotor ring and spacer plate or gerotor cover (with locating pin), over the gerotor assembly and into the pump housing, orienting them for the proper input shaft rotation direction. The pin in the gerotor ring or cover should be closest to the control for clockwise (CW) input rotation, and away from the control for counterclockwise (CCW) input rotation.

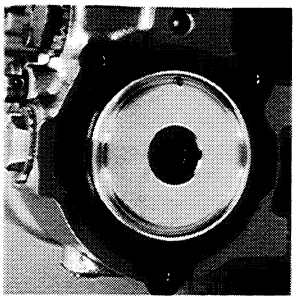


Fig. 53 - Orienting Gerotor Cover and Pin (CW) (Later Units Shown)

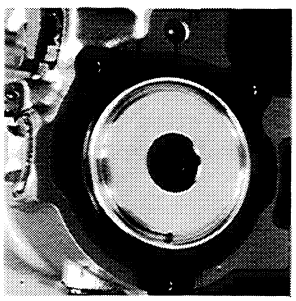


Fig. 54 - Orienting Gerotor Cover and Pin (CCW) (Later Units Shown)

Install a new temper load ring in the groove of the spacer plate or gerotor cover.

Install a new O-ring around the gerotor ring or cover. Install the charge pump cover or pad adapter onto the pump housing.

Reinstall the three (3) hex head screws and torque to 27 to 37 ft.lbs. (37 to 50 Nm). Check for proper internal assembly by slowly rotating the pump shaft while tightening these screws.

If the unit is equipped with an auxiliary pump mounting pad, install the O-ring and flange cover or auxiliary pump and secure with the hex head screws. Torque the screws to 20 to 25 ft.lbs. (27 to 34 Nm).



Fig. 55 - Install New Temper Load Ring

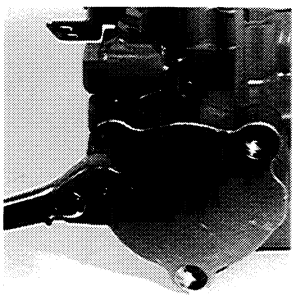


Fig. 56 - Install Charge Pump Cover or Pad Adapter

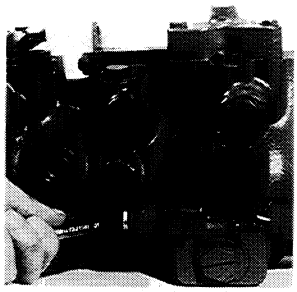


Fig. 57 - Remove 12 Point Screws

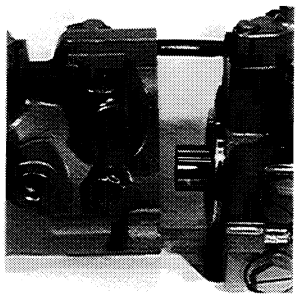


Fig. 58 - Separate Pump Sections



Fig. 59 - Remove Shaft Coupling (Earlier Unit Shown)

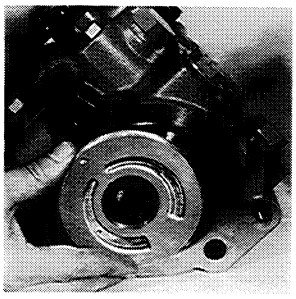


Fig. 60 - Remove Gerotor Plate (Earlier Unit)

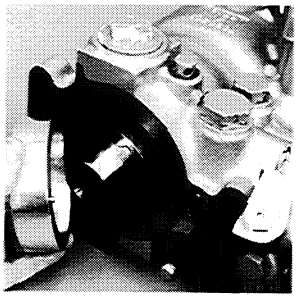


Fig. 61 - Remove Gerotor Cover (Later Unit)

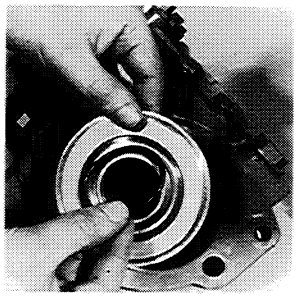


Fig. 62 - Remove O-Rings (Earlier Unit Shown)

Integral Charge Pump (Tandem Pump)

NOTE: Tandem Pumps without an integral charge pump have a pilot ring and a drive coupling with spring locating pin installed in the charge pump cavity. Procedures for separating and attaching the front and rear pump sections are similar to those for units with an integral charge pump.

Remove the two (2) 12 point head screws (using a 1/2" wrench) and the hex nut (using a 3/4" wrench) which retain the front and rear pump sections together. Separate the front and rear sections of the pump. The gerotor plate (earlier units) usually stays in the rear section of the pump.

Remove the two (2) small and one (1) large O-ring (a small O-ring and a gasket on units manufactured before date code 86-14).

NOTE: The gerotor ring and gerotor plate are incorporated into a one (1) piece gerotor cover on pumps built after first quarter, 1986.

On pumps with a separate gerotor ring and spacer plate, remove the shaft coupling and pin from the front section. Remove the gerotor assembly. Remove the gerotor ring and pin. Note the orientation of the gerotor ring and pin for reassembly. Remove the gerotor plate from the rear section of the pump.

On pumps with a one piece gerotor cover, remove the gerotor cover and pin. Note the orientation of the gerotor cover and pin for reassembly. Remove the shaft coupling and pin from the front section. Remove the gerotor assembly.

Remove the front gerotor spacer plate from units equipped with 0.95 in^3/rev (15.6 cc/rev) charge pumps.

Remove the outer O-ring from the rear section of the pump. Remove the inner O-ring from the gerotor plate or cover.

NOTE: Pumps with date code 87-34 and up use a modified gerotor cover and a smaller outer O-ring.

Each part should be inspected separately if they are to be reused. If either of the gerotor assembly parts needs to be replaced, they must both be replaced. Always replace the O-rings (and gaskets, where used).

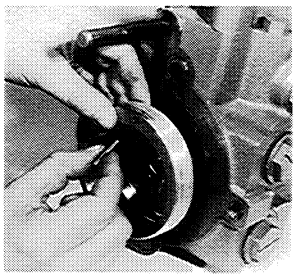


Fig. 63 - Orienting Gerotor Ring and Pin (CW) (Earlier Units)

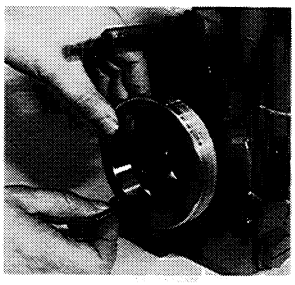


Fig. 64 - Orienting Gerotor Ring and Pin (CCW) (Earlier Units)

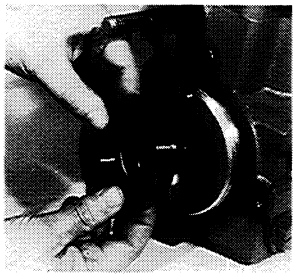


Fig. 65 - Install Gerotor Assembly (Earlier Units)

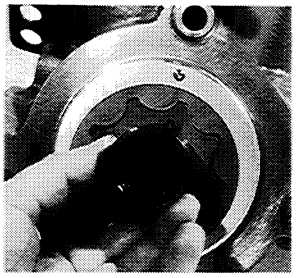
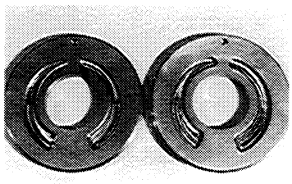


Fig. 66 - Install Drive Coupling (Earlier Units)



CCW CW

Fig. 67 - Location of Gerotor Plate Balance Hole

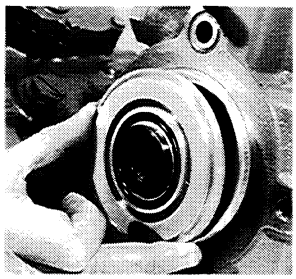


Fig. 68 - Install Gerotor Plate (Earlier Units)

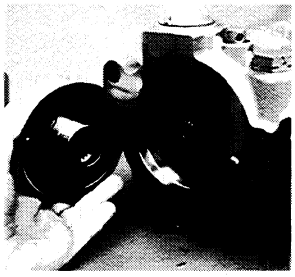


Fig. 69 - Orienting Gerotor Cover and Pin (CW) (Later Units)

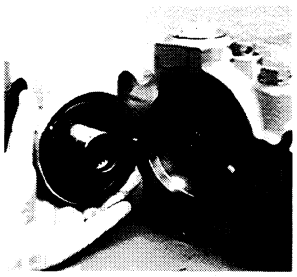


Fig. 70 - Orienting Gerotor Cover and Pin (CCW) (Later Units)

Prior to assembly, lubricate the gerotor assembly with clean hydraulic oil. Lubricate the O-rings with Petroleum jelly.

For units equipped with 0.95 in^3/rev (15.6 cc/rev) charge pumps, install the front gerotor spacer plate into the front pump housing.

NOTE: The charge pump rotation is determined by the position of the gerotor ring (earlier units) or gerotor cover (later units) and locating pin in the front pump housing. In addition, the gerotor plate or gerotor cover has a pressure balance hole which must always be installed on the outlet (pressure) side of the charge pump, opposite the charge inlet port. Different gerotor plates or covers are used for clockwise and counterclockwise rotation pumps.

Install the drive pin into the drive shaft coupling. Install the gerotor assembly into the gerotor ring or cover. Install the assembled gerotor and ring or cover onto the coupling, being certain the drive pin engages the slot in the gerotor.

For pumps with a separate gerotor ring and spacer plate, install the gerotor ring (with gerotor and coupling) into the pump housing, orienting it for the proper input shaft rotation direction. The locating pin hole in the gerotor ring should be closest to the control for clockwise (CW) input rotation, and away from the control for counterclockwise (CCW) input rotation. Install the locating pin into the gerotor ring and pump housing. Install the gerotor plate onto the gerotor ring. The pressure balance hole in the gerotor plate must always be located opposite the charge pump inlet. Install the inner O-ring in the groove on the back of the gerotor plate. Install the outer O-ring into the rear pump housing.

For pumps with a one piece gerotor cover, install the locating pin into the gerotor cover. Install the gerotor cover (with gerotor and coupling) into the pump housing, orienting it for the proper input shaft rotation direction. The locating pin in the gerotor cover should be closest to the control for clockwise (CW) input rotation, and away from the control for counterclockwise (CCW) input rotation. The pressure balance hole in the gerotor cover must always be located opposite the charge pump inlet. Be certain the drive pin engages the slot in the gerotor. Install the outer and inner O-rings in the grooves on the back of the gerotor cover.

NOTE: Pumps with date code 87-34 and up use a modified gerotor cover and a smaller outer O-ring. On these units, install the outer O-Ring into the groove on the gerotor cover, retaining it with petroleum jelly.

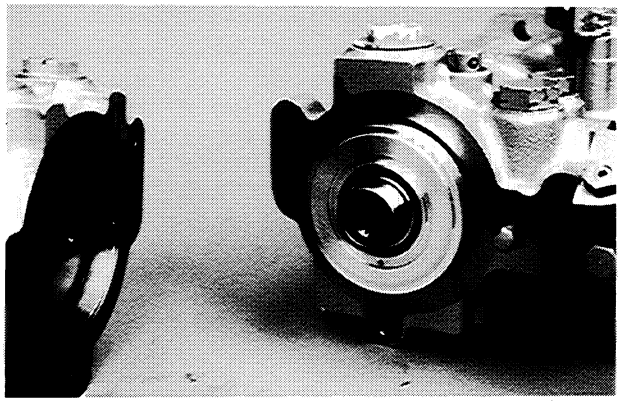


Fig. 71 - O-Rings Installed Between Sections (Later Units Shown)

Install the small O-ring and the gasket (2 (two) small O-rings and a large O-ring on units manufactured after date code 86-14).

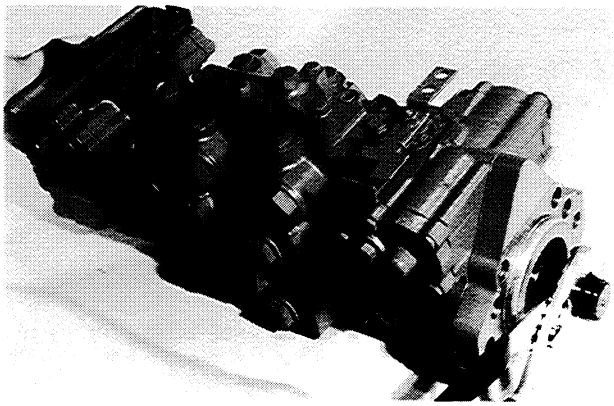


Fig. 72 - Rotating Shaft to Align Splines

Slide the front and rear sections of the pump together, rotating the front pump shaft to align the splines on the coupling and rear pump shaft. Install the two (2) 12 point head screws and the hex nut to retain the front and rear pump sections together. Torque the screws and nut to 67 to 82 ft.lbs. (91 to 111 Nm). Check for proper internal assembly by slowly rotating the pump shaft while tightening these screws and nut.

Auxiliary Pump Pad

The auxiliary pad cover or auxiliary pump is attached to the auxiliary pad with hex head screws (hex screws and nuts on tandem pumps with SAE "B" pad) and is sealed with an O-ring. For SAE "A" pads, torque these screws to 27 to 37 ft.lbs. (37 to 50 Nm). For SAE "B" pads, torque these screws (and nuts) to 67 to 82 ft.lbs. (91 to 111 Nm).

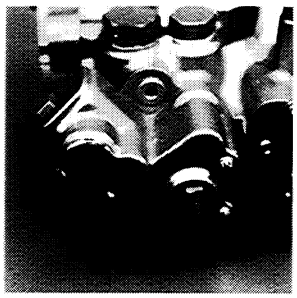


Fig. 73 - Remove Filter Adapter

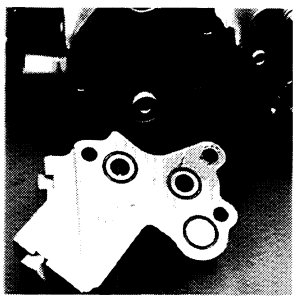


Fig. 74 - Filter Adapter O-Rings

Filter Adapter

Remove the filter adapter from the pump housing by removing three (3) hex head screws with a 1/2" wrench (earlier units) or three (3) 12 point head screws with a 5/16" wrench (later units). Remove the O-rings.

Earlier units use a filter adapter with two (2) O-rings. Later units have three (3) O-rings on the filter adapter. Always replace the O-rings.

Install new O-rings into the grooves of the filter adapter and install the adapter onto the pump housing. Reinstall the screws and torque to 16 to 21 ft.lbs. (22 to 28 Nm).

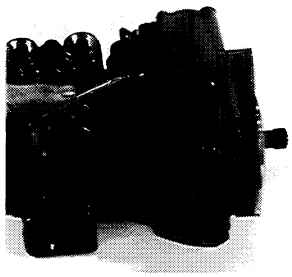


Fig. 75 - Remove Neutral Bracket Screw

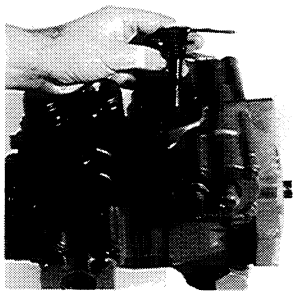


Fig. 76 - Remove Control Spool

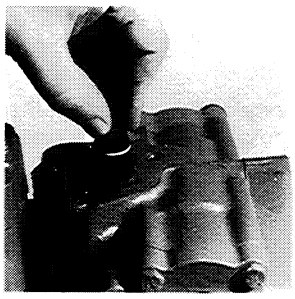


Fig. 77 - Remove Control Sleeve

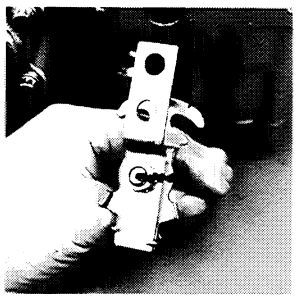


Fig. 78 - Mark Control Handle Position

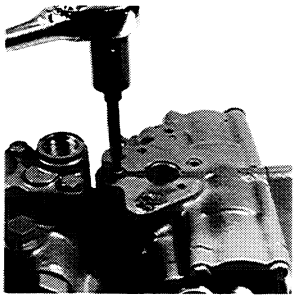


Fig. 79 - Remove Passage Plug

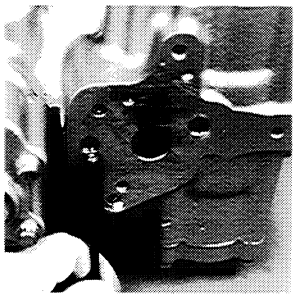


Fig. 80 - Remove Inlet Orifice Plug

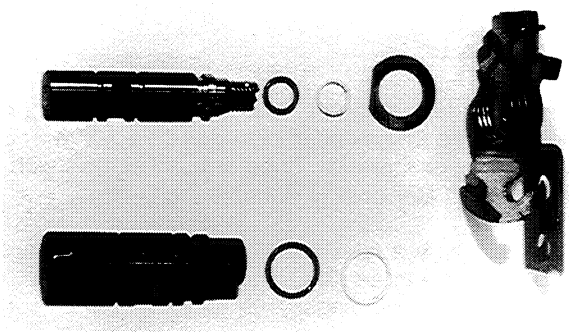


Fig. 81 - Manual Displacement Control Components

Manual Displacement Control (MDC)

CAUTION

The removal of any portion of the control mechanism may result in the loss of neutral, which will necessitate readjustment.

Before disassembly, note the position of the control handle and neutral bracket as either "up" or "down."

Remove the screw and washer or flange head screw retaining the neutral bracket to the housing using a 7/16" or 3/8" wrench.

The spool (with neutral bracket, neutral spring, control handle, and nut) can now be removed from the unit.

Remove the control sleeve from the unit by carefully gripping the end of the sleeve with pliers and pulling out.

If it is necessary to remove the control handle and neutral bracket from the spool, remove the nut from the spool using a 1/2" hex wrench. Remove the lock washer. Disengage the neutral spring from the handle and remove the handle from the spool. The neutral spring and neutral bracket can now be removed from the spool.

To gain access to the control inlet orifice, remove the plug located between the control sleeve bore and the filter adapter, using a hex wrench (9/16") on pumps with date code 86-13 or below, or an internal hex wrench (3/16") on pumps with date code 86-14 or above. Remove the inlet orifice plug using an internal hex wrench (1/8" for pumps with date code 86-13 or below, 5/32" for pumps with date code 86-14 or above).

After disassembly, all parts should be thoroughly cleaned in a suitable solvent. Replace the O-rings and backup rings. Lightly lubricate all O-rings with a small amount of clean petroleum jelly prior to assembly.

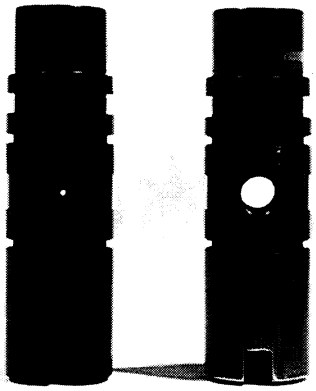


Fig. 82 - Control Valve Sleeve Drain Orifices



Fig. 83 - Slot in Control Sleeve



Fig. 84 - Install Control Sleeve

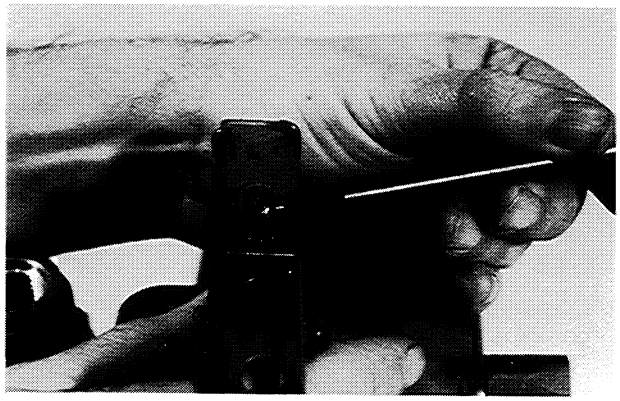


Fig. 85 - Install Control Spool

Inspect the control inlet orifice for plugging.

Always install a control inlet orifice WITH a screen when servicing the pump. Pumps not equipped with an inlet orifice should have a screen plug with a 0.156 " (3.96 mm) through-hole installed in the inlet orifice position. Pumps prior to date code 86-14 use an inlet orifice plug with a different thread from later units. Refer to the appropriate Service Parts Manual for orifice part numbers.

Inspect the control drain orifice, which is incorporated into the control valve sleeve. Refer to the appropriate Service Parts Manual for orifice size information and sleeve part numbers.

Install the control inlet orifice/screen plug and torque to 8 to 12 in.lbs. (0.9 to 1.3 Nm). Install the external plug. Apply a thread sealant to the external pipe plug used on later units.

Install the neutral bracket and neutral spring onto the spool. Install the handle onto the spool, aligning the marks made at assembly. Engage the neutral spring with the handle and neutral bracket. Install the external tooth lockwasher and nut onto the spool and torque to 10 to 12 ft.lbs. (13.6 to 16.3 Nm).

Align the control sleeve so its slot will engage the swashplate feedback pin (slot positioned toward the pump cover) and insert the sleeve into the housing. Install the special washer onto the control spool.

Install the control spool assembly into the control sleeve, being certain that the control handle is oriented as noted during disassembly. The slot in the handle end of the spool must be oriented toward the pump cover.

Orient the spool washer (if used) so its flat clears the neutral bracket. Align the marks made at disassembly and fasten the neutral bracket to the housing with the locking flange head screw.

NOTE: Pumps using a hex head screw and star lock washer to retain the neutral bracket should have this hardware replaced with the locking flange head screw. Refer to the appropriate Service Parts Manual for the part number.

Readjust the neutral position of the control. Refer to the instructions in the "Inspections and Adjustments" section for details.



Fig. 86 - Remove Control Cover (SN 02-XX-XXXXX and Below)

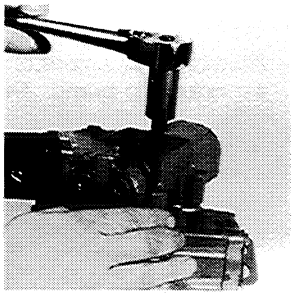


Fig. 87 - Remove Control Mounting Screws

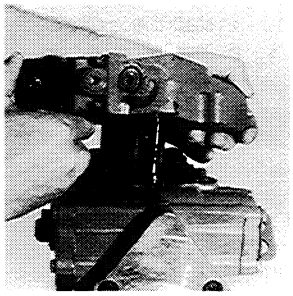


Fig. 88 - Remove Control

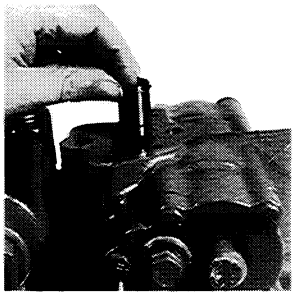


Fig. 89 - Remove Control Sleeve



Fig. 90 - Control Orifice Plug

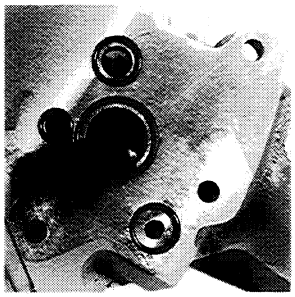


Fig. 91 - Control Housing O-Rings

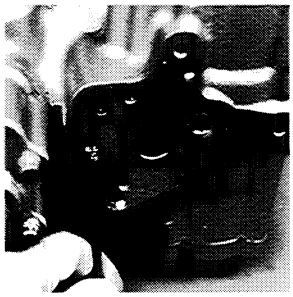


Fig. 92 - Control Inlet Screen Plug

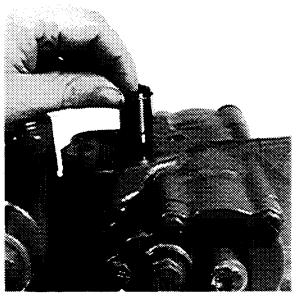


Fig. 93 - Install Control Sleeve

Electrical and Hydraulic Displacement Controls (EDC and HDC)

CAUTION

The removal of any portion of the control mechanism may result in the loss of neutral, which will necessitate readjustment.

On pumps with date code 86-13 or below, one of the control mounting screws is located under the control cover. On these pumps, first remove the four (4) control cover screws using an internal hex wrench (5/32"). Remove the cover and gasket to expose the screw. On pumps with date code 86-14 and above, all of the control mounting screws are external.

Remove the four (4) control mounting screws using an internal hex wrench (3/16").

Carefully lift the control off the pump housing.

Remove the control sleeve from the pump.

On later production pumps, remove the control inlet screen plug from the inlet passage next to the control sleeve bore, using an internal hex wrench (5/32").

The control orifice plugs are located in threaded passages under the servo piston covers. Remove the servo piston covers and gaskets, and remove the orifice plugs using an internal hex wrench (7/32").

Replace the O-rings on the bottom of the control housing. Lightly lubricate all O-rings with clean petroleum jelly prior to assembly. The control spool and sleeve are a matched set and are not available separately.

Reinstall the control orifice plugs into their passages and replace the servo piston covers.

Install and torque the control inlet screen plug to 8 to 12 in.lbs. (0.9 to 1.3 Nm). Always install a screen plug [with a 0.156 " (3.96 mm) through-hole] when servicing earlier production pumps. Pumps prior to date code 86-14 use a screen plug with a thread that is different from later units. Refer to the appropriate Service Parts Manual for plug part numbers.

Align the control sleeve so its slot will engage the swashplate feedback pin (slot positioned toward the pump cover) and insert the sleeve into the housing. Carefully align the control spool with the sleeve and install the control onto the pump housing. Install the four (4) mounting screws and torque to 10 to 11 ft.lbs (13 to 14 Nm).

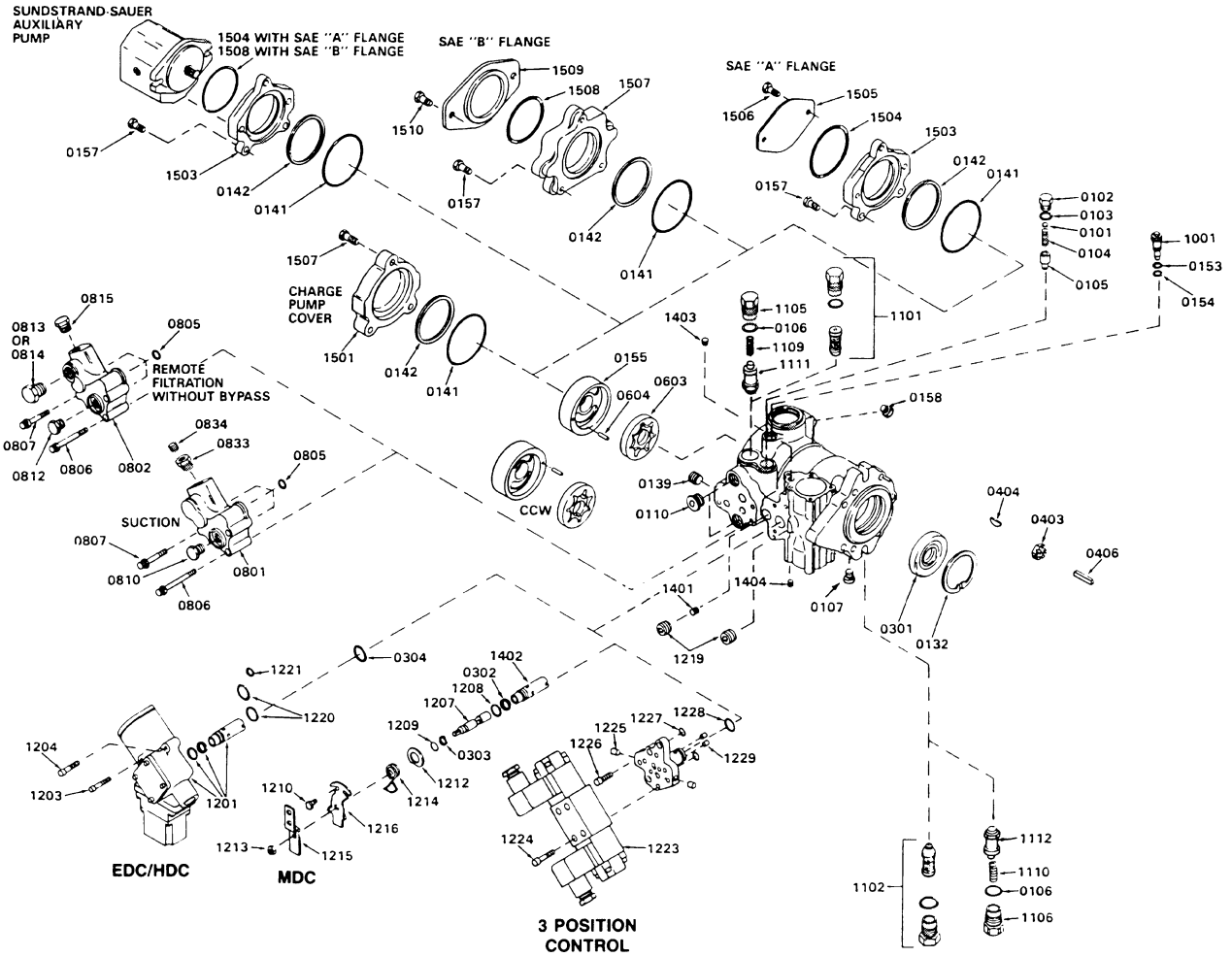
On pumps with date code 86-13 or below, install a new gasket and replace the control cover. Install the four (4) cover screws and torque to 18 to 24 in.lbs. (2.0 to 2.7 Nm).

Readjust the neutral position of the control. Refer to the instructions in the "Inspections and Adjustments" section for details.

General Parts Identification

The following Information is for general parts identification ONLY. Refer to the applicable Service Parts List when ordering service parts

M46 Variable Displacement Pump -- PV (Minor Repair)



M46 Variable Pump -- PV (Minor Repair)

COMMON PARTS GROUP 01		
ITEM	DESCRIPTION	QTY
0101	SHIM KIT CHG RELIEF VALVE	1
0102	PLUG	1
0103	O RING	1
0104	SPRING CHG RELIEF VALVE	1
0105	VALVE REL	1
0106	O-RING	2
0107	PLUG ST THD	2
0110	PLUG	2
0113	PLUG PLASTIC	2
0141	O-RING	1
0142	RING TEMPER LOAD	1
0153	RING BACK UP	1
0154	O-RING	1
0155	COVER GEROTOR	1
0157	SCREW HEX HD	3

SEAL GROUP 03		
ITEM	DESCRIPTION	QTY
0301	SEAL LIP	1
0302	O-RING MDC	1
0303	O-RING MDC	1
0304	O-RING EDC/HDC	1

INPUT/AUX DRIVE CONFIG. GROUP 04		
ITEM	DESCRIPTION	QTY
0403	NUT SLOTTED	1
0404	KEY	1

CHG PUMP DISPLACEMENT GROUP 06		
ITEM	DESCRIPTION	QTY
0603	GEROTOR ASSY	1
0604	PIN	1
0605	KEY WOODRUFF	1
0606	PLUG	1

FILTRATION GROUP 08		
ITEM	DESCRIPTION	QTY
0801	ADAPT SUCTION FILTER INLET	1
0802	ADAPT. REMOTE W/O BYPASS	1
0803	ADAPT. REMOTE W/BYPASS	1
0804	ADAPT. W/BYPASS AND FILTER	1
0805	O-RING	3
0806	SCREW	2
0807	SCREW	1
0808	SCREW	1
0809	SCREW 12 PT	2
0810	PLUG ST THD	2
0812	PLUG PLASTIC	1
0813	PLUG PLASTIC	1
0815	PLUG	1
0816	PLUG	1
0817	PLUG	1
0818	PLUG	1
0819	O-RING	1
0820	VALVE BYPASS	1
0821	SPRING	1
0822	WASHER	1
0823	PLUG EXPANDING	3
0824	PLUG SPECIAL	1
0825	O-RING	1
0826	VALVE BYPASS	1
0827	SPRING	1
0828	WASHER	1
0829	PLUG	2
0830	PLUG EXPANDING	1
0831	FILTER	1
0832	PLUG	1
0833	PLUG ST THD	1
0834	PIPE PLUG	1

BYPASS VALVE GROUP 10		
ITEM	DESCRIPTION	QTY
1001	BYPASS VALVE	1

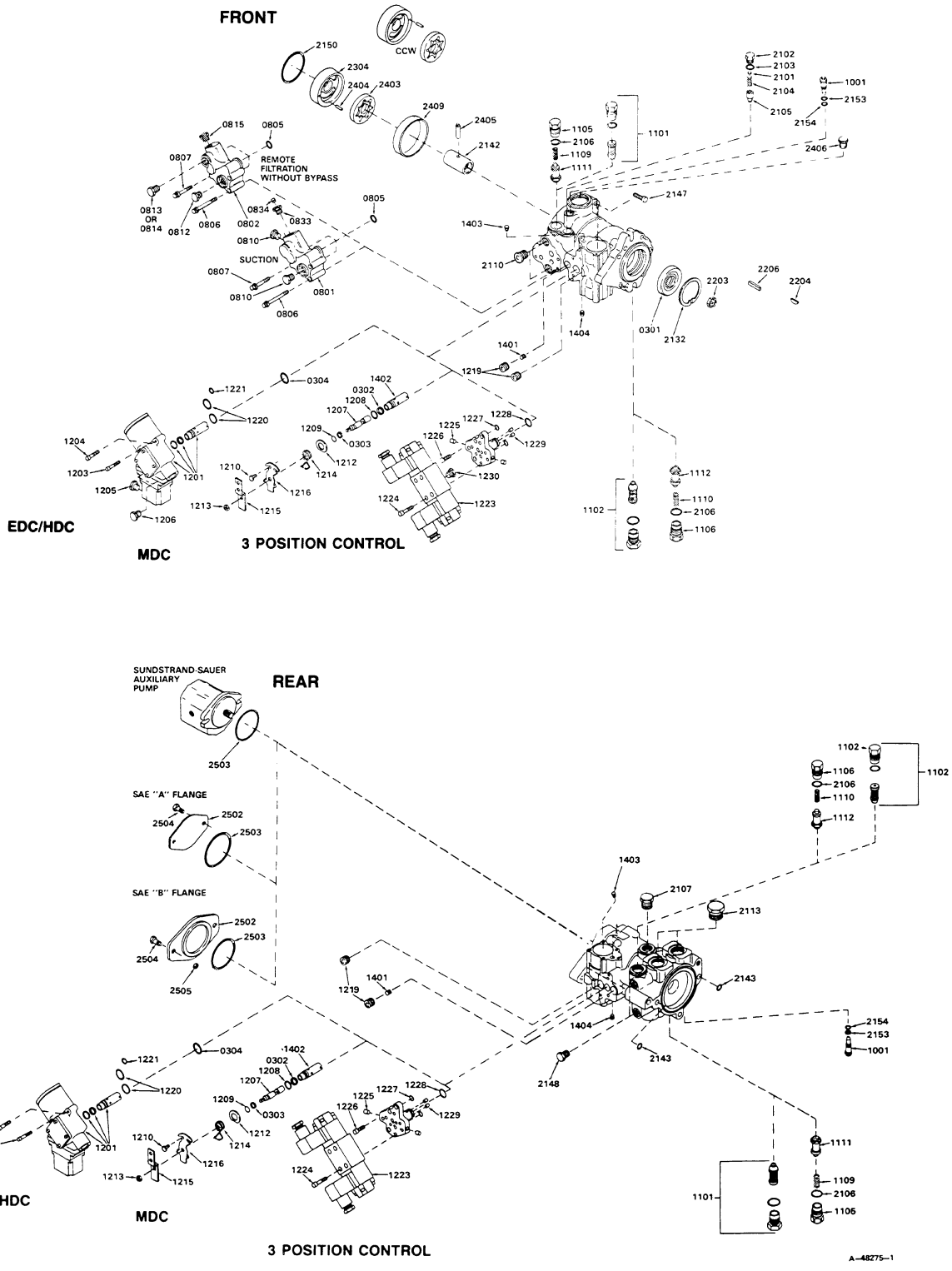
SYS PRESS PROTECTION GROUP 11		
ITEM	DESCRIPTION	QTY
1101	REL VALVE KIT	1
1102	REL VALVE KIT	1
1103	REL VALVE KIT	1
1104	REL VALVE KIT	1
1105	PLUG SPECIAL	1
1106	PLUG SPECIAL	1
1109	SPRING	1
1110	SPRING	1
1111	POPPET, CHECK	1
1112	POPPET, CHECK	1

CONTROL GROUP 12		
ITEM	DESCRIPTION	QTY
1201	HDC	1
1201	EDC	1
1203	SCREW	2
1204	SCREW SOC HD	2
1205	CAP PLASTIC	1
1206	PLUG PLASTIC	2
1207	SPOOL ROT VALVE MDC	1
1208	BACK UP RING	1
1209	RING BACK UP	1
1210	SCREW HEX HD	1
1213	NUT SPECIAL	1
1214	SPRING NEUTRAL RETURN	1
1215	HANDLE CONTROL VALVE	1
1216	BRACKET NEUTRAL RETURN	1
1219	PLUG	2
1220	O-RING	2
1221	O-RING	1
1223	VALVE-SOLENOID CONTROL	1
1224	METRIC SCREW SOC HD	4
1225	MANIFOLD 3-POS CONTROL	1
1226	SCREW SOC HD	3
1227	O-RING	2
1228	O-RING	1
1229	PLUG	2
1230	PLUG	2
1231	COVER PLATE FOR SHIPPING	1
1232	GASKET COVER	1
1233	SCREW	2

CONTROL ORIFICE GROUP 14		
ITEM	DESCRIPTION	QTY
1401	PLUG ORIFICE/SCREEN	1
1402	SLEEVE CONTROL VALVE MDC	1
1403	PLUG ORIFICE HDC/EDC	1
1404	PLUG ORIFICE HDC/EDC	1

AUXILIARY FLANGE GROUP 15		
ITEM	DESCRIPTION	QTY
1501	COVER CHARGE PUMP	1
1503	ADAPTER "A" FLANGE	1
1504	O-RING	1
1505	PLATE COVER	1
1506	SCREW HEX HD	2
1507	ADAPTOR "B" FLANGE	1
1508	O-RING	1
1509	COVER PLATE	1
1510	SCREW HEX HD	2

M46 Tandem Pump -- PT (Minor Repair)



M46 Tandem Pump -- PT (Minor Repair)

SEAL GROUP 03		
ITEM	DESCRIPTION	QTY
0301	SEAL LIP(FRONT PUMP)	1
0302	O-RING MDC	1
0303	O-RING MDC	1
0304	O-RING EDC/HDC	1

FILTRATION GROUP 08		
ITEM	DESCRIPTION	QTY
0801	ADAPT. SUCTION FILTER INLET	1
0802	ADAPT. REMOTE W/O BYPASS	1
0803	ADAPT. REMOTE W/BYPASS	1
0804	ADAPT. W/BYPASS AND FILTER	1
0805	O-RING	3
0806	SCREW	2
0807	SCREW	1
0808	SCREW	1
0809	SCREW 12 PT	2
0810	PLUG ST THD	2
0812	PLUG PLASTIC	1
0813	PLUG PLASTIC	1
0814	PLUG	1
0815	PLUG	1
0816	PLUG	1
0817	PLUG	1
0818	PLUG	1
0819	O-RING	1
0820	VALVE BYPASS	1
0821	SPRING	1
0822	WASHER	1
0823	PLUG EXPANDING	3
0824	PLUG SPECIAL	1
0825	O-RING	1
0826	VALVE BYPASS	1
0827	SPRING	1
0828	WASHER	1
0829	PLUG	2
0830	PLUG EXPANDING	1
0831	FILTER	1
0832	PLUG	1
0833	PLUG ST THD	1
0834	PIPE PLUG	1

BYPASS VALVE GROUP 10		
ITEM	DESCRIPTION	QTY
1001	BYPASS VALVE	1

SYS PRESS PROTECTION GROUP 11		
ITEM	DESCRIPTION	QTY
1101	REL VALVE KIT	1
1102	REL VALVE KIT	1
1103	REL VALVE KIT	1
1104	REL VALVE KIT	1
1105	PLUG SPECIAL	1
1106	PLUG SPECIAL	1
1109	SPRING	1
1110	SPRING	1
1111	POPPET, CHECK	1
1112	POPPET, CHECK	1

CONTROL GROUP 12		
ITEM	DESCRIPTION	QTY
1201	HDC	1
1201	EDC	1
1203	SCREW	2
1204	SCREW SOC HD	2
1205	CAP PLASTIC	1
1206	PLUG PLASTIC	2
1207	SPOOL ROT VALVE MDC	1
1208	BACK UP RING	1
1209	RING BACK UP	1
1210	SCREW HEX HD	1
1213	NUT SPECIAL	1
1214	SPRING NEUTRAL RETURN	1

CONTROL GROUP 12 (CON'T)		
ITEM	DESCRIPTION	QTY
1215	HANDLE CONTROL VALVE	1
1216	BRACKET NEUTRAL RETURN	1
1219	PLUG	2
1220	O-RING	2
1221	O-RING	1
1223	VALVE-SOLENOID CONTROL	1
1224	METRIC SCREW SOC HD	4
1225	MANIFOLD 3-POS CONTROL	1
1226	SCREW SOC HD	3
1227	O-RING	2
1228	O-RING	1
1229	PLUG	2
1230	PLUG	2
1232	GASKET COVER	1
1233	SCREW	2

CONTROL ORIFICE GROUP 14		
ITEM	DESCRIPTION	QTY
1401	PLUG ORIFICE/SCREEN	1
1402	SLEEVE CONTROL VALVE MDC	1
1403	PLUG ORIFICE	1
1404	PLUG ORIFICE	1

COMMON PARTS GROUP 21		
ITEM	DESCRIPTION	QTY
2101	SHIM KIT REL VAL	1
2102	PLUG	1
2103	O-RING	1
2104	SPRING REL VAL	1
2105	VALVE REL	1
2106	O-RING	4
2107	PLUG ST THD	3
2110	PLUG ST THD	2
2113	PLUG PLASTIC	4
2132	RING	3
2142	COUPLING	1
2143	O-RING	2
2144	NUT	1
2145	STUD	1
2147	SCREW 12 PT	2
2148	PLUG ST THD	2
2150	O-RING OR GASKET	1
2153	RING BACK UP	2
2154	O-RING	2
2155	PLUG ST THD	2

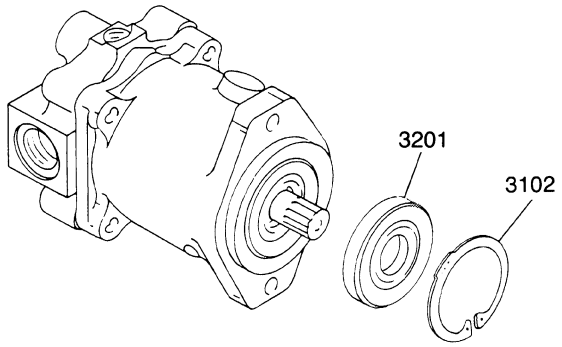
DRIVE SHAFT GROUP 22		
ITEM	DESCRIPTION	QTY
2203	NUT SLOTTED	1
2204	KEY	1
2206	KEY	1

ROTATION/CHARGE PUMP GROUP 23		
ITEM	DESCRIPTION	QTY
2304	COVER GEROTOR (CW / CCW)	1

CHG PUMP DISPLACEMENT GROUP 24		
ITEM	DESCRIPTION	QTY
2402	PLATE SPACER (.95 CIR)	1
2403	GEROTOR ASSY	1
2404	PIN	1
2405	PIN	1
2406	PLUG	1
2407	O-RING	1
2408	O-RING	1
2409	RING PILOT (LESS CHG. PUMP)	1

AUXILIARY FLANGE GROUP 25		
ITEM	DESCRIPTION	QTY
2502	COVER PLATE	1
2503	O-RING	1
2504	SCREW HEX HD	2
2505	NUT "B" FLANGE	2

M46 Fixed Displacement Motor -- MF (Minor Repair)

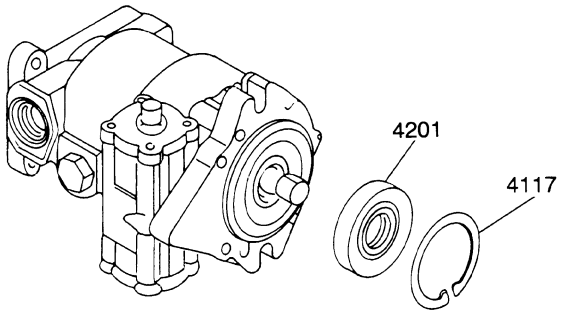


COMMON PARTS GROUP 31		
ITEM	DESCRIPTION	QTY
3102	RING	1
3117	PLUG ST THD	2

SEAL GROUP 32		
ITEM	DESCRIPTION	QTY
3201	SEAL LIP	1
3202	SEAL LIP THRU SHAFT	1

OUTPUT SHAFT / AUX DRIVE GROUP 33		
ITEM	DESCRIPTION	QTY
3303	NUT SLOTTED	1
3304	KEY	1
3306	KEY SQUARE	1

M46 Variable Displacement Motor -- MV (Minor Repair)

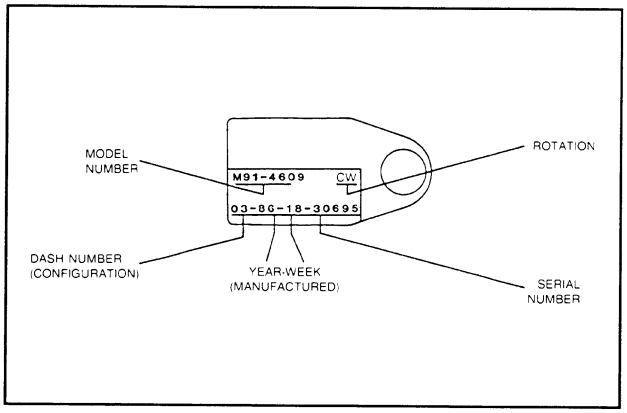


COMMON PARTS GROUP 41		
ITEM	DESCRIPTION	QTY
4117	RING	2
4127	PLUG ST THD	2

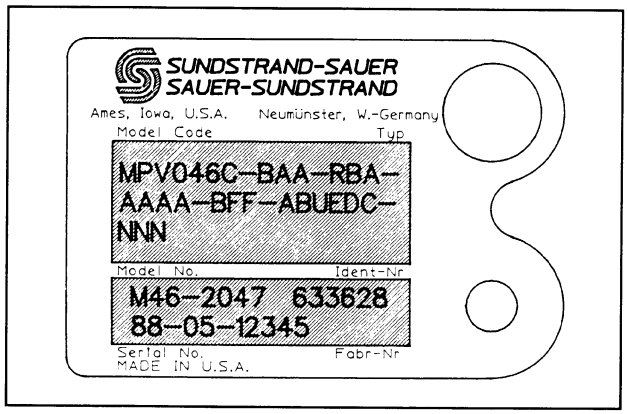
SEAL GROUP 42		
ITEM	DESCRIPTION	QTY
4201	SEAL LIP NITRILE	1
4202	SEAL NITRILE THRU SHAFT	1

OUTPUT SHAFT / AUX DRIVE GROUP 43		
ITEM	DESCRIPTION	QTY
4303	NUT SLOTTED	1
4304	KEY	1
4306	KEY THRU SHAFT	1

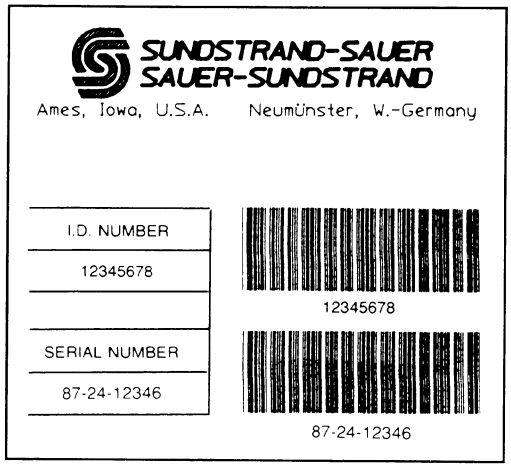
Unit Identification



Name Plate (Earlier Production)



Name Plate (Later Production)



Bar Coding - Tag

Name Plate

Each Series 40 pump and motor will have a name plate affixed to the housing. The name plate will include the following information:

Model (Identification) Number
The Model Number is used by the factory in manufacturing. On repeat orders, a complete unit can be ordered by the Model Number. The Model Number is cross referenced to the specific Model Code (Nomenclature) for the unit.

