INTRODUCTION

This manual has been issued to provide you with technical information on the design and construction of the various components which make up the LIEBHERR hydraulic excavator. This manual also contains information for troubleshooting, removing, installing, disassembling, assembling and adjusting work, as well as valuable reference data such as adjustment values, tightening torques and pressure settings. Unless specific values are given, all threaded connections should be tightened according to the torque charts.

The descriptions are brief but precise and are supported by photographs, drawings - exploded and sectioned - electrical circuit diagrams, hydraulic as well as pneumatic schematics, and troubleshooting charts.

We deliberately avoided full photographic details of each repair stage, a practice often adopted in workshop manuals of this kind, since only skilled mechanics, already familiar with most repair work described in this manual, should perform repair work. All information is intended to simplify any necessary repair work which can be performed on the LIEBHERR hydraulic excavator.

Instructions on regular care and maintenance is excluded from this manual since they are covered in the individual operator instruction manuals.

To perform all repairs listed in this manual, a complete set of standard tools, as well as the special tools and fixtures shown and listed, is necessary.

No special emphasis is put on replacing sealing components since it is taken for granted that all removed seals, o-rings and gaskets are renewed during the course of repair.

Correct test and repair procedures will give the machine a long service life. Before starting a test or repair job, you must read the respective section of the workshop manual and know the components to be worked on. It is essential to keep all equipment, parts, tools, and working areas clean and tidy.

READ, UNDERSTAND AND OBSERVE ALL SAFETY PRECAUTIONS AND REGULATIONS.

WARNING: ⚠ This symbol, used throughout this manual, warns against potential hazards which could cause bodily injury or death to you or other persons. Carefully read and follow the given instructions.

CAUTION: Procedures that may result in damage to the machine or its components are identified by the word "CAUTION".

It is impossible for LIEBHERR to anticipate every circumstance that might involve a hazard. The WARNINGS and CAUTIONS in this manual are therefore not all conclusive. If a repair or test procedure not specifically mentioned by LIEBHERR is used, you must satisfy yourself that it is safe for you and others. Assure that the machine is not damaged or made unsafe by the procedures you choose.

Please note that all our published material is the property of LIEBHERR-HYDRAULIKBAGGER GMBH and is intended for the internal use of the workshop manual holders. No part of those publications, technical or otherwise, may be reproduced or copied in any form or by any means, without the written permission of LIEBHERR-HYDRAULIKBAGGER GMBH, Kirchdorf/Iller Abteilung VS.

We trust that with the information contained in this manual and your cooperation, we have taken antoher step toward achieving a still more satisfactory service standard for LIEBHERR excavators.

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TORQUE VALUES FOR NUTS AND BOLTS WITH STANDARD (COARSE) METRIC THREAD - GRADE 8.8

This chart provides the standard torque values for nuts and bolts. This torque chart should be used unless a specific torque is given in the manual.

The torque values and torque conversions are approximate (rounded up or down) and apply to nuts and bolts without additional treatment (not lubricated).

NOTE: The torque value for treated (cadmium plated) or lubricated nuts and bolts is (approx) 20% less of the values shown in the charts.

EXAMPLE: The torque shown in the chart is 50 Nm (37 ft-lbs)
50 Nm (37 ft-lbs) less 20% = 40 Nm (30 ft-lbs)

TORQUE CONVERSIONS: 1 Kpm x 7.233 = ft-lbs
1 Nm x .7375 = ft-lbs

BOLT SIZE	TIGHTENING TORQUE FOR BOLTS W/O LOCK WASHERS		TIGHTENING TORQUE WHEN USING LOCK OR RIB WASHERS	
	Nm	Ft-Lbs	Nm	Ft-Lbs
M 5 x 0.8	5	3.7	6	4.5
M 6 x 1	9	6.5	10	7
M 8 x 1.25	22	16	25	18
M 10 x 1.5	43	32	50	37
M 12 x 1.75	75	55	90	65
M 14 x 2	120	90	145	105
M 16 x 2	185	135	220	160
M 18 x 2.5	255	185	300	220
M 20 x 2.5	360	260	430	315
M 22 x 2.5	485	360	585	425
M 24 x 3	600	440	745	540
M 27 x 3	900	660	1,100	800
M 30 x 3.5	1,250	920	1,500	1,100
M 33 x 3.5	1,700	1,250	2,000	1,450
M 36 x 4	2,200	1,600	2,600	1,900
M 39 x 4	2,800	2,050	3,300	2,400
M 42 x 4.5	3,500	2,500	4,200	3,100
M 45 x 4.5	4,300	3,150	5,200	3,800
M 48 x 5	5,300	3,900	6,300	4,600
M 52 x 5	6,800	5,000	8,000	5,900
M 56 x 5.5	8,500	6,200	10,000	7,300
M 60 x 5.5	10,500	7,700	12,500	9,300
M 64 x 6	12,500	9,300	15,000	11,000

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SUB GROUP INDEX

1.3.00	Special tool chart for excavators
1.3.01	Mini Test system
1.3.02	Pressure Gauge
1.3.03	Flow Meter
1.3.04	Test Fitting
1.3.05	Spool clamp
1.3.06	Leakage plate
1.3.07	Spool travel measuring tool
1.3.08	Mounting tool for hydraulic cylinder Pumps, and variable flow motors
1.3.09	Piston wrench
1.3.10	Piston nut wrench
1.3.12	Piston nut wrench
1.3.13	Test Fitting for variable flow motors LMV
1.3.30	Special tool for Deutz Diesel Engines