Model Code
The Model Code for the Series 40 pumps and motors is defined on the following pages. The Model Code completely defines the specific unit and must be used when ordering the complete unit for the first time or for ordering parts to service the product.

NOTE: Earlier production M46 units do not have the Model Code on the name plate.

Serial Number
The Serial Number is used to identify the build date and the unit sequence in the build. The Serial Number is also used to identify the unit's warranty time period, and MUST be referenced when ordering service parts.

The first four (4) digits represent the Build Date Code. The first and second digit denotes the year of manufacture. The third and fourth digits denote the calendar week of manufacture. For example, "86-19" indicates a unit which was manufactured in the nineteenth calendar week of the year 1986.

The fifth through ninth digits are sequential numbers used to identify a specific unit.

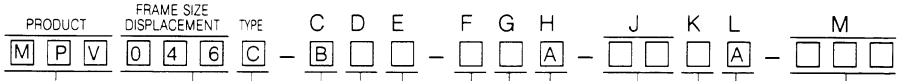
NOTE: Earlier production M46 units have a two (2) digit Dash Number (Configuration Code) preceding the Serial Number.

Bar Coding - Tag

A Universal Bar Code, representing the Identification Number and the Serial Number, will also be affixed to later production units so these items can be read electronically.

Model Code

M46 Variable Displacement Pump -- PV



PRODUCT
MPV = MEDIUM DUTY, PUMP, VARIABLE

DISPLACEMENT
046 = 46 CC/REV (2.8 CU. IN./REV)

TYPE
C = CLOSED CIRCUIT

C: SWASHPLATE GROUP
B = STANDARD

D: SEAL GROUP
A = SHAFT SEAL FOR MDC
B = SHAFT SEAL FOR EDC/HDC

E: INPUT SHAFT/AUXILIARY DRIVE
A = 13T 16/32P SPLINE/NONE
B = 13T 16/32P SPLINE/SAE "A" FLG 9T SPLINE
D = 13T 16/32P SPLINE/SAE "B" FLG 13T SPLINE
G = 15T 16/32P SPLINE/NONE
H = 15T 16/32P SPLINE/SAE "A" FLG 9T SPLINE
► J = 15T 16/32P SPLINE/SAE "A" FLG 11T SPLINE
K = 15T 16/32P SPLINE/SAE "B" FLG 13T SPLINE
► N = 1 IN. DIA TAPERED, 1.5 IN./FT./NONE
► P = 1 IN. DIA TAPERED, 1.5 IN./FT./SAE "A" FLG 9T SPLINE
► S = 1 IN. DIA TAPERED, 1.5 IN./FT./SAE "B" FLG 13T SPLINE
► V = 1 IN. DIA STR KEY/NONE
► W = 1 IN. DIA STR KEY/SAE "A" FLG 9T SPLINE

F: ROTATION
R = CW
L = CCW

G: CHARGE PUMP DISPLACEMENT
► A = NONE
B = 13.9 CC/REV (.85 CU. IN./REV)

H: CHARGE PRESSURE RELIEF VALVE SETTING*
A = 16.0 BAR (230 PSI)

J: FILTRATION
AA = SUCTION
BA = REMOTE PRESSURE W/O BYPASS
► BC = REMOTE PRESSURE W/O BYPASS (FOR NO CHARGE PUMP-OPT)

K: DISPLACEMENT
A = FULL DISPLACEMENT
► G = ADJUSTABLE MAX. STOPS - SUPPLIED WITH STOPS SET AT 46.0 CC/REV (2.8 CU. IN./REV)

L: BYPASS VALVE
A = BYPASS VALVE

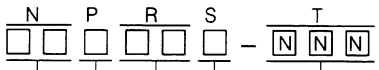
M: SYSTEM PRESSURE PROTECTION

	PROTECTION	
TYPE	PORT "A"	PORT "B"
A =	NONE	NONE
B =	PRESS. RELIEF	PRESS. RELIEF
C =	PRESS. RELIEF	NONE
D =	NONE	PRESS. RELIEF

SETTINGS (FOR PORT "A" & "B")*

A = NONE
M = 140 BAR (2030 PSI)
B = 175 BAR (2540 PSI)
C = 190 BAR (2755 PSI)
D = 210 BAR (3045 PSI)
E = 230 BAR (3335 PSI)
F = 250 BAR (3625 PSI)
G = 280 BAR (4060 PSI)
H = 300 BAR (4350 PSI)
J = 345 BAR (5000 PSI)

M46 Variable Displacement Pump -- PV (Continued)



T: SPECIAL HARDWARE FEATURES
NNN = NONE

S: AUXILIARY MOUNTING PAD
A = SAE "A" 9T SPLINE
D = SAE "A" 11T SPLINE
B = SAE "B" 13T SPLINE
C = NONE

R: CONTROL ORIFICE DIA

SUPPLY (MDC)	DRAIN (MDC)
F = NONE	F = NONE
A = .031 IN.	A = .031 IN.
B = .036 IN.	B = .036 IN.
C = .041 IN.	C = .041 IN.
D = .046 IN.	D = .046 IN.
E = .054 IN.	E = .054 IN.
ORIFICE "A" (EDC/HDC)	ORIFICE "B" (EDC/HDC)
G = .055 IN.	G = .055 IN.
H = .037 IN.	H = .037 IN.
J = NONE	J = NONE

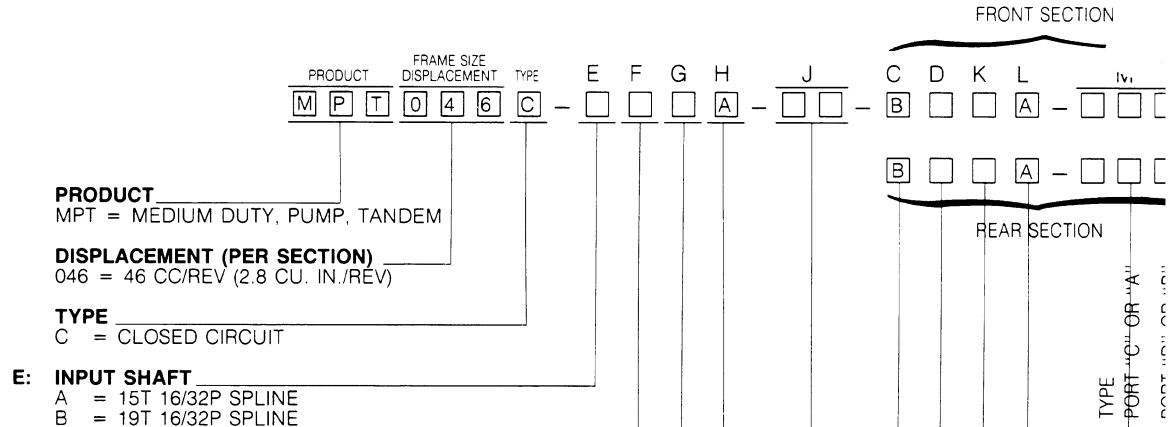
P: HANDLE POSITION
A = NOT APPLICABLE (EDC OR HDC)
D = DOWN
U = UP

N: CONTROL
AB = MDC
► BA = HDC
CA = EDC, SINGLE COIL, DRY CASE, PACKARD CONNECTOR
► CD = EDC, SINGLE COIL, OIL FILLED, MS CONNECTOR

► = Non-Standard

*All pressure settings above are nominal set pressure at factory test conditions. Actual pressures will vary due to actual conditions.

M46 Tandem Pump -- PT



PRODUCT
MPT = MEDIUM DUTY, PUMP, TANDEM

DISPLACEMENT (PER SECTION)
046 = 46 CC/REV (2.8 CU. IN./REV)

TYPE
C = CLOSED CIRCUIT

E: INPUT SHAFT
A = 15T 16/32P SPLINE
B = 19T 16/32P SPLINE
► C = 1 IN. DIA TAPERED, 1.5 IN./FT.
► D = 1 IN. DIA STR KEY

F: ROTATION
C = CW; W/22.9 CC/REV (1.40 CU. IN./REV) CHG PMP
D = CCW; W/22.9 CC/REV (1.40 CU. IN./REV) CHG PMP
► G = CW; W/O CHARGE PUMP
► H = CCW; W/O CHARGE PUMP

G: CHARGE PUMP DISPLACEMENT
A = NONE
C = 22.8 CC/REV (1.40 CU. IN./REV)

H: CHARGE PRESSURE RELIEF VALVE SETTING*
A = 16.0 BAR (230 PSI)

J: FILTRATION
AA = SUCTION
BA = REMOTE PRESSURE W/O BYPASS
► BC = REMOTE PRESSURE W/O BYPASS (FOR NO CHARGE PUMP-OPTION)

C: SWASHPLATE GROUP
B = STANDARD

D: SEAL GROUP
A = SHAFT SEAL FOR MANUAL DISPL. CONT-**FRONT SECTION**
B = SHAFT SEAL FOR EDC/HDC-**FRONT SECTION**
C = SHAFT SEAL FOR MANUAL DISPL. CONT—**REAR SECTION**
D = SHAFT SEAL FOR EDC/HDC-**REAR SECTION**

K: DISPLACEMENT
A = FULL DISPLACEMENT
► G = ADJUSTABLE MAX. STOPS - SUPPLIED WITH STOPS SET AT 46.0 CC/REV (2.8 CU. IN./REV)

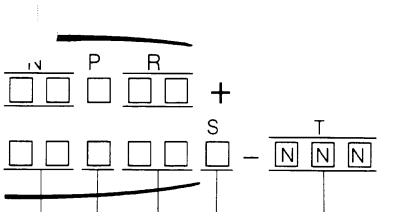
L: BYPASS VALVE
A = BYPASS VALVE

M: SYSTEM PRESSURE PROTECTION*

	PROTECTION	
TYPE	PORT "A" or "C"	PORT "B" or "D"
A =	NONE	NONE
B =	PRESS. RELIEF	PRESS. RELIEF
C =	PRESS. RELIEF	NONE
D =	NONE	PRESS. RELIEF

SETTINGS (SELECT FOR PORT "A" & "B" AND "C" & "D")
A = NONE
M = 140 BAR (2030 PSI)
B = 175 BAR (2540 PSI)
C = 190 BAR (2755 PSI)
D = 210 BAR (3045 PSI)
E = 230 BAR (3335 PSI)
F = 250 BAR (3625 PSI)
G = 280 BAR (4060 PSI)
H = 300 BAR (4350 PSI)
J = 345 BAR (5000 PSI)

M46 Tandem Pump -- PT (Continued)



T: SPECIAL HARDWARE FEATURES
NNN = NONE

S: AUXILIARY MOUNTING PAD
A = SAE "A" 9T SPLINE
► D = SAE "A" 11T SPLINE
B = SAE "B" 13T SPLINE
C = NONE

R: CONTROL ORIFICE DIA

SUPPLY (MDC OR DDC)	DRAIN (MDC OR DDC)
F = NONE	F = NONE
A = .031 IN.	A = .031 IN.
B = .036 IN.	B = .036 IN.
C = .041 IN.	C = .041 IN.
D = .046 IN.	D = .046 IN.
E = .054 IN.	E = .054 IN.
ORIFICE "A" (EDC/HDC)	ORIFICE "B" (EDC/HDC)
G = .055 IN.	G = .055 IN.
H = .037 IN.	H = .037 IN.
J = NONE	J = NONE

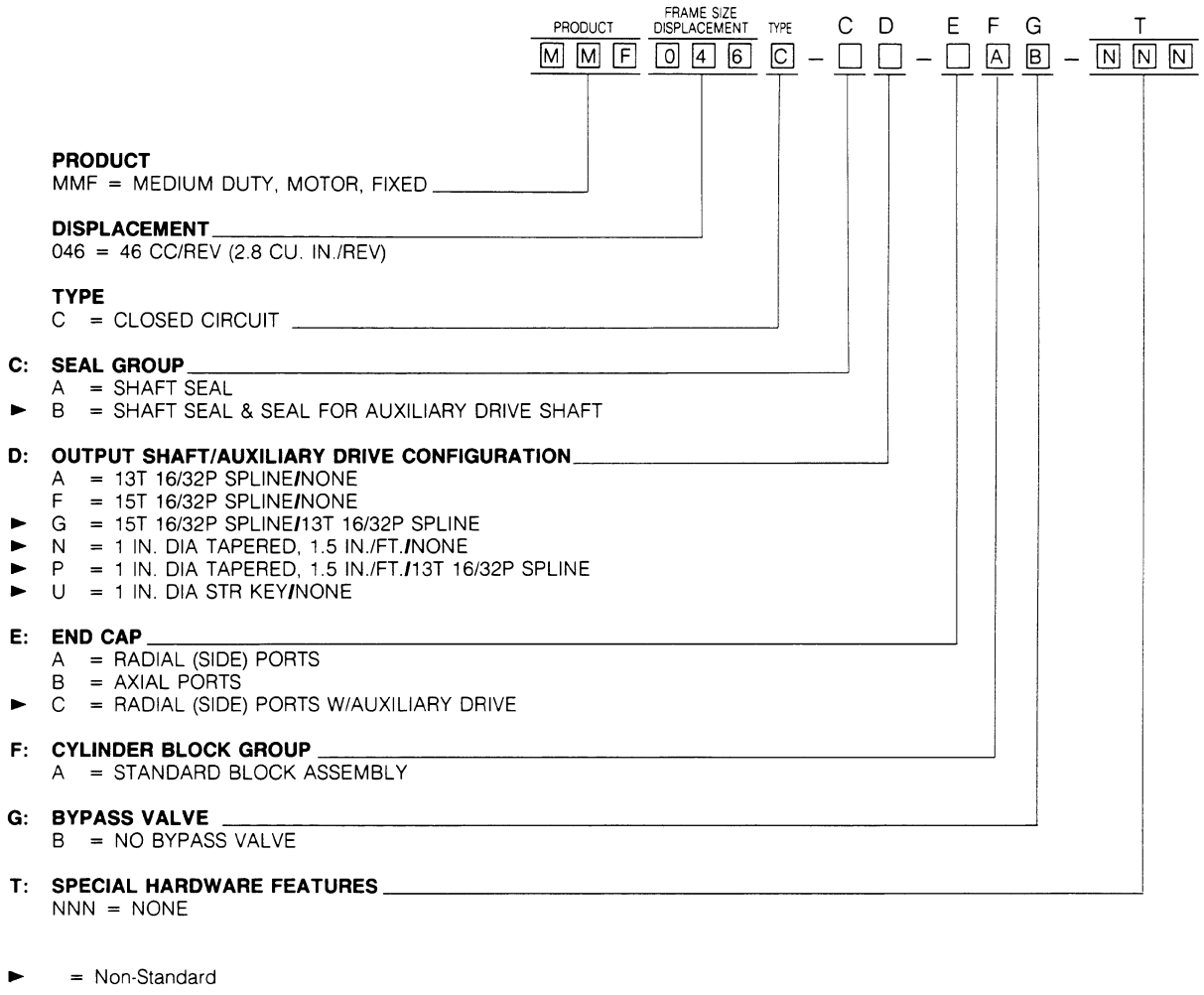
P: HANDLE POSITION
A = NOT APPLICABLE (EDC OR HDC)
D = DOWN
U = UP

N: CONTROL
AB = MDC
► BA = HDC
CA = EDC, SINGLE COIL, DRY CASE, PACKARD CONNECTOR
► CD = EDC, SINGLE COIL, OIL FILLED, MS CONNECTOR

► = Non-Standard

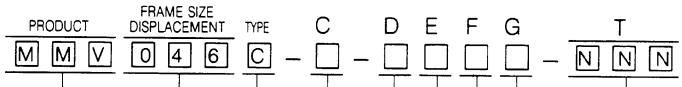
*All pressure settings above are nominal set pressure at factory test conditions. Actual pressures will vary due to actual conditions.

M46 Fixed Displacement Motor -- MF



► = Non-Standard

M46 Variable Displacement Motor -- MV



PRODUCT
MMV = MEDIUM DUTY, MOTOR, VARIABLE

DISPLACEMENT
046 = 46 CC/REV (2.8 CU. IN./REV)

TYPE
C = CLOSED CIRCUIT

C: SEAL GROUP
A = SHAFT SEAL
► B = SHAFT SEAL & SEAL FOR AUXILIARY DRIVE SHAFT

D: OUTPUT SHAFT/AUXILIARY DRIVE CONFIGURATION
A = 13T 16/32P SPLINE/NONE
► B = 13T 16/32P SPLINE/13T 16/32P SPLINE
E = 15T 16/32P SPLINE/NONE
► F = 15T 16/32P SPLINE/13T 16/32P SPLINE
► J = 1 IN. DIA TAPERED, 1.5 IN./FT/NONE

E: MINIMUM DISPLACEMENT
A = 11 DEGREE SWASHPLATE ANGLE, 29.5 CC/REV (1.8 CU. IN./REV)
B = 7 DEGREE SWASHPLATE ANGLE, 18.0 CC/REV (1.1 CU. IN./REV)
D = 6 DEGREE SWASHPLATE ANGLE, 16.1 CC/REV (.98 CU. IN./REV)
F = 9 DEGREE SWASHPLATE ANGLE, 24.6 CC/REV (1.5 CU. IN./REV)
H = 8.5 DEGREE SWASHPLATE ANGLE, 22.4 CC/REV (1.36 CU. IN./REV)

F: CONTROL FEATURES

	CONTROL PORT LOCATION	ADJUSTABLE MIN. DISPLACEMENT	MAX. DISPLACEMENT STROKE LIMITER
A =	BOTTOM	NO	NO
B =	BOTTOM & TOP	NO	NO

G: HOUSING/END CAP CONFIGURATION
A = STD. HOUSING/RADIAL (SIDE) PORTED END CAP
► B = STD. HOUSING/RADIAL (SIDE) PORTED END CAP FOR AUXILIARY DRIVE SHAFT

T: SPECIAL HARDWARE FEATURES
NNN = NONE

► = Non-Standard

Notes

Authorized Service Centers - North America

United States

ALASKA

ALASKA HYDRAULICS, INC.
500 West Potter
Anchorage, AK 99518
(907) 562-2217

ARKANSAS

FLUID COMPONENTS, INC.
7600 Fluid Drive
Little Rock, AR 72206
(501) 490-0222

CALIFORNIA

RUCKER FLUID POWER
11019 Greenstone Ave.
Santa Fe Springs, CA 90670
(213) 946-1010

RUCKER FLUID POWER
15095 Wicks Blvd.
San Leandro, CA 94577
(415) 895-7100

ZEMARC CORPORATION
2240 Gaspar Avenue
Los Angeles, CA 90040
(213) 721-5598

COLORADO

RUCKER FLUID POWER
4675 Joliet
Denver, CO 80239
(303) 373-4840

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2350 Neümunster
West Germany

Daikin Industries, Ltd.
Yodogawa Plant
700-1 Hitotsuya
Settsu-City
Osaka 546, Japan

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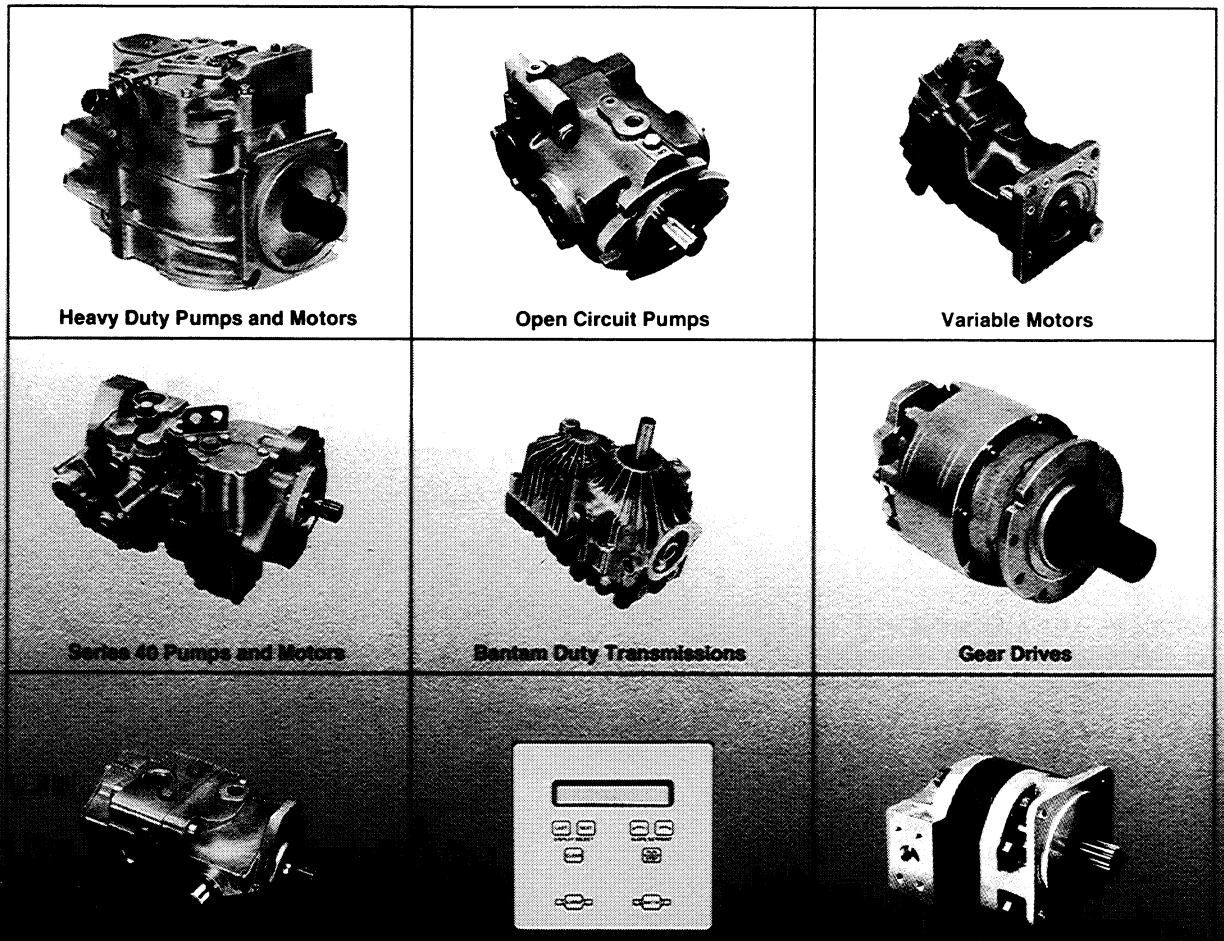
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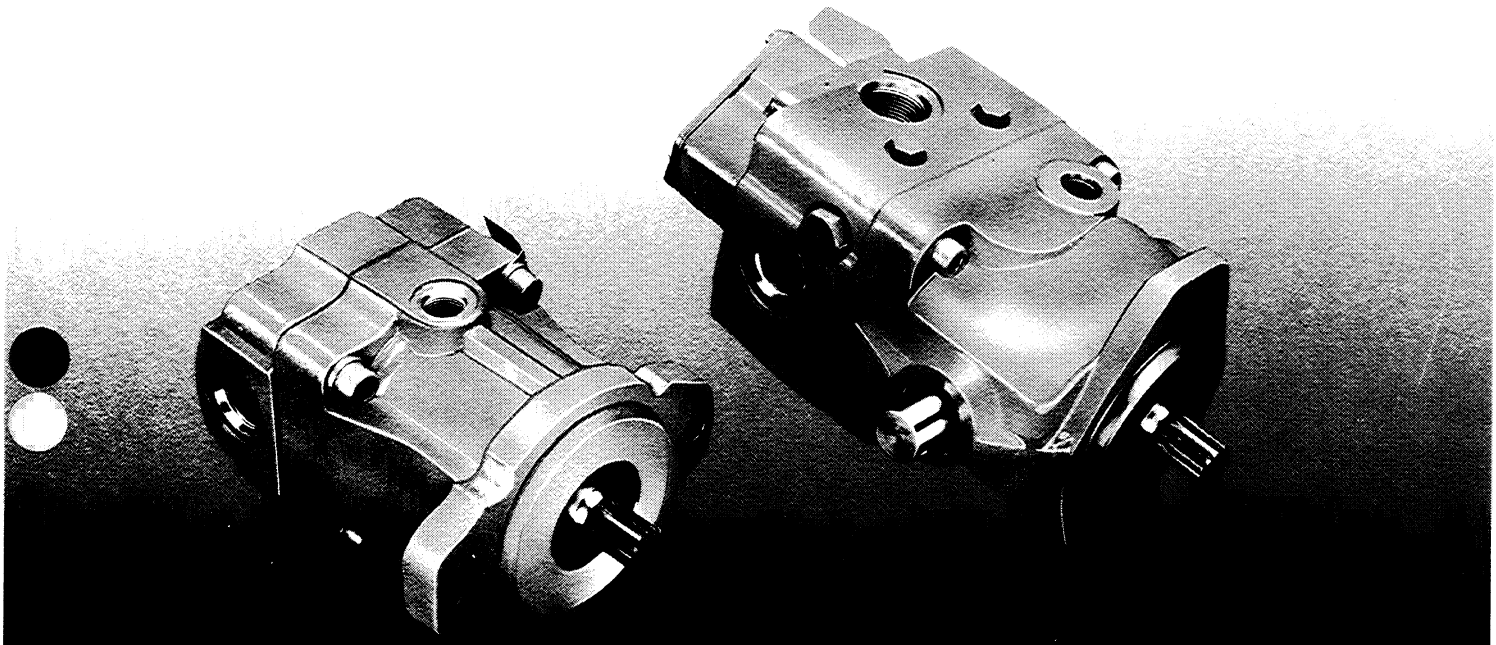
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BLN-9939 Rev. B
December 1988

SUNDSTRAND SAUER

18 Series



Axial Piston

Pumps and Motors

Service and Repair Manual

INTRODUCTION

The purpose of this manual is to provide the information necessary for the servicing of the Sundstrand-Sauer 18 Series hydrostatic transmissions. This includes general description, circuit development, trouble shooting, disassembly and repair. The repair procedures are divided into Minor and Major repairs covering the fixed and variable displacement motors as well as the variable displacement pumps.

Minor repairs are those that can be performed without removal of the end cap and can be accomplished without effecting the unit warranty.

Major repairs are those requiring the removal of the end cap. Major repairs may effect the unit warranty; therefore, the equipment manufacturer should be consulted prior to undertaking such repairs.

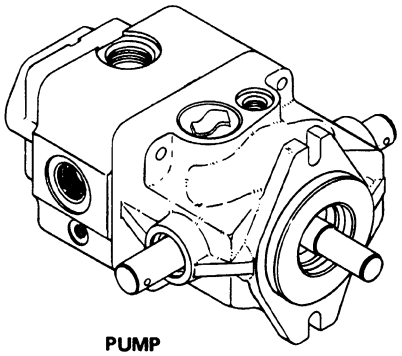
Sundstrand-Sauer provides a complete repair service for its products. Contact any Sundstrand-Sauer Authorized Service Center for details.

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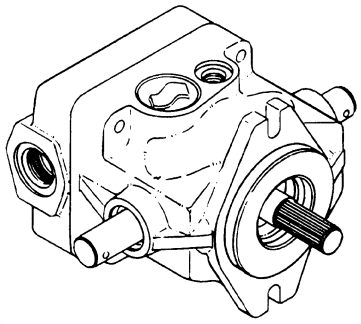
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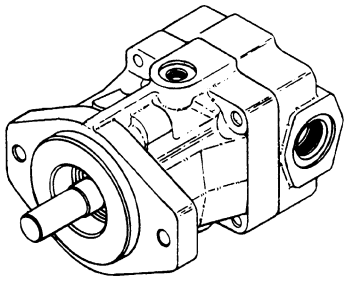
SECTION I: CONFIGURATION AND SPECIFICATIONS



PUMP
VARIABLE DISPLACEMENT



MOTOR
VARIABLE DISPLACEMENT



MOTOR
FIXED DISPLACEMENT

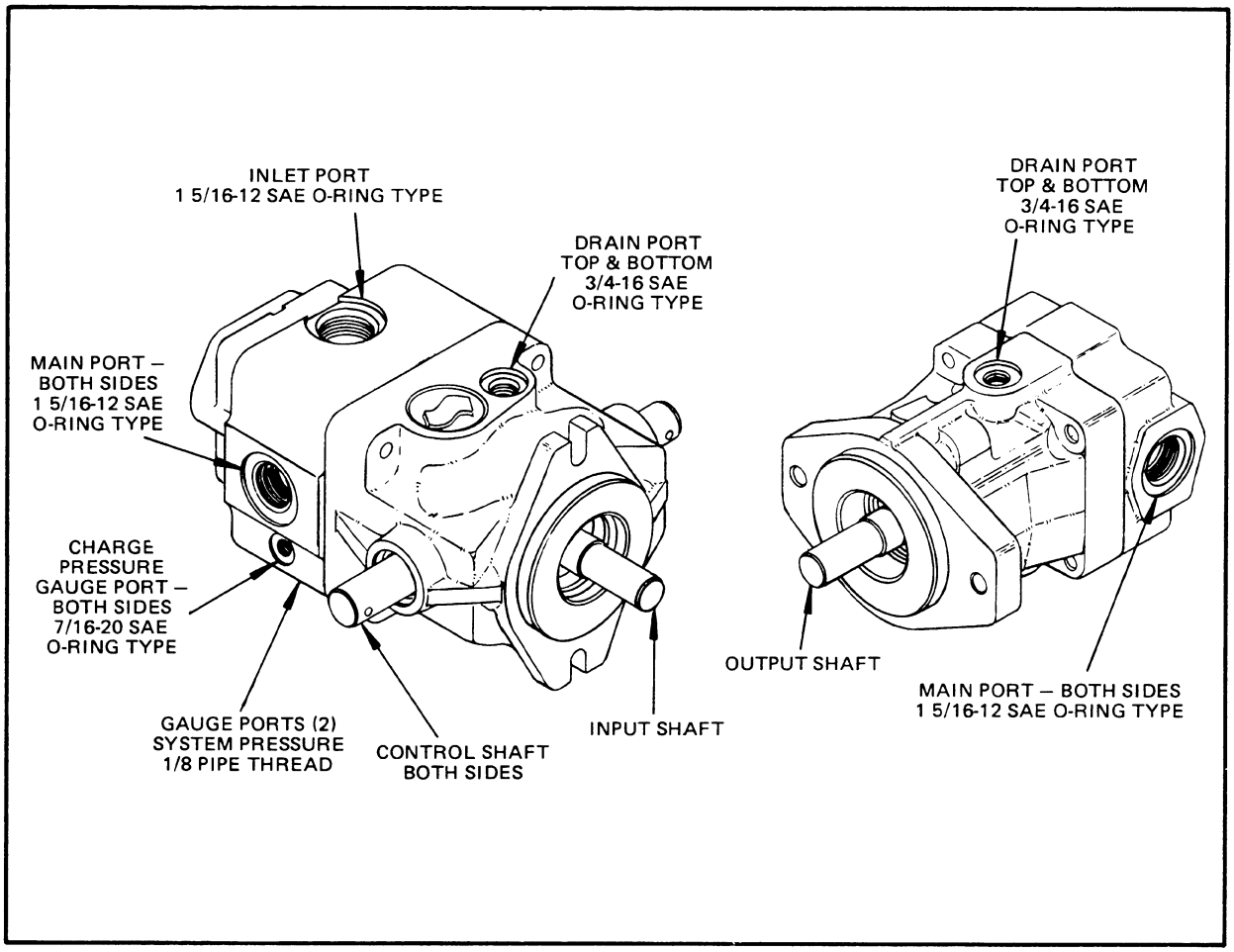
SPECIFICATIONS

PUMP DISPLACEMENT:	0-2.3 IN3/REV.
PUMP INPUT SPEED:	UP TO 3900 RPM
MOTOR DISPLACEMENT:	2.3 in3/REV
MOTOR OUTPUT SPEED:	0-3900 RPM
MAX. OPERATING PRESSURE:	3500 PSI
CHARGE RELIEF SETTING:	100 PSI MIN. @ 1800 RPM
MAX. CONTINUOUS INLET VACUUM:	5 IN. HG.
MAX. CASE PRESSURE:	25 PSI
INLET FILTRATION:	25 MICRON (NOMINAL)
CHARGE PUMP DISPLACEMENT:	OPTIONAL AT: .5, .7 OR 1.04 IN3/REV.

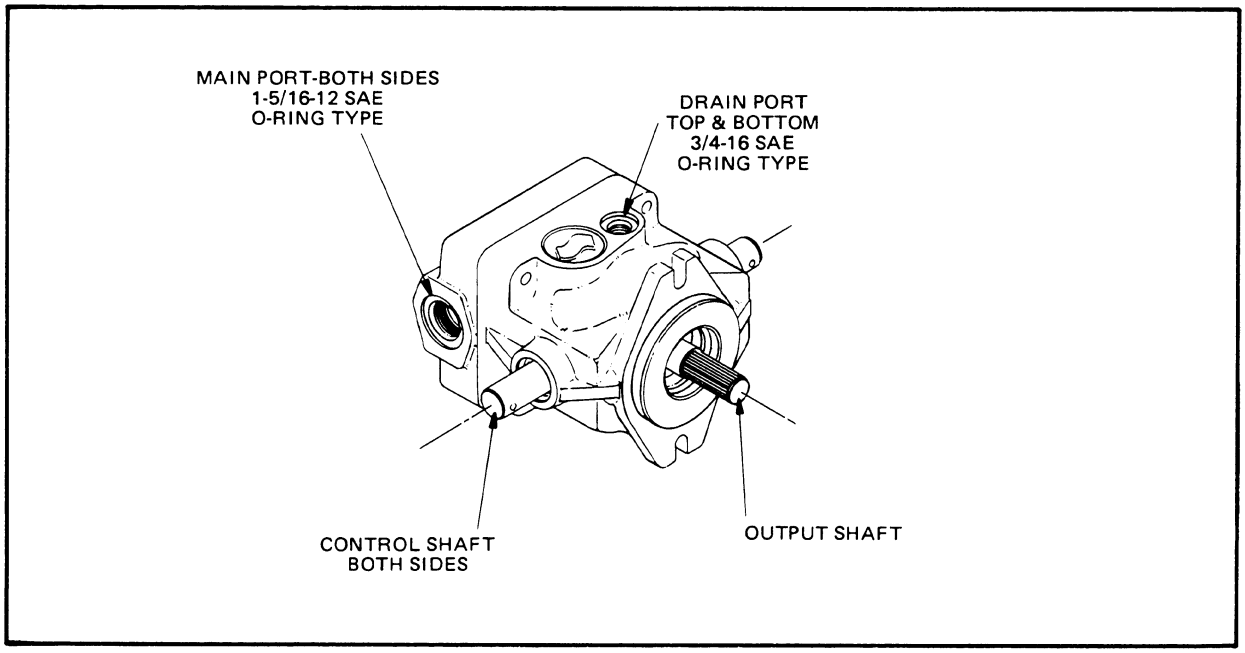
CONSULT MODEL NUMBER OF UNIT TO DETERMINE SPECIFIC UNIT CONFIGURATION REGARDING THESE OPTIONAL ITEMS:

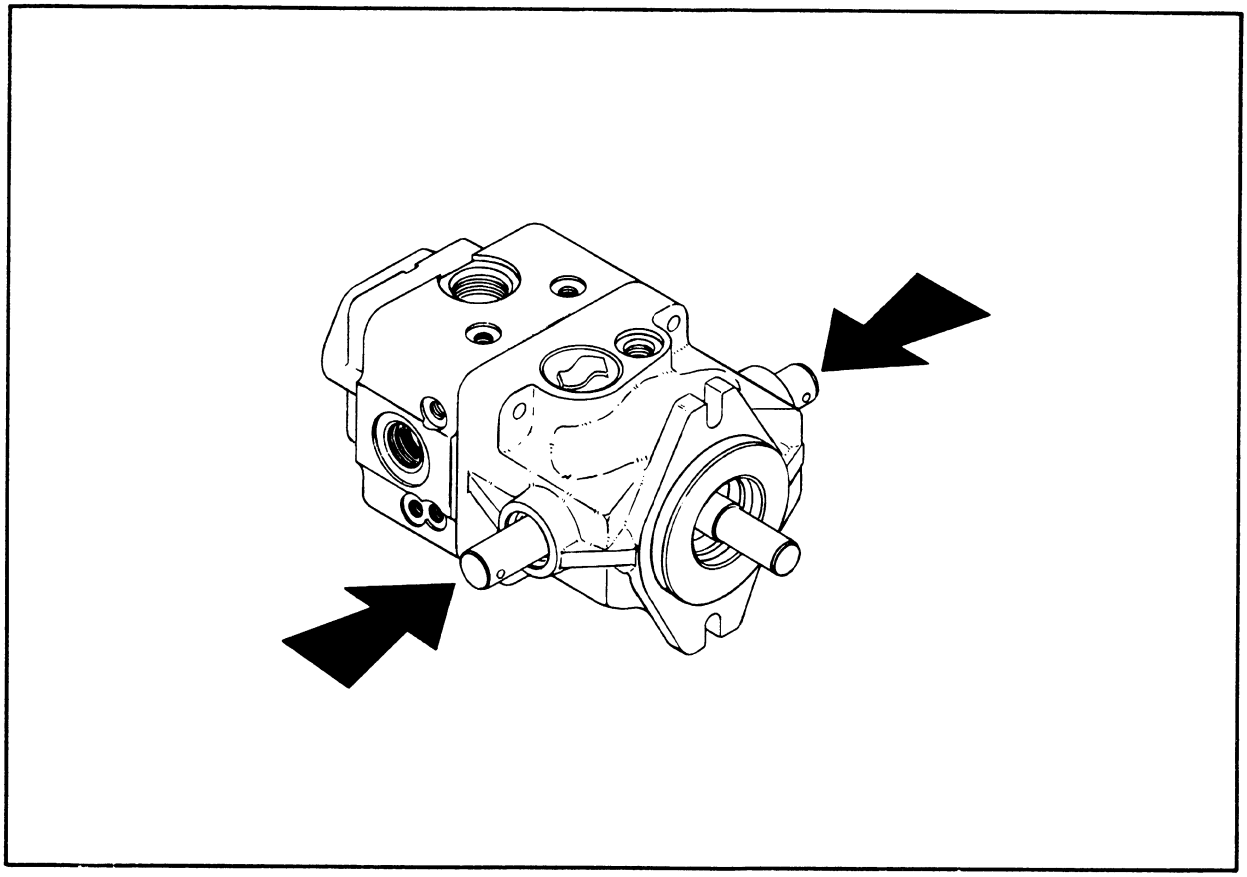
- SHAFT TYPE
- CHARGE PUMP DISPLACEMENT
- AUXILIARY PUMP MOUNTING PAD
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SECTION I: CONFIGURATION AND SPECIFICATIONS

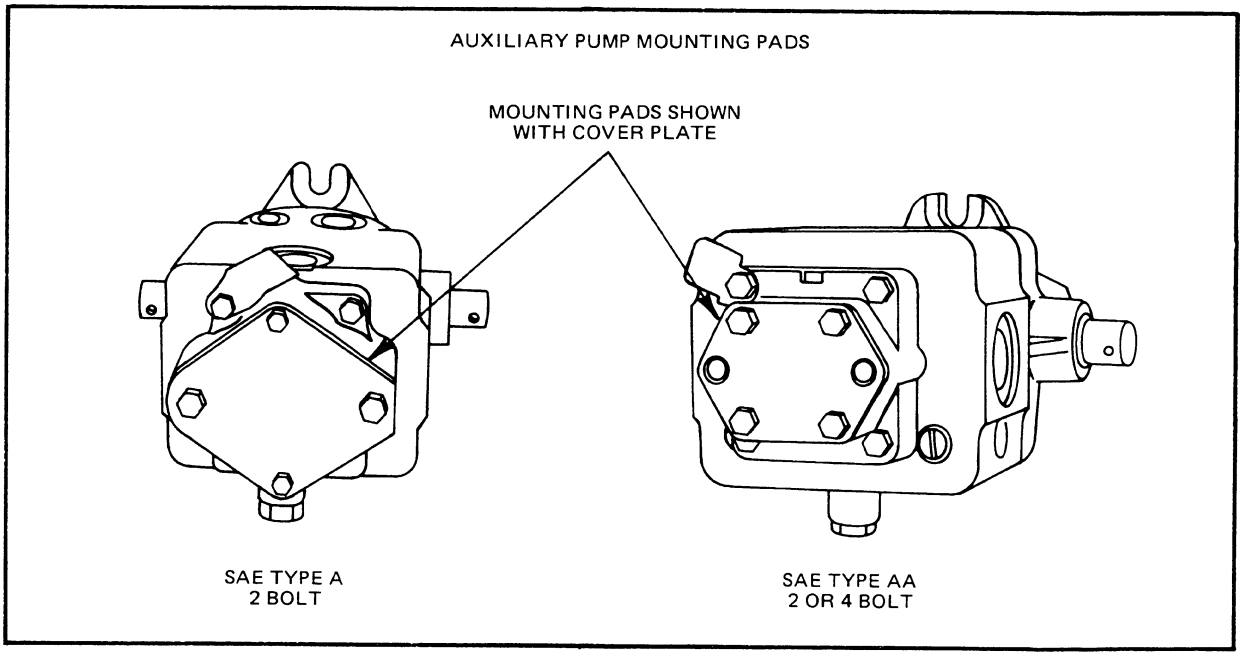


MOUNTING FLANGES FOR BOTH PUMP AND MOTORS ARE SAE TYPE B 2 BOLT





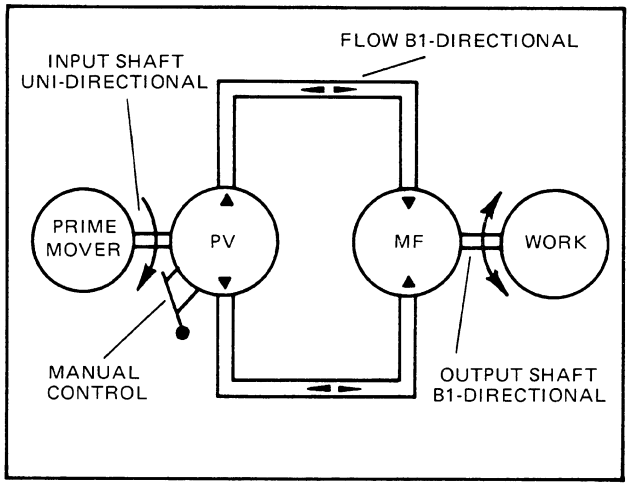
DO NOT use impact force when installing control linkage. Driving axially on the control shaft will result in internal damage to the pump. Installing collars, yokes, couplings, etc., in this manner can cause seal leakage and shearing of swashplate drive pins.



SECTION II: SYSTEM CIRCUIT DESCRIPTION

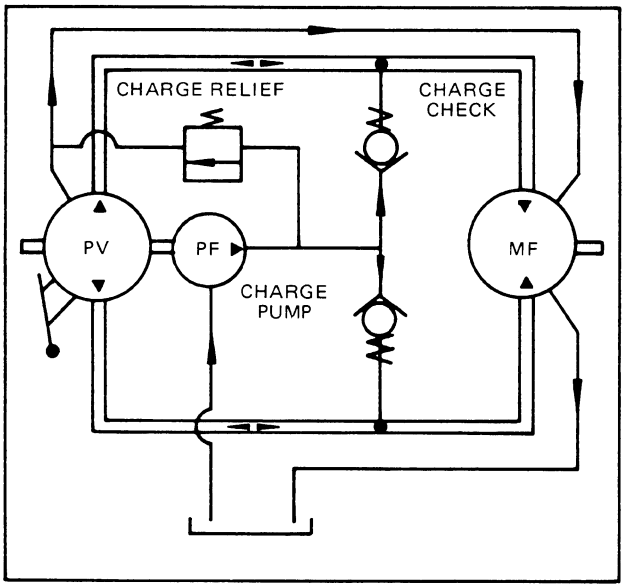
Pump/Motor

The 18 Series hydrostatic transmission consists of a variable displacement axial piston pump connected in a closed loop to a fixed displacement axial piston motor. The variable displacement pump is driven by a prime mover (internal combustion engine, electric motor, etc.) and the fixed displacement motor, which is driven by the fluid from the pump, drives the machine (vehicle, hoist, conveyor, etc.) The direction of rotation and speed of the fixed motor output shaft depends on the flow from the pump. The system pressure is determined by the machine load.



Charge Pump

The axial piston pump and motor have a small amount of internal leakage which is removed from the Pump/Motor closed loop circuit. This results in fluid loss from that circuit which must be replenished to prevent cavitation. To accomplish this task, a fixed displacement pump (gerotor type) is added. It is driven directly by the prime mover through the variable displacement pump shaft. This Charge Pump makes available a predetermined amount of fluid that is used by the Pump/Motor circuit as required to replenish leakage losses.



Since the Pump/Motor circuit is a closed loop and either side can be high pressure, two (2) check valves are needed to direct the charge pump flow into the low pressure side of the circuit.

The pressure in the Charge Pump circuit is limited by a factory set, direct operating relief valve so that any fluid not being used is discharged from the circuit over this valve, through the pump and motor housing and back to the system reservoir.

SECTION II: SYSTEM CIRCUIT DESCRIPTION

Control

SWASHPLATE CONTROL — 18 SERIES

The variable displacement pumps and motors of the 18 Series transmissions are mechanically controlled. That is, the control shaft is fastened directly to the swashplate so that any movement of the control shaft reflects in a direct, equivalent swashplate movement and resultant change in pump flow and/or motor shaft speed/direction.

CAUTION

These pumps and motors do not have any mechanical or hydraulic centering devices on the swashplate to return the swashplate to a neutral position. As a result, the swashplate may move to a position of maximum ratio. Therefore, one must consider these parameters when designing the control system to be used with the 18 Series Variable Pumps and Motors.

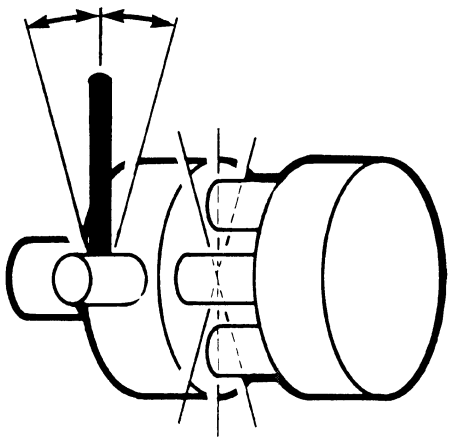
TAKE THE NECESSARY SAFETY PRECAUTIONS FOR YOUR APPLICATION.

It is necessary to provide a force in the control system that will hold the swashplate at the desired angle as internal forces may tend to move the swashplate in either direction. A "fail safe" design, which will return the swashplate to neutral in the event of linkage failure, is recommended.

Recommended minimum control force per 1,000 ΔPSI of operating pressure:

18 Series 125 in. lbs./1,000 PSI

TAKE THE NECESSARY SAFETY PRECAUTIONS FOR YOUR APPLICATION.



SECTION II: SYSTEM CIRCUIT DESCRIPTION

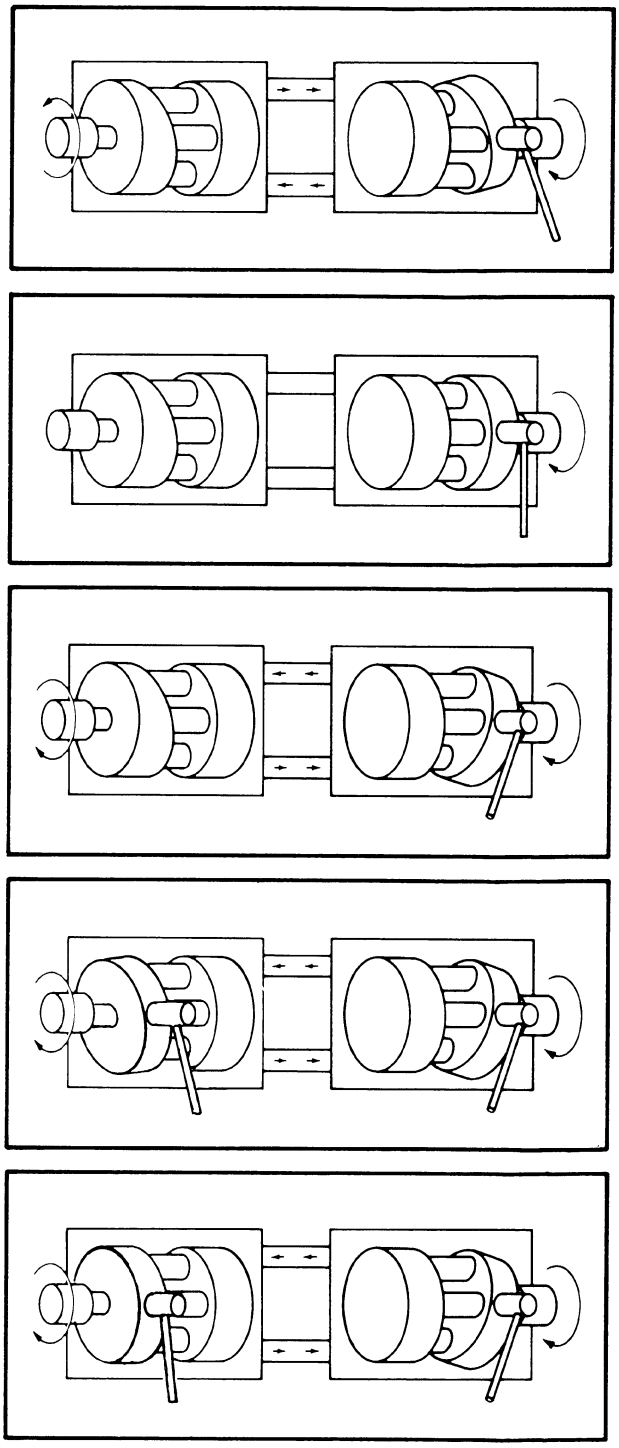
Control

The speed at which the output shaft turns is proportional to the position of the control lever and is infinitely variable between zero and maximum speed. The direction of rotation of the output shaft depends on the position of the control lever in relation to the neutral position.

The variable displacement pump has a manual control connected directly to the tiltable swashplate so that as the operator moves the control lever, the swashplate tilts to a corresponding angle resulting in fluid flow from the pump. The fluid enters the fixed displacement motor and pressure increases until the motor (output) shaft begins to rotate.

When the swashplate (control lever) is at neutral (zero tilt angle) there is no stroking of the internal axial pistons and therefore, no flow from the pump to the motor.

The direction of motor (output) shaft rotation depends upon which port the fluid enters the motor. Reversing the direction that the swashplate is tilted from neutral (zero angle) reverses the output shaft rotation and hence the direction of the machine.



Variable Displacement Motor

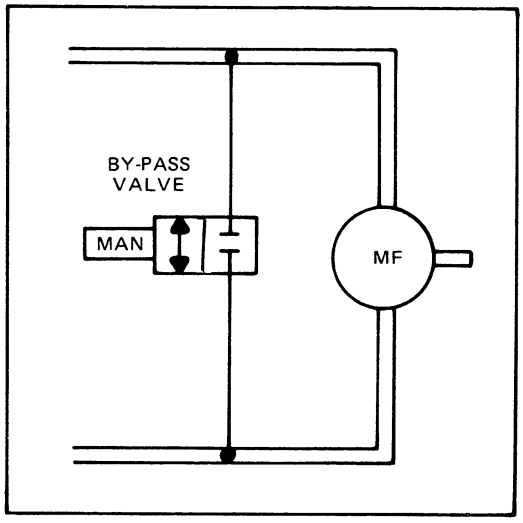
The variable displacement motor is used to provide a wider range of output speeds. It has a tiltable swashplate which can be moved from full angle to a lesser angle, thus reducing the motors displacement so it will turn faster for the same amount of input flow. Reducing the swashplate angle (motor displacement) also reduces the output torque for a given system pressure.

The variable displacement motor has a manual control connected directly to the swashplate so that as the operator moves the lever, the swashplate tilts to a corresponding angle.

SECTION II: SYSTEM CIRCUIT DESCRIPTION

Optional By-Pass Valve

In some applications it is desirable to by-pass fluid around the fixed displacement motor so that a vehicle can be moved so that a vehicle can be moved short distances without running the prime mover. This function is accomplished by the addition of a screw in type valve at the motor. When open (unscrewed) this valve connects both sides of the Pump/Motor circuit and allows the fixed motor to free wheel. This by-pass valve must be fully closed for normal operation.



Reservoir

The reservoir is an important component of the system. The suggested minimum reservoir total capacity (in gallons) is five-eighths (5/8) of the Charge Pump flow (GPM). The minimum fluid capacity should be equal to one-half (1/2) the Charge Pump flow.

Example: Charge Pump flow equal to 2 GPM
Total Reservoir capacity should be 1 1/4 GAL.
Fluid capacity should be 1 GAL.

The Charge pump inlet port in the reservoir must be above the bottom of the reservoir and must always be covered with fluid. The return port should be located as far from the inlet port as possible to provide maximum dwell time of the fluid in the reservoir. The returning fluid should always discharge below the fluid level. If an open or air breathing reservoir is used, the air breather must be of sufficient capacity to prevent contamination from airborne particles.

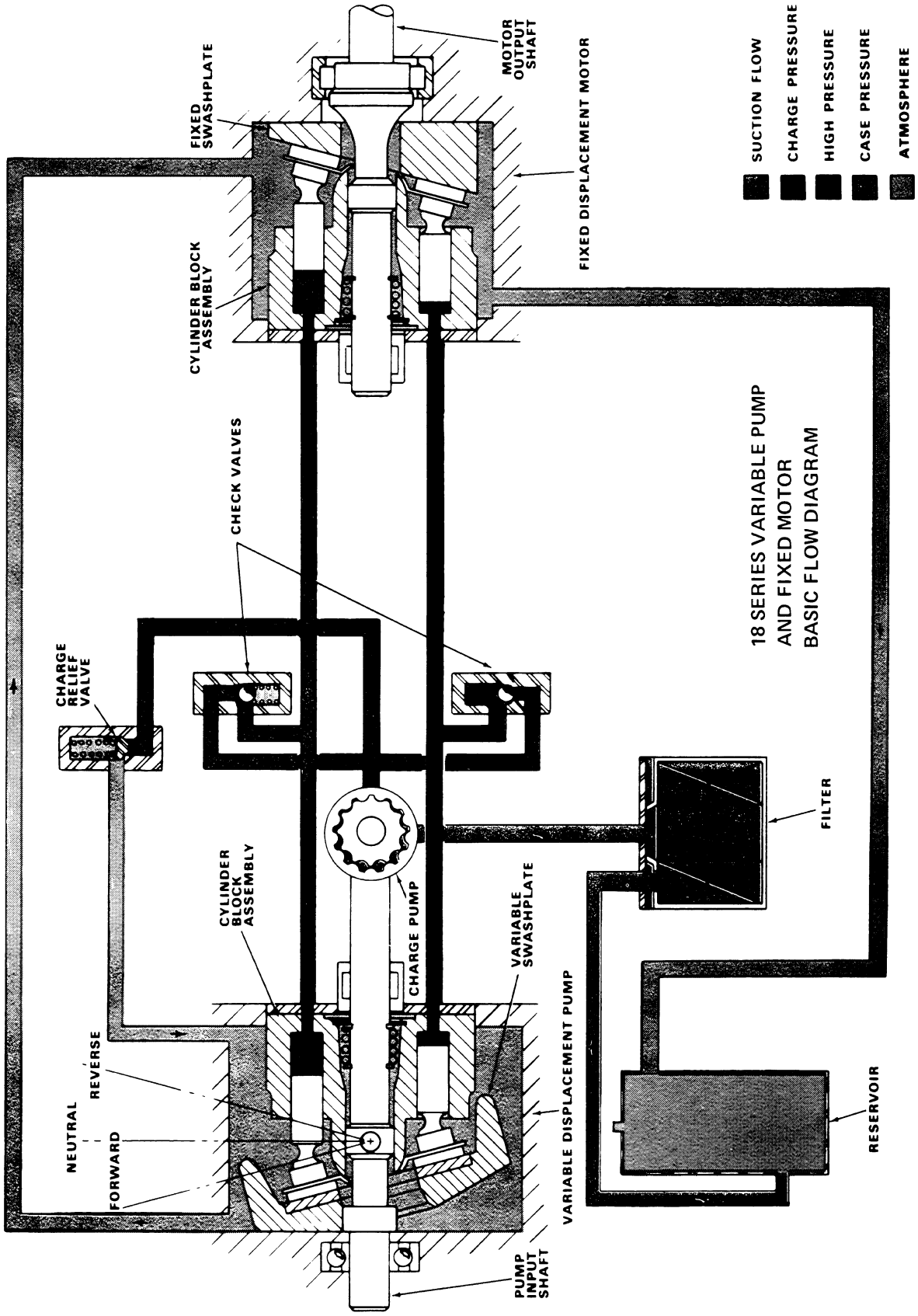
Inlet Filter

It is imperative to insure that only clean fluid enter the hydrostatic transmission circuit; therefore, a 25 micron (nominal rating) filter is required in the Charge Pump inlet line. This filter should not have a by-pass and must be changed regularly to insure system reliability.

Heat Exchanger

The hydrostatic transmission should not exceed 200°F as a continuous operating temperature. To maintain this maximum temperature may require the addition of a Heat Exchanger in the line returning fluid to the reservoir. The optimum Heat Exchanger should be capable of dissipating a minimum of 25% of the maximum input horsepower to the transmission.

Example: Maximum Input Horsepower at 12 HP
Heat Exchanger Capacity at 3 HP


18 SERIES VARIABLE PUMP
AND FIXED MOTOR
BASIC FLOW DIAGRAM
SUCTION FLOW
CHARGE PRESSURE
HIGH PRESSURE
CASE PRESSURE
ATMOSPHERE
FIXED SWASHPLATE
MOTOR OUTPUT SHAFT
FIXED DISPLACEMENT MOTOR
CYLINDER BLOCK ASSEMBLY
CHECK VALVES
CHARGE RELIEF VALVE
FILTER
CYLINDER BLOCK ASSEMBLY
CHARGE PUMP
VARIABLE SWASHPLATE
REVERSE
NEUTRAL
FORWARD
VARIABLE DISPLACEMENT PUMP
RESERVOIR
PUMP INPUT SHAFT

SECTION III: FLUID RECOMMENDATIONS

Hydraulic fluids selected for use with the Sundstrand-Sauer hydrostatic transmission should be a quality product carefully selected with assistance from a creditable supplier following the guidelines presented in the "Fluid Quality Requirements" bulletin, BLN-9887.

Characteristics of the fluid selected should include:

Viscosity	Rust Inhibition
Oxidation	Anti Foam
Thermal Stability	Water Compatibility
Shear Stability	Filtration Limitations
Low Temperature Fluidity	Anti-Wear Properties

The following types of fluids have been used successfully in the hydrostatic transmission: (1) anti-wear hydraulic oil, (2) automatic transmission fluid – Type "F", and (3) hydraulic transmission fluid *(type used by the Agricultural industry for combined transmission, hydraulic and wet brake systems).* If a fire resistant fluid is required, Pydraul 312 has been satisfactory.

Most of the above fluid types have acceptable viscosity characteristics in the operating range of 0° F. to 200° F. The fluids selected should provide a minimum viscosity of 47 SUS at 210° F. and a maximum measured viscosity of 6000 SUS at the lowest expected startup temperature. Typical fluid properties are listed on the attached table.

Your best assurance for a quality product is the assistance that can be offered in its selection by a fluid supplier. The major oil companies are quite capable of providing suitable products.

Fluid Type	Typical Viscosity SUS 0°	100°F	210°F	Viscosity Index	Pour Point °F	Operating Range (Typical °F)
Anti-Wear Hydraulic Oil	7000	200	50	130	-30	0-200° F.
Type "F"	3200	212	57.2	208	-40	-15-200° F.
Hydraulic Transmission Oil	12,000	233	49	100	-35	0-200° F.
*Pydraul 312	100,000	312	51	77	-10	50-200° F.
*Fire Resistant Fluid						

SECTION IV: START UP PROCEDURE

1. Prior to installing the transmission, inspect for damage during shipment and handling. Make certain all circuit components (reservoir, hoses, fittings, heat exchanger, etc.) are clean prior to installing and filling with fluid.

2. Fill the reservoir with recommended hydraulic fluid which should be passed through a ten (10) micron (nominal) filter prior to entering the reservoir. Never reuse fluid.

3. The inlet line leading from the reservoir to the pump housing on the transmission must be filled prior to start up. If gravity feed does not fill this line, it must be filled manually. Remember that the maximum inlet vacuum at normal conditions should not exceed 5 in. hg. Check inlet line for properly tightened fittings and be certain it is free of restrictions.

   Be certain to fill the main pump and motor housings with clean hydraulic fluid prior to start up.

4. Install a pressure gauge (500 PSI) in the charge pressure port with a short section of hose and a snubber or needle valve to dampen pulsations. Charge pressures should read as follows after start up. 18 Series:

   100 PSI minimum @ 1750 RPM
   130 PSI minimum @ 3600 RPM

5. Start the prime mover and run at the lowest possible RPM until charge pressure has been established.

> CAUTION
>
> Never start the prime mover unless the swashplate is in the neutral (zero angle) position or internal transmission damage can occur. This applies to any subsequent start-ups as well.

6. Once charge pressure has been established increase the speed to full RPM. If Charge Pressure is not maintained at the proper setting (it may increase but not decrease), shut down system and determine cause.

7. Run system at full input and output speeds with motor output shaft disconnected from drive train or drive wheels off the ground in both directions and observe Charge Pressure.

8. Operate system for at least fifteen (15) minutes then shut down and replace the inlet filter. Remove gauge and plug port. Check fluid level in reservoir.

9. Transmission is ready for operation.

SECTION V: SYSTEM MAINTENANCE

The hydrostatic-transmission and related system components, no matter how perfectly matched to the machine, will not give satisfactory service without proper and regular system maintenance of the following major areas.

Fluid

The hydraulic fluid should be changed at least every 2000 hours of operation when a sealed reservoir is used.

An open (air breathing) reservoir should have the hydraulic fluid changed at least every 500 hours.

If the fluid becomes contaminated with any foreign material (dirt, water, solvent, grease, etc.) or has been subjected to abnormal operating conditions, the fluid should be changed more frequently.

Use recommended fluid only (see machine specifications).

Filters

The charge pump inlet filter must be changed at least every 2000 hours when a sealed reservoir is used.

When an open (air breathing) reservoir is used, the filter must be changed at least every 500 hours.

The air filter on an open reservoir must be replaced or cleaned every 500 hours.

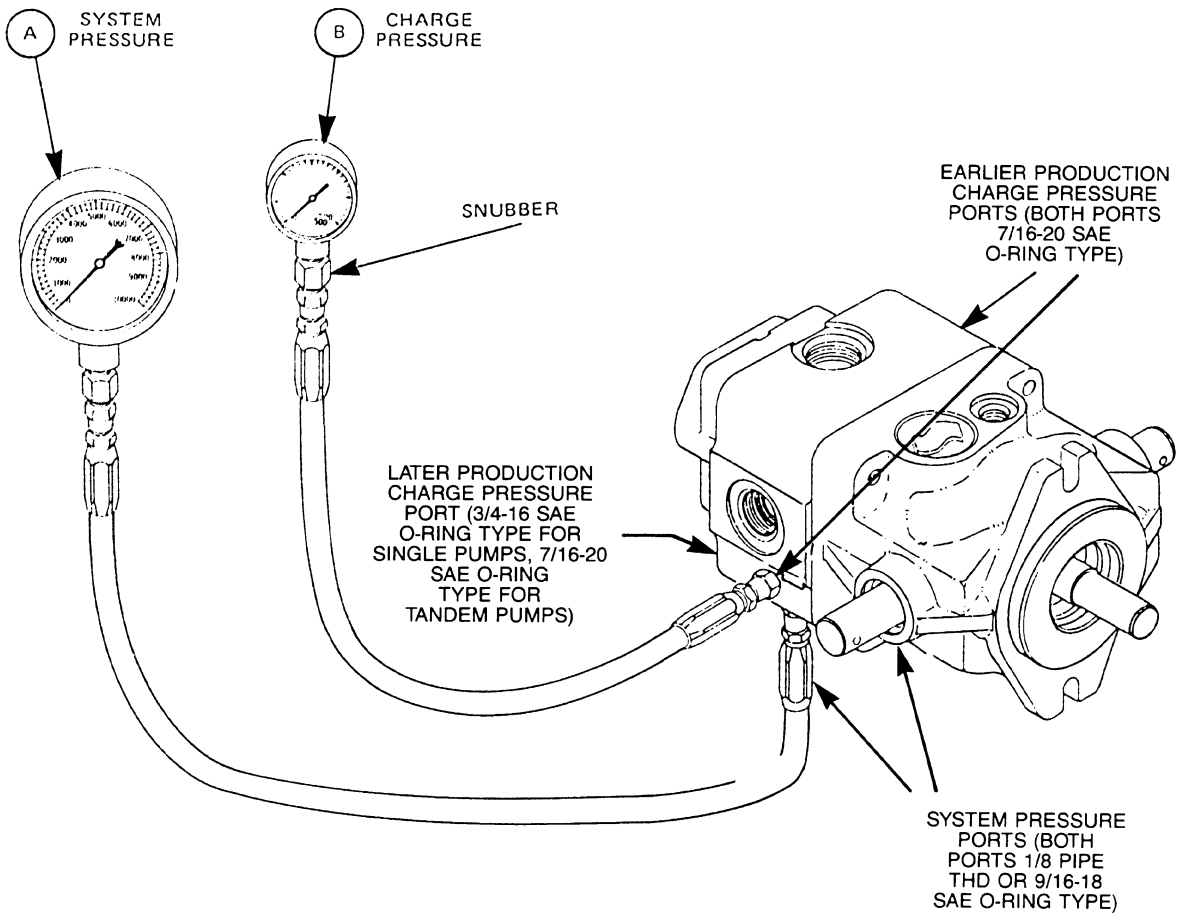
Filters should always be replaced when changing hydraulic fluid.

Reservoir

The reservoir should be checked daily for proper level, the presence of water (noted by a cloudy to milky appearance or free water in bottom of reservoir) and rancid odor (indicates excessive heat). When adding fluid to the reservoir, use only the fluid recommended for the equipment.

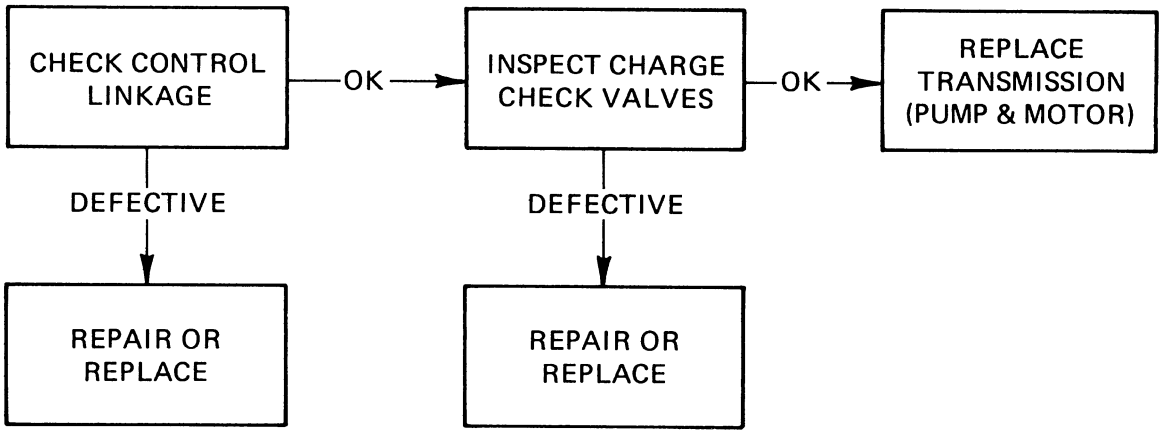
SECTION VI: TROUBLE SHOOTING PROCEDURES

TYPICAL GAUGE INSTALLATION



A. System Pressure gauge with 0 to 10,000 PSI Range
B. Charge Pressure gauge with 0 to 500 PSI Range

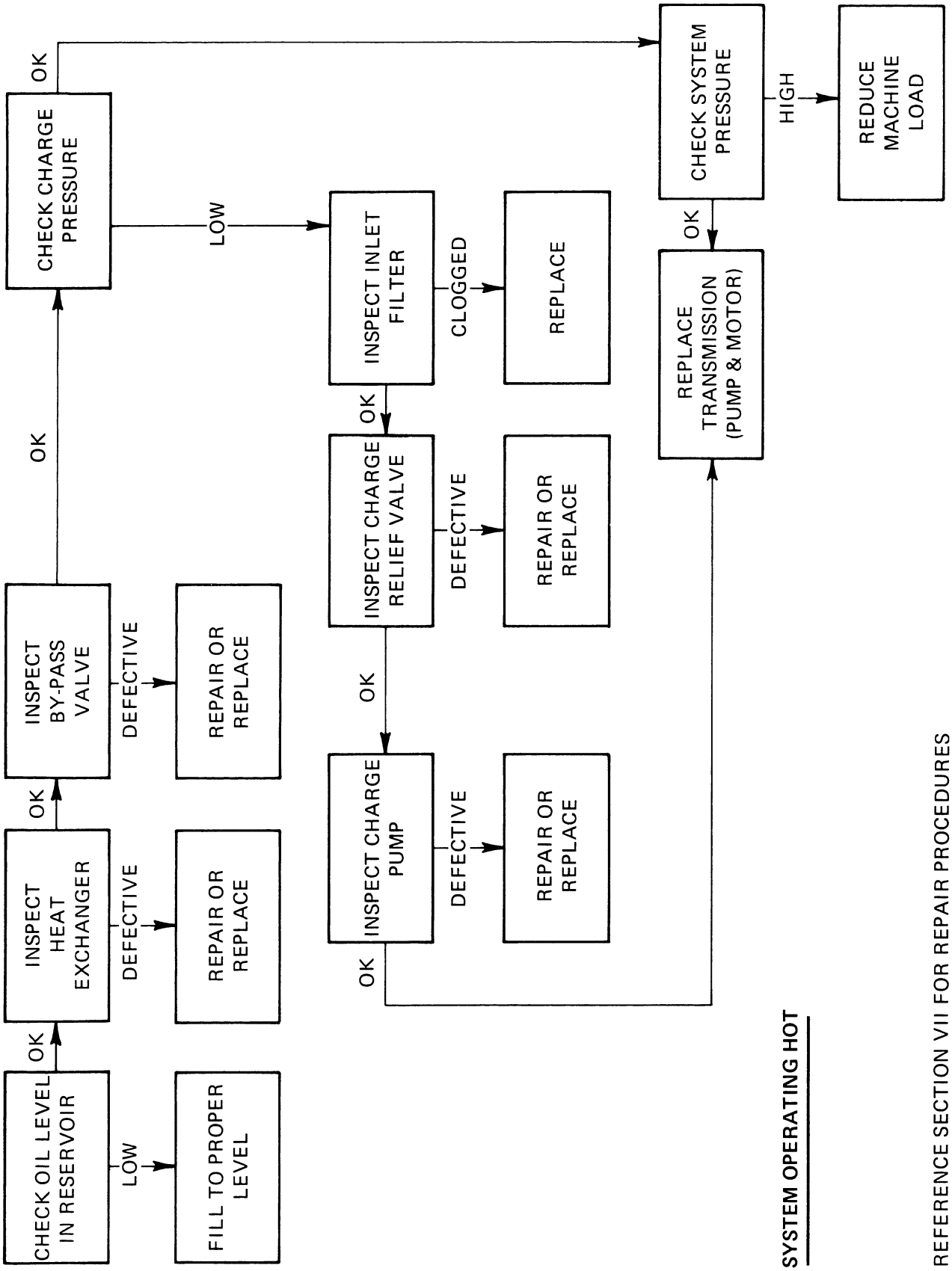
Snubbers are recommended to protect gauges. Frequent gauge calibration is necessary to insure accuracy. Input speed should be at or near max. rpm when taking gauge readings.



SYSTEM JERKY WHEN STARTING

SYSTEM OPERATES IN ONE DIRECTION ONLY

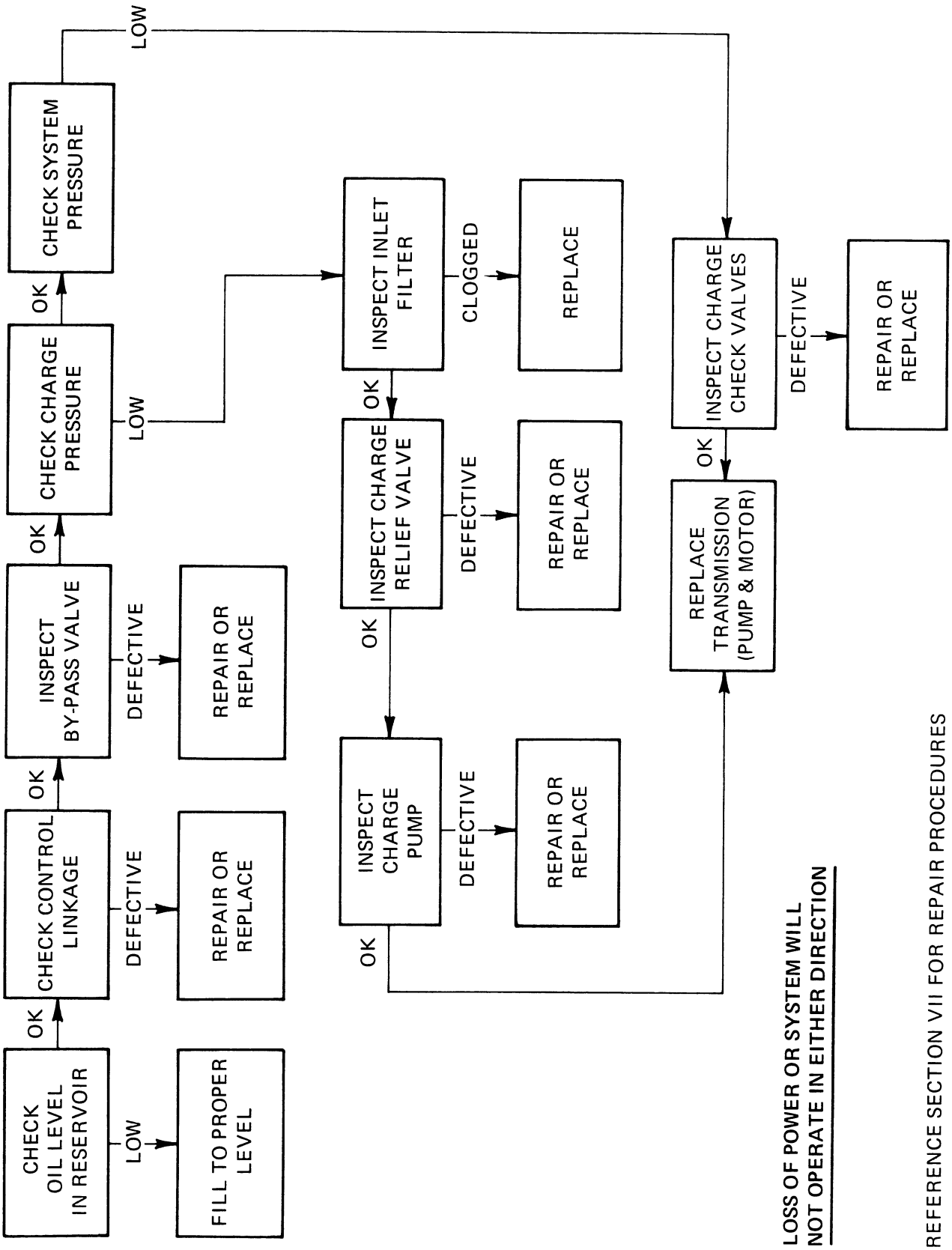
REFERENCE SECTION VII FOR REPAIR PROCEDURES



SYSTEM OPERATING HOT

REFERENCE SECTION VII FOR REPAIR PROCEDURES

SECTION VI: TROUBLE SHOOTING PROCEDURES



LOSS OF POWER OR SYSTEM WILL NOT OPERATE IN EITHER DIRECTION

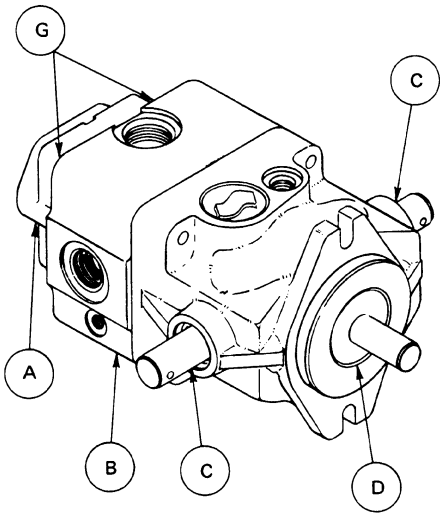
REFERENCE SECTION VII FOR REPAIR PROCEDURES

SECTION VII:

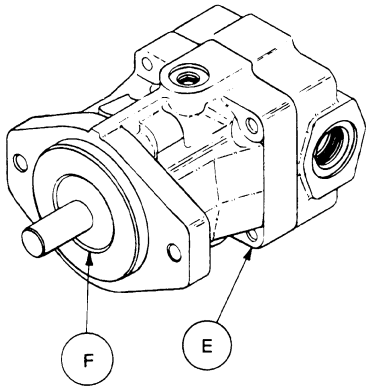
MINOR REPAIR PROCEDURES

The following procedures cover the minor repairs for the 18 Series hydrostatic transmissions. Minor repairs are those that can be accomplished without the removal of the end cap. These repairs can be performed, following the procedures in this manual, without voiding the unit warranty.

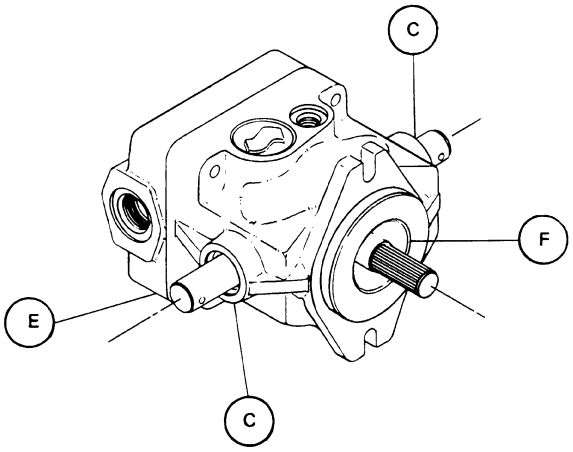
SECTION VII: MINOR REPAIR PROCEDURES



PUMP
VARIABLE DISPLACEMENT



MOTOR
FIXED DISPLACEMENT



MOTOR
VARIABLE DISPLACEMENT

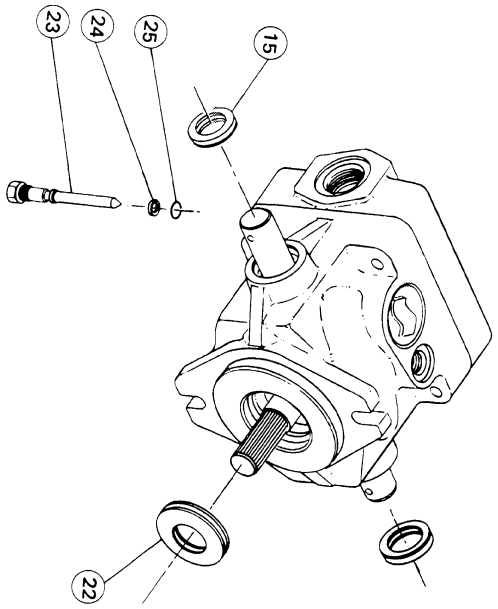
Service Kits are available for repairing the areas noted. Consult Parts List for Model Number for specific Service Kit and component part numbers.

AREA OF REPAIR

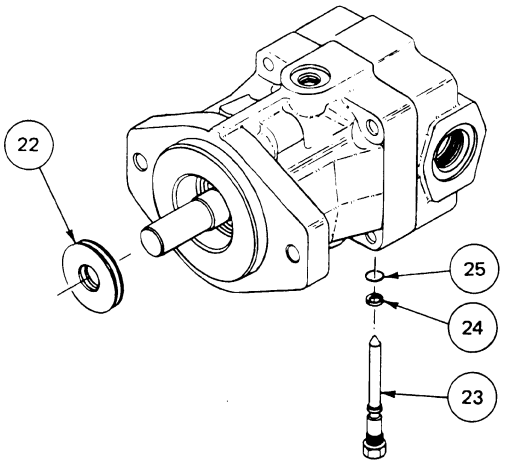
KIT	DESCRIPTION
A	Charge Pump*
B	Charge Relief Valve
C	Trunnion Seal
D	Input Shaft Seal
E	By-Pass Valve
F	Output Shaft Seal
G	Charge Check Valves

* Not applicable to pumps with SAE Type AA, 2 &4 bolt, auxiliary pump mounting pad.

SECTION VII: MINOR REPAIR PROCEDURES



MOTOR
VARIABLE DISPLACEMENT



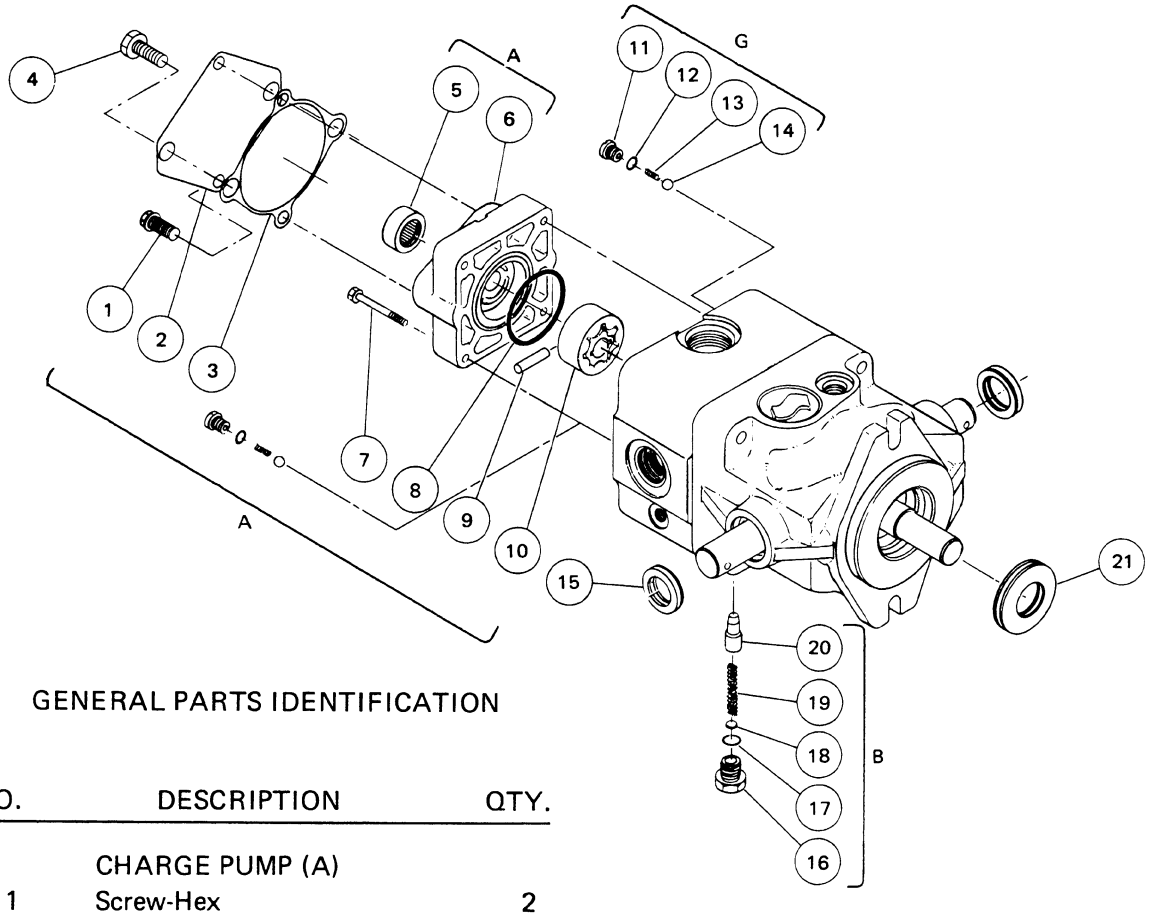
MOTOR
FIXED DISPLACEMENT

GENERAL PARTS IDENTIFICATION

NO.	DESCRIPTION	QTY
	TRUNNION SEAL (C)	
15	Seal-Lip	2
	OUTPUT SHAFT SEAL (F)	
22	Seal-Lip	1
	BY-PASS VALVE (G)	
23	By-Pass Valve Spool	1
24	Back-Up Ring	1
25	O-Ring	1

SECTION VII: MINOR REPAIR PROCEDURES

PUMP WITH SAE TYPE A AUXILIARY PUMP MOUNTING PAD

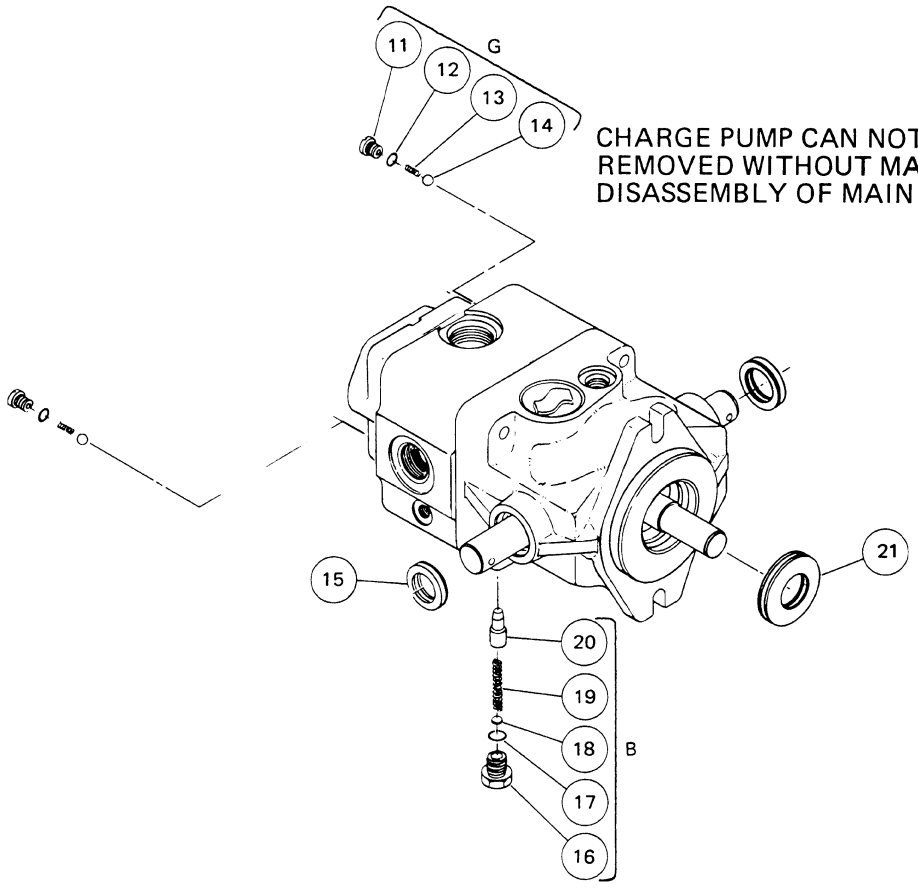


GENERAL PARTS IDENTIFICATION

NO.	DESCRIPTION	QTY.
	CHARGE PUMP (A)	
1	Screw-Hex	2
2	Cover Plate	1
3	Gasket	1
4	Screw-Hex.	2
5	Bearing	1
6	Housing-Chrg. Pump	1
7	Screw-Hex.	2
8	O-Ring	1
9	Pin-Drive	1
10	Charge Pump (Gerotor)	1
	CHARGE CHECK VALVES (G)	
11	Plug	2
12	O-Ring	2
13	Spring	2
14	Ball	2

NO.	DESCRIPTION	QTY.
	TRUNNION SEAL (C)	
15	Seal-Lip	2
	CHARGE RELIEF VALVE (B)	
16	Plug-Hex.	1
17	O-Ring	1
18	Shim	A/R
19	Spring	1
20	Poppet	1
	INPUT SHAFT SEAL (D)	
21	Seal-Lip	1

PUMP WITH SAE TYPE AA AUXILIARY PUMP MOUNTING PAD

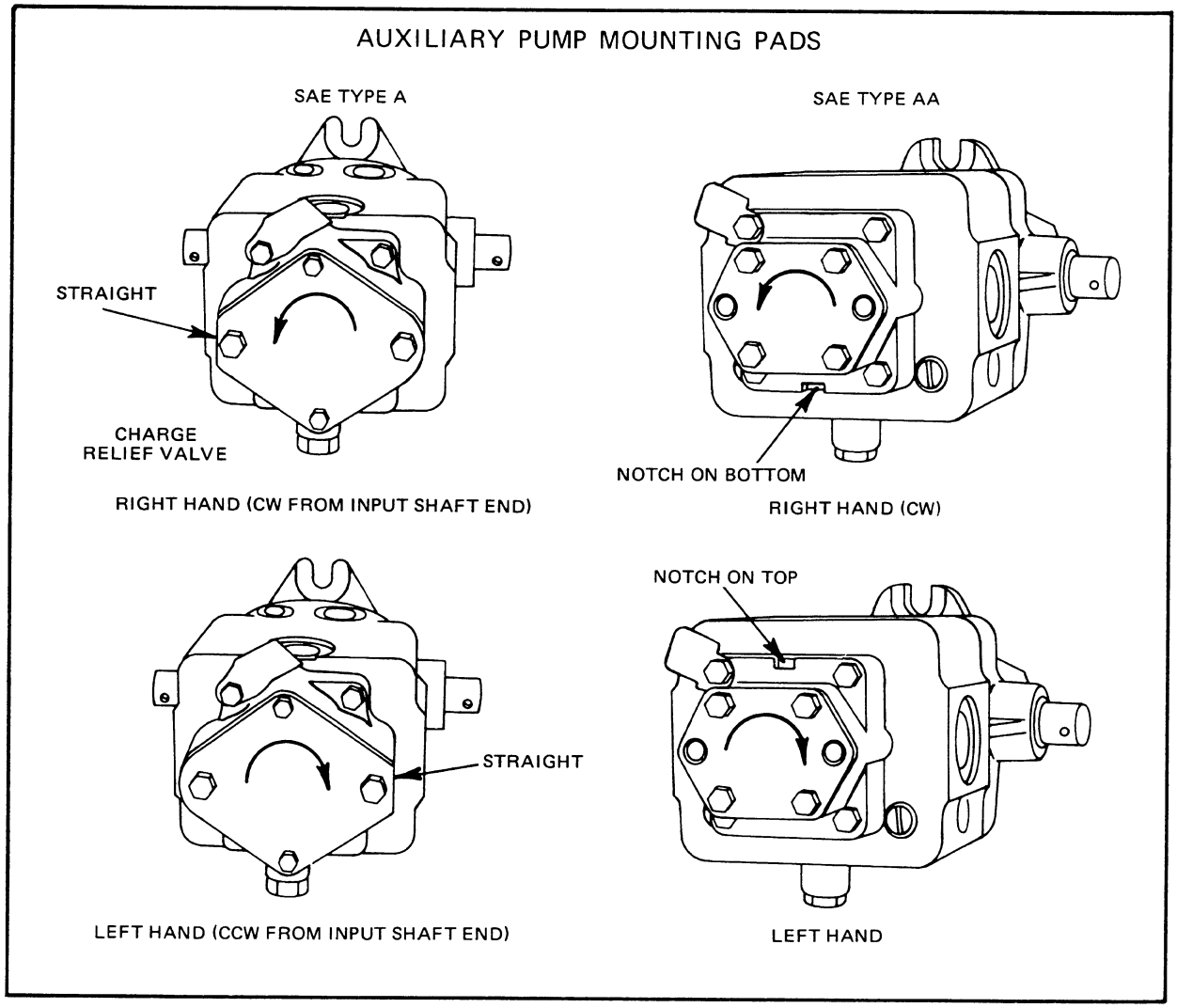


GENERAL PARTS IDENTIFICATION

NO.	DESCRIPTION	QTY.
	CHARGE CHECK VALVES (G)	
11	Plug	2
12	O-Ring	2
13	Spring	2
14	Ball	2
	TRUNNION SEAL (C)	
15	Seal-Lip	2

NO.	DESCRIPTION	QTY.
	CHARGE RELIEF VALVE (B)	
16	Plug-Hex.	1
17	O-Ring	1
18	Shim	A/R
19	Spring	1
20	Poppet	1
	INPUT SHAFT SEAL (D)	
21	Seal-Lip	1

SECTION VII: MINOR REPAIR PROCEDURES



CHARGE PUMP

Rotation

Note the orientation of charge pump housing to insure proper assembly regarding input rotation which is the rotation when viewing from input shaft end of pump.

RH (CW) Input Rotation
- SAE type A – Straight side to left of charge relief
- SAE type AA – Notch on bottom (same side as charge relief)

LH (CCW) Input Rotation
- SAE type A – Straight side to right of charge relief
- SAE type AA – Notch on top (opposite charge relief)

Repair

The charge pump cannot be removed from units with SAE type AA auxiliary pump mounting pad without major disassembly of main pump.