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LUBRICANT CHART

SYMBOL IN ACCORDANCE WITH LUBR.-CHART	LUBRICATION POINT	SPECIAL LUBRICANT	LUBRICANT DESIGNATION	VISCOSITY SAE DIN 51512	COMPARABLE SPECIFICATIONS REMARKS
SAE 10W	Engine		CC 10 W CD 10 W	SAE 10 W	MIL - L - 46152 (MIL - L - 2104 B) MIL - L - 2104 C (MIL - L - 45199 or Series 3)
SAE 20 W20	Engine Gearbox		CC 20 W - 20 CD 20 W - 20	SAE 20 W - 20	MIL - L - 46152 (MIL - L - 2104 B) MIL - L - 2104 C (MIL - L - 45199 B or Series 3)
SAE 30	Engine		CC 30 CD 30	SAE 30	MIL - L - 46152 (MIL - L - 2104 B) MIL - L - 2104 C (MIL - L - 45199 B or Series 3)
SAE 80	Gearbox		API - GL - 4 - 80	SAE 80	MIL - L - 2105
SAE 90	Gearbox		API - GL - 4 - 90	SAE 90	MIL - L - 2105 B
K 2 K	Roller bearings (Slewing ring ball race) gen. lubrication points		K 2 K	Consistency 2 NL GI class DIN 51818	DIN 51825
△	Slewing ring teeth	*	Molydag 147/400		with autom. lub. of slewing ring
		*	LH - N 3013		with autom. lub. of slewing ring
			VISKOGEN LN 855		Messrs Optimal, Munich
			CEPLATTYNE		Messrs Reiner Weilerbach-Kaiserslautern
			Molub-Alloy 882 EP Arctic		Messrs Chemotechnik, Düsseldorf
		*	Compound Spray 2000 E		* can be obtained through Liebherr Spare Parts Service
			Adhesive lubricant		for open gearing

Remark : for turbocharges diesel engines use only CD oils (according to MIL - L - 2104 C).

HYDRAULIC OILS RECOMMENDED FOR HYDRAULIC EXCAVATORS, DOZERS AND WHEEL LOADERS

Single grade engine oils are specified in accordance with the
Mercedes Benz Lubricant Recommendations, pages 226 and 227.1

SYMBOL IN ACCORDANCE WITH LUBR.-CHART	LUBRICATION POINT AND AMBIENT TEMPERATURES	VISCOSITY	INSTRUCTIONS FOR WARMING UP
⬡	Hydraulic system - 10 °C to + 15 °C	SAE 10 W	1. With temperatures down to about 10° below the limit indicated, run engine at half rpm after starting. Operate motors and cylinders, holding cylinders at extremes of travel for a short time. Warming-up time approx. 10 minutes. 2. Where temperatures are of greater severity, warm oil tank before starting engine.
⬡	Hydraulic system 0 °C + 30 °C	SAE 20 W - 20	
⬡	Hydraulic system above + 10 °C	SAE 30	

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ENGINE MODEL		F3L 912	F4L 912	F5L 912 LK14	F6L 912 LK 13
MACHINE MODEL		A 900	A 900 ▲	A/R 902 ▲	A/R 912 ▲
			A/R 902	A/R 912	A/R 922
VALID FROM S/N		101	101	101	101
Displacement	cm^3/cu in	2827/173	3770/230	4712/288	5655/345
Engine output	Kw/HP	38/51	49 / 67	65 / 88,5	78 / 106
RPM		2300	==	==	==
Lowest operating RPM		1200	==	==	==
Direction of rotation		Left	==	==	==
Firing order		1-2-3	1-3-4-2	1-2-4-5-3	1-5-3-6-2-4
Minimum idle RPM		650 - 700	==	==	==
Oil pressure at max RPM		5 ± 0.5/71 ± 7	==	==	==
Oil pressure at idle RPM - min	bar/psi	0.5/7	==	==	==
Setting of oil pump safety valve		5-6/71-85	==	==	==
Bypass valve at filter	bar/psi	2.5 ± 0.3/36 ± 4	==	==	==
Compression ratio		17:1	==	==	==
Compression pressure (@150-200 RPM)	bar/psi	20-28/290-406	==	==	==
Firing sequence	°Kw	240	180	144	120
Valve clearance - intake	mm/in	0.15/0.006	==	==	==
Valve clearance - exhaust	mm/in	0.15/0.006	==	==	==
Valve spring - no tension	mm/in	59 ± 1.9/2.323 ± 0.075	==	==	==
Valve spring - fatigue limit	mm/in	56/2.205	==	==	==
Cylinder head capscrew normal length	mm	211 ± 0.5	==	==	==
Cylinder head capscrew limit length	mm	212.5	==	==	==
Cylinder new - min/max	mm	100 + 0.022	==	==	==
Cylinder oversize - min/max	mm	100.5 + 0.022/101 + 0.022	==	==	==
Cylinder wear limit	mm	+0.20	==	==	==
Piston new - min/max	mm	99.910 ± 0.009	==	==	==
Piston oversize - min/max	mm	100.410 ± 0.009	==	==	==
Piston to head clearance	mm	1.0 - 1.2	==	==	==
Piston ring groove width —	mm	+ 0.120	==	==	==
—1st groove	mm	2.205 + 0.100	==	==	==
Piston ring groove width —	mm				
—2nd & 3rd groove	mm	2.5 + 0.090 to 0.110	==	==	==
Oil scraper ring	mm	5.0 + 0.030 to 0.050	==	==	==
Piston ring side clearance					
—No. 1 compr. ring	mm	0.079 - 0.119	==	==	==
—Clearance limit	mm	0.5	==	==	==
—No. 2 & 3 compr. ring	mm	0.1 - 0.132	==	==	==
—Clearance limit	mm	0.3	==	==	==
—Oil scraper ring	mm	0.04 - 0.072	==	==	==
—Clearance limit	mm	0.15	==	==	==
Gap compression rings	mm	0.35 + 0.2	==	==	==
—Gap limit	mm	4.	==	==	==

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⚠ Warning: Do not disconnect any hoses, lines or fittings until all oil and air pressure in the main and servo system has been released. To avoid burns, be alert for hot hydraulic oil.

1. Remove Swing Gear

NOTE: Park machine on flat and solid ground, engage swing lock and lower attachment to the ground.

1.1 Remove drain plug 9 and drain gear oil.
1.2 Remove drain pipe 7.
1.3 Disconnect the hydraulic pressure hoses and leak oil line from the oil motor 4 (see above warning ⚠).
Remove bolts and oil motor 4.
1.4 Disconnect brake line 13 at the master cylinder 3 and the air line at the air cylinder.
1.5 Unscrew bolts 18 and remove protective cover 6, complete with master and air cylinder.
1.6 Remove gear mounting bolts 20 and 21. Using the mounting bolts, press the complete gear 1 out of its seat in the upper carriage. Install forged eye-bolts, knock roll pin 32 out of the gear housing and lift out swing gear.

NOTE: Use proper lifting devices as outlined in Sub Group 1.1.

1.7 For disassembly and assembly instructions, refer to Section 2.2.05.

2. Install Swing Gear

2.1 Lift the complete swing gear 1, with the roll pins 32 installed and lined up, into the upper carriage.

NOTE: Assure that the swing pinion is lined up with the swing ring teeth.

Install and torque gear mounting bolts 20/21 (see torque values).

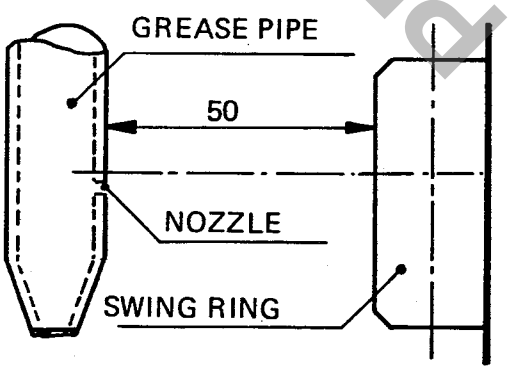
2.2 Install protective cover 6, complete with master and air cylinder, on the brake carrier using bolts 18.
2.3 Connect brake line 13 at the master cylinder 3 and air line at the air cylinder 10.
2.4 Install oil motor 4 on the swing gear mounting flange; install and torque bolts. Connect hydraulic pressure hoses and leak oil lines to the oil motor 4.
2.5 Install drain pipe and drain plugs 7 and 9.
2.6 Remove oil filler plug and refill swing gear with oil (10 ltr / 2.6 gal). See lube chart. Reinstall filler plug.
2.7 Bleed swing brake as outlined on Page 2.2.12.01.

3. Automatic Swing Ring Lubrication

Any time the swing gear/swing ring is removed and installed, the position and function of the grease pipe/spray nozzle has to be checked

NOTE: The distance from the grease pipe to the tooth point must be approx. 50 mm. The spray nozzle should point to the center of the tooth (see Figure 2).

FIGURE 2



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1. Introduction

Chapter 2.3 deals with the construction, function, repair and troubleshooting of the hydraulic system. In order to fully utilize this chapter, a basic knowledge of the hydraulic system is necessary.

a. Principles of Pressure
b. Principle of Flow
c. Hydraulic Graphical Symbols

To explain the Liebherr hydraulic system, pictures, cut-aways and graphic symbols are used.

- Pictures are useful in showing the inter-connection of components.
- Cut-aways empahsize construction.
- Graphic Symbols emphasize the function and methods of operation in the system and of components. Graphic symbols are also simple to draw and are capable of crossing the language barrier.

In Sub Group 1.2, the most commonly used hydraulic symbols are shown and described. However, basic symbols can be combined in any combination to make up a hydraulic schematic.

Full explanations of graphic symbols can be found in the American Standards Association Drafting Manual.

Due to limited space on schematics and charts, the data is given in Metric.

2. Safety

Read, UNDERSTAND, and observe all safety precautions. Improper repair procedures are dangerous and could result in bodily injury or death.

⚠ WARNING: This symbol warns against potential hazards which could cause bodily injury or death. Carefully read and follow the given instructions. See also Sub Group 1.1 Accident Prevention.

Your own safety, as well as the safety of others, is the number ONE consideration when working around the hydraulic excavator. To thoroughly understand a job to be done and the use of common sense is a matter of safety.

⚠ WARNING: Do not operate the hydraulic excavator until you have read and understand the instructions given in the Instruction (Operators) Manual. Improper machine operation is dangerous and could result in bodily injury or death.

⚠ WARNING: Always park machine on flat and solid ground. Block machine so it cannot roll or move while working on or under the machine.