Refer to Section VIII, page 32, for disassembly of charge pump for this type of unit.

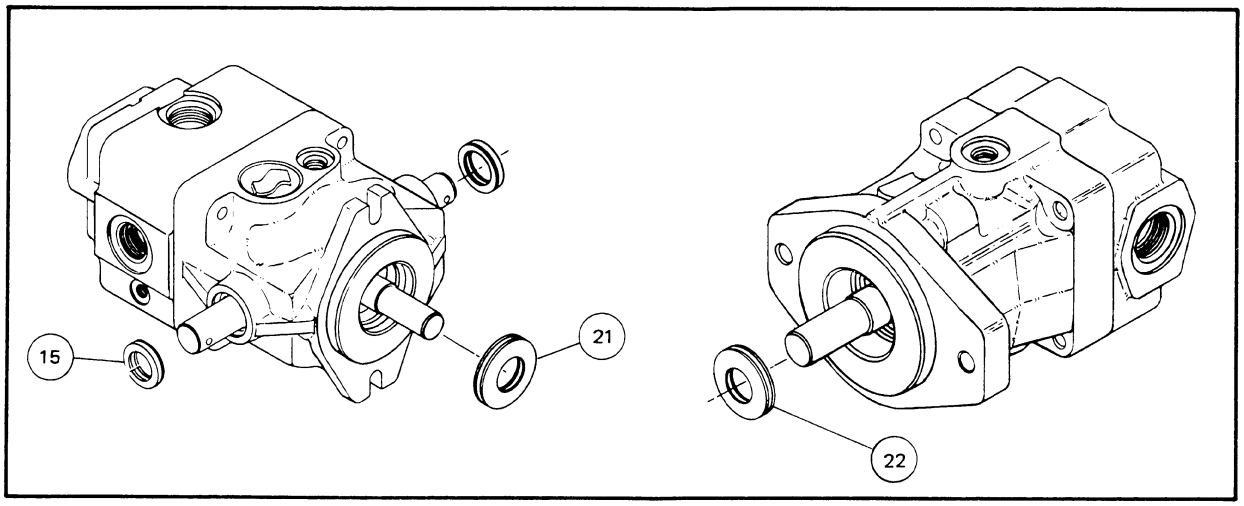
SECTION VII: MINOR REPAIR PROCEDURES

Replacement of Shaft & Trunnion Seals

Lip type seals are used throughout these transmissions. These seals can be replaced without major disassembly of the transmission; however, replacement of either the input or output seal requires removal of the transmission from the machine.

Pry the seal carefully out of the housing bore, using care not to distort the housing or damage the bore or shaft. Once removed the seal is not reusable.

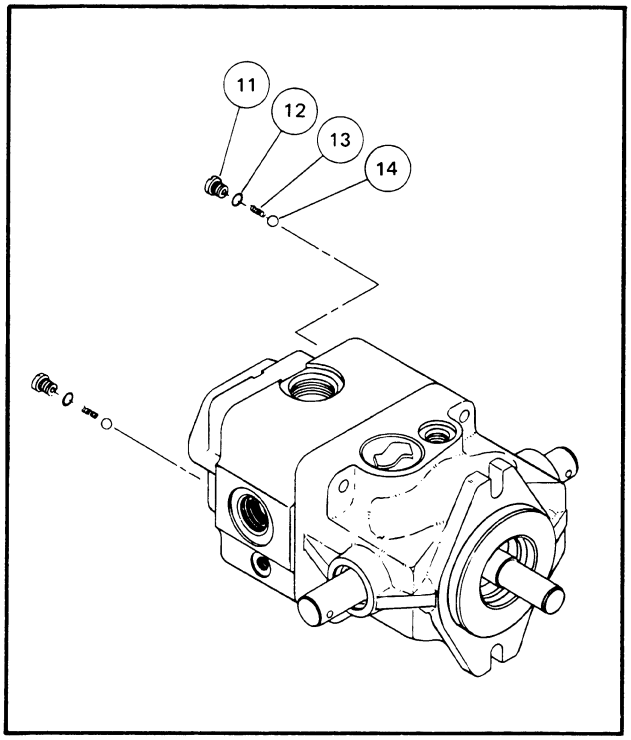
Prior to installing the new seal, polish the shaft extension, wrap it in thin plastic and lubricate with clean hydraulic oil to insure the seal is not damaged during assembly. Slide the seal over the shaft and press into housing bore.



Charge Check Valves

Remove slotted head plug (11) then slide the spring (13) and ball (14) out of the end cap. Inspect the ball and the mating seat in the end cap for damage. Remove any foreign material in the valve area. Replace parts as required and reinstall into end cap. In some instances the plugs (11) may not clear the charge pump housing. If this happens, remove the four (4) screws holding the housing to the pump and rotate it out of the way. Be certain to keep proper orientation of charge pump housing to insure correct rotation.

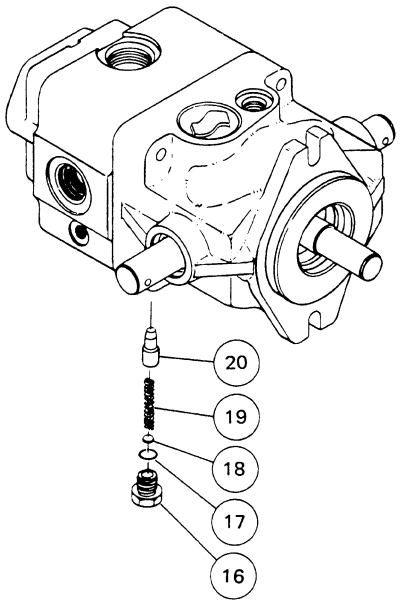
NOTE: Later production pumps have high pressure relief valves which incorporate the charge check function into their operation.



SECTION VII: MINOR REPAIR PROCEDURES

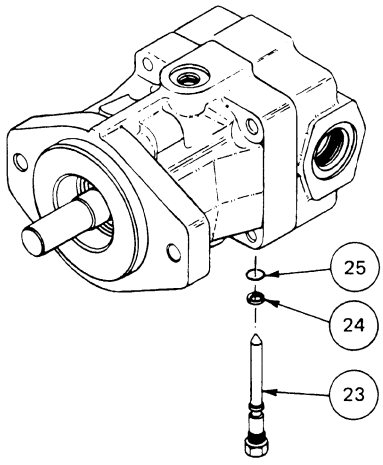
Charge Relief Valve

Remove plug (16) then slide the spring (19) and poppet (20) out of the end cap. Do not alter the shims (17) or interchange parts with another valve. Inspect the poppet and seat in end cap for damage and remove any foreign material in the valve area. Replace parts as required and reinstall into end cap bore.

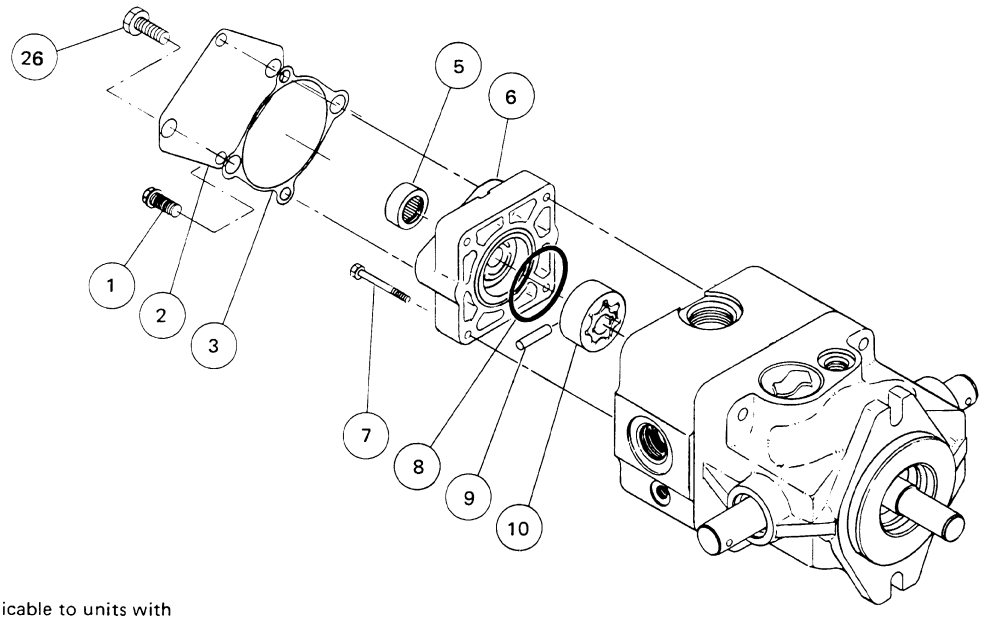


By-Pass Valve

Unscrew the by-pass valve (23) from the motor end cap. Inspect valve and seat in end cap for damage and remove any foreign material in the valve area. Replace parts as required and reinstall into end cap bore.



SECTION VII: MINOR REPAIR PROCEDURES



Applicable to units with
SAE Type A Auxiliary
Pump mounting pad only

Charge Pump

Remove hex. head screws (1 & 26) then cover (2) and gasket (3). Remove four (4) hex. head screws (7) and slide the housing assembly (5, 6 & 8) off the shaft holding the charge pump (gerotor) cartridge (10) in place, then remove the charge pump (10) and drive pin (9) from the shaft. Remove the bearing (5) from the housing only if replacement is necessary.

Examine the wear surfaces of pump cartridge for excessive scratching or heavy wear patterns. Replace both parts of this cartridge if necessary. Do not replace or interchange individual parts within the cartridge. The drive pin (9) should always be replaced. Visually inspect bearing (5) and O-ring (8) and replace as required.

Coat both sides of pump cartridge (10) and housing face with clean hydraulic oil. Install drive pin (9) into hole in shaft, then slide pump cartridge into place. Place O-ring (8) in housing then slide housing assembly (5, 6 & 8) into position over shaft. Orient housing to main pump for proper input shaft rotation and torque screws (7) to 16-21 foot lbs. Check for roper internal assembly by slowly rotating pump shaft while tightening these screws. Replace gasket (3) then install cover (2) and screws (1 & 26).

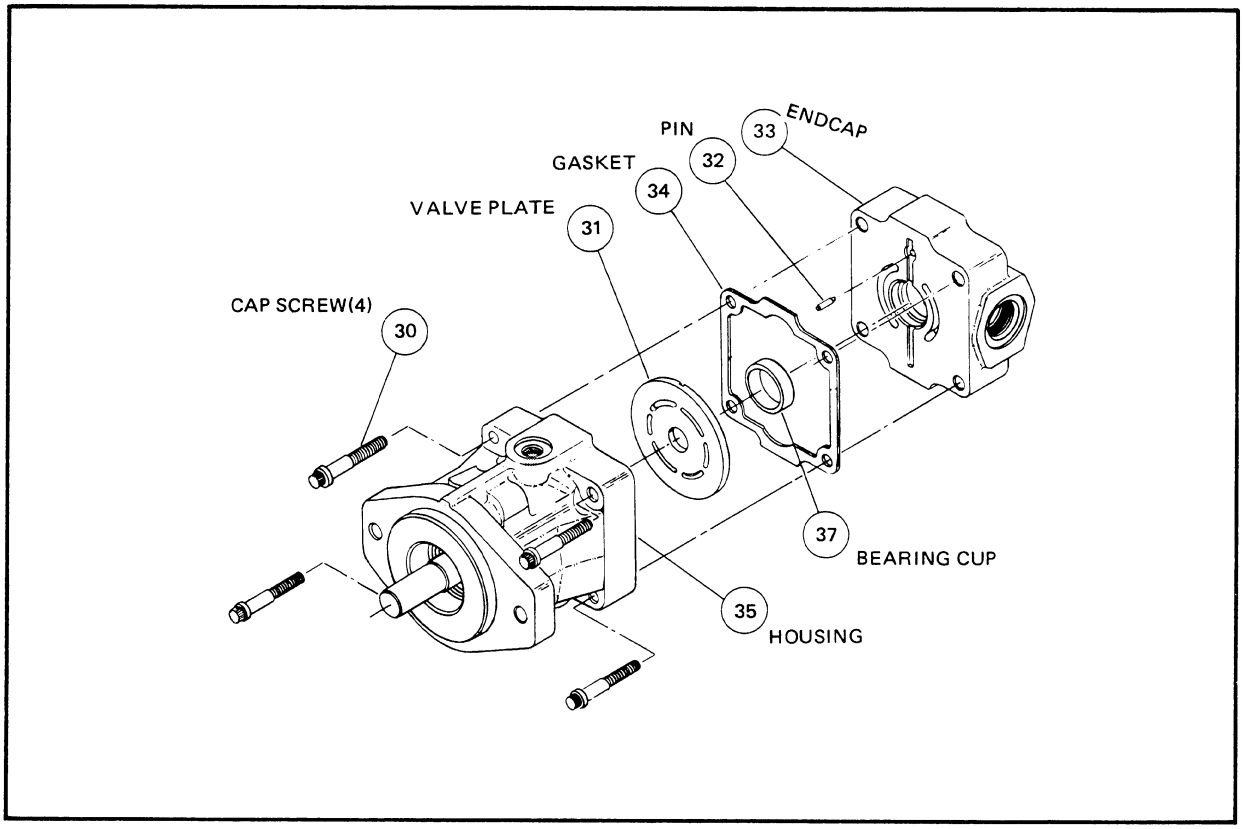
SECTION VIII:

MAJOR REPAIR PROCEDURES

The procedures on the following pages are for complete disassembly and reassembly of the units. The equipment manufacturer should be consulted regarding any effect such repairs may have on warranty.

Cleanliness is the primary means of insuring satisfactory transmission life, either on new or repaired units. Cleaning parts by using a solvent wash and air drying is adequate, providing, clean solvent is used. As with any precision equipment, the internal mechanism and related items must be kept free of chemical and particulate contamination.

SECTION VIII: MAJOR REPAIR PROCEDURES



FIXED DISPLACEMENT MOTOR DISASSEMBLY

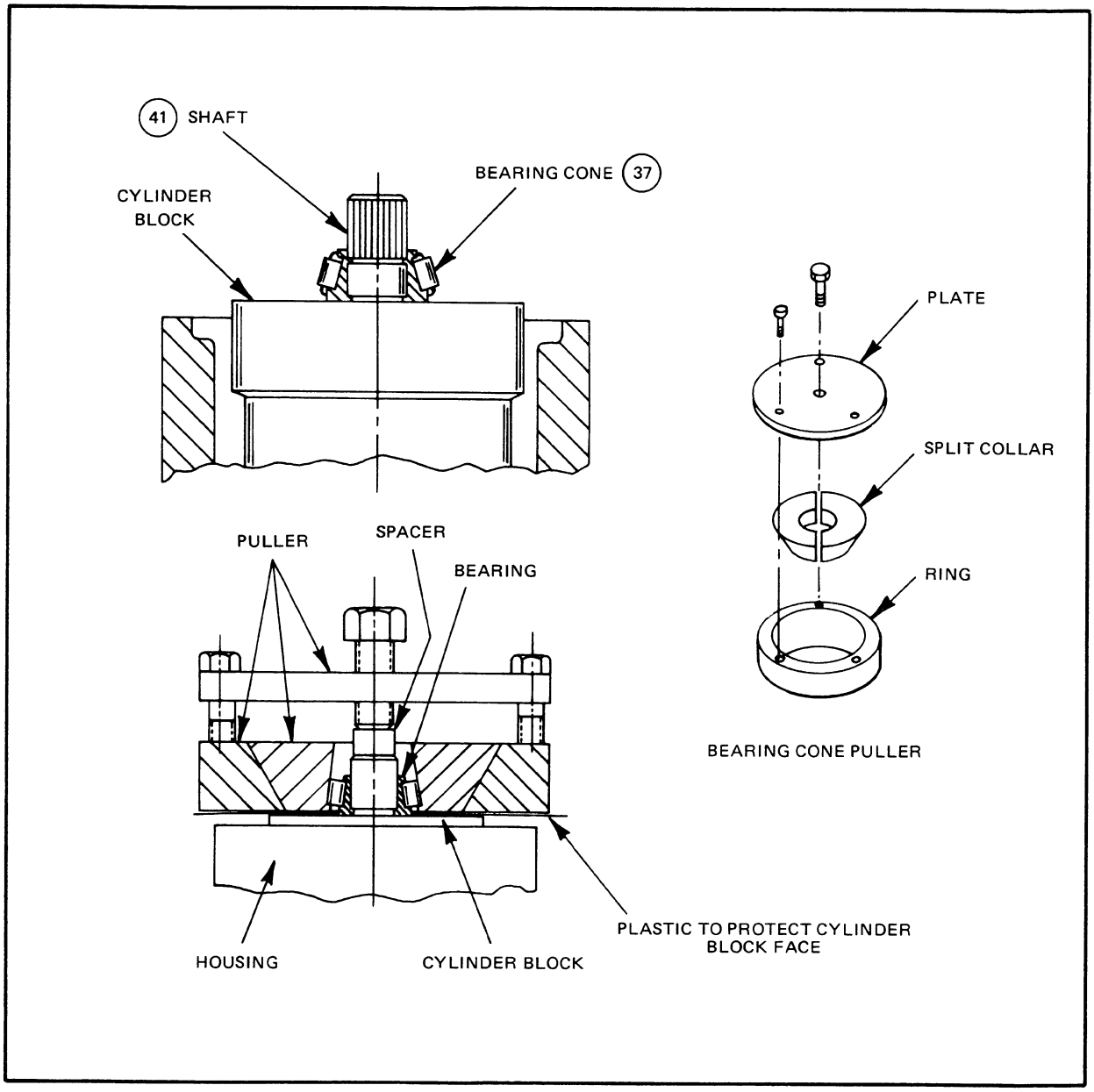
When the four (4) cap screws (30) are loosened, the internal spring loading will cause the end cap (33) to separate slightly. Loosen these screws evenly to prevent distortion of parts. If end cap does not separate from housing as screws are loosened, tap end cap with soft hammer until these parts separate.

CAUTION

All surfaces exposed are critical and caution must be used to avoid damage.

The end cap can now be removed from the motor, however, be certain that the valve plate (31) does not fall and become damaged. If the valve plate tends to lift off with the end cap, hold it in place on the end cap and remove both parts together. If the valve plate remains on the cylinder block, remove it at this time.

The end cap is actually an assembly consisting of a bearing cup which is a slip fit in the end cap and the valve plate locating pin (32). These parts should be removed from the end cap.

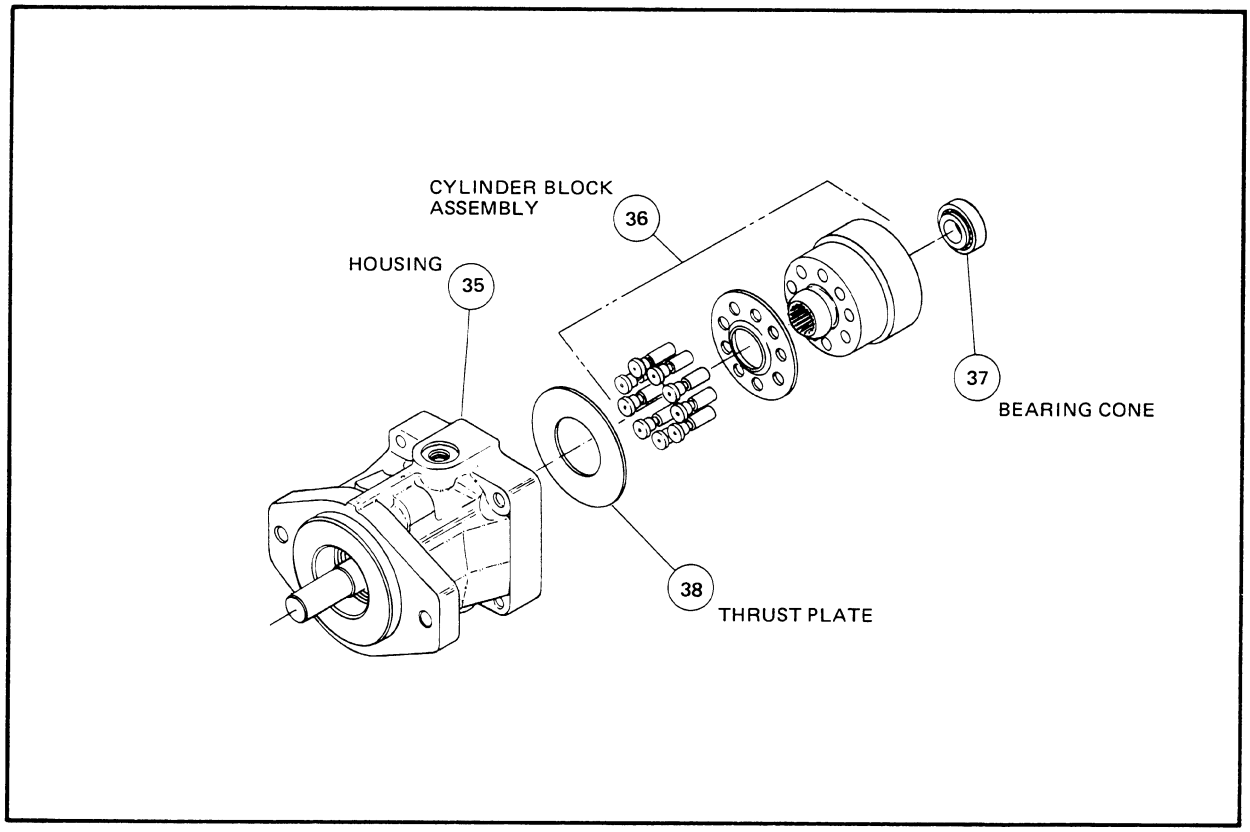


FIXED DISPLACEMENT MOTOR DISASSEMBLY

The bearing cone (37) must now be removed from the shaft (41). A bearing cone puller as illustrated will provide a satisfactory method for removing this bearing.

Protect the cylinder block face during this operation and use a spacer between the center puller screw and shaft to prevent damage to the end of the shaft.

It is recommended that this bearing be replaced as its roller cage is easily damaged during removal.



FIXED DISPLACEMENT MOTOR DISASSEMBLY

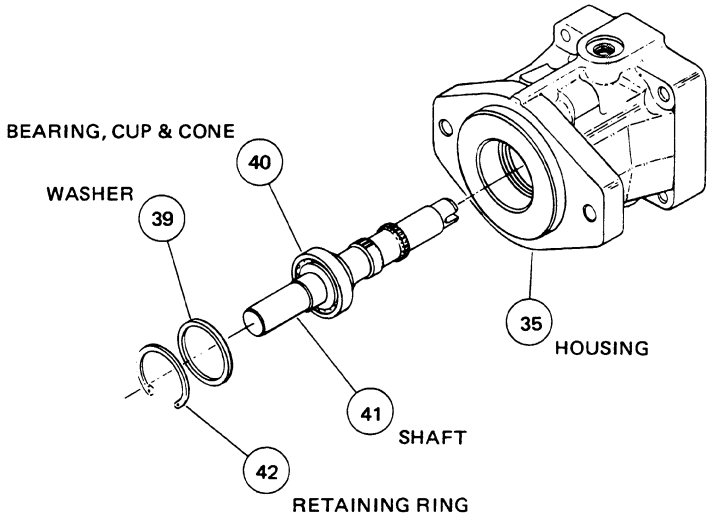
Slide the cylinder block assembly (36) off the shaft while holding the external end of the shaft. The pistons may come out of the cylinder block bores during removal. There is no special orientation of piston to bore that needs to be maintained.

Do not attempt to disassemble the spring and other parts from the center bore of the cylinder block. The entire cylinder block assembly should be replaced if any of its components are damaged.

Visually inspect wear surfaces of valve plate, cylinder block and slippers for damage. Check to be sure pistons are free in bores.

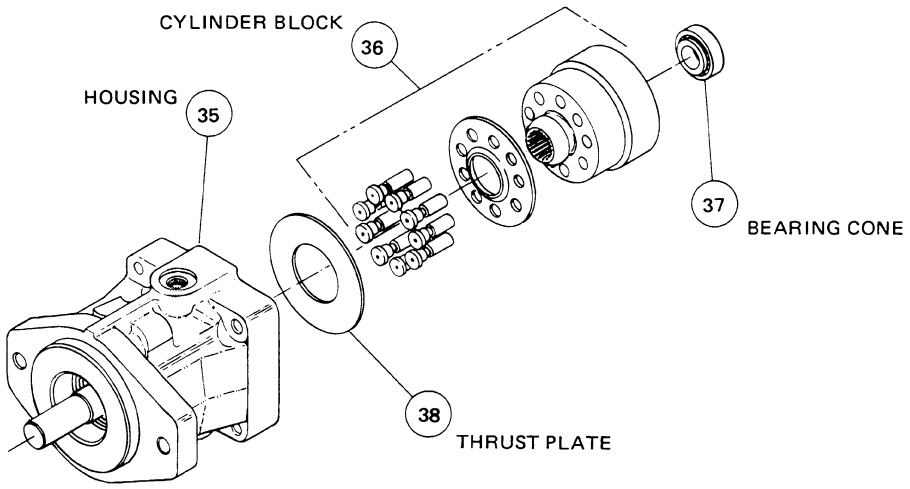
Remove thrust plate (38) from counterbore in housing (35). Visually inspect both sides for damage and flatness.

SECTION VIII: MAJOR REPAIR PROCEDURES



FIXED DISPLACEMENT MOTOR DISASSEMBLY

Remove retaining ring (42) and washer (39). Shaft (40) and bearing cup and cone (40) can be pressed out of housing (35). Press bearing cone off shaft if replacement is necessary.



FIXED DISPLACEMENT MOTOR ASSEMBLY

Prior to reassembly all parts, used and new, should be cleaned. Cleaning with solvent and air drying is adequate, providing that clean solvent is used.

A supply of clean hydraulic oil is needed to lubricate parts during reassembly, especially the cylinder block assembly, thrust plate and valve plate.

It is recommended that all gaskets, O-rings and seals be replaced in addition to the rear shaft bearing.

Press bearing cone (40) onto shaft (41) then install into housing (35).

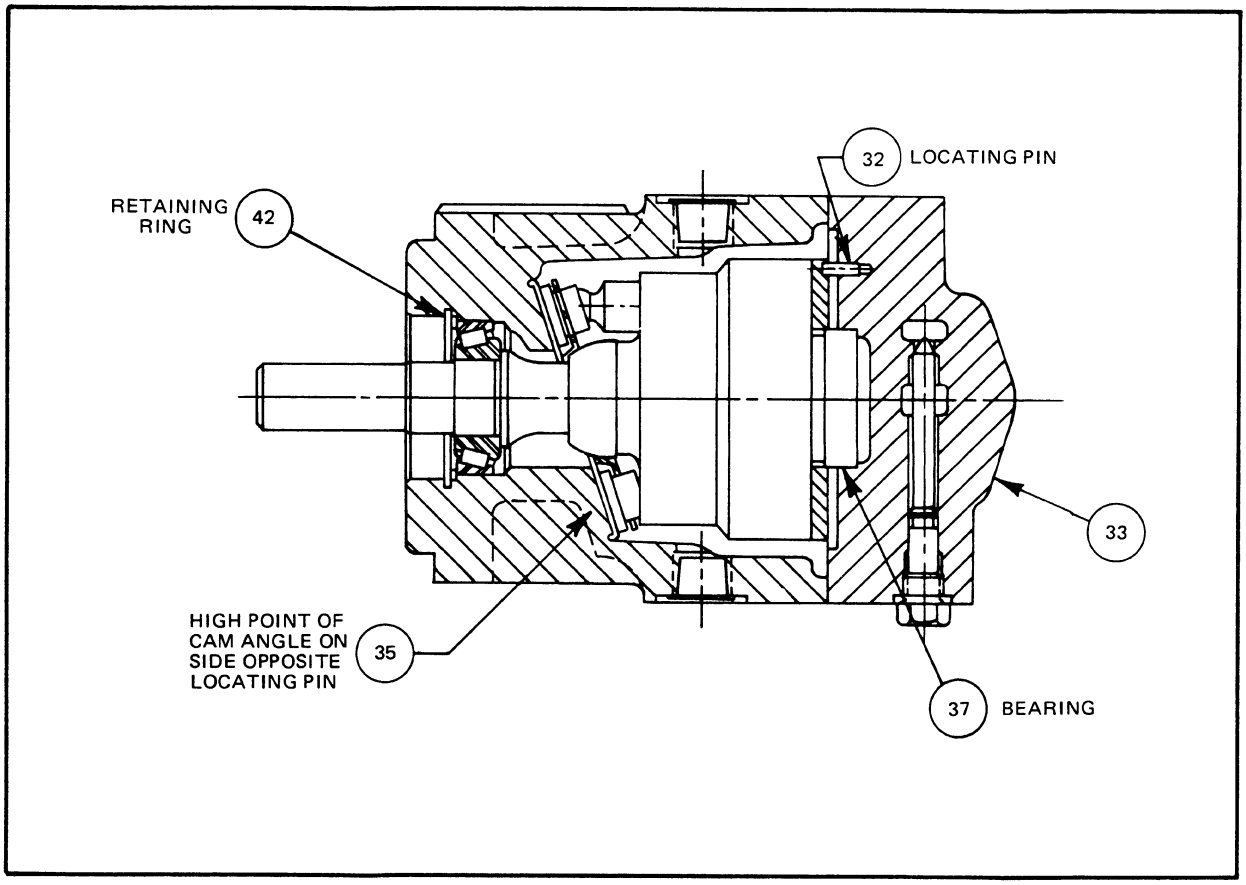
If the bearing cup (40) was removed or replaced, press it into housing (35) then insert washer (39) and retaining ring (42).

Lubricate thrust plate (38) with clean hydraulic oil and insert in counterbore of housing (35).

Assemble cylinder block parts if necessary and lubricate with clean hydraulic oil. There is no special orientation of piston to bore that needs to be maintained.

Slide cylinder block assembly (36) over shaft and engage spline. Be certain that pistons and thrust plate remain in place. When properly installed a slight spring tension can be felt when pushing on cylinder block.

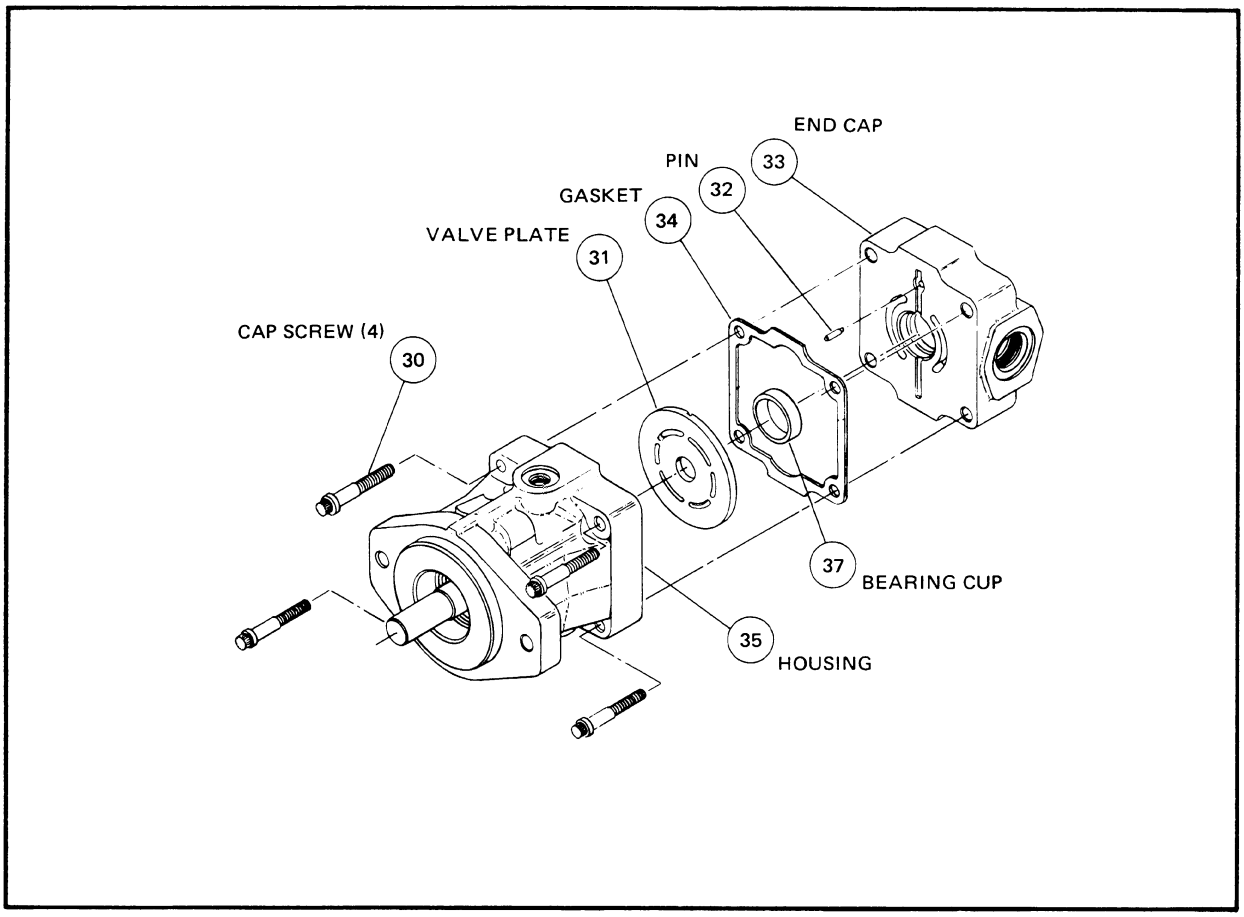
Lubricate exposed surface of cylinder block with clean hydraulic oil.



FIXED DISPLACEMENT MOTOR ASSEMBLY

Install the cone of the tapered bearing (37) onto shaft at this time. This bearing should be installed with an arbor type press for the most satisfactory results. The external end of the shaft must be supported while pressing on bearing to prevent retaining ring (42) from being damaged. Use caution to insure the bearing does not contact the cylinder block.

Properly orient the housing (35) and the end cap (33). The high point of the cam angle machined in housing should be on the side opposite the locating pin (32).



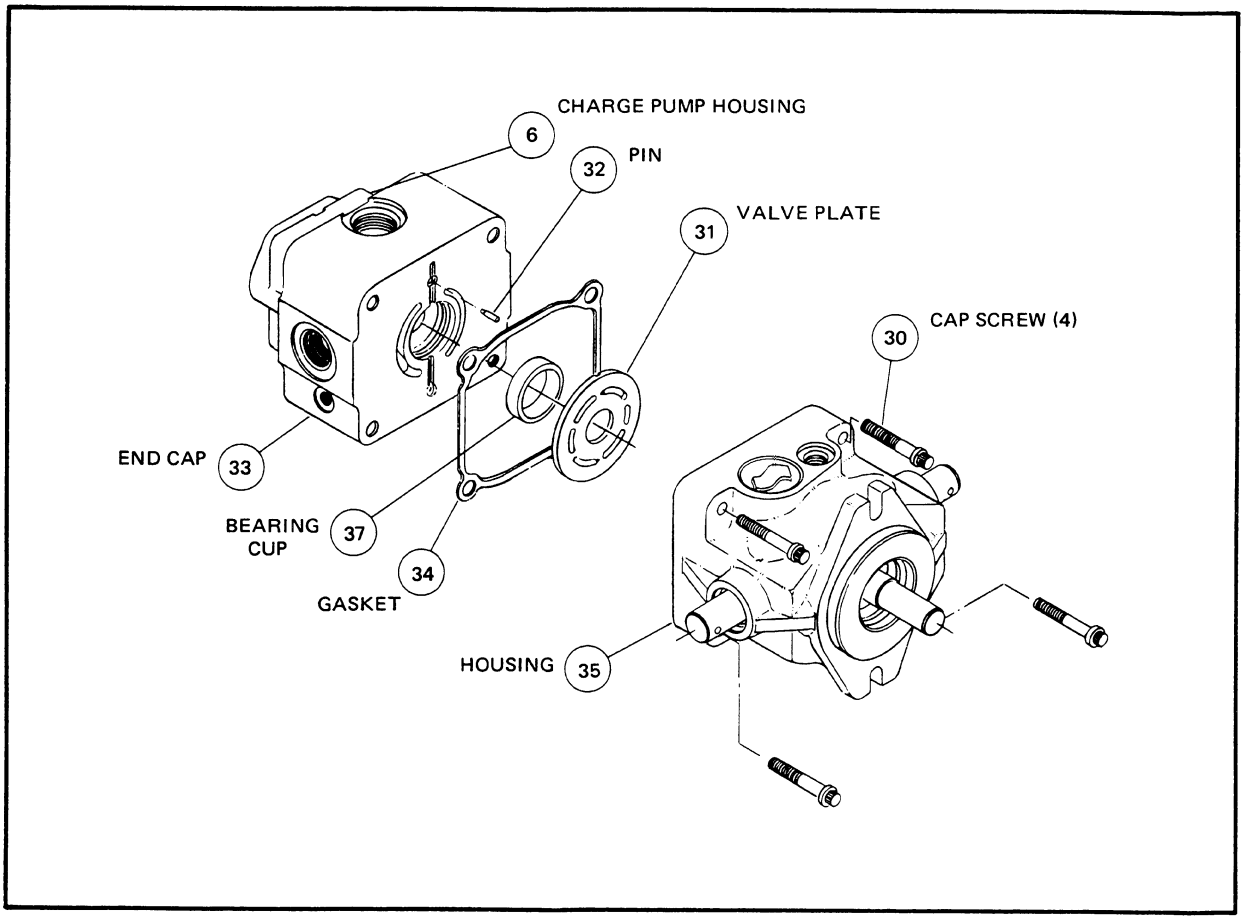
FIXED DISPLACEMENT MOTOR ASSEMBLY

Insert locating pin (32) and bearing cup (37) into end cap (33). Lubricate the slotted side of the valve plate (31) and slip it over the locating pin and protruding bearing cup. The motor and pump valve plates are interchangeable in the 18 Series units.

Place the gasket (34) on housing, then install the end cap and valve plate. Hold the valve plate so it does not drop off during assembly.

Install four (4) cap screws (30), and tighten alternately until the end cap and housing are pulled completely together. Torque screws to 45-57 foot lbs.

SECTION VIII: MAJOR REPAIR PROCEDURES



VARIABLE DISPLACEMENT PUMP DISASSEMBLY

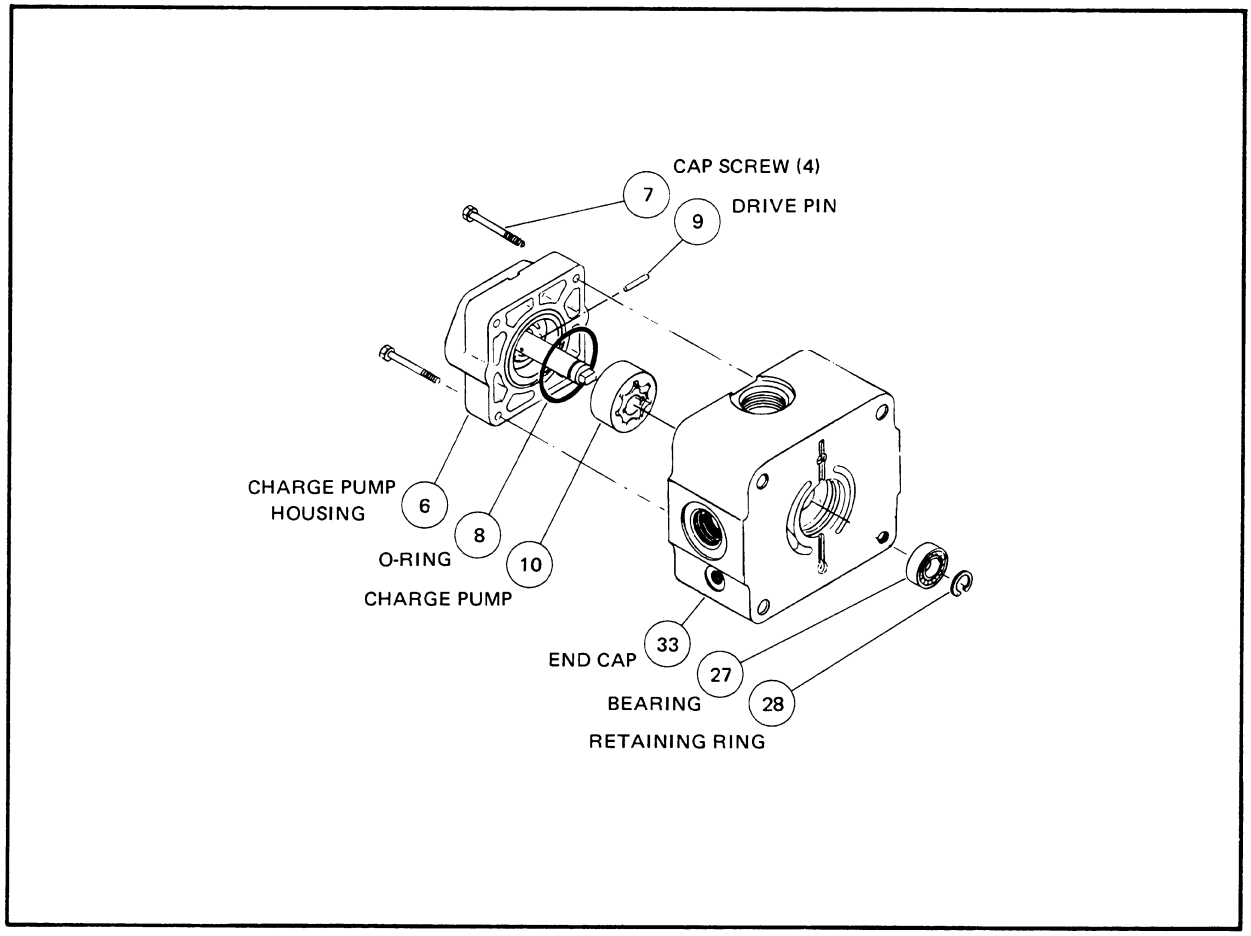
When the four (4) cap screws (30) are loosened, the internal spring loading will cause the end cap (33) to separate slightly. Loosen these screws evenly to prevent distortion of parts. If end cap does not separate from housing as screws are loosened, tap end cap with soft hammer until these parts separate.

CAUTION
All surfaces exposed are critical and caution must be used to avoid damage.

The end cap can now be removed from the pump, however, be certain that the valve plate (31) does not fall and become damaged. If the valve plate tends to lift off with the end cap, hold it in place and remove both parts together. If the valve plate remains on the cylinder block, remove it at this time.

The end cap is actually an assembly consisting of a bearing cup (37) which is a slip fit in the end cap and the valve plate locating pin (32). These parts should be removed from the end cap.

SECTION VIII: MAJOR REPAIR PROCEDURES



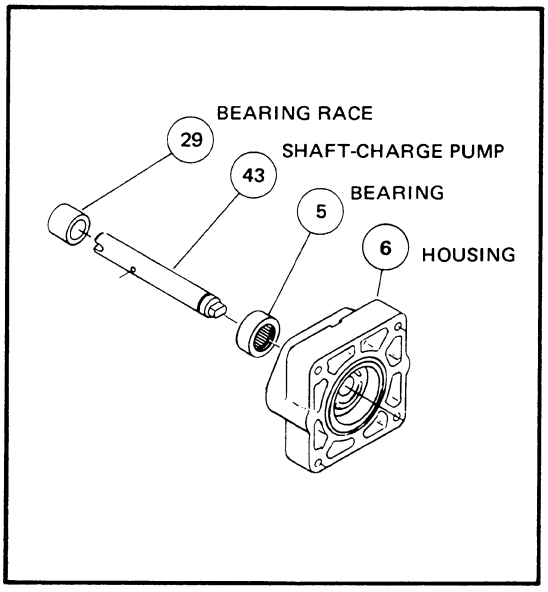
VARIABLE DISPLACEMENT PUMP DISASSEMBLY

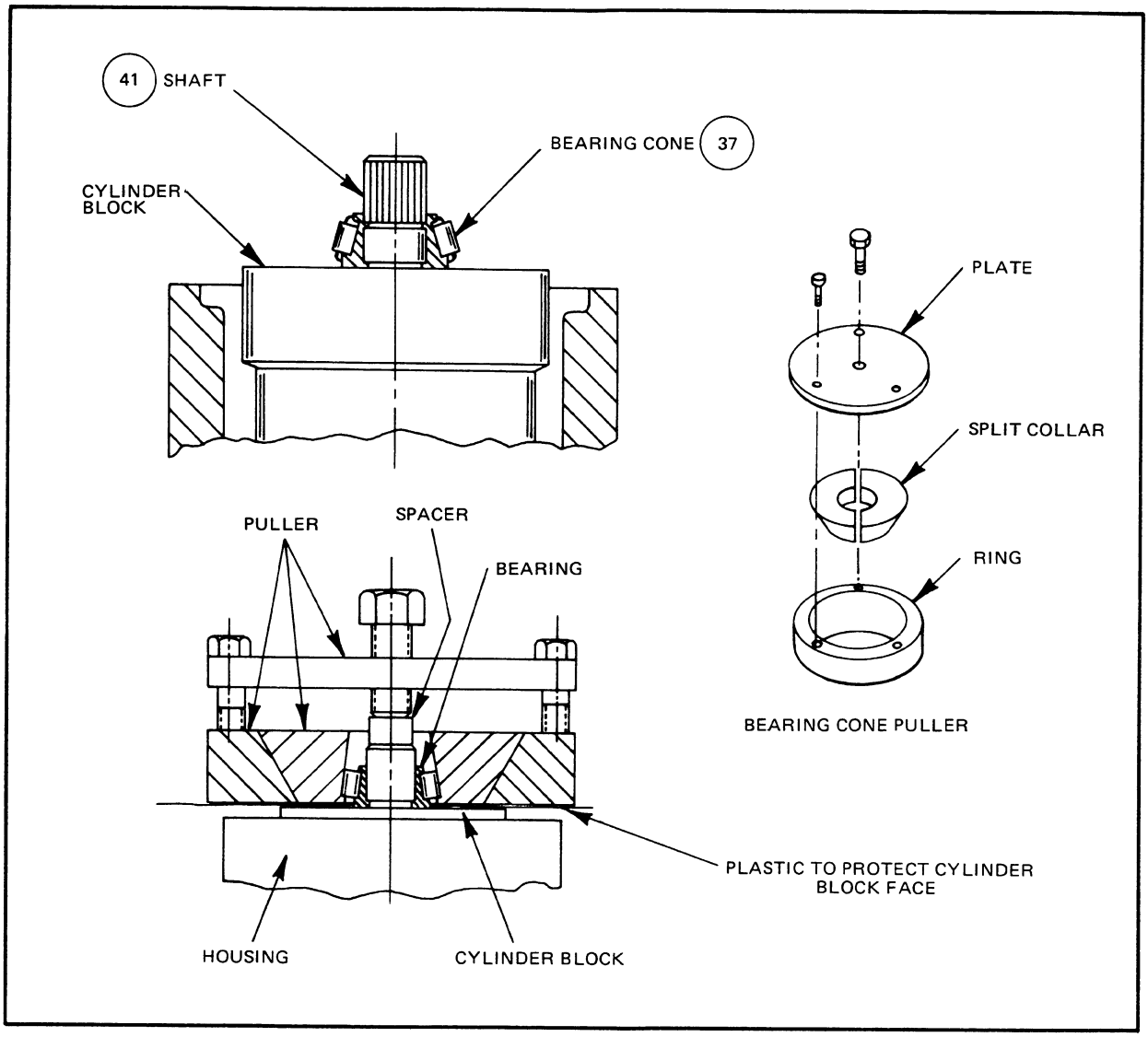
(PUMPS WITH SAE TYPE AA AUXILIARY MOUNTING PAD)

After removing the retaining ring (28) the charge pump can be removed from the end cap (33). Remove four (4) cap screws (7) and slide the housing assembly (5, 6, 8, 29 & 43) out of the end cap holding the charge pump (gerotor) cartridge (10) in place.