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⚠ Warning: Do not disconnect any hoses, lines or fittings until all oil and air pressure in the main and servo system has been released.

1. Description and Operating Principle (see Schematic on Page 2.4.05.05)

During the following description, it is assumed that all components (valves) are in normal position and the system is without pressure.

1.1 The air compressor, 2, driven by the engine draws air from the air filter, 1, and delivers air via the antifreeze pump and pressure regulator, 3 and 4, to the air tank, 5.
The pressure present in the air tank, 5, and the connected air lines is also available at the pressure relief valve, 7, foot pedal brake valve, 22, air valve, 25, and the dual air pressure gauge, 20.

1.2 After reaching the opening pressure of relief valve, 7, the valve opens and air pressure flows to the second tank, 8, and to the air valve, 24, of the travel motor parking brake, 42.

1.3 Once the pressure in tank 8 reaches the opening pressure of relief valve, 10, the valve opens and air pressure flows to reducing valve, 11, brake valve, 23 and 27 (swing brake), gear selector valve, 29, air valve, 26 (stabilizer) and the push button valve, 28 (swing ring lubrication).

1.4 The pressure regulator, 3, controls the system pressure which must not be above or below a certain value. The system pressure is indicated by the black dial on the dual gauge, 20.

1.5 The pressure reducing valve, 11, reduces the system pressure to pressurize the hydraulic tank, 13.

1.6 The check valve, 12, prevents hydraulic oil from entering the air pressure system.

1.7 With the shut off valve, 15, the air pressure line to the hydraulic tank can be closed and the tank pressure can be released.

1.8 Any excessive air pressure in the hydraulic tank, 13, is prevented by the safety valve, 14, which opens at 1.2 bar (7 PSI).

1.9 Via the drain valves, 6/9, moisture may be drained from the air tanks, 5/8, (see Maintenance and Inspection schedule).

2. Actuate Foot Pedal Brake Valve, 22 - Travel Brake

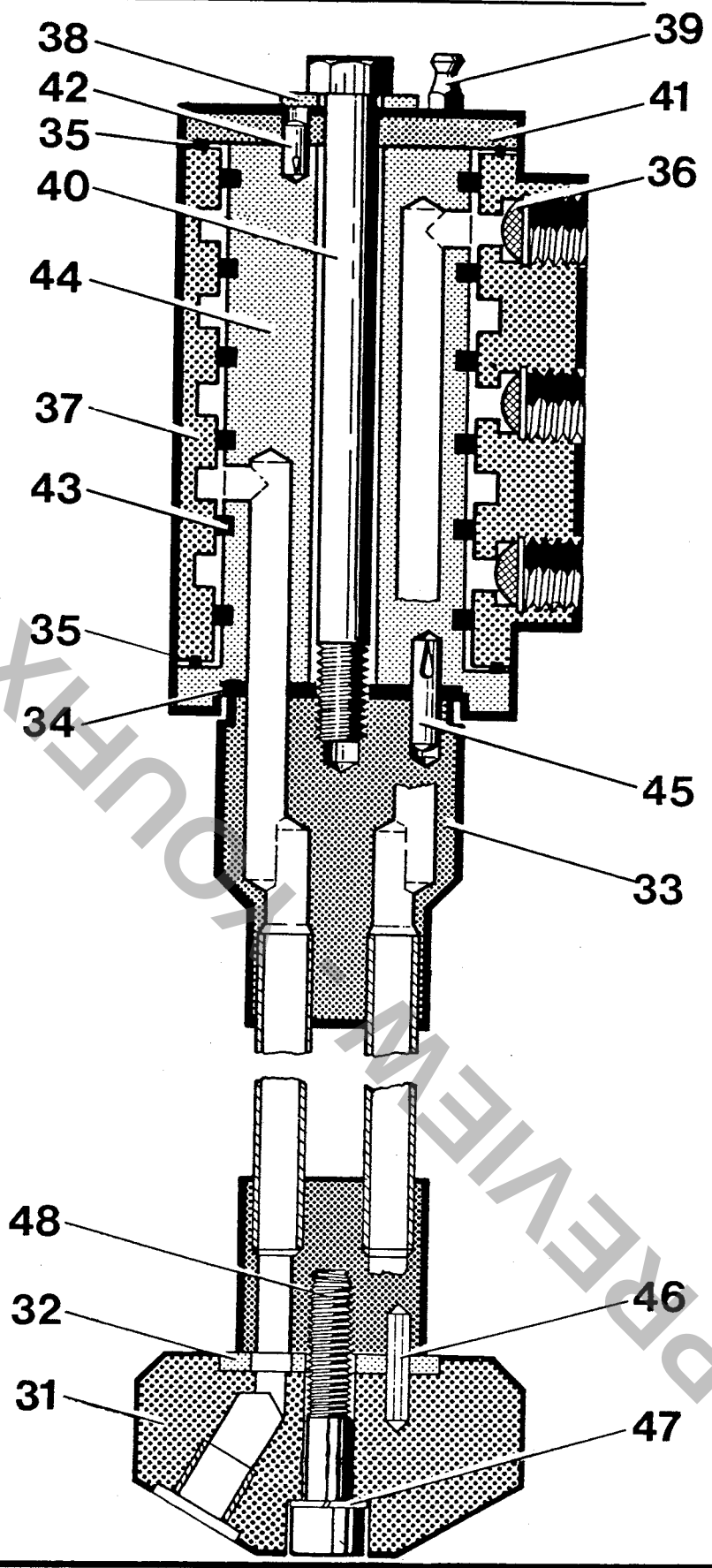
2.1 As soon as the brake valve, 22, located at the right front of the operator's cab is activated, air pressure flows via connection P to A to connection Y of the two-way check valve, 30.

The air pressure moves the piston in the two-way check valve, and the compressed air flows via connection A and the air rotary, 40, to the air cylinders, 44/47. The air pressure present in the travel brake circuit is indicated at the dual gauge, 20, with the red dial.

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FOR DETAILS OF CONSTRUCTION AND RESEALING, SEE BACK OF PAGE

30	Fitting
31	Connector
32	Sealing Plate
33	Spacer
34	Sealing Plate
35	Felt Ring
36	Strainer
37	Housing
38	Lock Plate
39	Grease Fitting
40	Hex Bolt
41	Cover
42	Dowel Pin
43	O-Ring
44	Rotor
45	Dowel Pin
46	Roll Pin
47	Spring Washer
48	Allen Bolt



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LIEBHERR	DESCRIPTION	MODEL	A MODELS
PRINTED	FIVE-WAY AIR CONNECTION	VALID FROM	101
FEBRUARY 1982		PAGE NO.	2.5.02.02

General Information to operate, maintain and repair the electrical system.

NOTE: Subgroup 2.6 is used to describe the basic function of the electrical system and some of its components. It also provides basic troubleshooting, testing and minor repair procedures.
It is not the intent of this subgroup to teach electrical theory or the design of electrical components.
The rebuilding of electrical components should only be attempted by personnel with the proper training and with the necessary facilities and according to the manufacturers specifications.

1. The electrical system has basically three separate circuits:

- the charging circuit
- the starting circuit
- low amperage (accessory) circuit.

The charging circuit is in operation with the engine running and the alternator (generator) producing electricity for the charging circuit. A voltage regulator in the charging circuit controls the electrical output to keep the battery fully charged.

The starting circuit is in operation only when the starter switch is actuated.

The low amperage (accesory) circuit as well as the charging circuit are connected to the same side of the Ammeter. The starting circuit is connected on the opposite side of the Ammeter.

CAUTION: To assure trouble-free operation of the hydraulic excavator the electrical system must be in good condition. The gauges, indicators and components of the electrical system should be checked daily for proper functions. Check the electrical system periodically as outlined below.

- Always replace burnt out fuses and bulbs. Check and correct the cause of the burnt out fuse, check for overloads. (Do not repair fuses.) Always keep spare fuses handy. Look for bare or damaged wires which could cause damage to the electrical system or a fire.

- Check for loose, dirty or corroded connections, particularly at the battery.

All "A" Model machines are equipped with a Main Battery Switch. This switch is manually operated and prevents damage to the major components, in case the electrical lines between the starter switch, starter and battery are damaged. In addition, the switch is a theft deterrent by turning the switch off and removing the handle.

CAUTION: The battery switch must not be operated with the engine running.

2. A properly maintained battery is of the utmost importance in any piece of equipment. Always keep the battery clean and the battery connections free of corrosion. If corrosion is present at the connections, clean outside of batteries with baking

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2.7.05	ENGINE OIL CAB HEATER DESCRIPTION, FUNCTION, OPERATION, MAINTENANCE AND REPAIR. (DEUTZ ENGINE ONLY)	A/R 902 to A/R 942
2.7.07	CAB HEATER INSTALLATION - DIL	A 900 from S/N 183 R 900 from S/N 101
2.7.08	CAB HEATER INSTALLATION - DIL	A/R 902 from S/N 101 A 912 from S/N 101 A 922 from S/N 101
2.7.09	CAB HEATER INSTALLATION - DIL	R 912,922,932,942 A 942 from S/N 101
2.7.10	CAB HEATER - MODEL DIL DESCRIPTION, FUNCTION, OPERATION, MAINTENANCE AND REPAIR.	A/R 900 to A/R 942

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1. Construction and Function of Two-Speed Gearbox

1.1 The two-speed gearbox is a multi-stage spur gear reduction unit driven by an axial-piston hydraulic motor. The hydraulic motor turns the drive shaft and differential and both front and rear axles.

1.2 The shifting of the gearbox is done by a three-position cylinder installed in the gear housing, and is controlled by compressed air from a four-way valve in the operator's cab.

1.3 Power flow in off-road range is from the input shaft 6 over gear 32 and selector sleeve 35, to output shaft 36.

1.4 Power flow in on-road range is from the input shaft 6 over gear 37 and selector sleeve 35, to output shaft 36.

Caution: The gearbox must only be shifted when the excavator and the hydraulic motor are at a standstill. When the excavator is towed, the shift lever must be in position 1 (neutral position).

2. Remove Gearbox

For removal of the two-speed gearbox from the undercarriage, see Page 3.1.03.01.

3. Disassemble Gearbox

3.1 Loosen the brake with a 24 mm open end wrench and an 8 mm punch (see description of the spring loaded air cylinder on Page 2.4.27.01). Remove split pin 74, pin 73 and connector 72 from lever 65. Remove bolts 66 and 67. Remove air cylinder 64 complete from gearbox.

3.2 Remove bolts 86 and hydraulic motor 90. Remove nuts 18 and adapter flange 3 from housing 2. Unscrew bolt 78 and remove cover 70.