Remove the charge pump and drive pin (9) from the shaft (43). Remove the shaft and bearing race (29). If bearing (5) is replaced, also press off bearing race (29) and replace.

Examine the wear surfaces of pump cartridge for excessive scratching or heavy wear patterns. Replace both parts of this cartridge if necessary. Do not replace or interchange individual parts within the cartridge. The drive pin (9) should always be replaced.



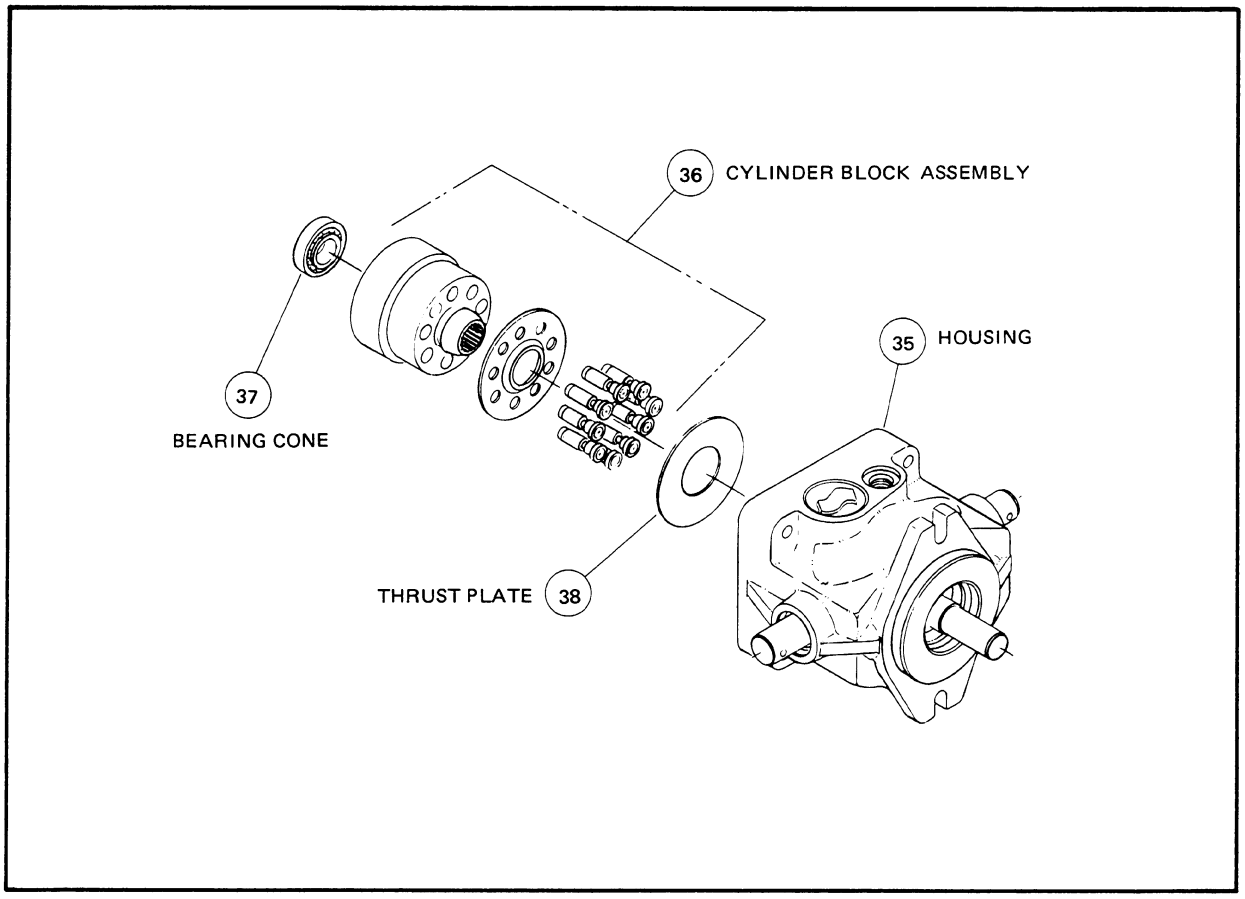


VARIABLE DISPLACEMENT PUMP DISASSEMBLY

The bearing cone (37) must now be removed from the shaft (41). A bearing cone puller as illustrated will provide a satisfactory method for removing this bearing.

Protect the cylinder block face during this operation and use a spacer between the center puller screw and shaft to prevent damage to the end of the shaft.

It is recommended that this bearing be replaced as its roller cage is easily damaged during removal.



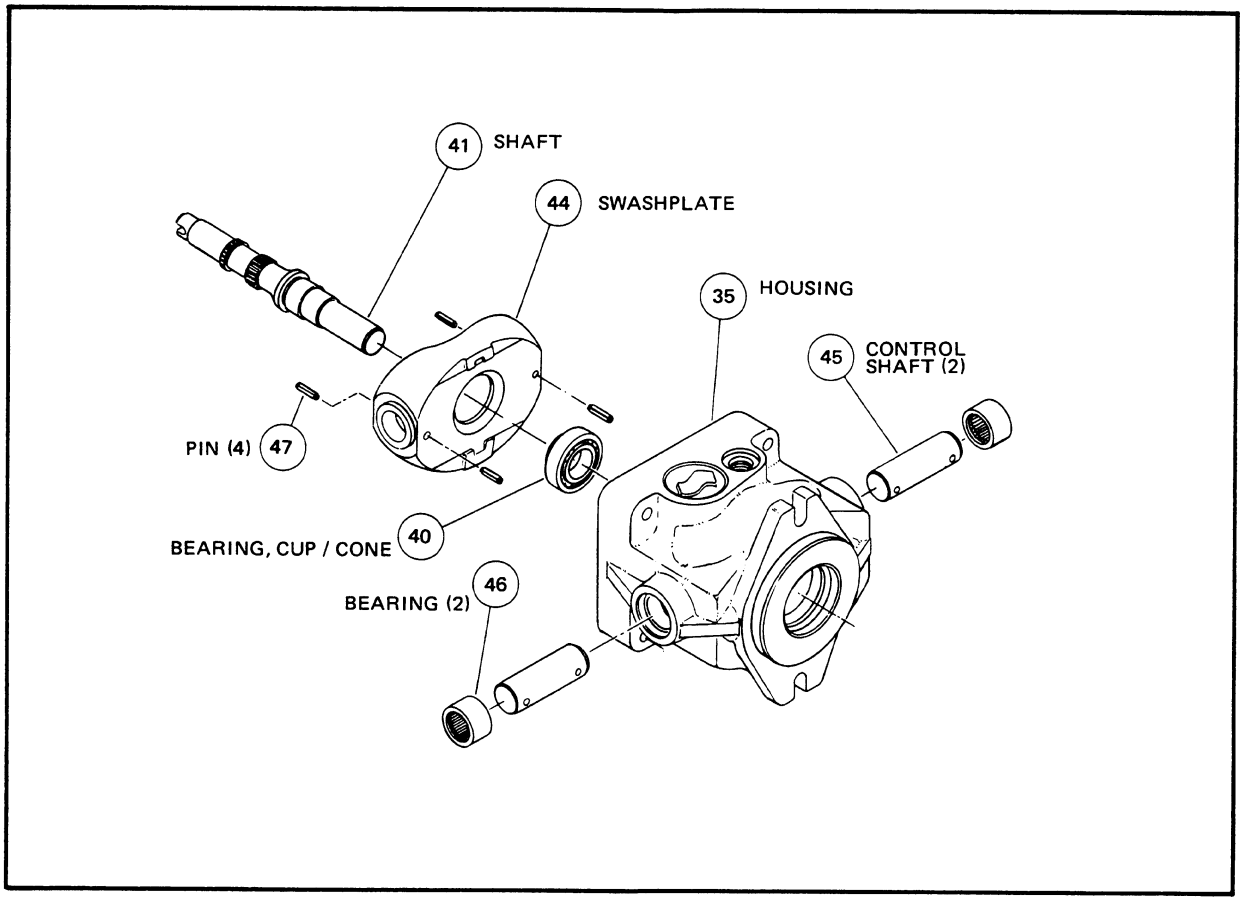
VARIABLE DISPLACEMENT PUMP DISASSEMBLY

Slide the cylinder block assembly (36) off the shaft while holding the external end of the shaft. The pistons may come out of the cylinder block bores during removal. There is no special orientation of piston to bore that needs to be maintained.

Do not attempt to disassemble the spring and other parts from the center bore of the cylinder block. The entire cylinder block assembly should be replaced if any of its components are damaged.

Visually inspect wear surfaces of valve plate, cylinder block and slippers for damage. Check to be sure pistons are free in bores.

Remove thrust plate (38) from counterbore in swashplate (44). Visually inspect both sides for damage and flatness.



VARIABLE DISPLACEMENT PUMP DISASSEMBLY

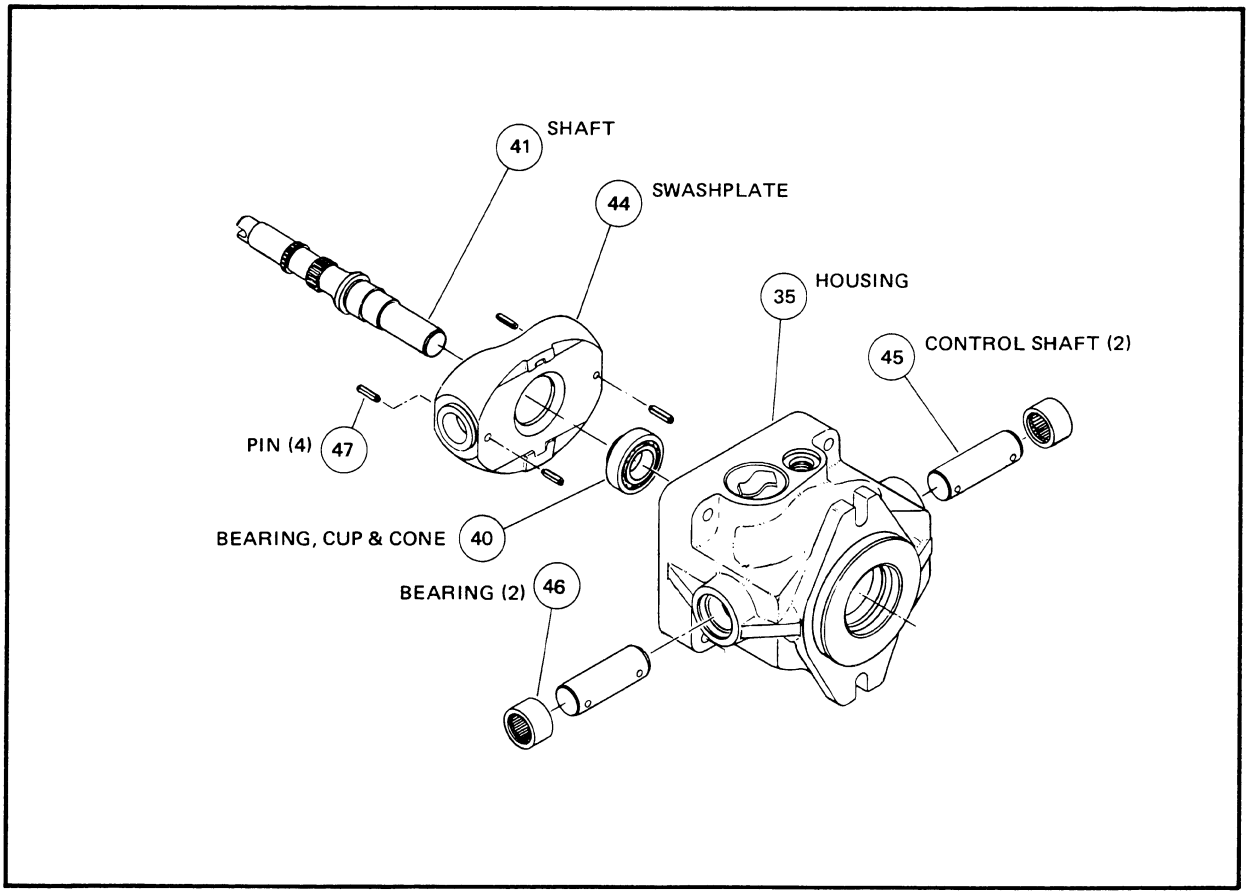
Using a 5/16 diameter drift punch, drive spring pins (47) out of control shafts (45). The pump housing is provided with a cast recess so that the pins can be driven free of the trunnion shafts.

Drive control shafts out of swashplate (44) toward outside of housing (35). Once clear of swashplate bore, the trunnion shafts can be removed easily. The swashplate can now be removed from the housing.

The shaft (41) and bearing (40) can now be removed from the housing. If bearing replacement is required, replace both the cup and cone of the bearing.

Remove needle bearings (46), if replacement is required, by pressing out of bore toward outside of housing.

SECTION VIII: MAJOR REPAIR PROCEDURES



VARIABLE DISPLACEMENT PUMP ASSEMBLY

Prior to reassembly all parts, used and new, should be cleaned. Cleaning with solvent and air drying is adequate, providing that clean solvent is used.

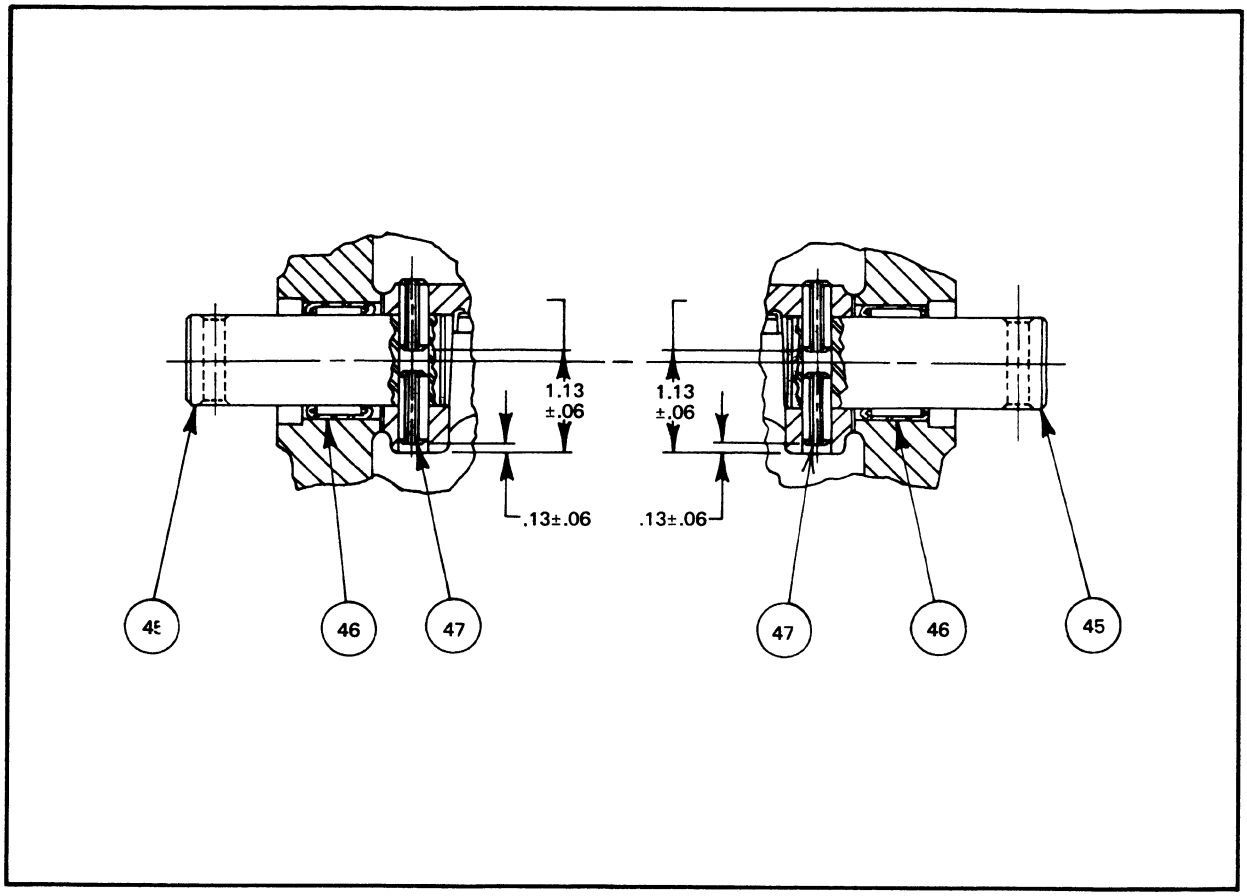
A supply of clean hydraulic oil is needed to lubricate parts during reassembly, especially the cylinder block assembly, thrust plate and valve plate.

It is recommended that all gaskets, O-rings and seals be replaced in addition to the charge pump drive pin, rear shaft bearing and swashplate pins.

Press the bearing cup into housing (35) then insert the shaft and bearing cone assembly (41 & 40).

Press needle bearings (46) into each side of housing until flush to 1/64 inch below counterbore for lip seals.

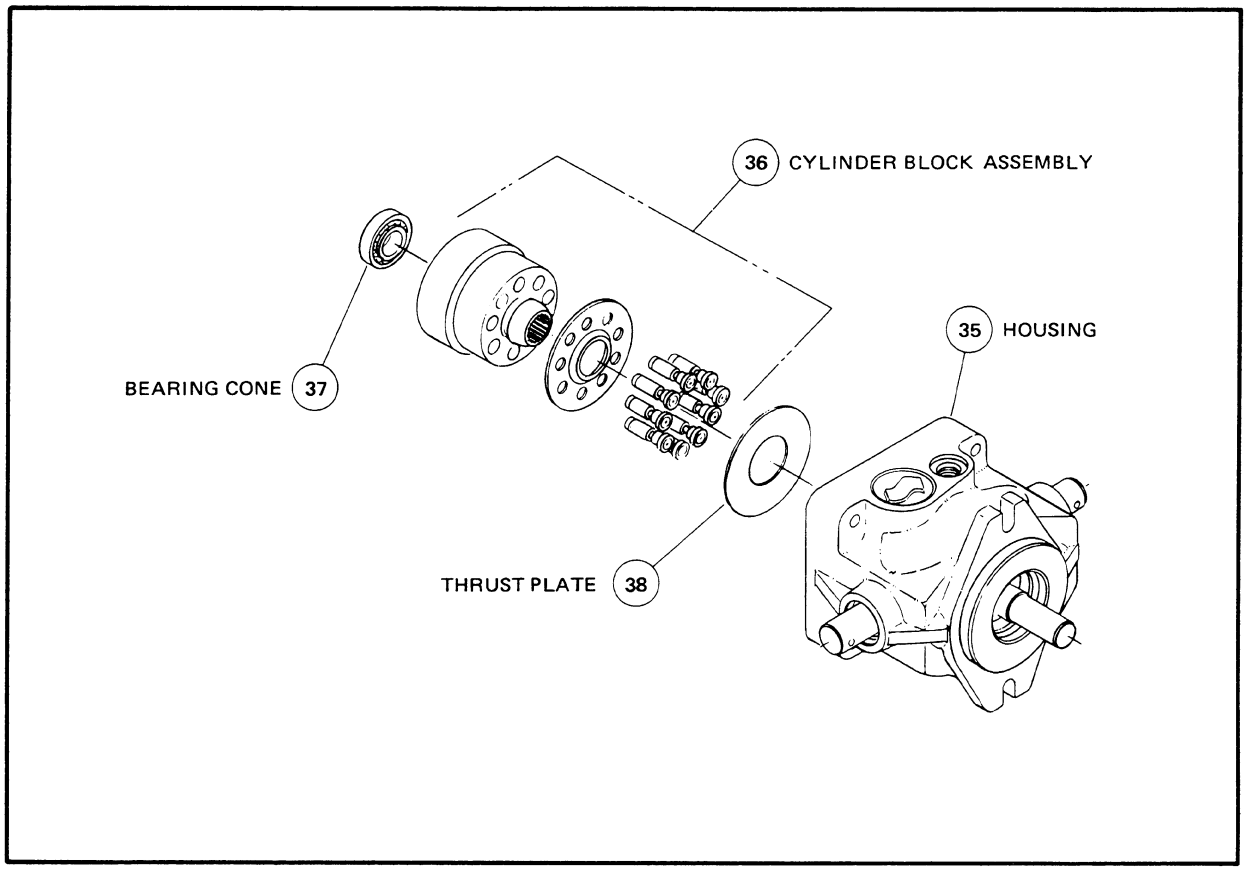
Place swashplate (44) into housing with counterbore for thrust plate up. Install control shafts (45) and align holes for spring pins in swashplate and shafts using 5/16 drift punch.



VARIABLE DISPLACEMENT PUMP ASSEMBLY

Install new spring pins (45) through swashplate (44) and shafts (45). Use two (2) pins on each side. Install the first pin on each side until it is 1 1/8 inches below swashplate. Install second pin until it is 1/8 below swashplate.

The swashplate should swing freely in the housing to 18°each side of center.



VARIABLE DISPLACEMENT PUMP ASSEMBLY

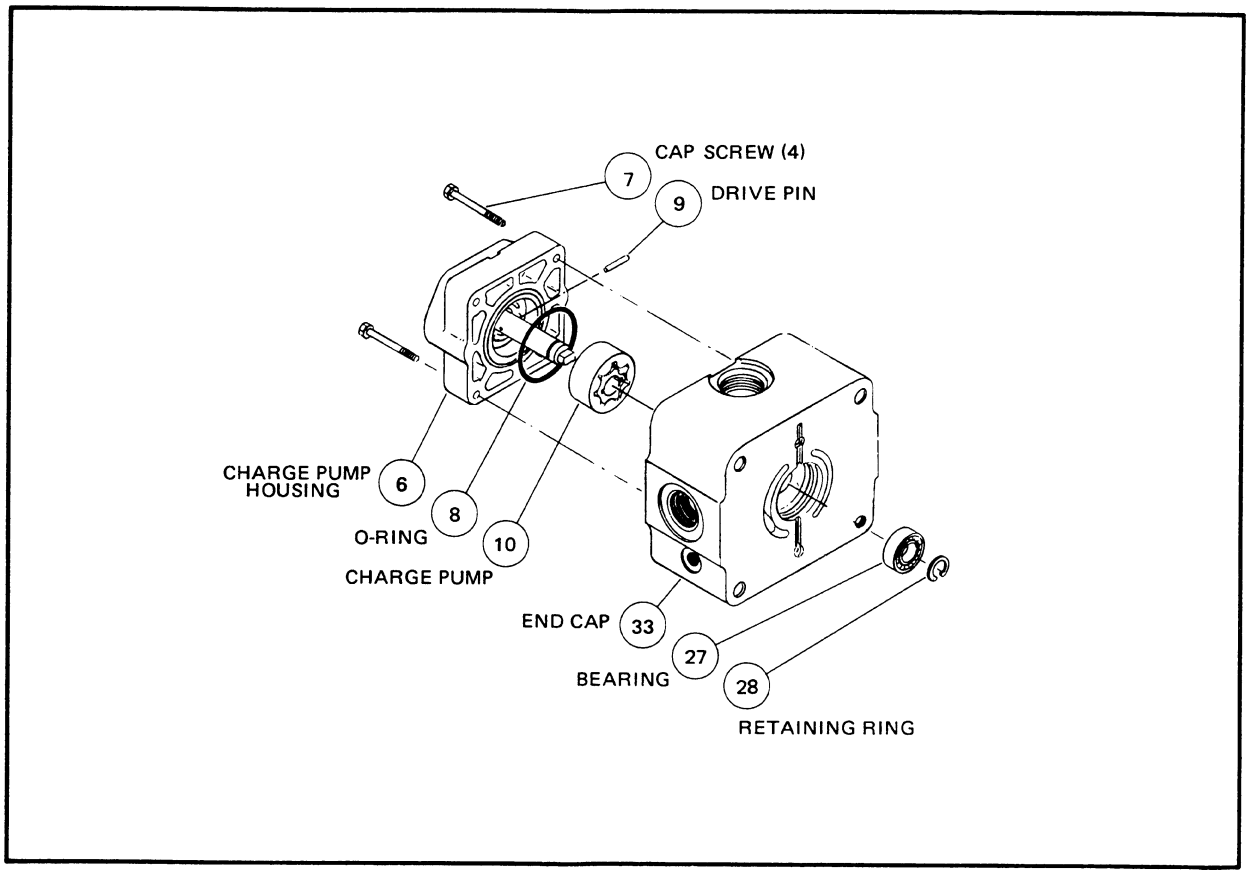
Lubricate thrust plate (38) with clean hydraulic oil and insert in counterbore of swashplate (44).

Assemble cylinder block parts if necessary and lubricate with clean hydraulic oil. There is no special orientation of piston to bore that needs to be maintained.

Slide cylinder block assembly (36) over shaft and engage spline. Be certain that pistons and thrust plate remain in place. When properly installed a slight spring tension can be felt when pushing on cylinder block.

Lubricate exposed surface of cylinder block with clean hydraulic oil.

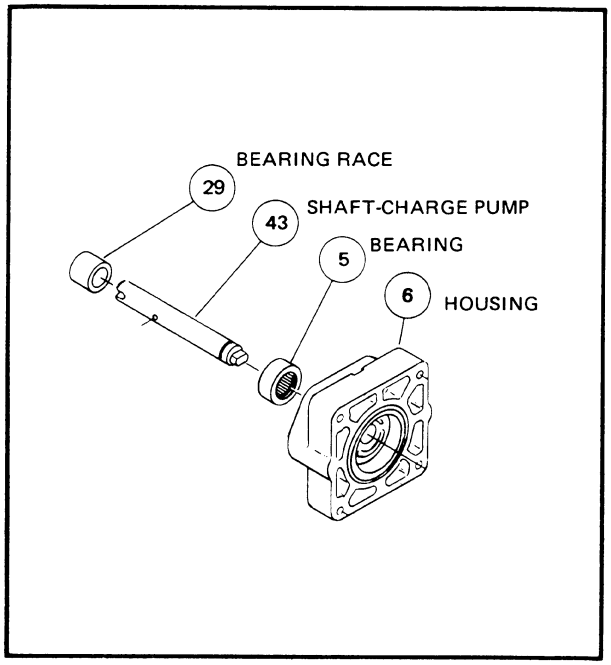
Install the cone of the tapered bearing (37) onto shaft at this time. This bearing should be installed with an arbor type press for the most satisfactory results. Support the shaft and use caution during this operation to insure the bearing does not contact the cylinder block.

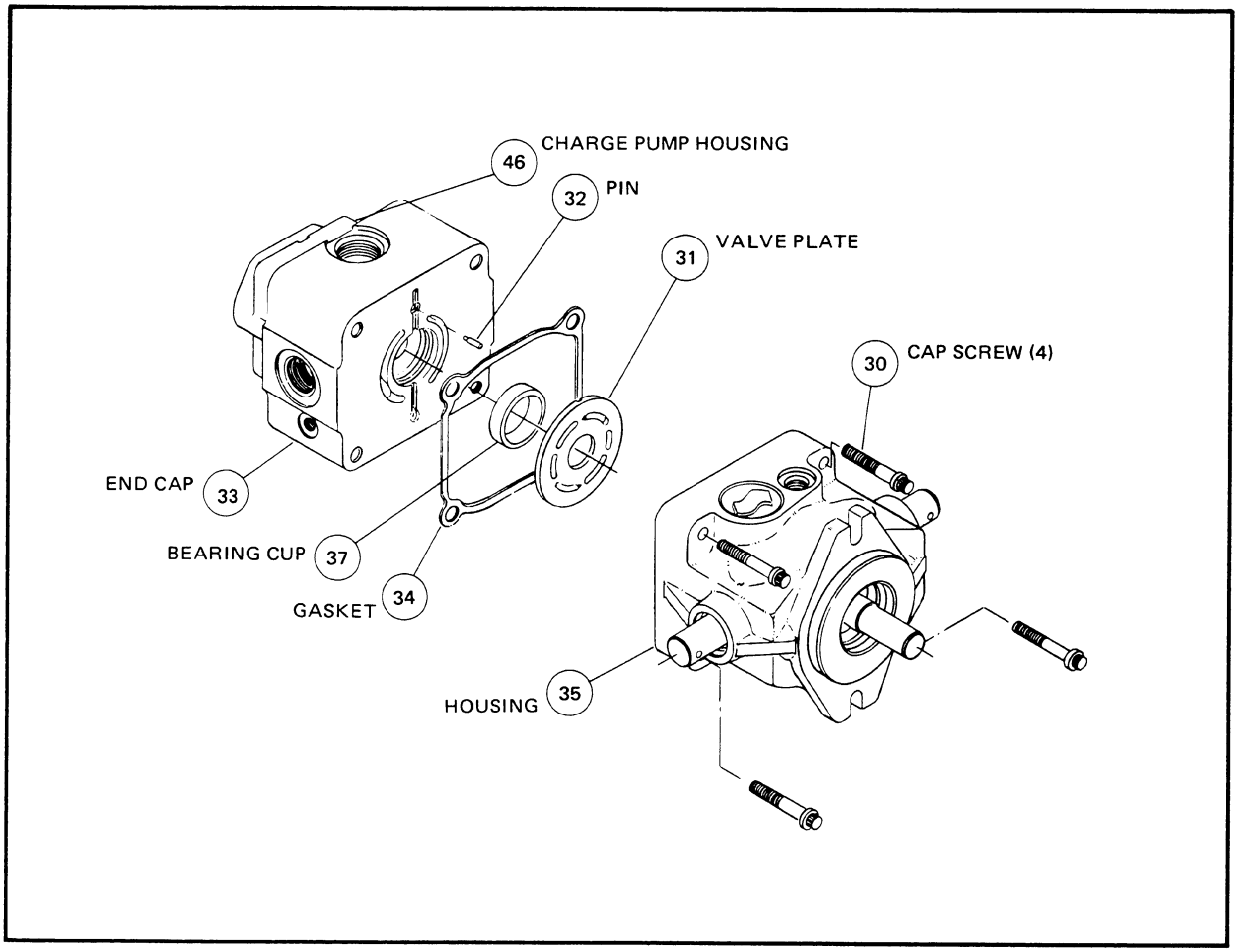


VARIABLE DISPLACEMENT PUMP DISASSEMBLY

(PUMPS WITH SAE TYPE AA AUXILIARY MOUNTING PAD)

Insert shaft and coupling assembly (43 & 29) into housing and bearing (5 & 6). Coat both sides of pump cartridge (10) and housing faces with clean hydraulic oil. Install drive pin (9) into hole in shaft, then slide pump cartridge into place. Place O-ring (8) in housing then slide into position on end cap. Orient housing (6) to end cap (33) for proper input shaft rotation then install screws (7) and torque to 16-21 foot lbs. The charge pump must rotate smoothly after torquing cap screws.



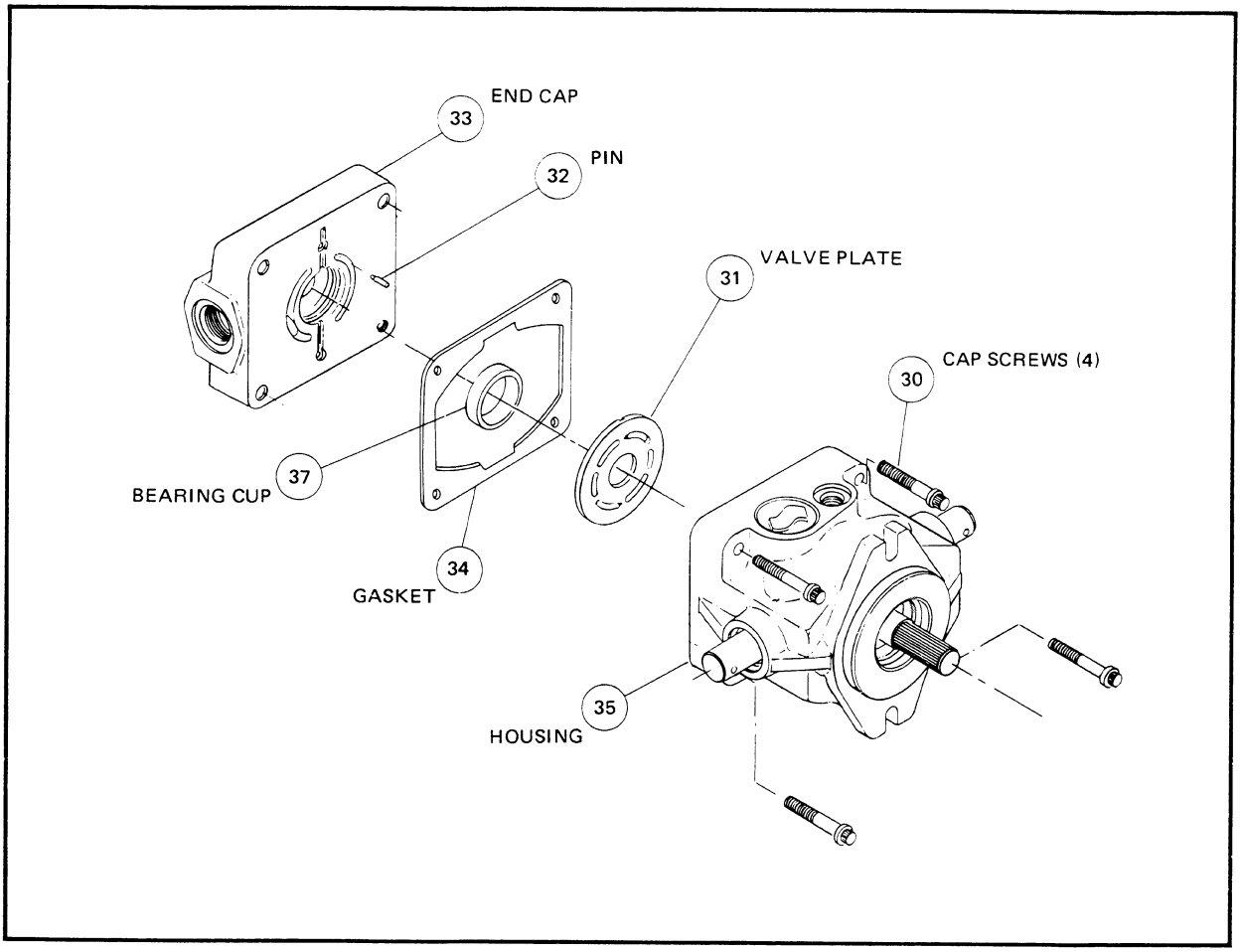


VARIABLE DISPLACEMENT PUMP ASSEMBLY

Insert locating pin (32) and bearing cup (37) into end cap (33). Lubricate the slotted side of the valve plate (31) and slip it over the locating pin and protruding bearing race. The motor and pump valve plates are interchangeable in the 18 Series units.

Place the gasket (34) on housing, then install the end cap and valve plate. Hold the valve plate so it does not drop off during assembly.

Install four (4) cap screws (30), and tighten alternately until the end cap and housing are pulled completely together. Torque screws to 45-57 foot lbs. Check for proper internal assembly by rotating pump shaft while tightening these screws.



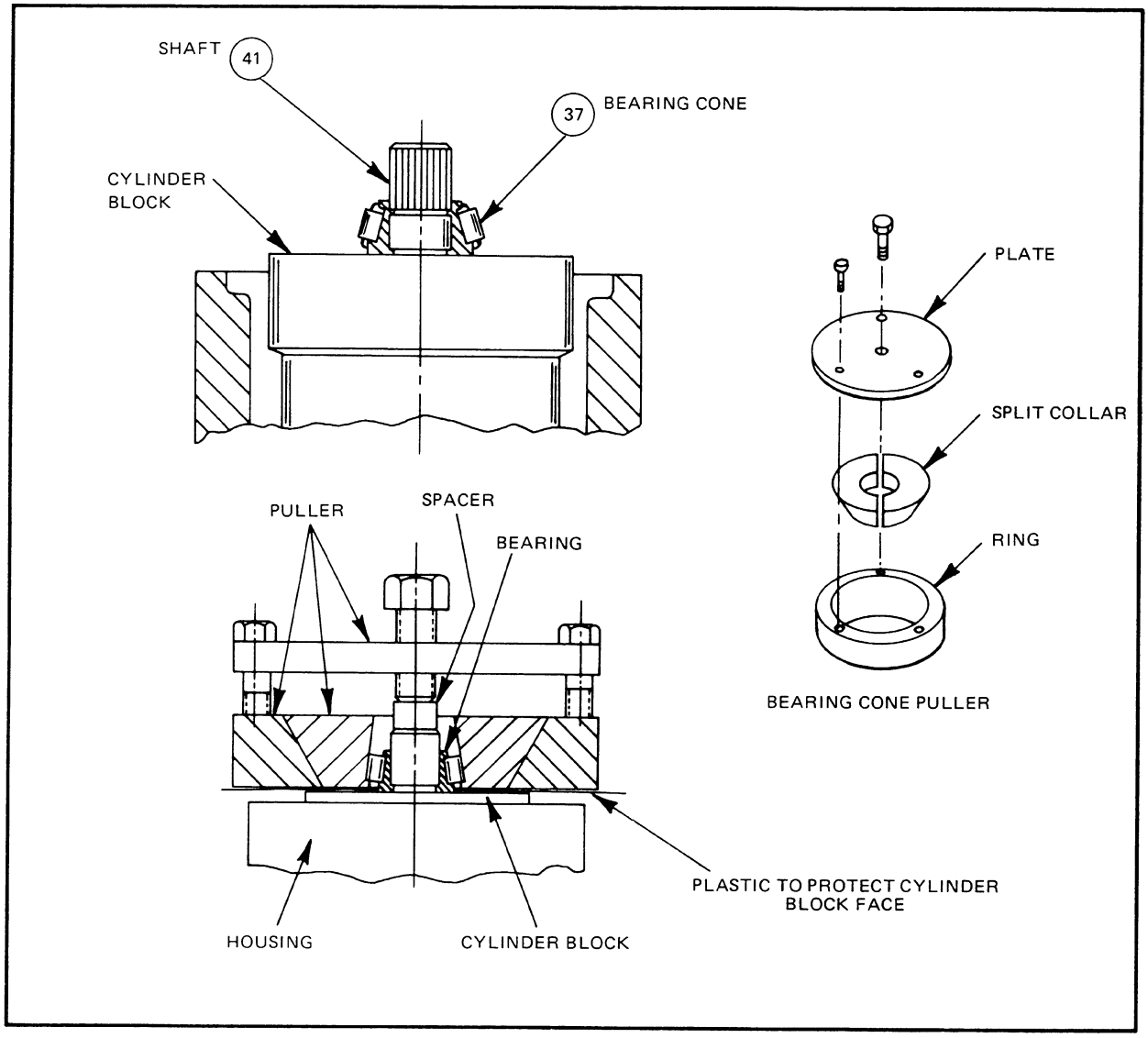
VARIABLE DISPLACEMENT MOTOR DISASSEMBLY

When the four (4) cap screws (30) are loosened, the internal spring loading will cause the end cap (33) to separate slightly. Loosen these screws evenly to prevent distortion of parts. If end cap does not separate from housing as screws are loosened, tap end cap with soft hammer until these parts separate.

> CAUTION
> All surfaces exposed are critical and caution must be used to avoid damage.

The end cap can now be removed from the motor, however, be certain that the valve plate (31) does not fall and become damaged. If the valve plate tends to lift off with the end cap, hold it in place on the end cap and remove both parts together. If the valve plate remains on the cylinder block, remove it at this time.

The end cap is actually an assembly consisting of a bearing cup which is a slip fit in the end cap and the valve plate locating pin (32). These parts should be removed from the end cap.

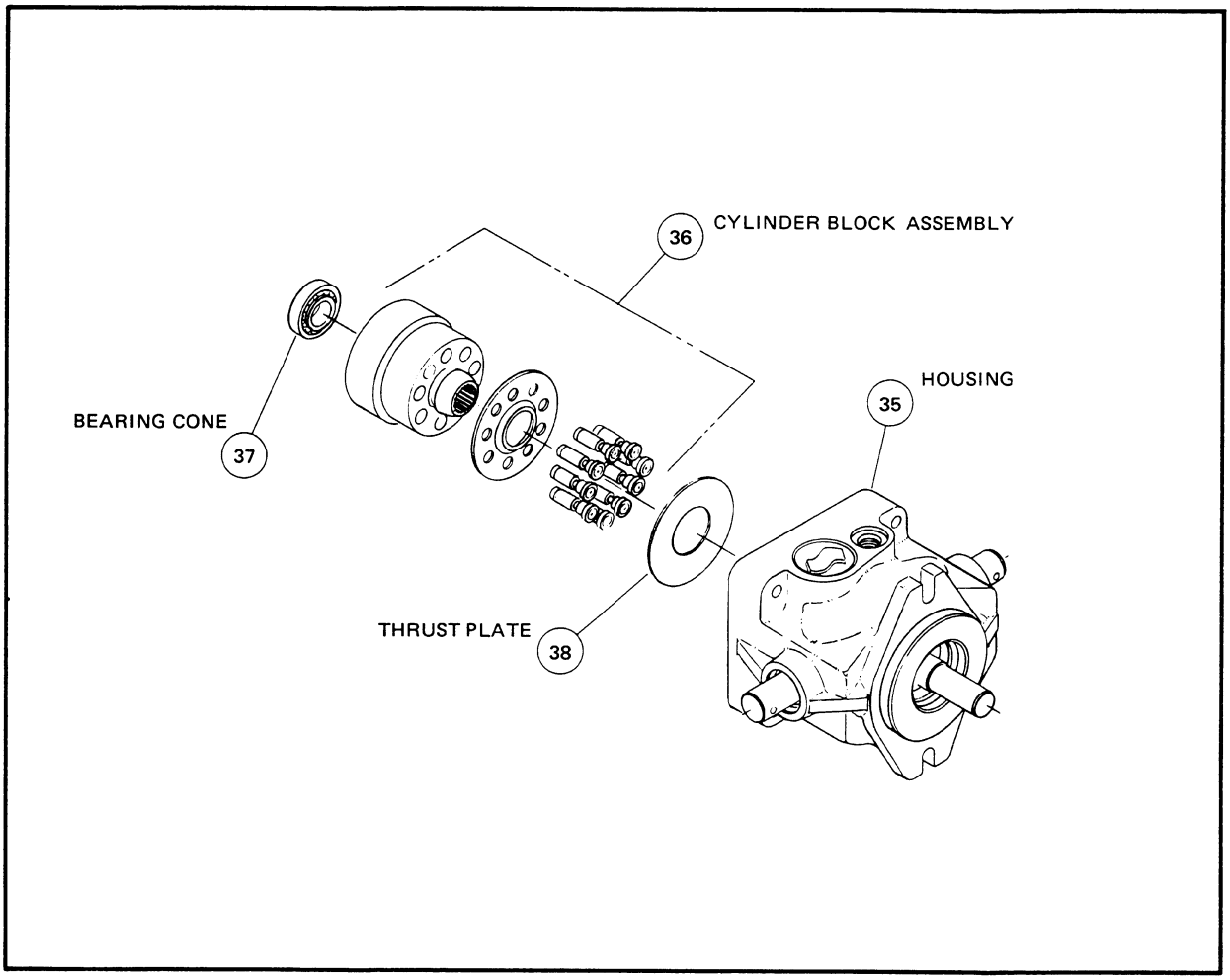


VARIABLE DISPLACEMENT MOTOR DISASSEMBLY

The bearing cone (37) must now be removed from the shaft (41). A bearing cone puller as illustrated will provide a satisfactory method for removing this bearing.

Protect the cylinder block face during this operation and use a spacer between the center puller screw and shaft to prevent damage to the end of the shaft.

It is recommended that this bearing be replaced as its roller cage is easily damaged during removal.



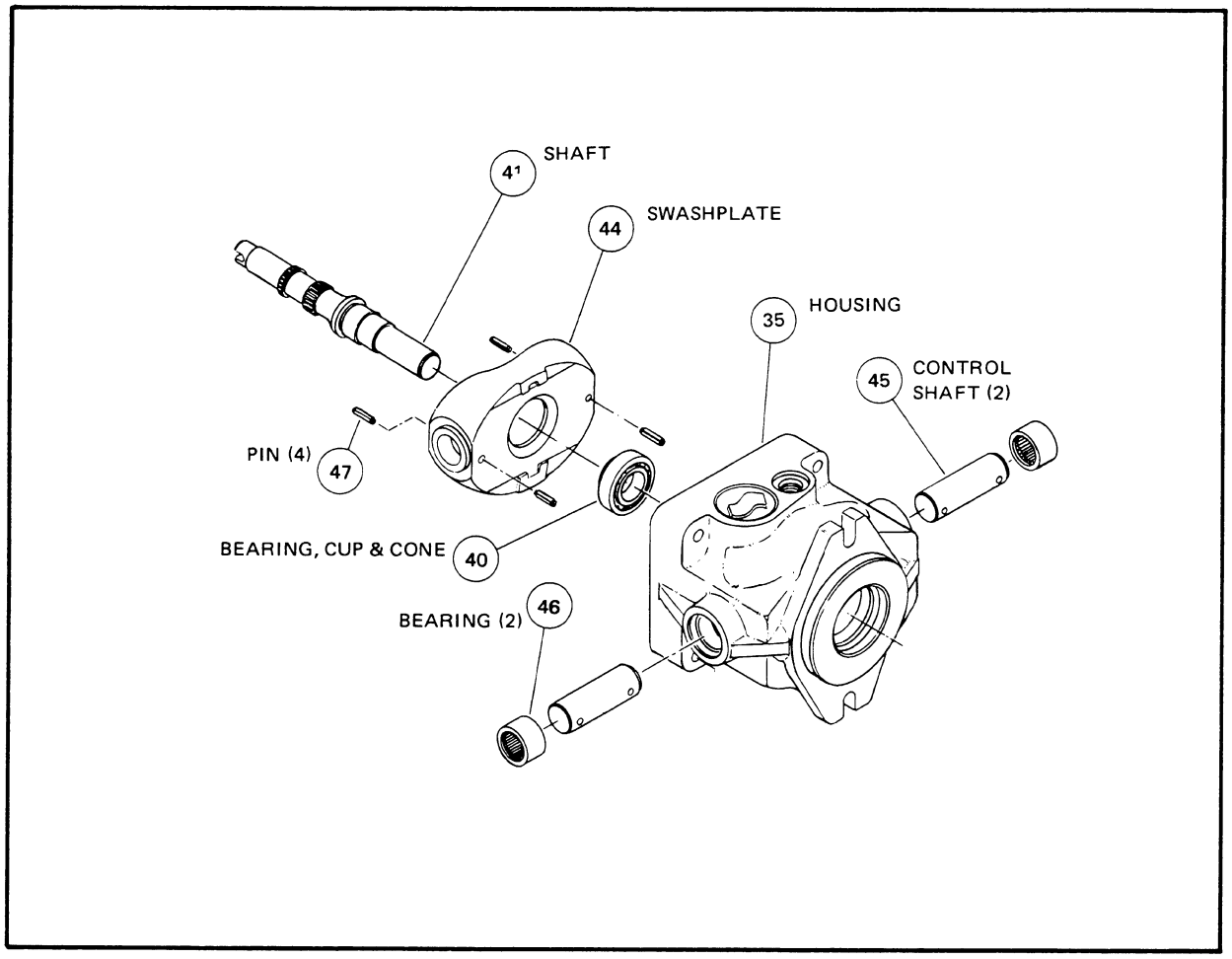
VARIABLE DISPLACEMENT MOTOR DISASSEMBLY

Slide the cylinder block assembly (36) off the shaft while holding the external end of the shaft. The pistons may come out of the cylinder block bores during removal. There is no special orientation of piston to bore that needs to be maintained.