3.3 Remove allen bolts 47 and cylinder 48. Remove upper snap ring 49, piston 50, o-rings 51 and 52. Remove lower snap ring 49, bushing 57 and thrust washer 54. Pull o-ring 52, spring 58 and bushing 59 off of shaft 62.

3.4 Remve bolts 45 and brake drum 46. Open lock plates 22, unscrew bolts 21 and pull both output flanges 24 and 43 complete with thrust washer 23, off output shaft 36.

3.5 Remove bolts 40 and brake 39 complete. Remove output shaft 36 complete with gear 37, bearing 27 and brake carrier 38, out of gear 32 and housing 2.
Note: Lock gear in axial position.
Press brake carrier 38, bearing 27, thrust washer 28, gear 37 and needle bearing 33 from output shaft 36.

3.6 Remove seals 26 from brake carrier 38 and cover 25. Remove selector sleeve 35 and gear 32 out of housing 2. Push needle bearing 33 out of gears 32 and 37. Knock out roll pin 60 and remove shifting rod 62 and selector fork 61 out of housing.

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1. Remove Complete Front Axle

1.1 Park the machine on flat and solid ground and lower attachment to the ground. Release air pressure in hydraulic tank. SECURE rear axle wheels with wheel chocks.

⚠ WARNING: DO NOT disconnect any hoses, lines or fitting until all oil and air pressure in the main and servo system has been released.

Raise the front of the machine until the tires are off the ground. Support undercarriage with wooden blocks and lower machine.

1.2 Remove front wheels. Disconnect brake lines from wheel cylinder and the pressure lines from steering cylinder 5.

1.3 Remove drain plug 9 and 84, drain gear oil and reinstall plugs.

1.4 Remove drive shaft between two speed gear box and differential 6.

1.5 Support front axle and attach a proper lifting device to the front axle. Remove nuts 92 and carefully lift axle from undercarriage.

1.6 For front axle disassembly and assembly instructions, see Sub Group 3.2.10.

2. Install Complete Front Axle

2.1 Using the proper lifting device, lift front axle under the uppercarriage, install front axle using bolts 90 and nuts 92.

2.2 Install drive shaft between gear box and differential 6.

2.3 Remove drain plug 9 and 84, refill with the proper oil. See Sub Group 1.5. Reinstall drain plugs 9 and 84.

2.4 Connect pressure lines to steering cylinder 5 and brake lines onto wheel cylinder. Start machine, check for leaks and bleed brakes as outlined in Sub Group 3.5. Install wheels and torque lug nuts. Raise machine, remove wooden blocks. Check machine for proper operation.

3. Remove Differential 6 from Front Axle (Front axle installed)

3.1 Proceed as outlined in paragraph 1.1 and 1.2.

3.2 Remove drain plug 9, drain gear oil, reinstall drain plug. Support both wheel hubs with wooden blocks or install proper lifting device.

3.3 Remove split pins 7.4 /34.4 and castle nuts 34.3 /7.3. Remove pins 7.1/34.1. Remove tie-rod 4 and steering cylinder 5.

3.4 Remove drive shaft between two speed gear box and differential 6.

3.5 Remove bolts 32 and press out king pins 28/29 using a grease gun. See also Sub Group 3.2.10. Do not damage sealing washers 18.

3.6 Carefully pull steering knuckle 3/27 complete with wheel hub from the axle housing 2, until the drive axle 26 is pulled out of the differential.

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1. Construction of Steering Unit - See Figures 1 and 2.

1.1 Hand Pump

The hand pump, 10, delivers the oil coming from the steering pump to the steering cylinders. When the steering wheel is turned, the drive shaft, 12, is turned through the steering spindle, 19, and the rotating bar, 14. The drive shaft engages with the internal rotor, 10.2, for the hand pump and turns it.
The rotor is driven by the drive shaft, 12, which is connected to the steering wheel via steering spindle, 19. The rotor is carried on the internal splines of the stator, and executes a planetary movement when turned. This is in the opposite direction to the movement of the steering spindle and at 6 times greater angular velocity. The actuating journal of drive shaft, 12, drives control disc, 8, which is thus synchronized with the rotor, so that the suction and discharge zones created as the hand pump revolves are also linked continuously with the fixed supply and outlet channels in the steering housing.

1.2 Control Valve

As steering spindle, 19, is turned in one direction or the other, valve spool, 13, moves away from its central position axially, and at the same time rotates with the steering spindle.
Axial movement of the valve spool, 13, is obtained by a relative rotary movement between the steering spindle, 19, and the drive shaft, 12, resulting from the reactive force of torsion bar, 14. When the spool valve is displaced, oil flows from the engine-driven pump to the hand pump and from there to the appropriate side of the steering actuating cylinder.

1.3 Primary Valve

The primary valve, 32, in the housing restricts the engine-driven pump discharge pressure to 100/130 Bar.

1.4 Secondary Valve

The two secondary valves in the steering unit are set to 200 Bar. These open only when shocks received from the road cause sudden peak pressures to build up in the power steering circuit.

1.5 Suction Valves

The two suction valves, 35, ensure that oil from the return, connection "T", can be brought to the appropriate inlet side of the hand pump when the engine pump is stopped.

1.6 One-Way Check Valve

The check valve, 38, in the housing, 1, connection "P", prevents the oil from entering connection "P" if steering is operated with the hand pump only.