Do not attempt to disassemble the spring and other parts from the center bore of the cylinder block. The entire cylinder block assembly should be replaced if any of its components are damaged.

Visually inspect wear surfaces of valve plate, cylinder block and slippers for damage. Check to be sure pistons are free in bores.

Remove thrust plate (38) from counterbore in swashplate (44). Visually inspect both sides for damage and flatness.



VARIABLE DISPLACEMENT MOTOR DISASSEMBLY

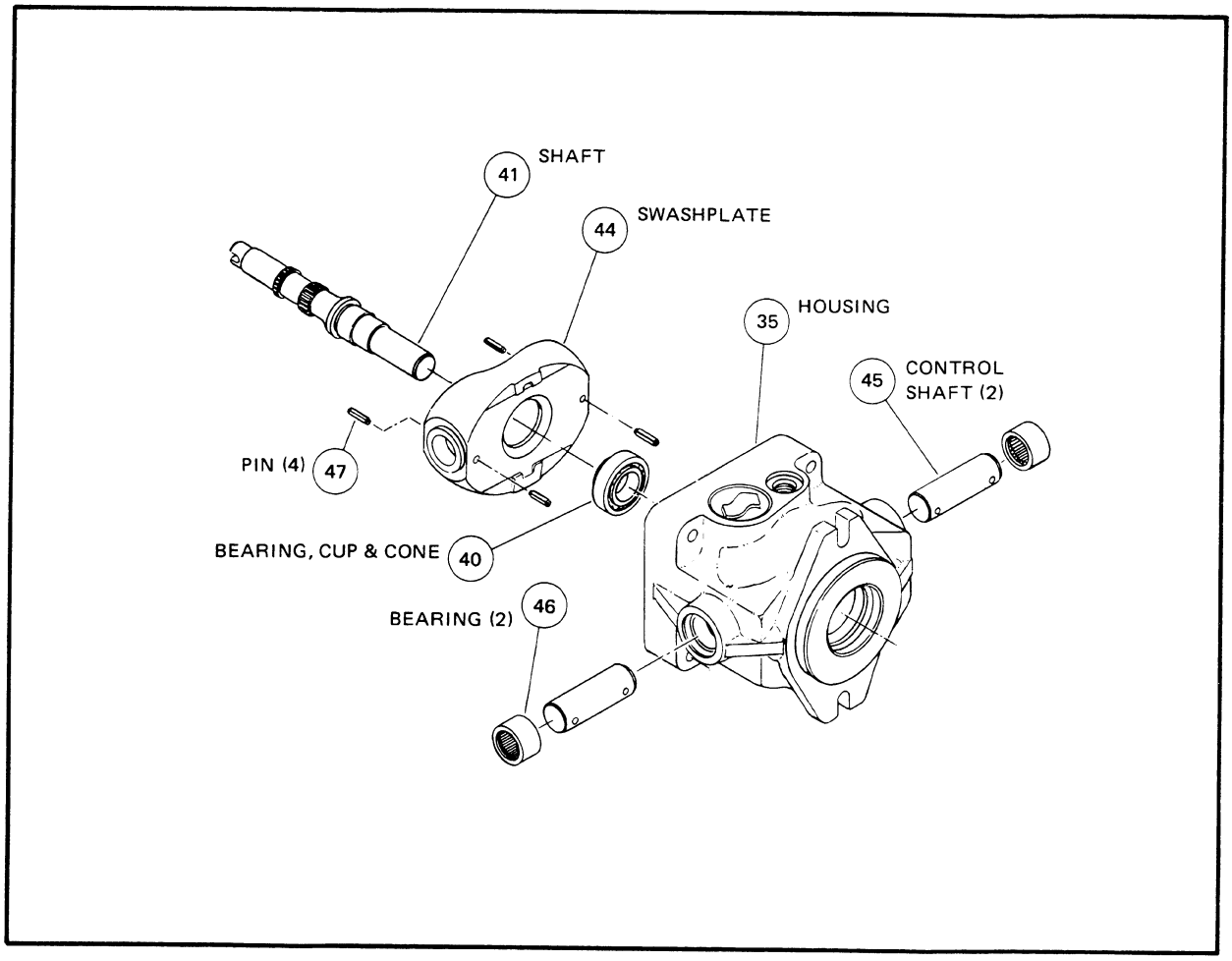
Using a 5/16 diameter drift punch, drive spring pins (47) out of control shafts (45). The pump housing is provided with a cast recess so that the pins can be driven free of the trunnion shafts.

Drive control shafts out of swashplate (44) toward outside of housing (35). Once clear of swashplate bore, the trunnion shafts can be removed easily. The swashplate can now be removed from the housing.

The shaft (41) and bearing (40) can now be removed from the housing. If bearing replacement is required, replace both the cup and cone of the bearing.

Remove needle bearings (46), if replacement is required, by pressing out of bore toward outside of housing.

SECTION VIII: MAJOR REPAIR PROCEDURES



VARIABLE DISPLACEMENT MOTOR ASSEMBLY

Prior to reassembly all parts, used and new, should be cleaned. Cleaning with solvent and air drying is adequate, providing that clean solvent is used.

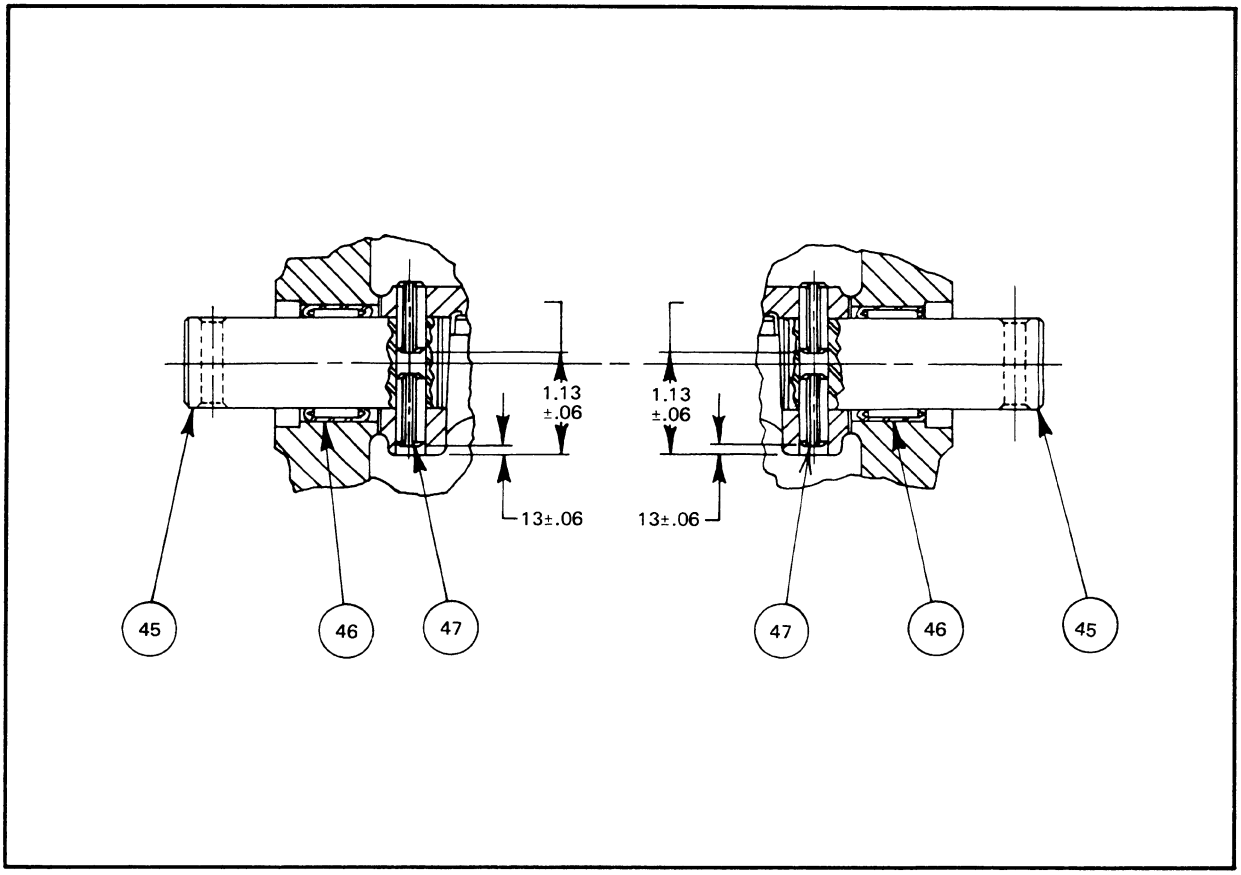
A supply of clean hydraulic oil is needed to lubricate parts during reassembly, especially the cylinder block assembly, thrust plate and valve plate.

It is recommended that all gaskets, O-rings and seals be replaced in addition to the charge pump drive pin, rear shaft bearing and swashplate pins.

Press the bearing cup into housing (35) then insert the shaft and bearing cone assembly (41 & 40).

Press needle bearings (46) into each side of housing until flush to 1/64 inch below counterbore for lip seals.

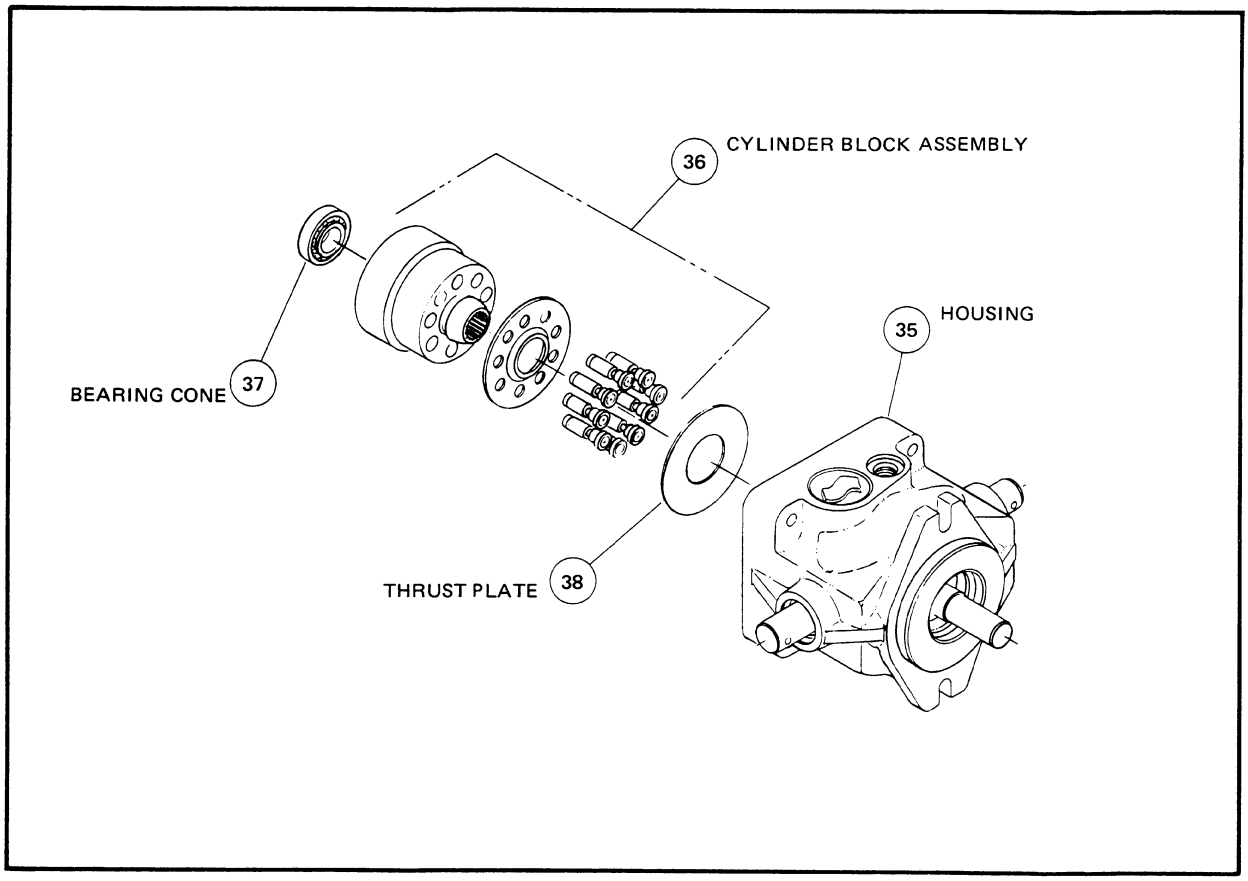
Place swashplate (44) into housing with counterbore for thrust plate up. Install control shafts (45) and align holes for spring pins in swashplate and shafts using 5/16 drift punch.



VARIABLE DISPLACEMENT MOTOR ASSEMBLY

Install new spring pins (45) through swashplate (44) and shafts (45). Use two (2) pins on each side. Install the first pin on each side until it is 1-1/8 inches below swashplate. Install second pin until it is 1/8 below swashplate.

The swashplate should swing freely in the housing to 18^{o} each side of center.



VARIABLE DISPLACEMENT MOTOR ASSEMBLY

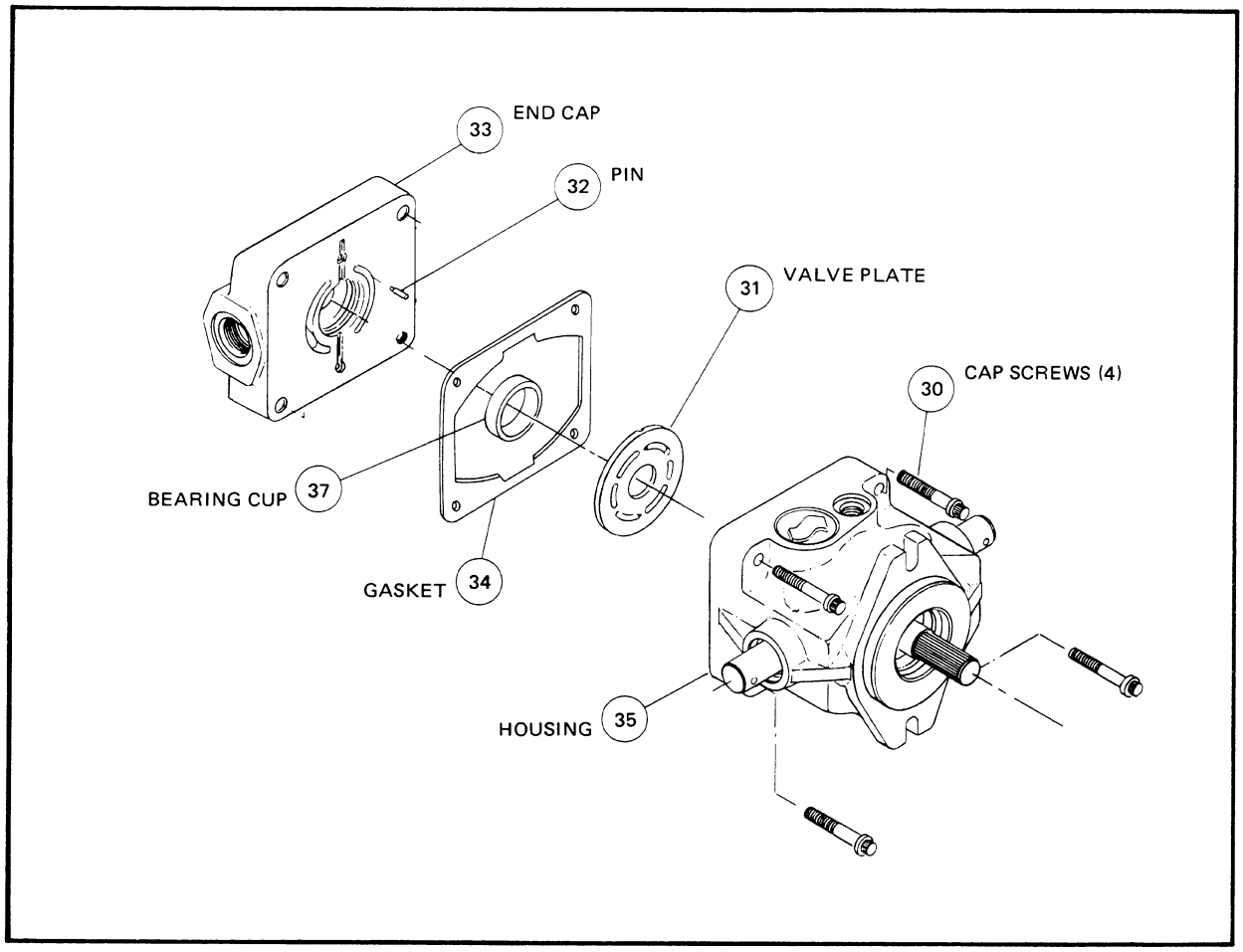
Lubricate thrust plate (38) with clean hydraulic oil and insert in counterbore of swashplate (44).

Assemble cylinder block parts if necessary and lubricate with clean hydraulic oil. There is no special orientation of piston to bore that needs to be maintained.

Slide cylinder block assembly (36) over shaft and engage spline. Be certain that pistons and thrust plate remain in place. When properly installed a slight spring tension can be felt when pushing on cylinder block.

Lubricate exposed surface of cylinder block with clean hydraulic oil.

Install the cone of the tapered bearing (37) onto shaft at this time. This bearing should be installed with an arbor type press for the most satisfactory results. Support the shaft and use caution during this operation to insure the bearing does not contact the cylinder block.



VARIABLE DISPLACEMENT MOTOR DISASSEMBLY

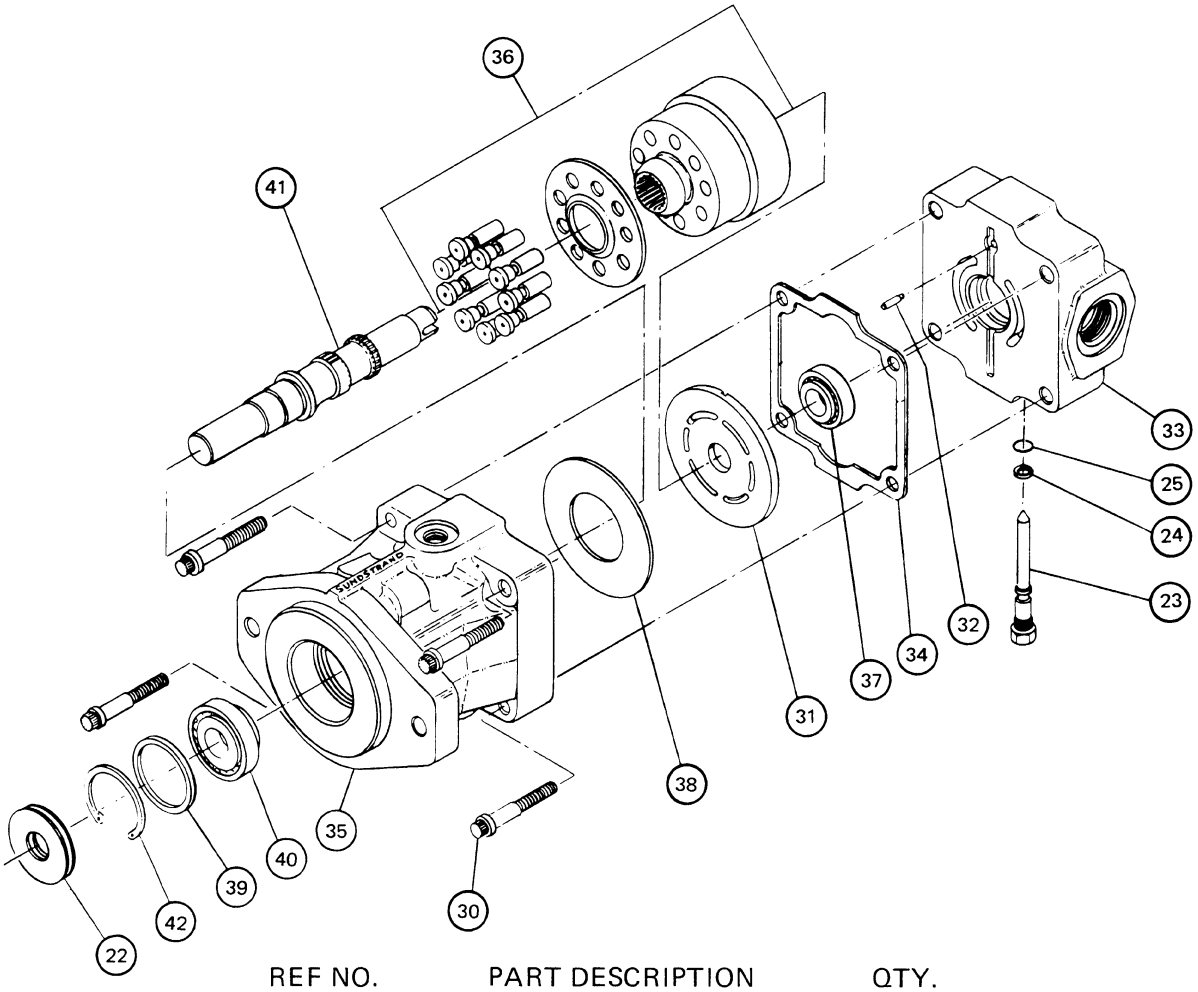
Insert locating pin (32) and bearing cup (37) into end cap (33). Lubricate the slotted side of the valve plate (31) and slip it over the locating pin and protruding bearing cup. The motor and pump valve plates are interchangeable in the 18 Series units.

Place the gasket (34) on housing, then install the end cap and valve plate. Hold the valve plate so it does not drop off during assembly.

Instll four (4) cap screws (30), and tighten alternately until the end cap and housing are pulled completely together. Torque screws to 45-57 foot lbs.

SECTION IX: GENERAL PARTS IDENTIFICATION

FIXED DISPLACEMENT MOTOR

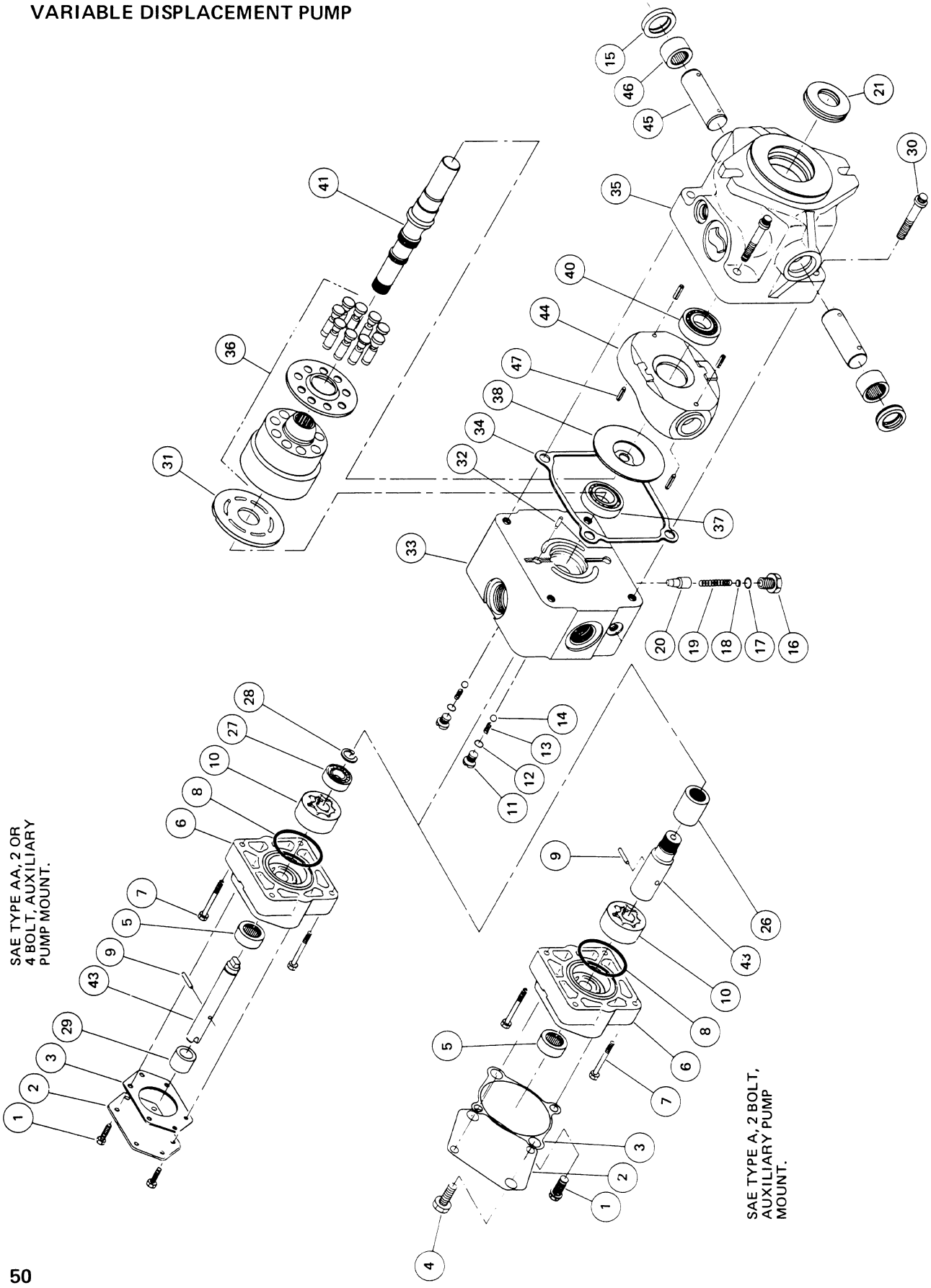


REF NO.	PART DESCRIPTION	QTY.
22	SEAL-LIP, OUTPUT	1
23	BY-PASS VALVE	1
24	BACK-UP RING	1
25	O-RING	1
30	SCREW-12 PT	4
31	VALVE PLATE	1
32	HEADLESS STR PIN	1
33	END CAP	1
34	GASKET	1
35	HOUSING	1
36	CYL BLOCK ASSEMBLY	1
37	REAR BRG, CUP & CONE	1
38	THRUST PLATE	1
39	SPACER	1
40	FRONT BRG, CUP & CONE	1
41	SHAFT	1
42	RETAINING RING	1

For part numbers refer to Parts List for specific Model number.

SECTION IX: GENERAL PARTS IDENTIFICATION

VARIABLE DISPLACEMENT PUMP



SECTION IX: GENERAL PARTS IDENTIFICATION

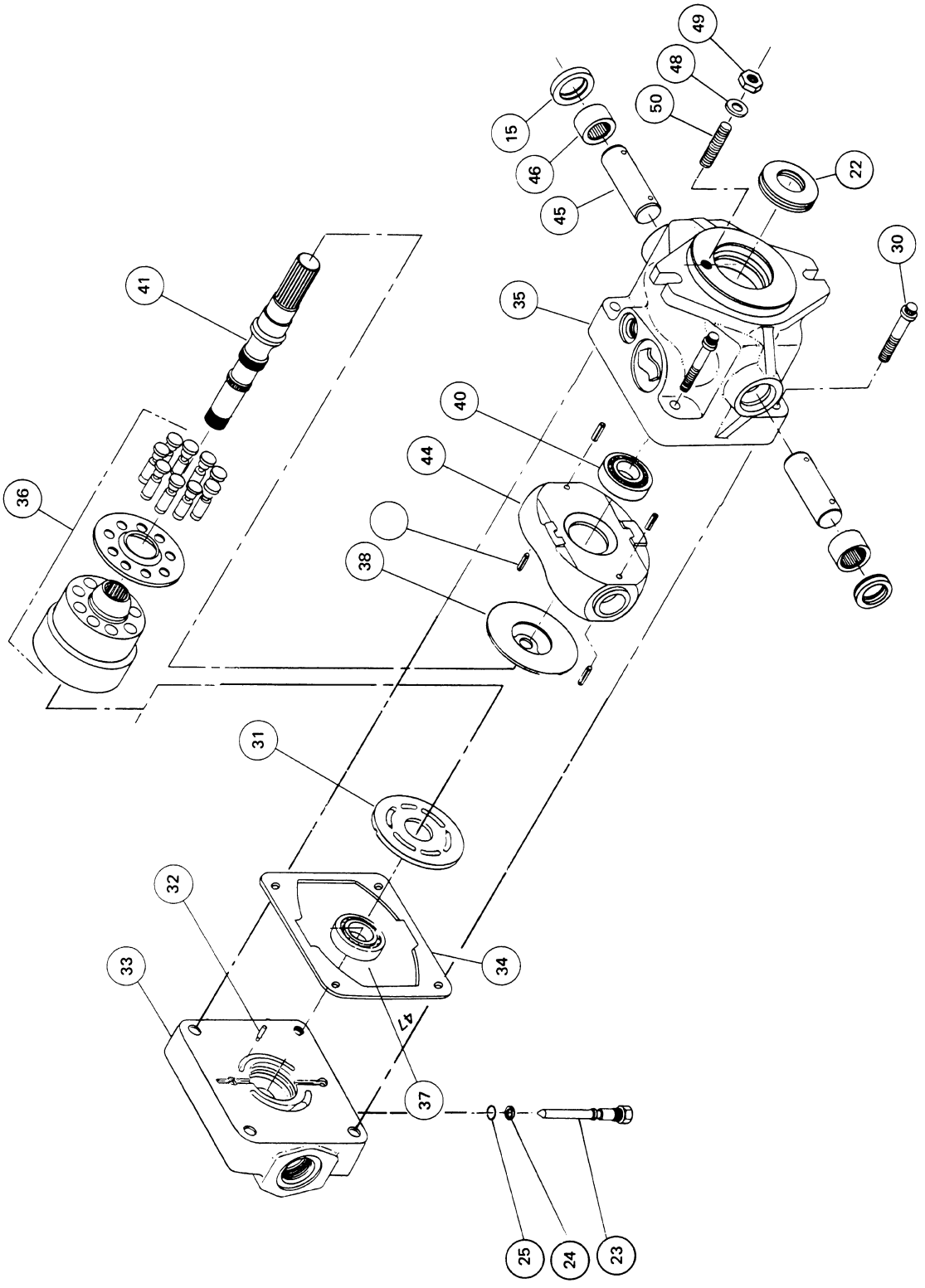
VARIABLE DISPLACEMENT PUMP

REF. NO.	PART DESCRIPTION	QTY
1	Screw – Hex. Hd.	2
2	Cover Plate	1
3	Gasket	1
4	Screw – Hex. Hd.	2
5	Bearing – Needle	1
6	Housing – Charge Pump	1
7	Screw – Hex. Hd.	2
8	O-Ring	1
9	Pin – Drive	1
10	Charge Pump (Gerotor)	1
11	Plug – Slotted Hd.	2
12	O-Ring	2
13	Spring	2
14	Ball	2
15	Seal – Lip	2
16	Plug – Hex.	1
17	O-Ring	1
18	Shim	A/R
19	Spring	1
20	Poppet	1
21	Seal – Lip, Input	1
26	Coupling	1
27	Bearing – Ball	1
28	Retaining Ring	1
29	Bearing Race	1
30	Screw – 12 pt. hd.	1
31	Valve Plate	1
32	Pin-Locating	1
33	End Cap	1
34	Gasket	1
35	Housing	1
36	Cylinder Block Assembly	1
37	Rear Bearing (Cup & Cone)	1
38	Thrust Plate	1
40	Front Bearing (Cup & Cone)	1
41	Shaft	1
43	Shaft – Charge Pump	1
44	Swashplate	1
45	Control Shaft	2
46	Bearing – Needle	2
47	Pin – Swashplate	4

For part numbers refer to Parts List for specific model number.

SECTION IX: GENERAL PARTS IDENTIFICATION

VARIABLE DISPLACEMENT MOTOR



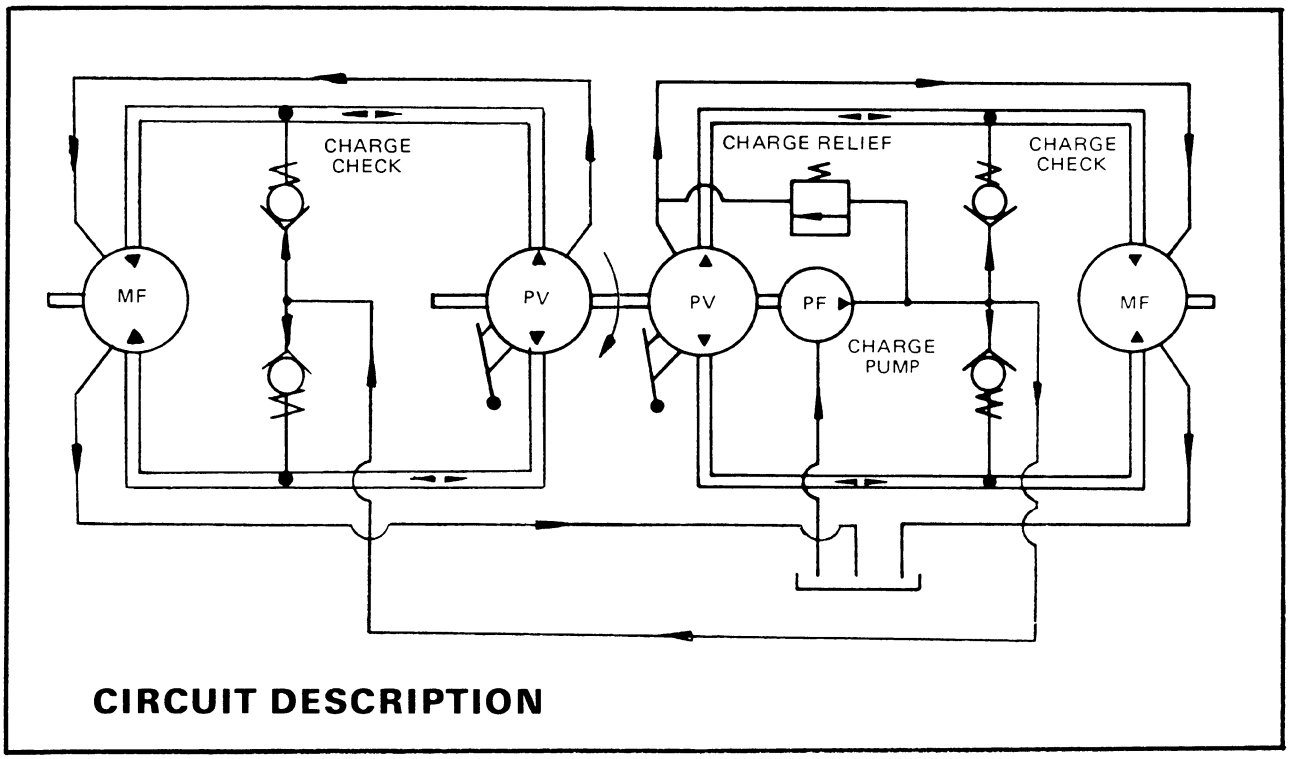
SECTION IX: GENERAL PARTS IDENTIFICATION

VARIABLE DISPLACEMENT MOTOR

REF. NO.	PART DESCRIPTION	QTY.
22	Seal-Lip, Output	1
23	By-Pass Valve	1
24	Back-Up Ring	1
25	O-Ring	1
30	Screw—12 Pt.	1
31	Valve Plate	1
32	Pin-Locating	1
33	End Cap	1
34	Gasket	1
35	Housing	1
36	Cyl. Block Ass'y	1
37	Rear Brg., Cup & Cone	1
38	Thrust Plate	1
40	Front Brg., Cup & Cone	1
41	Shaft	1
44	Swashplate	1
45	Control Shaft	2
46	Bearing – Needle	2
47	Pin—Swashplate	4
48	Washer	1
49	Screw	1
50	Nut	1

For part numbers refer to Parts List for specific model number.

18 SERIES TANDEM PUMP

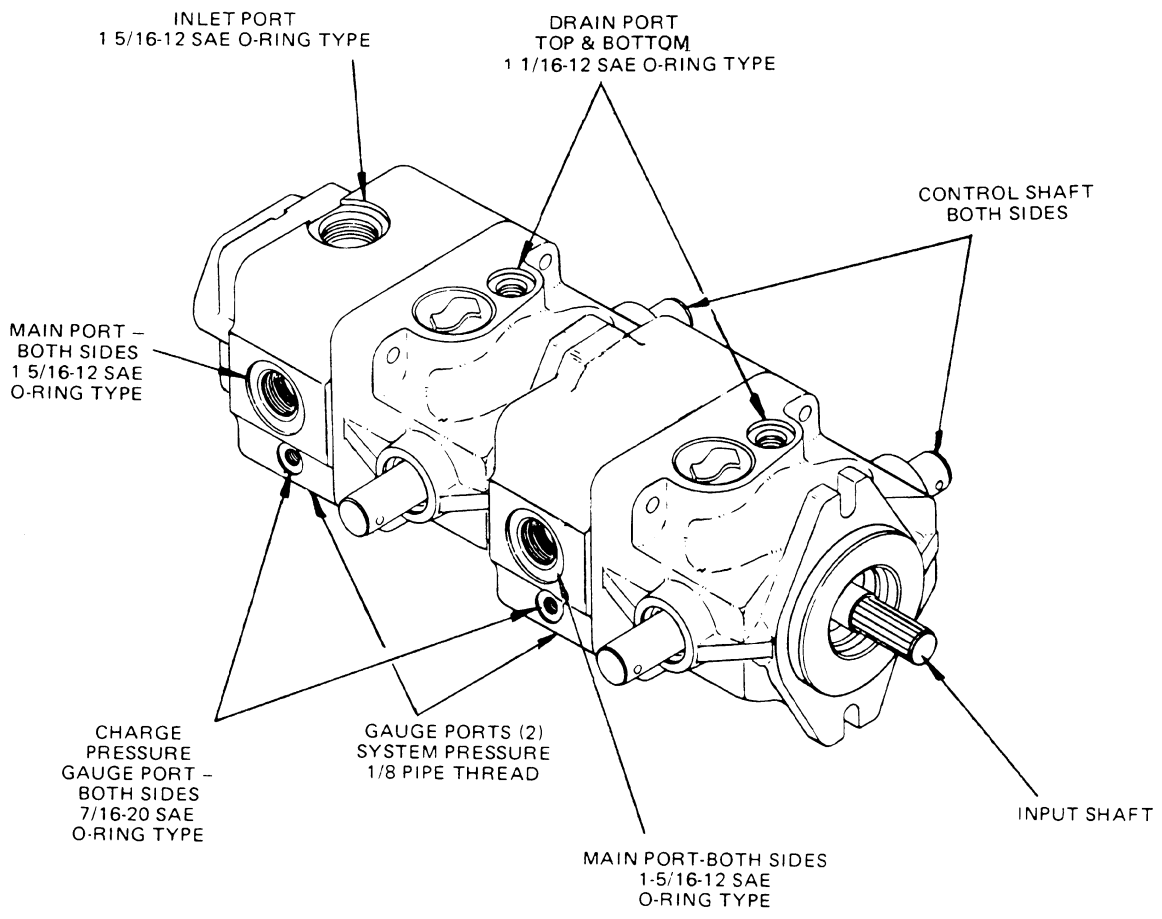


CIRCUIT DESCRIPTION

The 18 Series tandem pump consists of two (2) variable displacement axial piston pumps, driven by a common shaft. Each pump is designed to be connected in a closed loop to a fixed displacement motor. Each pump can be controlled independently so that the output speed and direction of rotation of the motors are also independent.

A fixed displacement (gerotor type) Charge Pump is driven by the common shaft and provides fluid to both closed loop circuits, through the Charge Check Valves, to replenish losses and prevent cavitation. The charge pressure is limited by a single Charge Relief Valve.

18 SERIES TANDEM PUMP

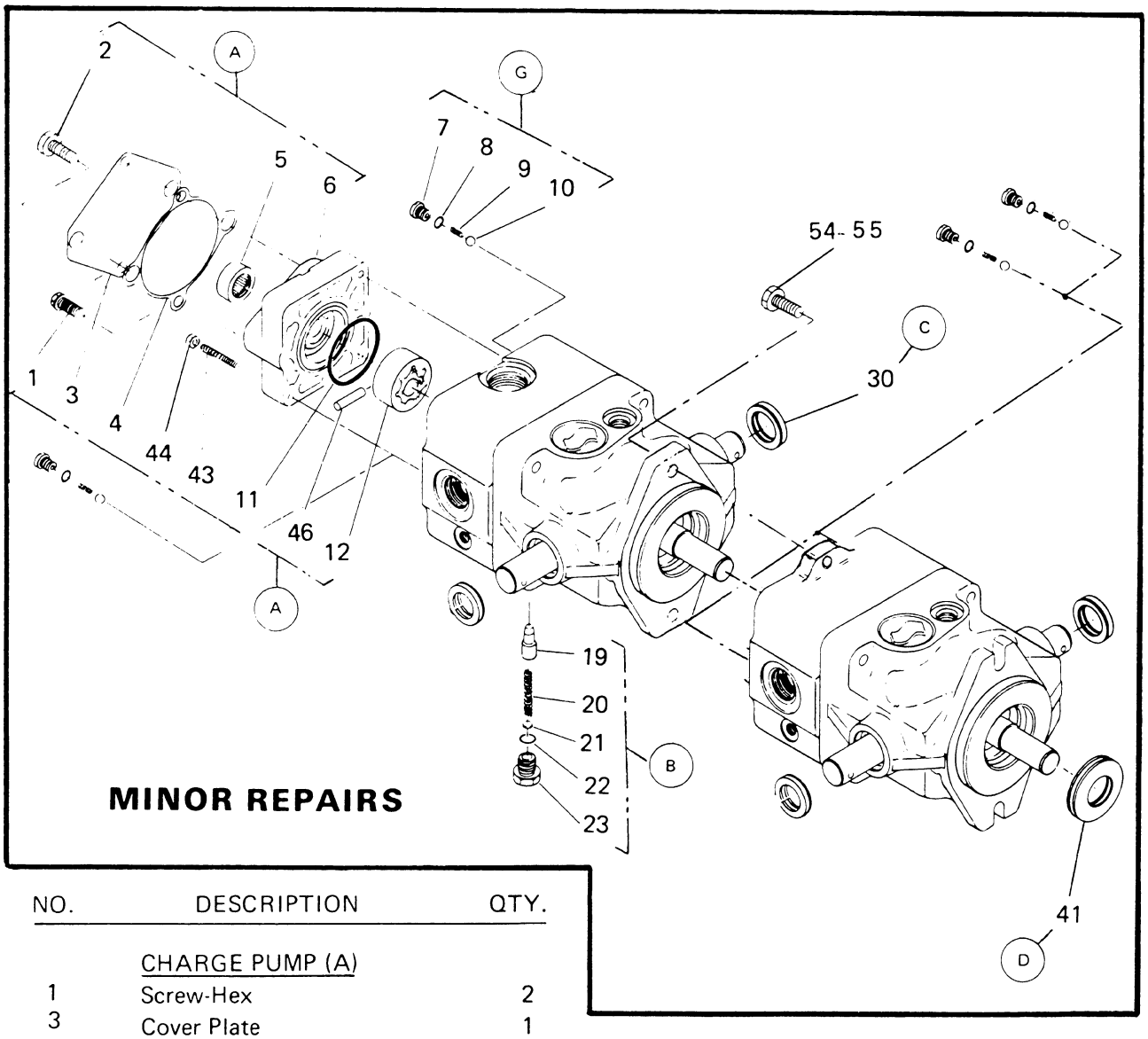


CONSULT MODEL NUMBER OF UNIT TO DETERMINE SPECIFIC UNIT CONFIGURATION

CONFIGURATION AND SPECIFICATIONS

PUMP DISPLACEMENT:	2.3 in3/REV
PUMP INPUT SPEED:	0-3900 RPM
CHARGE PUMP DISPLACEMENT:	.72 IN3/REV.
MAX. OPERATING PRESSURE:	3500 PSI
CHARGE RELIEF SETTING:	100 PSI MIN. @ 1800 RPM
MAX. CONTINUOUS INLET VACUUM:	5 IN. HG.
MAX. CASE PRESSURE:	25 PSI
INLET FILTRATION:	25 micron (nominal)

18 SERIES TANDEM PUMP

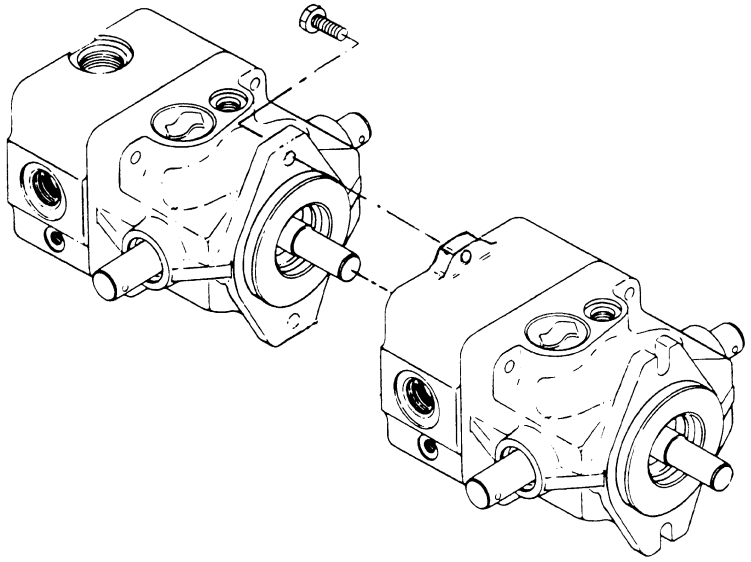


MINOR REPAIRS

NO.	DESCRIPTION	QTY.
	CHARGE PUMP (A)	
1	Screw-Hex	2
3	Cover Plate	1
4	Gasket	1
2	Screw-Hex.	2
5	Bearing	1
6	Housing-Chrg. Pump	1
4 3	Screw	2
11	O-Ring	1
46	Pin-Drive	1
12	Charge Pump (Gerotor)	1
44	Nut	2
	CHARGE CHECK VALVES (G)	
7	Plug	4
8	O-Ring	4
9	Spring	4
10	Ball	4

NO.	DESCRIPTION	QTY.
	TRUNNION SEAL (C)	
30	Seal-Lip	4
	CHARGE RELIEF VALVE (B)	
23	Plug-Hex.	1
22	O-Ring	1
21	Shim	A/R
20	Spring	1
19	Poppet	1
	INPUT SHAFT SEAL (D)	
41	Seal-Lip	1

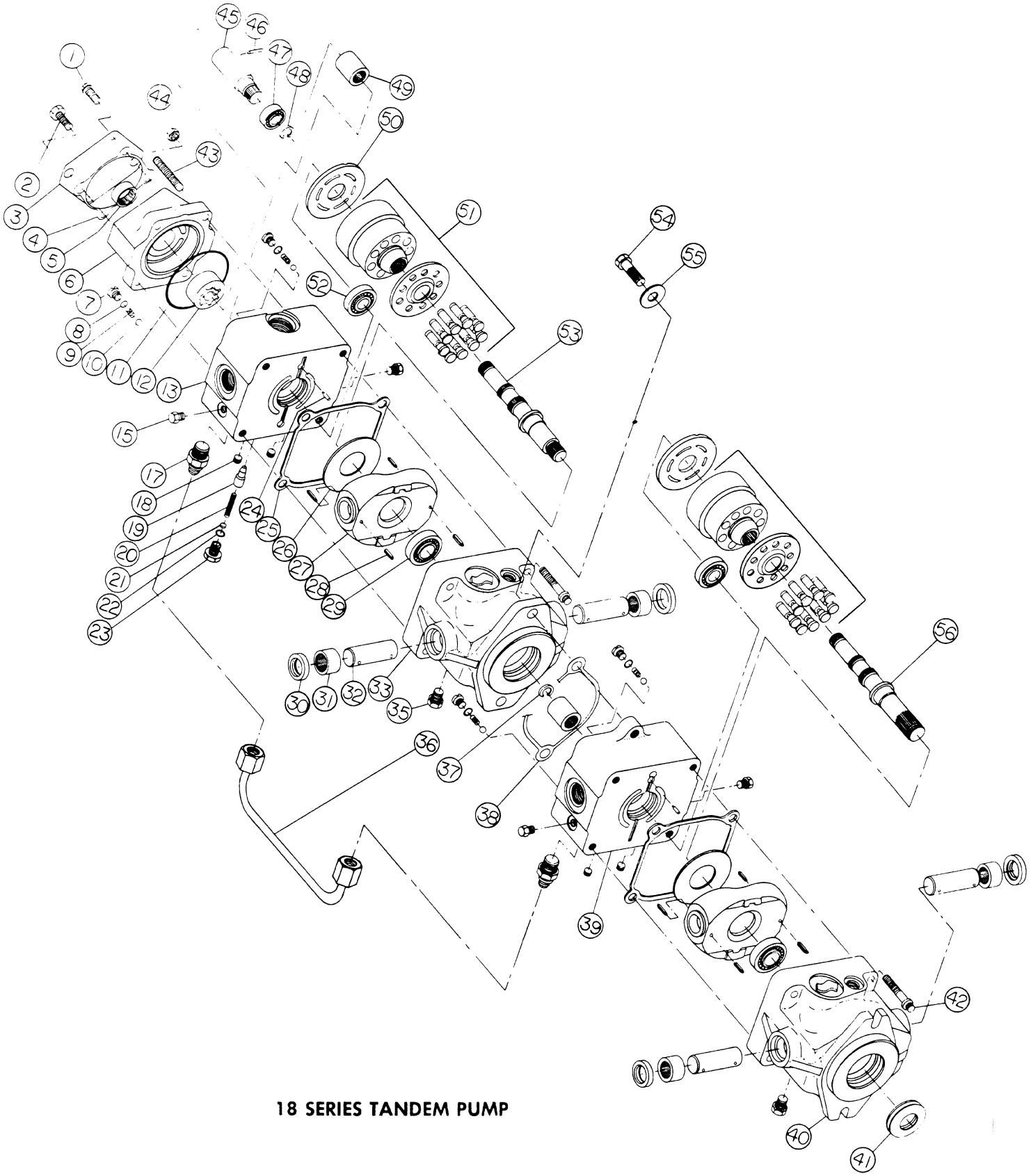
18 SERIES TANDEM PUMP



MAJOR REPAIR

The unit can be separated into two (2) pump sections after removal of cap screws (54).