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2. Two-Way Valve (see Fig.2)

2.1 Function of Two Way Valve.

The two-way valve 19.1 is a hydraulic valve, operated by compressed air, with two settings, two operating circuit connections A and B, a leak oil connection L and an oil return connection RV which replenishes the system if oil is lost. The valve return movement is provided by a coil spring.

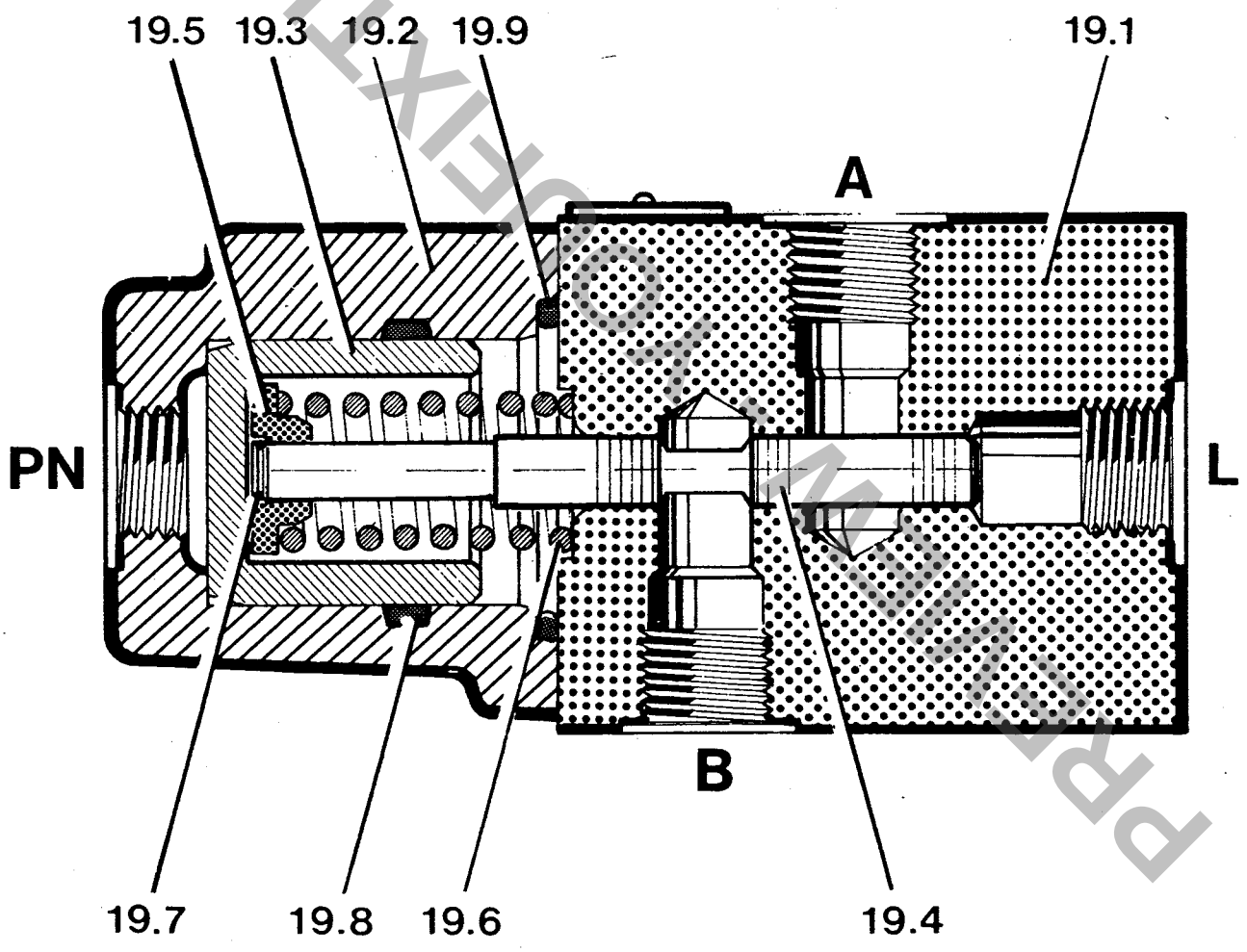
2.2 Disassembly of Two-Way Valve

Remove air and hydraulic lines from the valve 19.1. Then remove valve. Remove bolts from cover 19.2 and cover with piston 19.3. Pull piston 19.3 out of cover 19.2; remove snap ring 19.7, spring retainer 19.5, spring 19.6, piston 19.4, rubber seal 19.8 and o-ring 19.9.

2.3 Assembly of Two Way Valve

Insert piston 19.4 into the housing. Place coil spring 19.6 and spring retainer 19.5 onto piston and insert snap ring 19.7. Install rubber seal 19.8 and o-ring 19.9 into cover. Insert piston 19.3 and bolt cover 19.2 to housing 19.1.