After separation, each pump section can be disassembled following the procedures outlined in the Major Repair Section for the Variable Displacement Pump.



18 SERIES TANDEM PUMP

18 SERIES TANDEM PUMP
GENERAL PARTS IDENTIFICATION

REF NO.	PART DESCRIPTION	QTY
1	SCREW-TAP TITE	2
2	SCREW-HEX.HD.CAP	2
3	PLATE-COVER	1
4	GASKET-COVER	1
5	BEARING-NEEDLE	1
6	HOUSING-CHG. PUMP	1
7	PLUG-CHECK VALVE	4
8	"O" RING	4
9	SPRING-CHECK VALVE	4
10	BALL	4
11	"O" RING	1
12	GEROTOR ASS'Y	1
13	END CAP - PUMP	1
15	PLUG-STR.THD. HEX	4
17	CONNECTOR	2
18	PLUG-PIPE	4
19	VALVE-RELIEF	1
20	SPRING-CHG.REL.VALVE	1
21	SHIMS	A/R
22	"O" RING	1
23	PLUG	1
24	PIN-STR. HD'LESS	2
25	GASKET	2
26	PLATE-THRUST	2
27	SWASHPLATE-VAR.	2
28	PIN-SPRING	8
29	FRONT BEARING KIT ASS'Y	1
30	SEAL-LIP	4
31	BEARING-NEEDLE	4
32	SHAFT-TRUNNION	4
33	HOUSING-VARIABLE	1
35	PLUG-STR.THD.HEX.	2
36	TUBE-ASS'Y	1
37	RING-RETAINING	1
38	GASKET	1
39	END CAP - PUMP	1
40	HOUSING-VARIABLE	1

18 SERIES TANDEM PUMP
GENERAL PARTS IDENTIFICATION

REF NO.	PART DESCRIPTION	QTY
41	SEAL-LIP	1
42	SCREW-SOC HD. CAP (OR)	8
	SCREW-12 PT. CAP	8
43	STUD	4
44	NUT	4
45	SHAFT-CHG.PUMP DR.	1
46	PIN-STR. HD'LESS	1
47	BEARING-BALL	1
48	RING-RETAINING	1
49	COUPLING	1
50	PLATE-VALVE	2
51	CYL BLOCK KIT	2
52	REAR BEARING KIT ASS'Y	1
53	SHAFT-PUMP	1
54	SCREW-HEX HD	2
55	WASHER-PLAIN	2
56	SHAFT-PUMP	1
57	COUPLING	1

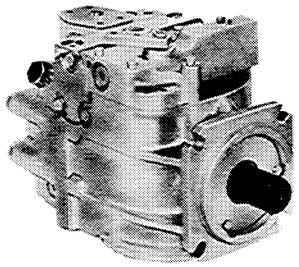
SERVICE PARTS KITS AVAILABLE

CHECK VALVE KIT (Contains Ref. No. 7, 8, 9, 10)	4
CHARGE RELIEF VALVE (Contains Ref. No. 19, 20, 21, 22, 23)	1
CHARGE PUMP KIT (Contains Ref. No. 1, 2, 3, 4, 5, 6, 11, 12, 46)	1

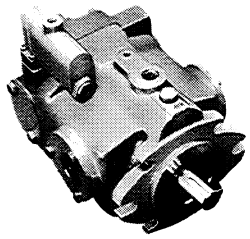
For part numbers refer to Parts List for specific model number.

Sundstrand-Sauer Hydraulic Power Systems—Market Leaders Worldwide

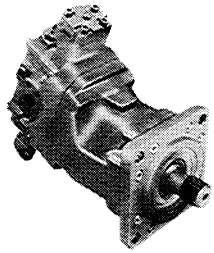
SUNDSTRAND-SAUER is a world leader and your source for hydraulic power system technology, utilizing both North American and European resources in design and manufacturing. SUNDSTRAND-SAUER specializes in integrating a full range of system components including closed circuit hydrostatic transmissions, electrohydraulic controls, open circuit pumps, gear drives, and gear pumps and motors.



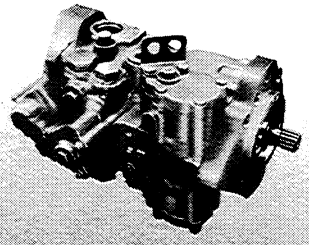
Heavy Duty Pumps and Motors



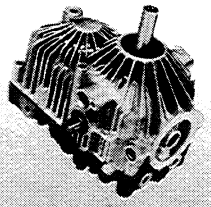
Open Circuit Pumps



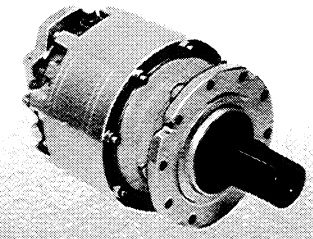
Variable Motors



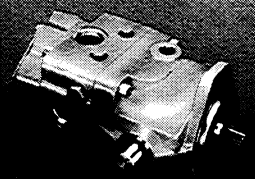
Medium Duty Pumps and Motors

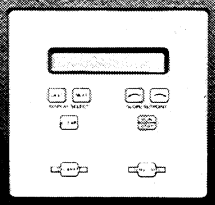


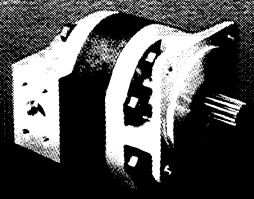
Bantam Duty Transmissions



Gear Drives







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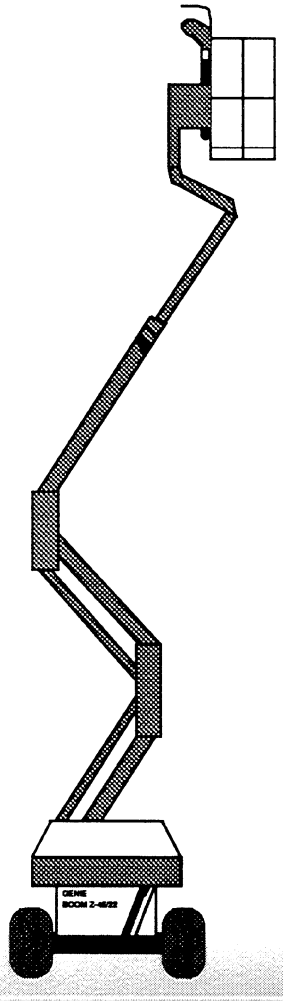
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BLN-9666 Rev. D
January 1988
9007395

SAUER SUNDSTRAND

Production System



Anti-Stall Control

For Genie 45/22 Aerial Lift

ANTI-STALL CONTROL

System Description

The Anti-Stall Control is a control system which prevents engine stall by sensing engine speed and proportionately limiting the input signal to the hydrostatic transmission relative to engine RPM.

Other features of the system are steering inputs, propel input, low speed function and parking brake function. A limp home function is also provided should a circuit board failure occur.

The control consists of three primary components outside the hydrostatic propel components. These are: 1) Control Handle, 2) Anti-Stall Controller, and 3) Electrical Displacement Control on the hydrostatic pump.

Control Handle - The MCH59AD1165 is a single axis, spring return, panel mount Control Handle. The handle grip contains a three-position momentary switch, oriented in the lateral axis relative to the basic handle motion. This switch is used to activate solenoid valves to provide machine steer function.

The handle electrical interface is a pair of extended life carbon element potentiometers, geared to provide near full pot travel for full handle travel.

An internal switch, normally open (NO), powers the potentiometers when the handle is moved off center. This provides a fail safe feature by de-powering the system when the handle moves to neutral. This switch is powered from the Anti-Stall Board output which varies from 0.5 to 10.5 Vdc.

A second internal switch, also normally open (NO), powers the brake OFF when the handle is moved off center. This switch is powered from the machine supply voltage (12 Vdc).

All external electrical connection is made through an 8-position terminal strip.

Anti-Stall Controller - The MCA102A1049 is an electronic circuit board containing all the electrical componentry required to perform the anti-stall function for the gasoline engine powered machine. This unit senses engine speed through the ignition system coil operating at 50 Hz. The device is terminated through a 10-position terminal strip.

This device senses engine speed and compares this with a setpoint or desired engine speed. If the actual speed is less than the desired, the output voltage decreases and reduces the authority of the control handle, thus reducing the output of the hydrostatic pump.

The device consists of three primary sections. The frequency/voltage convertor changes the engine timing frequency to a dc signal which is compared to the setpoint dc signal. This second section amplifier processes this signal which becomes the input for the final section, the power stage. The power stage output is the source voltage for the control handle which drives the hydrostatic pump

An adjustable two-speed mode is provided in the device by grounding a terminal through a switch.

Anti-Stall Controller - The MCA102A1063 is an electronic circuit board containing all the electrical componentry required to perform the anti-stall function for the diesel engine powered machine. This unit senses engine speed through the alternator charging system operating at 400 Hz. The device is terminated through a 10-position terminal strip.

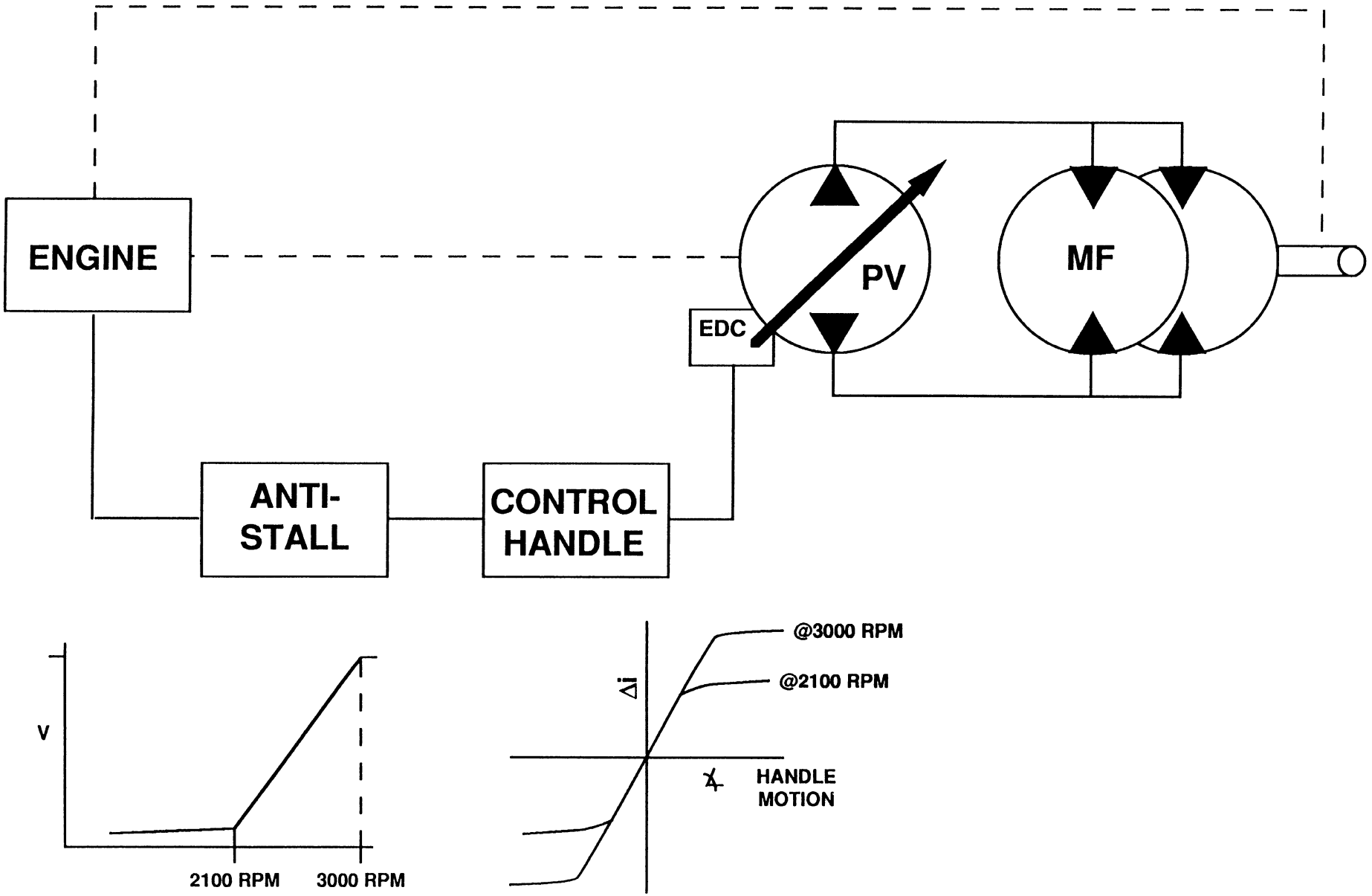
This device senses engine speed and compares this with a setpoint or desired engine speed. If the actual speed is less than the desired, the output voltage decreases and reduces the authority of the control handle, thus reducing the output of the hydrostatic pump.

The device consists of three primary sections. The frequency/voltage convertor changes the engine timing frequency to a dc signal which is compared to the setpoint dc signal. This second section amplifier processes this signal which becomes the input for the final section, the power stage. The power stage output is the source voltage for the control handle which drives the hydrostatic pump.

An adjustable two-speed mode is provided in the device by grounding a terminal through a switch.

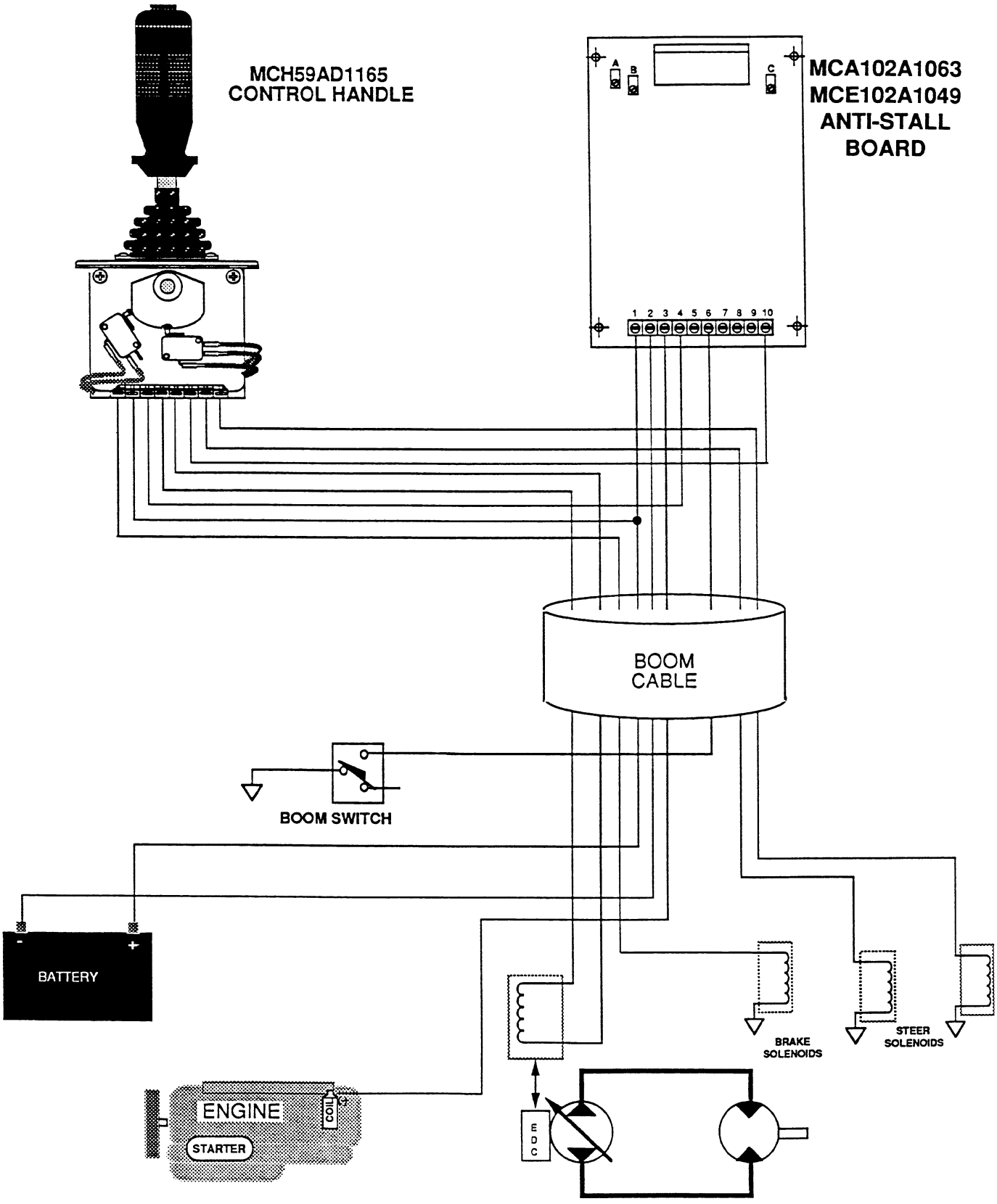
Electrical Displacement Control - This system will operate with any single coil EDC on a Sauer-Sundstrand hydrostatic pump.

BLOCK DIAGRAM - ANTI-STALL



ANTI-STALL CONTROL WIRING DIAGRAM

3/1/89
LTJ



Calibration Procedure

All wiring connected per wiring drawing.

A. Engine running at high idle, Control Handle centered. and EDC connector disconnected Check the following voltages relative to ground on the load control board.

#1 12 Vdc minimum
#2 0 Vdc (ground)
#3 Approximate 50 Hz frequency on the gasoline powered machine and 400 Hz on the diesel powered machine.
#4 0 Vdc (ground)
#6 0 Vdc when boom switch closed; 3 Vdc minimum when open
#10 9 Vdc to 12 Vdc

MCH59AD1165 Control Handle Terminals - EDC wire disconnected.

#1 0 Vdc - handle center; 12 Vdc - handle off center
#2 12 Vdc minimum at all times
#3 0 Vdc (ground)
#4 to #5 0 Vdc at handle center, ± 3 Vdc minimum at full ± handle defection
#6 9 Vdc to 12 Vdc (same as term #10 of MCE102)
#7 12 Vdc when steer switch is defected
#8 12 Vdc when steer switch is defected

If these values are not found, check wiring continuity.

B. Adjustments - If all continuity checks per "A" above, perform the following calibration.

1. Set Engine High Idle, Control Handle centered, 2 speed switch open, place voltmeter between terminals #2 (-) and #10 of MCE102A board.

   - Set adjustment potentiometer "F/V" to give voltage reading 9.0 Vdc (may vary as procedure is refined).

   - Close 2 speed switch; voltage reading will drop. Set adjustment potentiometer "SPAN" to give voltage reading of 1.8 Vdc (approximately 20% of full speed).

2. Control Handle is factory calibrated - no adjustments required.

3. Turn OFF Engine - reconnect EDC wiring.

4. To set system Gain - Run machine on incline.

   - If engine exhibits excess droop, turn adjustment potentiometer "GAIN" clockwise to increase circuit gain and minimize droop.

   - If engine exhibits instability, surging when under load, adjust the same potentiometer counter clockwise until stability is achieved.

NOTE: This setting is a compromise between machine stability and engine droop.

Trouble Shooting

For trouble shooting, perform the checks of section "A" of the Calibration Procedure. If the proper voltages are not found, check the wiring for continuity.

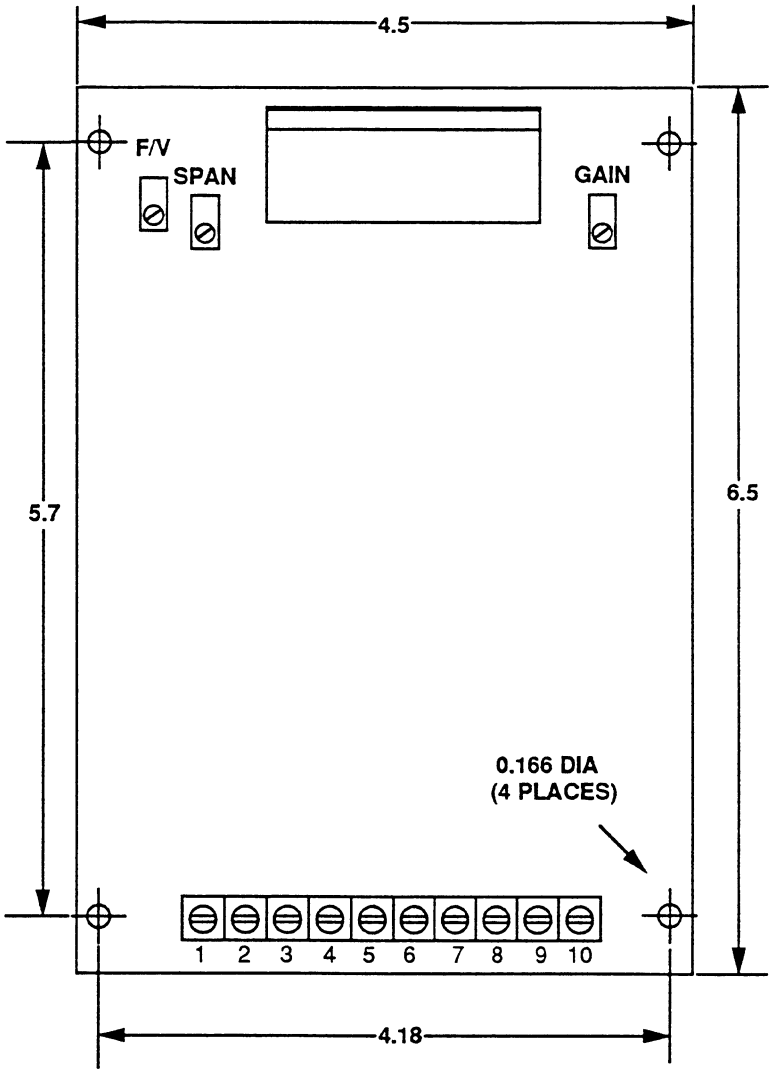
If Terminal #4 voltage on the MCE102 cannot be found, and the speed switch is open, turn the adjustment potentiometer "F/V" full clockwise or counterclockwise. If proper voltage is not found, replace the board.

If Terminal #4 voltage on the MCE102 does not change with opening or closing the 2 speed switch, turn the potentiometer "Span" full clockwise or counterclockwise. If proper voltage is not found, replace the board.

If Terminals #4 and #5 of the Control Handle produce the specified voltage of Section "A" but the machine does not propel with the EDC connected:

Remove wire from Terminal #5 and check resistance between wire and Terminal #4. Value should be approximately 23 ohms. If open, check for broken wires or open EDC coil. If OK, check charge pump pressure per hydraulic specifications.

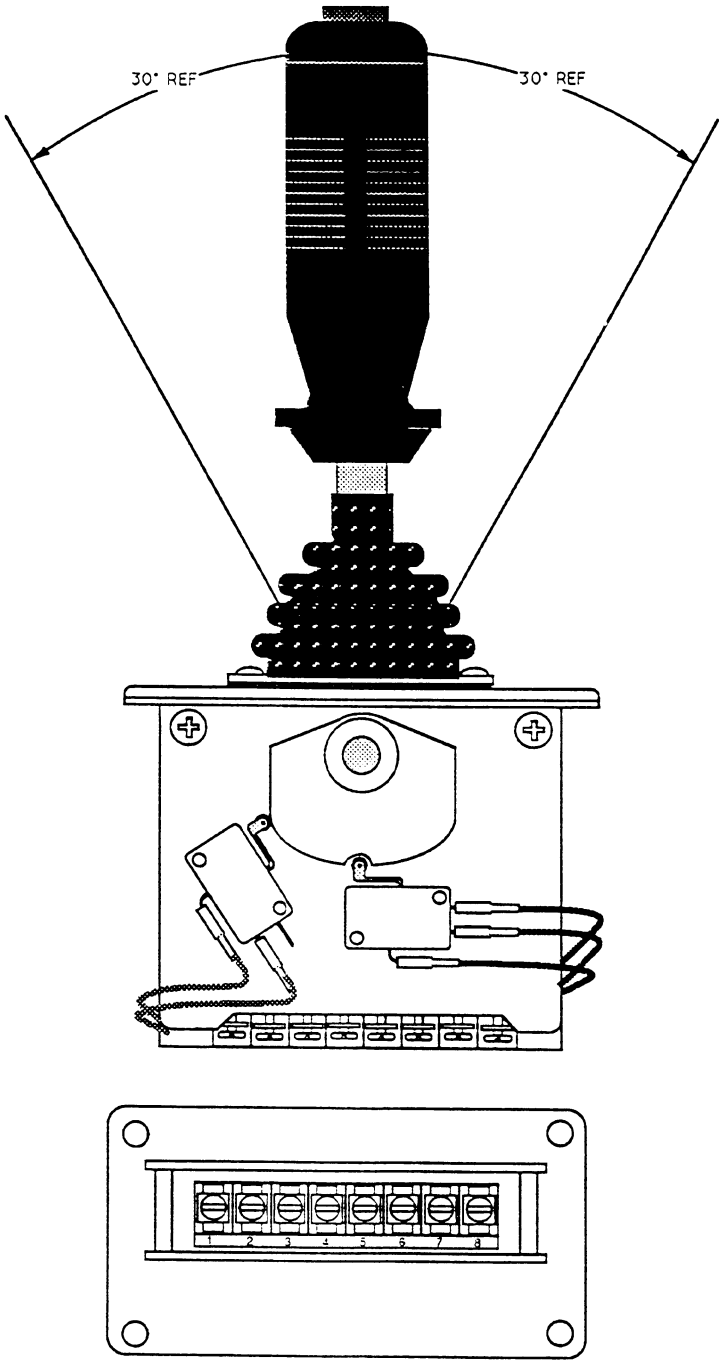
ANTI-STALL BOARD MOUNTING DIMENSIONS



ADJUSTMENT POTENTIOMETER
F/V - ENGINE SPEED SETPOINT
SPAN - LOW SPEED ADJUST
GAIN - GAIN ADJUST

WIRING CONNECTIONS TO TERMINALS
1. MACHINE SUPPLY VOLTAGE
2. MACHINE GROUND
3. ENGINE COIL TERMINAL (-)
4. CONTROL HANDLE TERMINAL #3
5.
6. LOW SPEED SWITCH
7.
8.
9.
10. CONTROL HANDLE TERMINAL #6

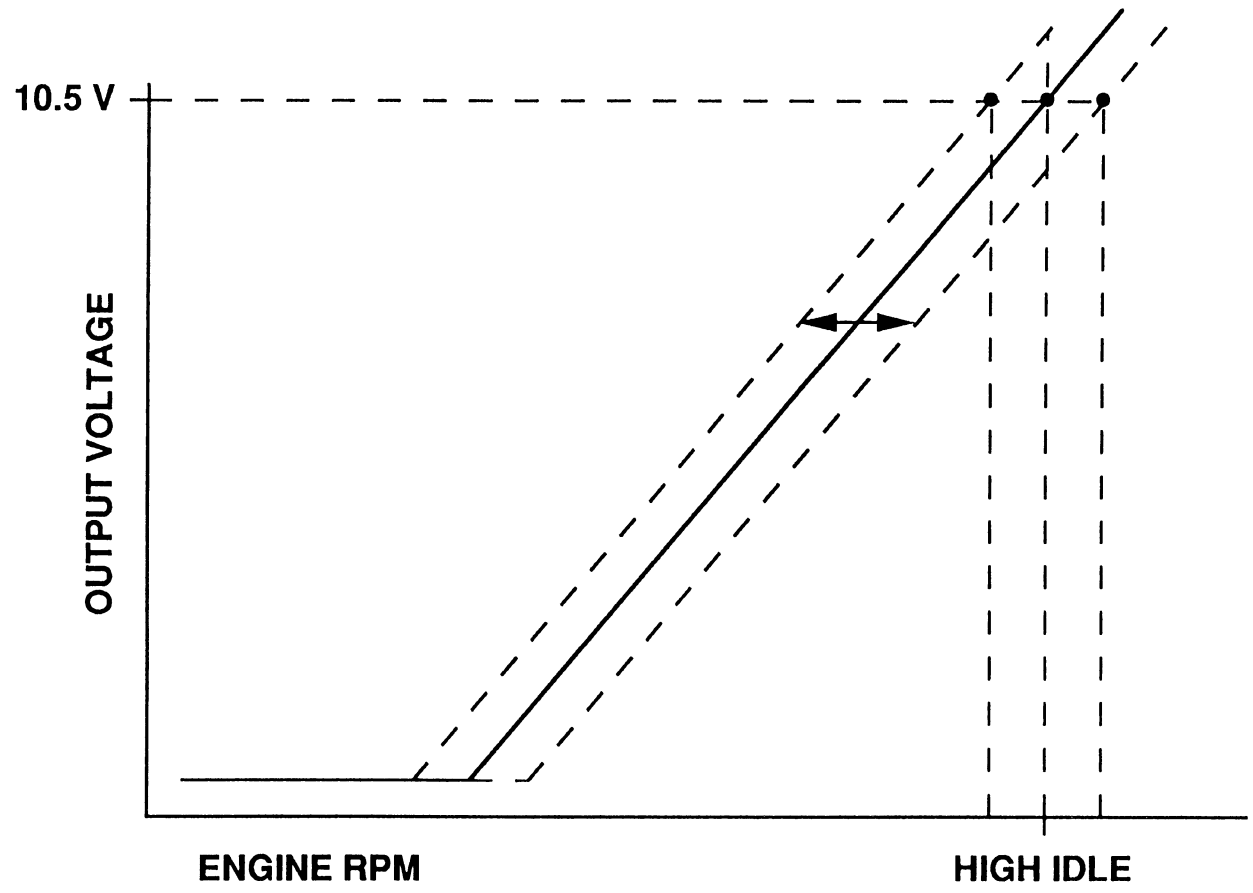
MCH59AD1165 CONTROL HANDLE



TERMINAL CONNECTIONS

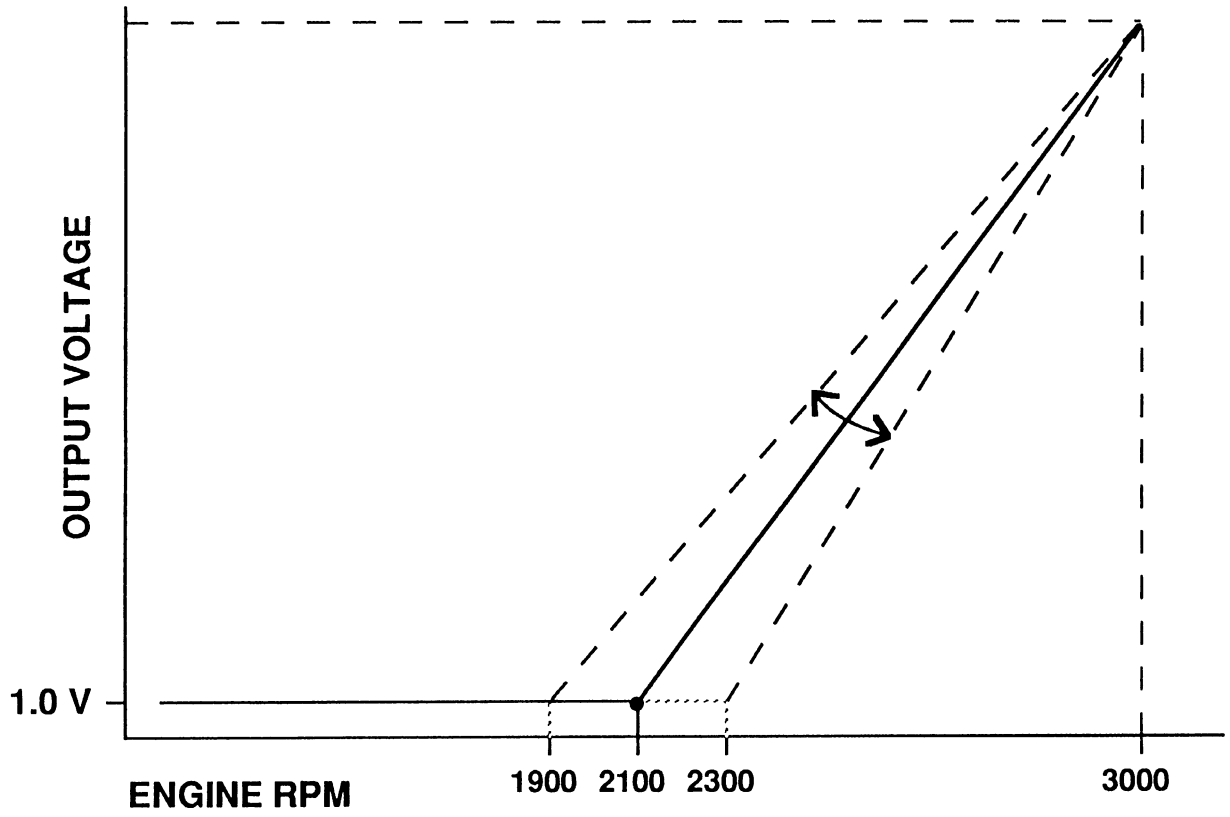
1. BRAKE SWITCH - NEUTRAL OPEN
2. MACHINE SUPPLY VOLTAGE
3. LOAD CONTROL GROUND - TERM#4
4. PROPEL VALVE TERM #
5. PROPEL VALVE TERM #
6. LOAD CONTROL SIGNAL - TERM#10
7. STEER VALVE -
8. STEER VALVE -

ANTI-STALL ADJUSTMENTS - SETPOINT



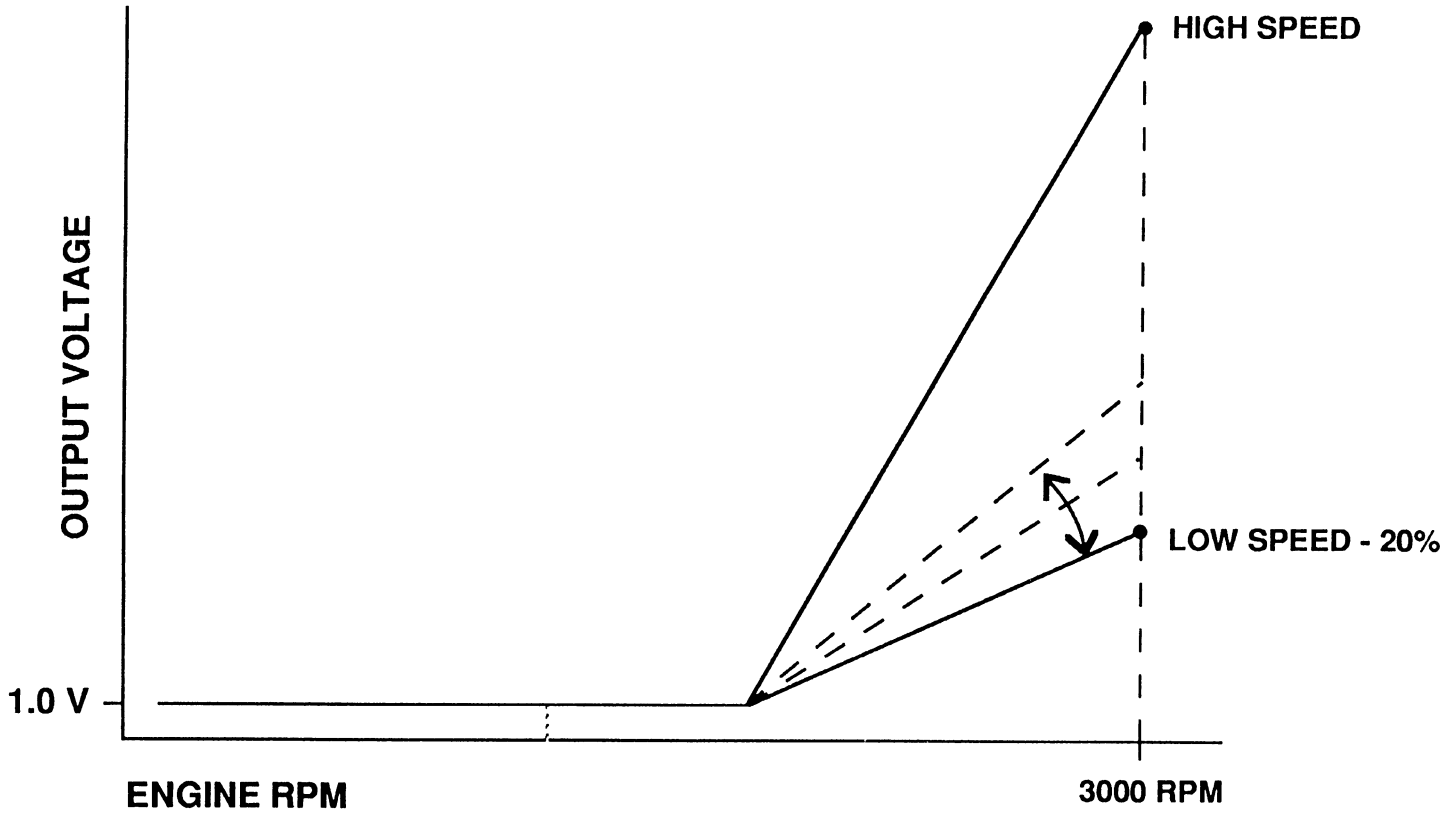
Adjustment potentiometer "F/V" adjusts output voltage at Engine High Idle.
Read Board Terminal #4
Factory Set - 10.5 V @ 3000 RPM (50 Hz)

ANTI-STALL ADJUSTMENTS - GAIN



Potentiometer "Gain" adjusts slope of curve
Read Board terminal #4
Factory set - 1.0 V @ 2100 RPM (35 Hz)

ANTI-STALL BOARD ADJUSTMENTS
2-SPEED



Potentiometer "Span" adjusts low speed setting.
Read Board terminal #4

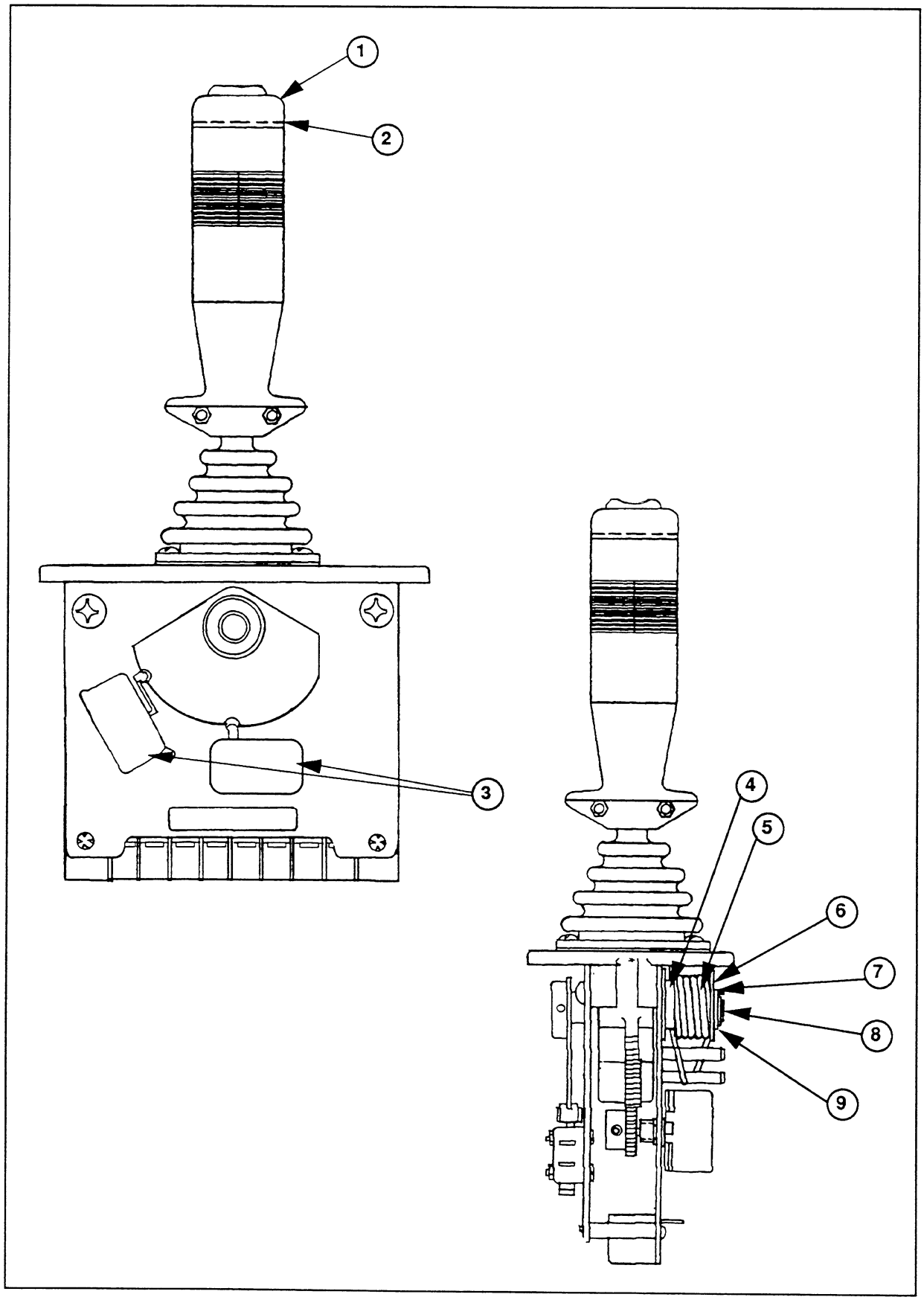


Figure 1. Replacement parts for the MCH59AD.

Item Number	Part Number	Description
1	K08357	Sealing cap
2	K08358	Lock ring
3	K03340	Switch assembly
4	K00567	Bushing
5	K00551	Spring
6	K00568	Bushing
7	K00574	Washer - nylon
8	K07213	Retaining ring
9	K04589	Washer - steel

Replacing Existing Switches

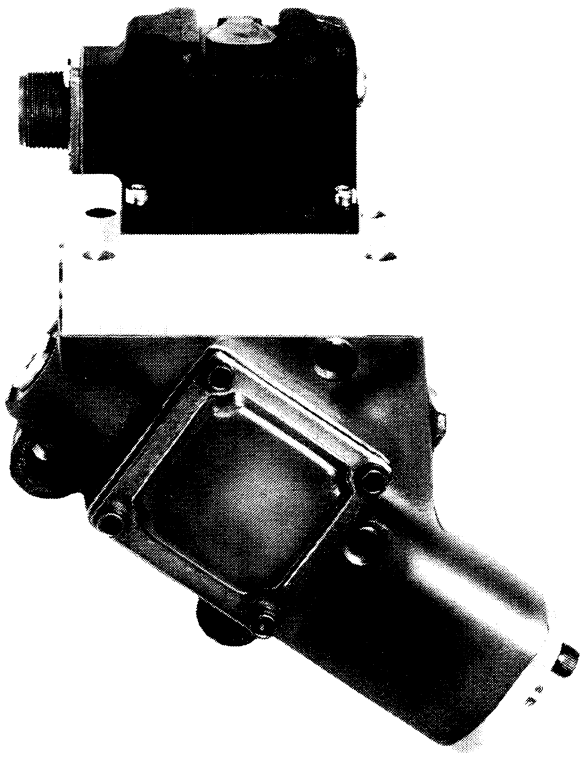
1. Identify and record wire positions.
2. Remove wires form switch.
3. Remove switch. (Do not remove CAM.)
4. Install switch.
5. Adjust switch to within ±1° of desired switching angle.
6. Tighten switch mounting screws. Do not adjust auxiliary switches by moving CAM, as this will destroy center switch adjustment.
7. Install wires in the original positions.

Replacing Centering Spring

1. Remove snap ring.
2. Remove washers.
3. Remove bushing.
4. Remove spring.
5. Install new spring. (Tabs on spring may require bending to ensure minimum handle movement and proper center lock function in the neutral position.)
6. Replace bushing.
7. Replace washers. (Nylon washer to the inside.)
8. Replace snap ring.

SUNDSTRAND SAUER

MCV 105A



Electrical Displacement Control

MCV105A Electrical Displacement Control

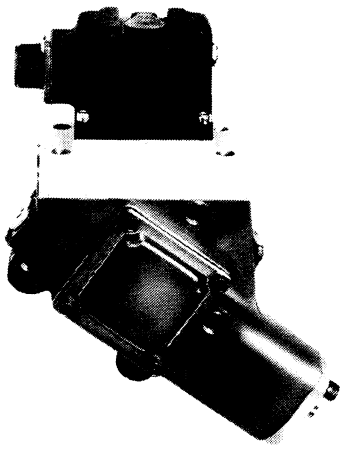
Application

The MCV105A Electrical Displacement Control (EDC) is a two-stage electrohydraulic pump stroke control which uses mechanical feedback to establish closed loop control of the swashplate angle of Sundstrand-Sauer 46 CC Medium Duty Pumps.

The first stage is a torque-motor actuated, double-nozzle flapper valve that produces a differential output pressure proportional to the applied electrical signal. The second stage uses the differential pressure to drive its double spool arrangement and port oil to the pump servo pistons. The second-stage rotary spool configuration allows a null deadband (for machine safety) in the pump's output while maintaining optimum dynamic response to control commands.

Features

- Single command source can be used to control both hydrostatic pump and motor.
- Servo control deadband independent of signal null deadband: offers safety combined with accurate and response control.
- Intrinsically safe pilot valve available - meets requirements for Class I, II and III, Division 1, Groups C, D and G for hazardous locations.
- Resistance to the environment: standard dry torque motor with optional silicone oil fill, environmentally sealed first/second stage interface, full environmental testing
- Minimum long term null shift
- Pilot supply screens in series, upstream screen is externally serviceable
- Plugged first stage orifice will not drive pump towards full stroke
- First and second stages can be individually replaced in the field
- Single or dual coil torque motor



Specifications

Electrical

THRESHOLD
16 ± 3.5 ma (single coil)
23 ± 4.6 ma (using one of the dual coils)
11.5 ± 2 ma (using the dual coils in series)
23 ± 4 ma (using the dual coils in parallel)

DEADBAND
32 ± 7 ma (single coil)
46 ± 9 ma (using one of the dual coils)
23 ± 4 ma (using the dual coils in series)
46 ± 9 ma (using the dual coils in parallel)

FULL STROKE CURRENT
90 ± 12 ma (single coil)
130 ± 18 ma (using one of the dual coils)
65 ± 9 ma (using the dual coils in series)
130 ± 18 ma (using the dual coils in parallel)
For sizing drive sources, use 100 ma in computations for single coil EDCs. See Figure 1.

COIL RESISTANCE @ 24° C (76° F)
23 ohms (single coil)
19.5 ohms (A, B terminals), 15.5 ohms (C, D terminals) (dual coil)

COIL RESISTANCE @ 104° C (220° F)
29 ohms (single coil)
24.7 ohms (A, B terminals), 19.7 ohms (C, D terminals) (dual coil)

SUGGESTED DRIVE VOLTAGES
The MCV105A EDC uses a pilot valve that is current-driven. Since coil resistance is a function of temperature, as the pilot's coil temperature increases, a higher input voltage is required

TABLE A.

	120° F (49° C) OIL TEMPERATURE		180° F (82° C) OIL TEMPERATURE	
COIL	CURRENT (ma)	VOLTAGE (Vdc)	CURRENT (ma)	VOLTAGE (Vdc)
SINGLE	90	2.2	90	2.5
DUAL COIL (Coil A)	130	2.7	130	2.4
DUAL COIL (Coil B)	130	2.2	130	2.4
DUAL COIL (In Series)	65 *	2.4	65 *	2.6
DUAL COIL (In Parallel)	130 *	1.2	130 *	1.3

* Algebraic sum of currents in the two coils.

to drive the pilot to full stroke. Table A demonstrates this relationship and lists the suggested voltage drives for two coil temperatures.

MAXIMUM CONTINUOUS VOLTAGE THAT WILL NOT DAMAGE THE DEVICE

7.5 Vdc (single coil)
6.8 Vdc (dual coil, with coil A used alone)
6.1 Vdc (dual coil, with coil B used alone)
9.2 Vdc (dual coils, with coils in series)
4.6 Vdc (dual coils, with coils in parallel)

COIL INDUCTANCE

.085 Henries (single coil)
.062 Henries (A, B terminals), .047 Henries (C, D terminals) (dual coil)

MAXIMUM CONTINUOUS CURRENT @ 104° C (220° F)

25% of full stroke current

Hydraulic

OIL VISCOSITY

40 - 6000 SSU

FLUID

Automatic transmission fluid or hydraulic oil (Ref. Mobil DTE 24 or equivalent)

FLUID TEMPERATURE

The valve will be functional and undamaged at oil temperatures of -40° to 121° C (-40° to 250° F). The valve will meet performance specifications with a fluid temperature of 21° to 82° C (70° to 180° F).

FILTRATION

The system hydraulics will have a filtration rating of $\beta_{10} = 2$ or better

Environmental

SHOCK

50 g's for 11 milliseconds. Three shocks in both directions of the three mutually perpendicular axes for a total of 18 shocks.

VIBRATION

Withstands a vibration test designed for mobile equipment control consisting of two parts:

1. Cycling from 5 to 2000 Hz in each of the three axes.
2. Resonance dwell for one million cycles for each resonance point in each of the three axes.

Subject to acceleration levels of 1 g to 46 g's. Acceleration level varies with frequency.

HUMIDITY

After being placed in a controlled atmosphere of 95% humidity at 49° C (120° F) for 10 days, the EDC will perform within specification limits.

Performance

CASE PROOF PRESSURE

1000 psi at 121° C (250° F). The control will operate with repeated case pressure surges of 500 psi.

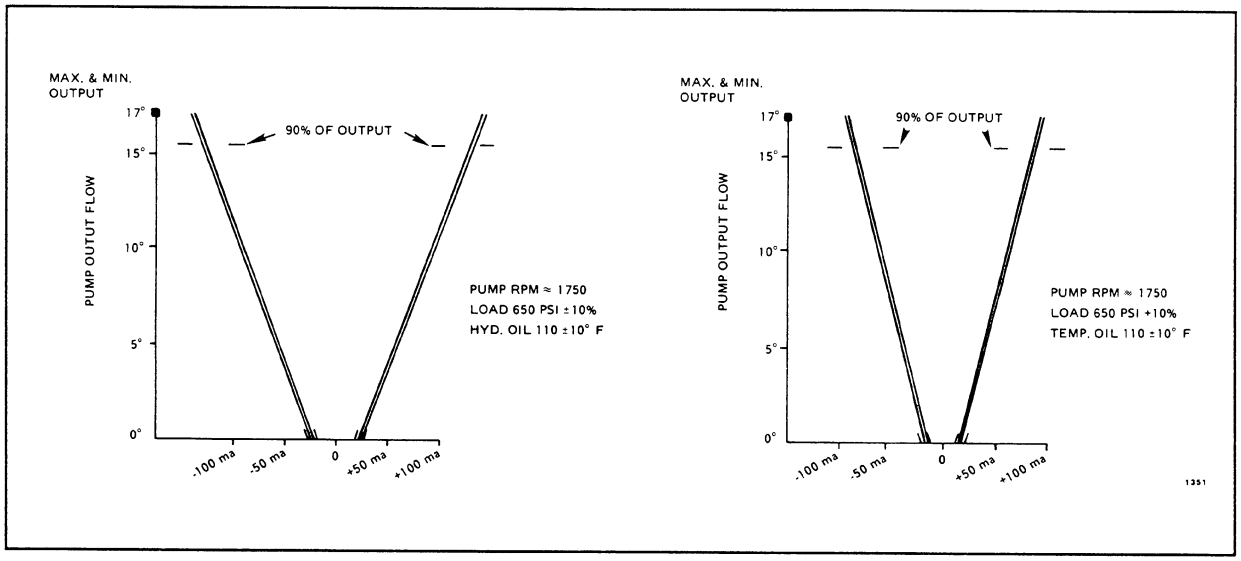


FIGURE 1. Input Current vs. Pump Swashplate Angle. Pump rpm is 1750 and the output load is 650 psi. Left curve is a single coil EDC and right is a dual coil.

MAXIMUM HYSTERESIS

4 ma at .01 Hz

SYMMETRY

Input current required to reach rated output in each direction must be equal within 16 ma.

LINEARITY

10% maximum of swashplate angle change between any two points except within 5 ma of the threshold current.

NEUTRAL LEAKAGE

.65 gpm maximum at 200 psi across the valve with oil of 145 - 160 SUS at 38° C (100° F).

POLARITY

A positive voltage applied to terminal B (single coil) terminals B or D (dual coil) will cause a pressure rise at the C2 port.

NOMINAL FREQUENCY RESPONSE

90° phase lag and negative 6db amplitude ratio at less than 3 Hz (defined without orifices in A and B ports and a charge pressure of 300 psi. The average current input is 40 ma with a sine wave input of ± 15 ma.) See Figure 2.

STEP RESPONSE (Null to 63% full stroke)

The response to a current step input of plus or minus 85 ma will result in a pump stroke response time of .5 ± .1 second to 63% of full stroke.

STEP RESPONSE (full to full), maximum

The response from full forward stroke to full reverse stroke varies per orifice size:

Orifice Size In Inches	Response In Seconds (± .9 seconds)
No Orifice	1.2
.037	2.7
.047	1.7
.055	1.3
.064	0.9

See Ordering Information.

SENSITIVITY

The valve will respond to a 2% change in input current throughout the rated current range except for the deadband region.

PULSE WIDTH MODULATION

When using a pulse width modulated current input, do not exceed 110 ma for single coil devices or 150 ma (algebraically summing the currents in coil A and B) for dual coil devices.

Avoid pulse width modulated frequencies between 300 and 500 Hz, which approach the pilot's resonant frequency of 400 Hz.

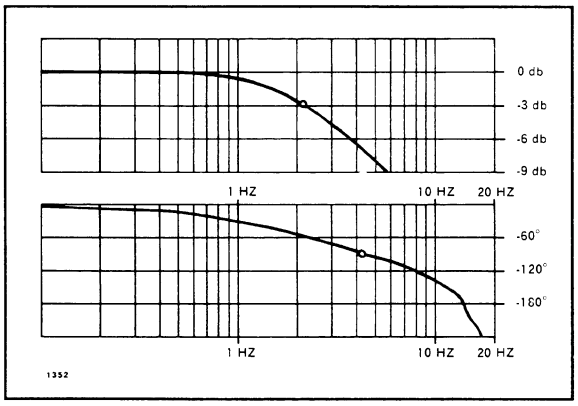


FIGURE 2. Amplitude and phase response of the MCV105A tested over the given frequency range with a supply pressure of 225 psi. Amplitude response curve is on top; phase lag is on bottom. The amplitude at low frequency is 40 ± 15 ma and the load is 650 psi. Frequency response varies with the applied load. Curves are shown with a current driver.

DIMENSIONS
See Figure 3.

Theory Of Operation

The MCV105A Electric Displacement Control (EDC) is a two-stage electrohydraulic pump stroke control which uses mechanical feedback to establish closed loop control of the swashplate angle of Sundstrand-Sauer Medium Duty Pumps.

The first stage, the MCV101A Pressure Control Pilot, is a torque motor actuated, double-nozzle flapper valve that produces a differential output pressure proportional to the applied electrical signal. The second stage uses the differential pressure to drive a linear motion piston which actuates a rotary spool through a cam and ports oil to the pump servo piston. The second stage spool configuration allows a null deadband (for machine safety) in the pump's output while maintaining optimum dynamic response to control commands.

A command source such as a control handle or electronic controller applies a dc current signal to the pilot stage of the MCV105A Electric Displacement Control. The input current commands the pilot's torque motor stage, a bridge network consisting of an armature mounted on a torsion pivot and suspended in the air gap of a magnetic field. Two permanent magnets polarized in parallel and a connecting plate form a frame for the magnetic bridge. At null the armature is centered in the air gap between the magnet's opposing poles by the equivalence of their magnetic forces and the null adjust centering springs. As input current rises, the end of the armature becomes biased either north or south, depending on the direction of the current. The resulting armature movement is determined by the amperage of control current and the differential pressure feedback forces, explained below.

The magnetic bridge output, flapper torque, in turn controls the hydraulic bridge ratio. At null, the flapper is centered between two nozzles. Upstream from each nozzle is an orifice which provides a nominal pressure drop when the system is at null. Between the nozzle and the orifice on each side is a control port. As the torque motor shifts the flapper away from one nozzle toward the other, a differential control pressure results, the high side being the one nearer the flapper. Fluid pressure rises on this side and moves the flapper back towards null. When the torque output from the motor equals the torque output from the pressure feedback, the pilot system is in equilibrium. It is this pressure feedback that makes the pilot a stand-alone closed loop pressure control valve.

The second stage of the EDC uses a piston and rotary valve arrangement that serves to separate the null deadband from the feedback, giving both safety against null drift and quick dynamic response to command changes.

The second stage's null adjust is set with the modulating spring compressed to the equivalent of 12 psi, which is the amount of differential pressure required to move the actuator spool one direction or the other. This is a factory setting that defines the width of the actuator spool deadband and cannot be changed. By tightening or loosening the null adjust screw, the fixed deadband is moved toward or away from the "A" control port.

As differential control pressure (C1 - C2) rises beyond the 12 psi deadband, the actuator piston moves in one direction or the other, pivoting a cam which turns a rotary valve. When the valve turns far enough, oil is ported to the pump servo piston, causing rotation of the swashplate in one direction or the other. As the swashplate turns, an attached valve sleeve, concentric with the rotary valve, turns and closes off the oil being ported to the servo piston. Thus the swashplate angle is forced to follow the angular input of the rotary valve.

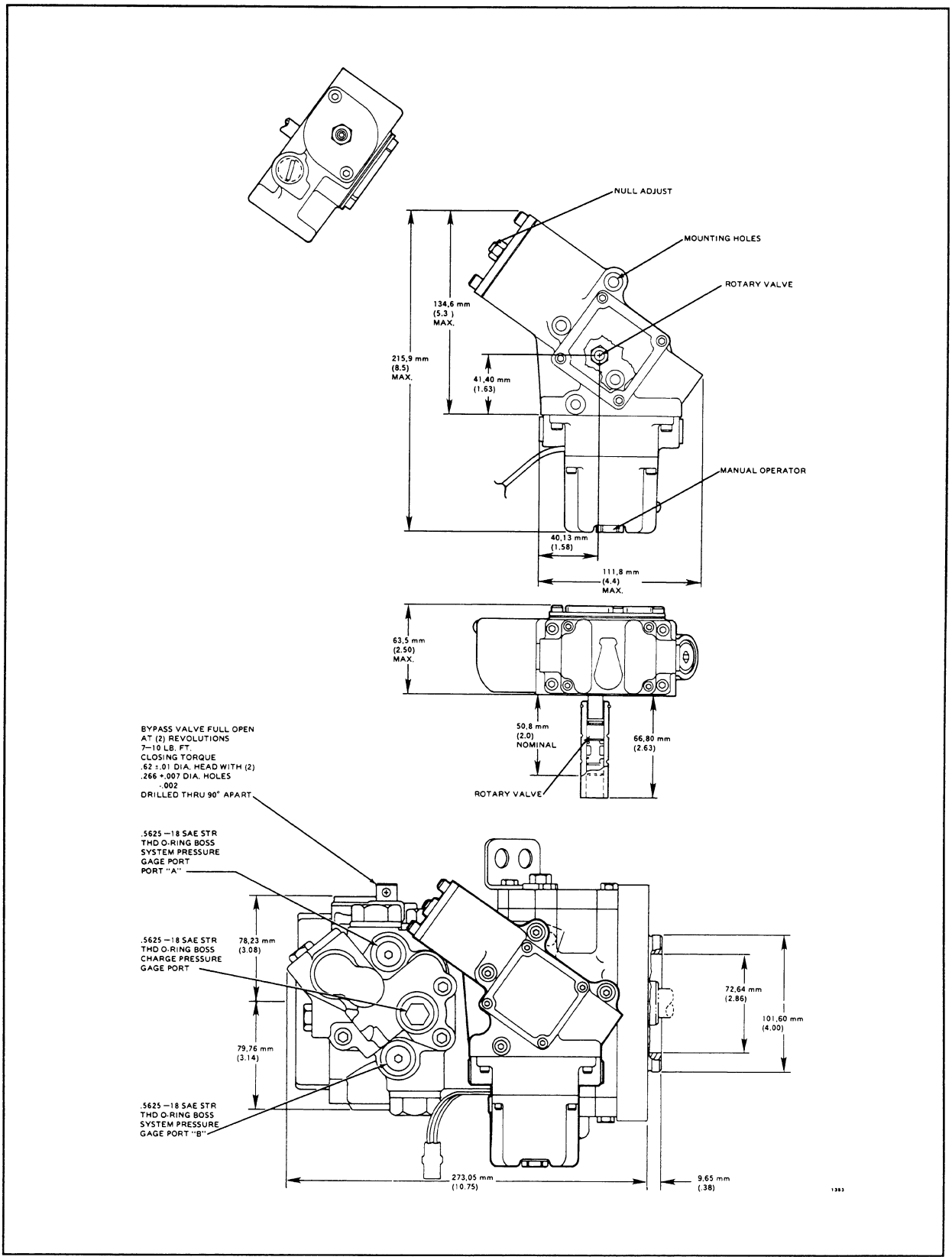


FIGURE 3. Dimensions of the MCV105A EDC in millimeters (inches).

Wiring

Two wiring styles are available: MS and Packard Connectors. The MS Connector is Part Number MS3102C14S-2P and has four pins, only two of which are used (A and B) for single coil devices. Its mate is Part Number MS3106E-14S-2S. See Figure 4 for proper pin locations. With both designs, phasing is such that a positive voltage on the Red wire (Pin B) will cause a pressure rise at the C2 port for single coil valves.

Included with the Packard Connector EDC is a bag assembly comprised of:

1. 2 (or 4) 14-16 gauge sleeves
2. 2 (or 4) 18-20 gauge sleeves
3. 1 plastic housing
4. 2 (or 4) gray cable seals
5. 2 (or 4) green cable seals
6. 2 (or 4) blue cable seals

See Ordering Information.

To assemble the female tower connector, use the following directions:

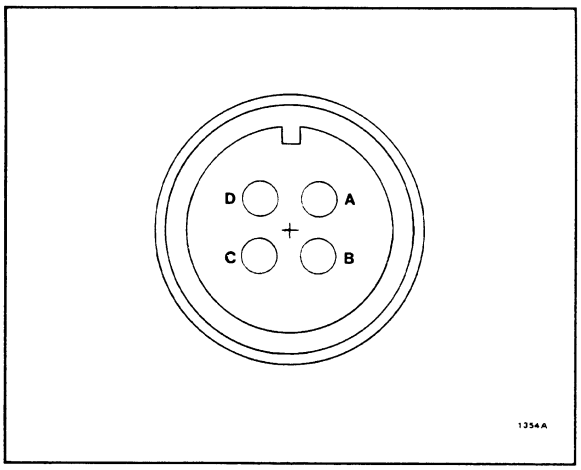


FIGURE 4. Pin orientation of the MS Connector (Part Number MS3102C14S-2P).

1. Isolate the wires that extend from the command source to the EDC.
2. Strip back the insulation 5.5 millimeters on both sides.
3. Tin (i.e., pre-solder) the exposed 5.5 millimeters.

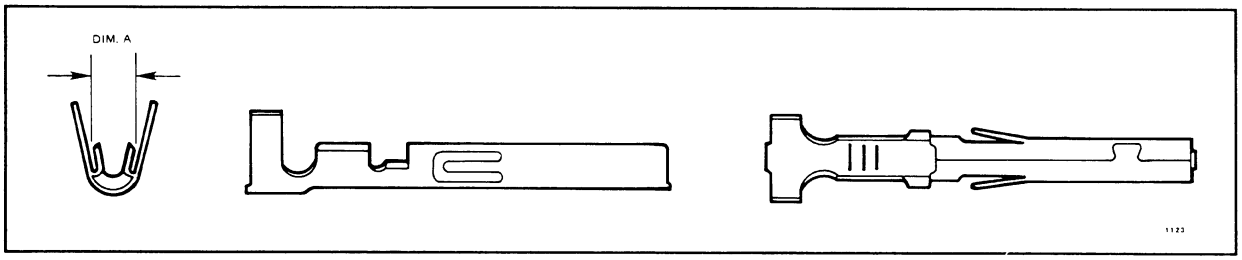


FIGURE 5. Dimension A for selecting correct terminal.

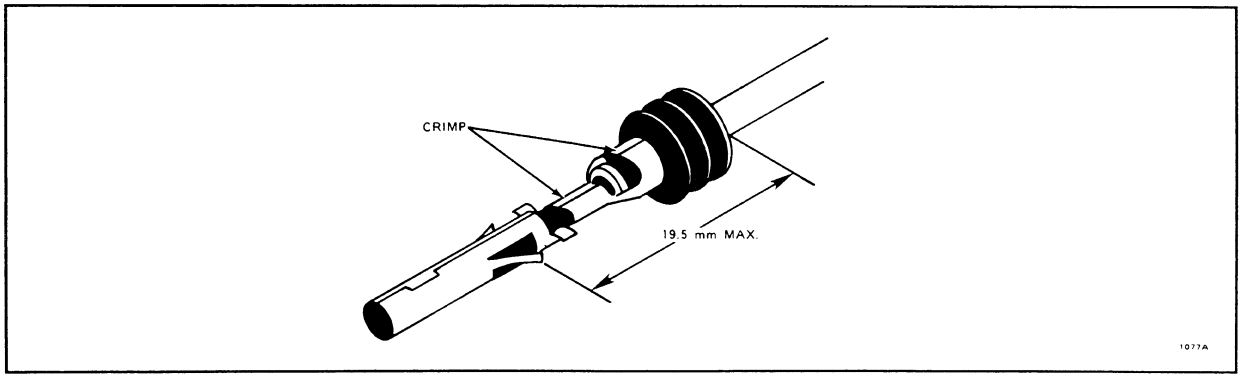


FIGURE 6. Distance from tang to third rib of Packard Connector.

4. Push a ribbed cable seal over each of the wires with the smaller-diameter shoulder of the seals toward the wire tip. Select the pair of seals that fits tightly over the wires. The distance from the tip of the wires of the first (nearest) rib should be 9.5 millimeters. Thus the insulation should just protrude beyond the seal.

5. Select the larger of the two sets of pins, as measured at Dimension A. See Figure 5 if using 14-16 gauge wire. Choose the smaller if using 18-20 gauge. Place the wire into the socket so that the seal edge is pushed through and extends slightly beyond the circular tabs that hold it in place. Crimp in the locations shown in Figure 6 with a Packard 12014254 crimp tool or needle nose pliers.

6. Reflow the solder by applying heat on the now-covered wire tips. Avoid overheating, which may destroy the spring characteristics of the dual lock tangs. The distance from the back of the tangs to the furthest rib may not exceed 19.5 millimeters. See Figure 6.

7. Manually insert the assembled wires into the back end (large hole) of the plastic housing. Push until the wire detents with an audible click, then pull back slightly to ensure proper seating (observe the proper phasing of the wires when installing: Black wire to "A" hole, Red wire to "B", Brown to "C" and Orange to "D"). Terminals may be removed from the connector bodies with a Packard 12014012 removal tool.

8. Swing the holder down into the detented position to trap the wires in the housing. The third rib should be sealed into the housing.

9. Plug the shroud connector from the valve into the tower connector just constructed. They are sealed with a double (or quadruple) plug seal over the double (or quadruple) barrel of the tower assembly. The two connector halves should detent into each other. See Figure 7.

Mounting

The following section refers to Sundstrand-Sauer pumps manufactured after April 1, 1986. These pumps have serial numbers whose first two digits are "03".

Included with the MCV105A EDC is a bag assembly (Part Number KK05601) which includes all hardware necessary to mount the valve. The bag assembly contains two shorter screws, two longer

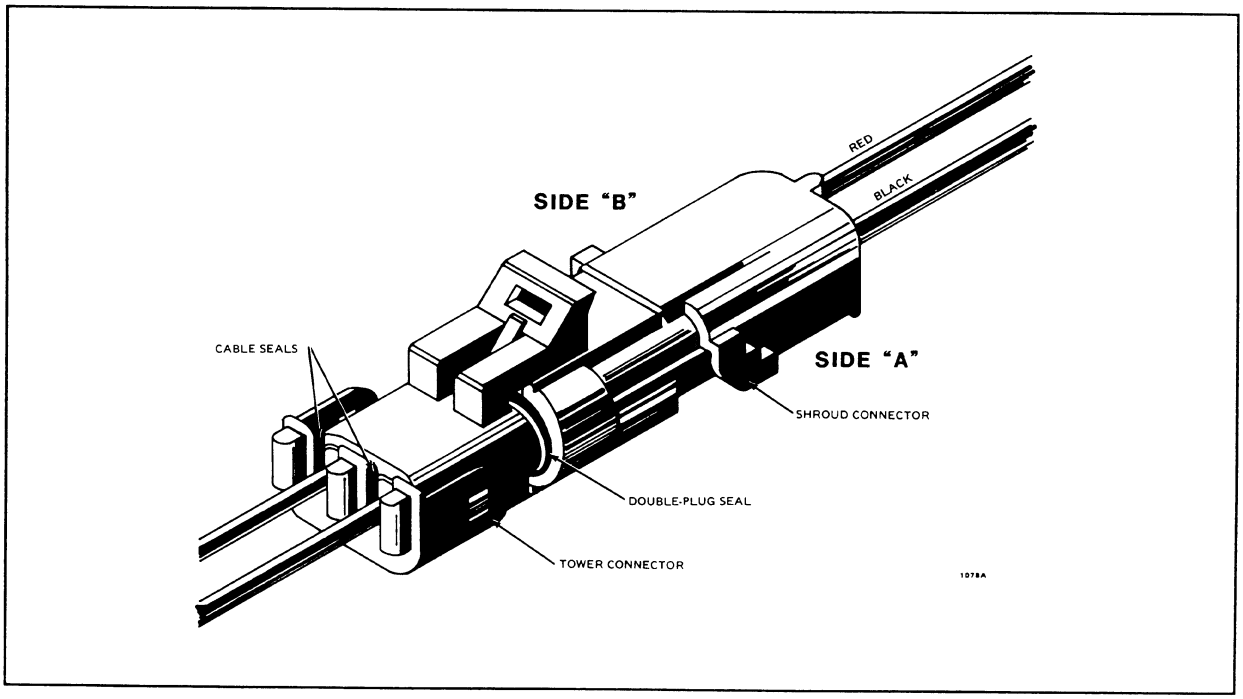


FIGURE 7. Interlocked connector halves with parts identified. Two wire connector shown.

screws, two smaller O-rings, one larger O-ring and this literature.

Removing The Old Control

If there is a manual control mounted on the pump, it must be removed before the MCV105A is mounted. To do so:

1. Thoroughly clean all external surfaces of the pump and control with steam or solvent. Blow dry.

2. Remove the bolt under the handle of the manual control. Lift off the handle, rotary spool and spring and bracket assembly. Use a vise grip to pull the old sleeve out of the pump. Remove the two pipe plugs from the pressure and return ports. Remove the inlet orifice in the pressure port.

If There Is No Manual Control

1. The EDC is shipped with an attached spool and sleeve assembly. Remove the sleeve from the valve. With the notch in the sleeve facing down and toward the pump shaft, place the sleeve in the pump valve bore until the attached snap ring bottoms out. See Figure 8.

2. If there are caps over the pump's pressure and return ports, take them off.

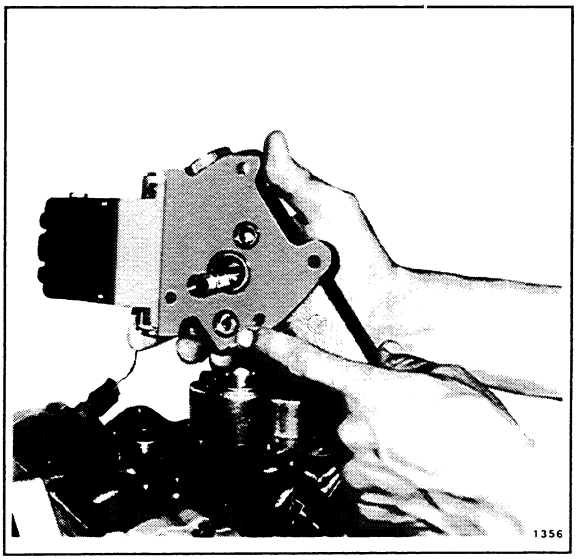


FIGURE 8. Sleeve placement on the pump.

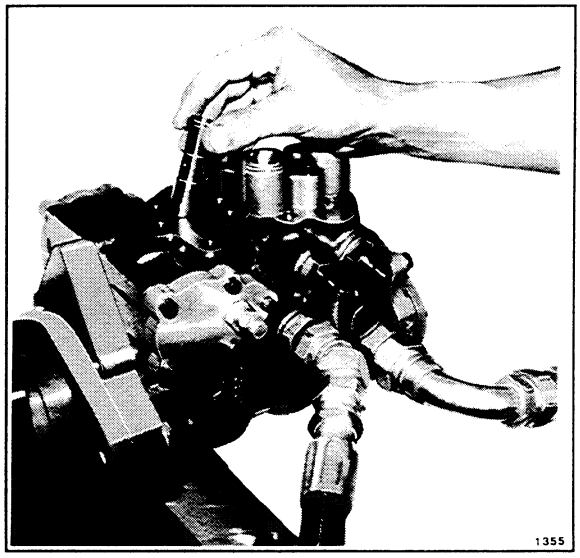


FIGURE 9. Electrical Displacement Control O-ring placement.

3. Put two smaller (.63" O.D. X .49" I.D. X .07" width) O-rings from the bag assembly into the pressure and return ports in the EDC housing. See Figure 9. Put the larger O-ring (1.00" O.D. X .86" I.D. X .07" width) into the sleeve counter-bore in the EDC housing.

4. Drop the EDC with attached spool carefully into the sleeve and onto the pump so that the four bolt holes are properly aligned. There is only one possible alignment.

5. Put the 2 short screws (1/4-20 X 3/4") through the bosses on the side of the valve. Put the two long screws (1/4-20 X 2.5") through the valve body. See Figure 3. Torque the four screws to 10-11 ft. lbs.

6. If needed, install control orifices under both servo covers.

Pump Neutral Adjustment

Use the following procedure to bring the pump to neutral once the electrical displacement control has been mounted.

1. Install a 300 psi gauge in each servo pressure gauge port on the pump. See Figure 10.

2. Using a 9/16-inch wrench, loosen the hex lock

nut on the null adjustment screw. See Figure 3.

3. Disconnect the electrical line at the connector.

WARNING

To adjust neutral requires operating the pump. Take the necessary safety precautions such as having unnecessary personnel stand away from the machine. Maximum system pressure may occur upon start up, and the machine may move. Ensure that the operator is not in a position to be injured should the machine move.

4. Start the prime mover and run at low idle.

5. Warm the system up for several minutes to bleed air.

6. Slowly increase the prime mover speed to rated rpm.

7. Slowly rotate the neutral adjustment screw, with a 5/32" Allen wrench, until the pressure is equal in both servo gauges.

8. Slowly rotate the neutral adjust screw until one of the servo gauges starts to increase in pressure.

9. Slowly rotate the neutral adjust screw in the opposite direction until the other servo gauge begins to increase in pressure. Note the amount the neutral adjust screw was turned in this step.

10. Turn the neutral adjust screw back one half the amount turned in Step 9.

11. Hold the neutral adjust screw and torque the lock nut to 25-30 in.-lbs.

12. Stop the prime mover.

13. Reconnect the electrical line.

14. Run the system briefly to ensure that it operates proportionally on both sides of the null command. Swashplate movement can be verified by watching movement of the swashplate feedback shaft, shown in Figure 3.

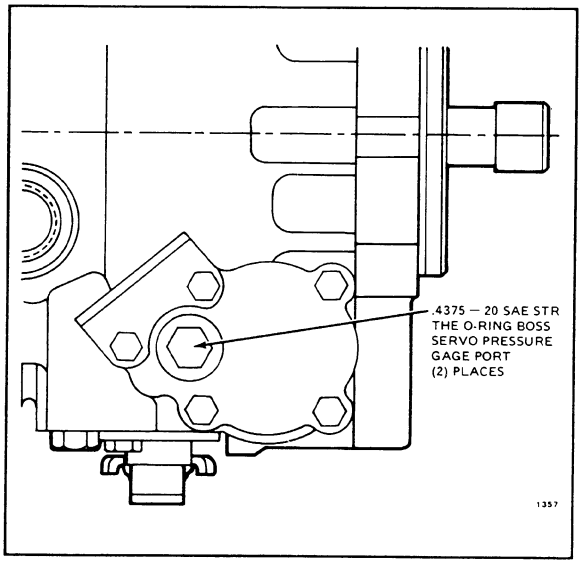


FIGURE 10. Location of one of the servo gauge ports on the pump.

Troubleshooting

The MCV105A EDC is one component in a control system. When the system fails, check the most obvious failure modes first. Is the battery fully charged? Is there a hydraulic leak somewhere? Are all connections tightly fastened? Are O-rings in place?

When a process of elimination indicates that the system problem may reside in the EDC, the failure mode is likely to be one of the following six.

WARNING

Electrical actuation of the valve and/or hydraulic jogging of the valve may cause pump output and movement by the driven machine. Take precautions to ensure that no personnel are in a position to be injured by the machine if it should move.

I. NO PUMP OUTPUT

1. Check voltage or current supply to the pilot stage. If faulty, check the electrical system. If fine:

2. Check the coil resistance in the pilot at the input connector to the pilot. The resistance across the two Pins (A and B) should be 23 ohms for single coil pilots. For dual coil pilots, resistance is 19.5 ohms across A and B and 15.5 ohms across C and D. If resistance is infinite across either coil, the pilot should be replaced.

3. Jog the manual operator on the top of the pilot. If the hydraulic system does respond, the failure must be an electrical problem. If there is no response, check the service filter in the casting for the possibility of damage or plugging. See Figure 3. If the filter is dirty, replace it. If it is clean, replace the pilot.

II. THE PUMP CANNOT BE NULLED OR CREEPS SLOWLY IN ONE DIRECTION

1. Replace the pilot with a spare. If the problem is solved, the pilot is faulty. If the problem is not solved, unbolt the second stage from the pump and check the spool and sleeve for contamination or damage. If cleaning these parts clears up the problem there is a filtration problem. Check the charge pump filter and change pump oil.

III. THE PUMP RETURNS SLOWLY OR NOT AT ALL TO NEUTRAL

1. Check charge pump pressure. If sufficient:

2. Unbolt the second stage from the pump and check the spool and sleeve for contamination or damage. If cleaning these parts clears up the problem there is a filtration problem. Check the charge pump filter and change pump oil.

IV. PUMP OPERATES IN ONE DIRECTION

1. Check the electrical signal from the command source. Current should flow in both directions. If not, there is an electrical problem.

2. Jog the manual operator on top of the pilot. This may free a contaminant in the pilot itself. If after several jogs to either side the pump continues to operate in only one direction, replace the pilot.

V. PUMP DOES NOT REACH FULL OUTPUT

1. Check the input current to the pilot. Verify that full drive current from the command source is at least as high as that specified in the Electrical section of the Specifications. If the current drive is high enough:

2. Jog the manual operator on the pilot. If full output is attained, replace the pilot. If pump output is low on both sides of null, the filter may be plugged in the second stage. If the pump output is full on one side and low on the other, replace the pilot.

VI. PUMP NULL DEADBAND IS ASYMMETRICAL

1. Adjust the second stage null using the null adjust procedure described previously.

2. If the problem persists and the noise from the pump on either side of null indicates that null is unstable (i.e., the pump creeps), replace the pilot.

   See Ordering Information for repairs and returns.

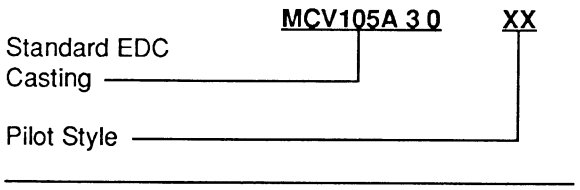
Spare Parts

Sundstrand-Sauer provides spare parts for the MCV105A. See Figure 11 for the item number/part number and description correspondence.

Ordering Information

The standard EDC is a single coil (one input to the torque motor), dry torque motor (no oil in the sealed motor cavity), Packard Connector device. The options are a dual coil, which allows two command sources to be compared at the torque motor, the resulting signal being the algebraic sum between the two, and an oil-filled torque motor cavity, which prevents moisture from condensing on the inside of the cover (necessary for machines encountering extreme temperature swings and/or high altitudes). MS-Type Connectors are the second connector option available. Dual pilot coils are available with both connector types. See Wiring section.

Order the MCV105A using the following information:



PILOT STYLE	DESCRIPTION
01	Dry Torque Motor, Single Coil, Packard Connector
02	Oil Filled, Single Coil, Packard Connector
03	Oil Filled, Dual Coil, Packard Connector
04	Dry Torque Motor, Dual Coil, Packard Connector
05	Dry Torque Motor, Single Coil, MS Connector
06	Oil Filled, Single Coil, MS Connector
07	Oil Filled, Dual Coil, MS Connector
08	Dry Torque Motor, Dual Coil, MS Connector

Order replacement parts through Sundstrand-Sauer, Minneapolis, MN. For a complete list of spare parts see Figure 11. All MCV105A orifices will be provided through Sundstrand-Sauer, Ames, IA.

Order the EDC either factory installed on pumps or as an individual control.

Order Factory Installed EDC On Pump From

SUNDSTRAND-SAUER
2800 East 13th. Street
Ames, Iowa 50010
(515) 239-6000

Order Individual EDCs From

SUNDSTRAND-SAUER
3900 Annapolis Lane North
Minneapolis, Minnesota 55447
(612) 559-2121

Device Repair

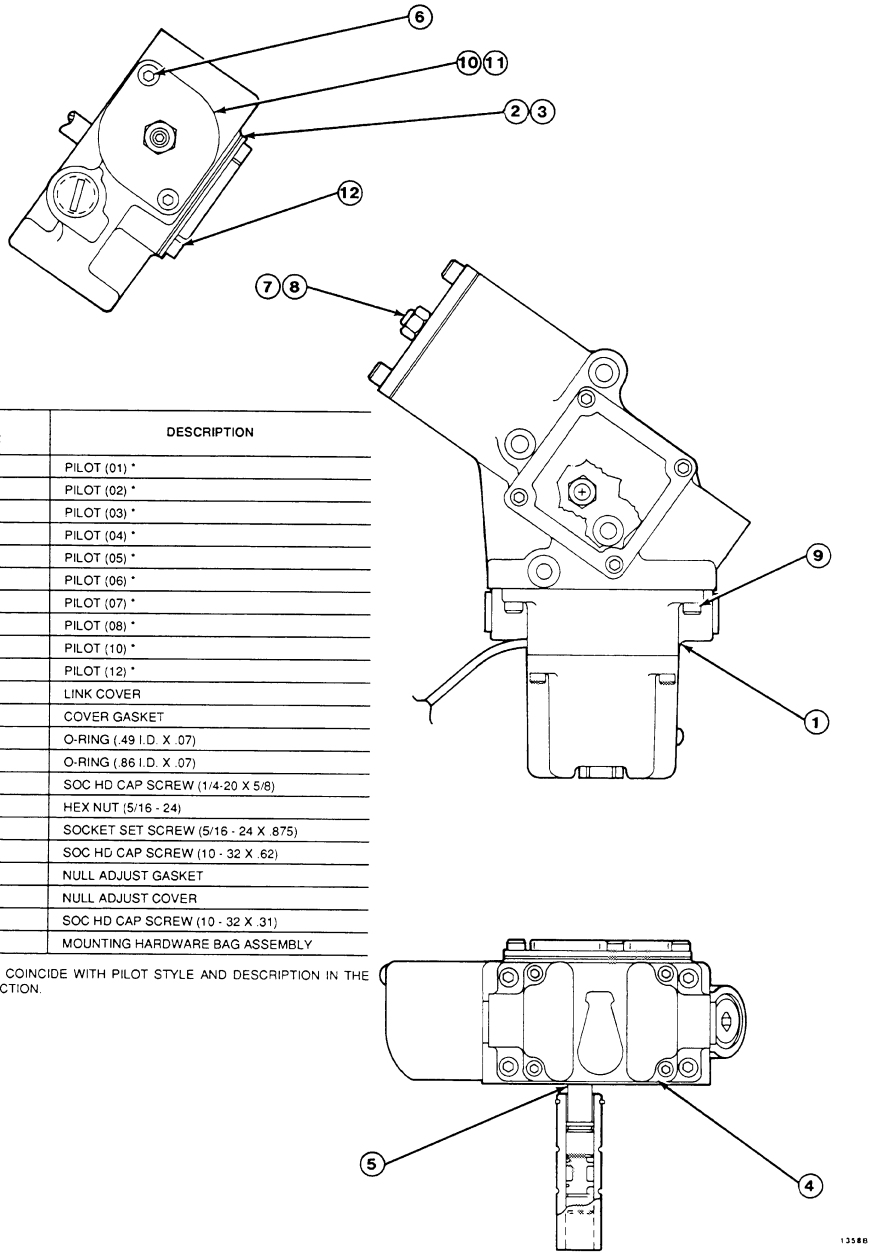
For devices in need of repair, include a description of the problem, a copy of the purchase order and your name and address.

Return To

SUNDSTRAND-SAUER
2800 East 13th. Street
Ames, Iowa 50010

OR

SUNDSTRAND-SAUER
Return Goods Department
3900 Annapolis Lane North
Minneapolis, Minnesota 55447



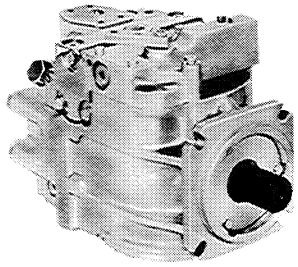
ITEM NUMBER	PART NUMBER	DESCRIPTION
1	MCV101A1214	PILOT (01) *
1	MCV101A1255	PILOT (02) *
1	MCV101A1248	PILOT (03) *
1	MCV101A1222	PILOT (04) *
1	MCV101A1313	PILOT (05) *
1	MCV101A1347	PILOT (06) *
1	MCV101A1339	PILOT (07) *
1	MCV101A1321	PILOT (08) *
1	MCV101C1063	PILOT (10) *
1	MCV101C1071	PILOT (12) *
2	K00941	LINK COVER
3	K00942	COVER GASKET
4	K00839	O-RING (.49 I.D. X .07)
5	K00840	O-RING (.86 I.D. X .07)
6	K07057	SOC HD CAP SCREW (1/4-20 X 5/8)
7	K06029	HEX NUT (5/16 - 24)
8	K00952	SOCKET SET SCREW (5/16 - 24 X .875)
9	K04064	SOC HD CAP SCREW (10 - 32 X .62)
10	K00943	NULL ADJUST GASKET
11	K00944	NULL ADJUST COVER
12	K04282	SOC HD CAP SCREW (10 - 32 X .31)
--	K02800	MOUNTING HARDWARE BAG ASSEMBLY

* NUMBERS IN PARENTHESES COINCIDE WITH PILOT STYLE AND DESCRIPTION IN THE ORDERING INFORMATION SECTION.

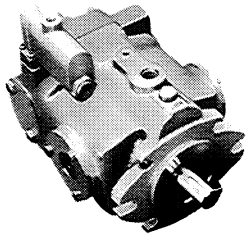
FIGURE 11. Spare parts locations.

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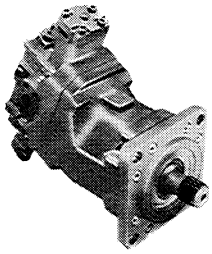
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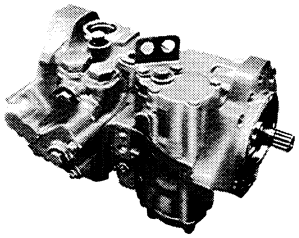
Heavy Duty Pumps and Motors



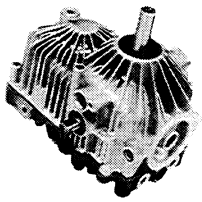
Open Circuit Pumps



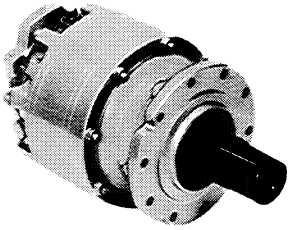
Variable Motors



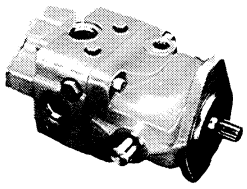
Series 40 Pumps and Motors



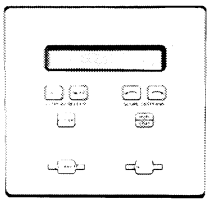
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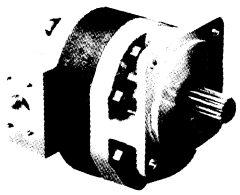
Gear Drives



Light Duty Pumps and Motors



Microcontrollers



Gear Pumps and Motors

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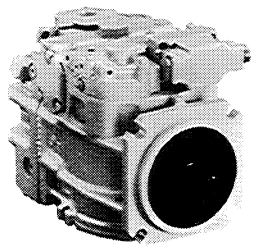
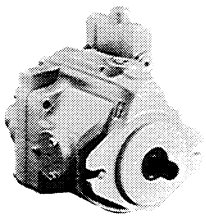
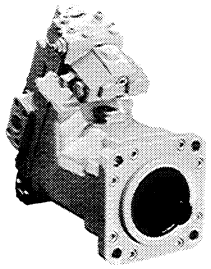
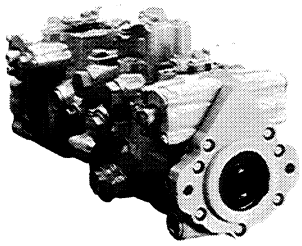
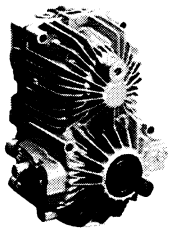
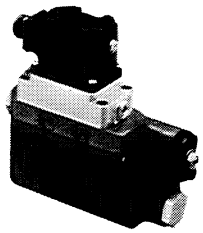
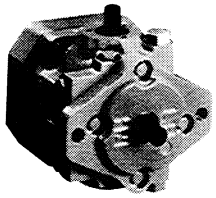
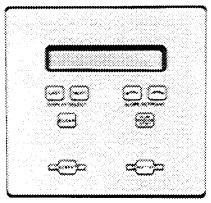
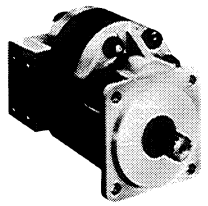


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