FIGURE 2



19.1 Housing
19.2 Cover
19.3 Piston
19.4 Piston
19.5 Spring Retainer
19.6 Spring
19.7 Snap Ring
19.8 Rubber Seal
19.9 O-Ring

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SUBGROUP - INDEX

SUPPLEMENTS

FOUR - WHEEL BRAKE

3.5.01 PRESSURE CHART AND INSTRUCTIONS

3.5.02 DESCRIPTION OF REMOVING AND INSTALLING FOUR-WHEEL BRAKE

3.5.03 CONSTRUCTION AND FUNCTION OF BRAKES AND BLEEDING OF BRAKE SYSTEM

3.5.04 DESCRIPTION - FUNCTION AND ADJUSTING HYDRAULIC - SIMPLEX BRAKE

DESCRIPTION OF OPERATION AND REPAIR OF WHEEL CYLINDERS

3.5.05 DESCRIPTION - FUNCTION AND REPAIR OF MASTER CYLINDER

3.5.06 TROUBLESHOOTING OF BRAKE SYSTEM

PARKING BRAKE

3.5.10 CONSTRUCTION - FUNCTION AND INSTRUCTIONS OF BRAKE (PNEUMATIC)

3.5.11 FUNCTION AND ADJUSTING OF BRAKE (MECHANICAL)

3.5.12 TROUBLESHOOTING OF BRAKE SYSTEM

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3. Remove Swing Ring (see Figures 7, 8 and 9)

To replace the swing ring, the upper carriage has to be lifted off by one of two methods:

a. Using an overhead lifting device (crane). When using this method, the complete attachment has to be removed before the upper is lifted off. Lifting and shoring material, such as chains, cables, slings, shackles and wood should be properly selected (see column showing weight of upper carriage).

b. The second and most common method to remove the upper carriage is with the use of hydraulic jacks and the machine's hydraulic power.

NOTE: Check boom cylinders for internal leakage and correct if necessary.

⚠ WARNING: When replacing the swing ring (separating the upper carriage from the undercarriage), the manufacturer's instructions must be followed and all safety regulations must be observed. It is not permitted or necessary for any person to be under the jacked up upper carriage. For method "b", see the following instructions:

3.1 Park the machine with upper carriage turned 90° on flat and solid ground. Retract stick and bucket fully, and lower the attachment to the ground. Release air pressure in hydraulic tank. Secure wheels with wheel chocks.

⚠ WARNING: DO NOT disconnect any hoses, lines or fittings until all oil and air pressure in the main and servo system has been released.

3.2 Mark, remove and plug air and hydraulic oil pressure lines from the rotary connection in the undercarriage. Collect fluid in a suitable container.

3.3 Mark, remove and plug air and hydraulic oil pressure lines from the rotary connection in the upper carriage. Disconnect and remove air rotor and air lines from rotary connection.

3.4 Disconnect lube line, item 36, from the grease tube, item 26. Remove bolt item 32, and lift out the grease tube, item 26.

3.5 Remove bolts from rotary mounting flange and lift the complete rotary connection out (see Section 2.5, Rotary Connection, for more details).

3.6 Remove bolts (see Figure 7), item 15, which hold the swing ring to the upper carriage, with the exception of the two opposite bolts, front and rear.

3.7 Erect wood platform and position hydraulic jacks under the counterweight as shown in Figures 7 and 8. Remove the remaining two swing ring-to upper bolts.

3.8 Lift the upper carriage, by actuating the hydraulic boom cylinders, approximately 60 to 80 mm (2 to 3 in.), or half of the swing ring height, and leave the cab. Raise the other end of the upper with the hydraulic jacks until the upper carriage is completely clear (see swing gear pinion Figure 7). To prevent the upper carriage from sinking (hydraulic jacks may leak down), additional wooden blocks must be installed (see Figures 7 and 9).

3.9 Carefully pull out the undercarriage and secure upper carriage with an additional wooden platform, as shown in Figure 9, item 17.

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TYPE	MODEL NUMBER	ATTACHMENT	DRAWING NUMBER	REMARK	GROUP	UL x TYPE
A 912	144 Single Outrigger	Adjustable Boom	26 110 1000 61 000	w/o Outrigger	5.2.04	B
A 912	145 double Outrigger 145 double Outrigger with 4 m Basis double Outrigger 922 Undercarriage	Industrial Boom Bore II	26 110 2000 61 000	w/o Outrigger	5.2.04	B
A 912	145 double Outrigger	Industrial Boom Bore II	26 169 1000 63 000	switchable w. Outrigger	5.2.05	B
A 912	145 double Outrigger with 4 m Basis	Industrial Boom Bore II	26 169 2000 64 000	switchable w. Outrigger	5.2.05	B
A 912	922 Undercarriage double Outrigger	Industrial Boom Bore II	26 169 3000 65 000	switchable with Outrigger	5.2.05	B
A 912	145 double Outrigger	Industrie Gooseneck Boom Bore II	26 169 4000 66 000	switchable w. Outrigger	5.2.05	B
A 912	922 Undercarriage double Outrigger	Industrie Gooseneck Boom Bore II	26 169 5000 67 000	switchable with Outrigger	5.2.05	B
A 912	145 double Outrigger 4 m Basis	Industrie Gooseneck Boom Bore II	26 169 6000 68 000	switchable w. Outrigger	5.2.05	B
A 912	922 Undercarriage double Outrigger	Industrie Gooseneck Boom Bore II	26 169 5000 67 000	switchable w. Outrigger	5.2.05	B
A 912	145 double Outrigger 4 m Basis	Industrie Gooseneck Boom Bore II	26 169 6000 68 000	switchable w. Outrigger	5.2.05	B
R 912	146 Standard Undercarriage	Adjustable Boom	26 127 1000 61 100		5.2.04	A
R 912	146 Standard Undercarriage	Gooseneck Boom	26 126 1000 61 100		5.2.04	A
R 912	147 LC-Undercarriage	Adjustable Boom	26 127 2000 61 100		5.2.04	A
R 912	147 LC-Undercarriage	Gooseneck Boom	26 126 2000 61 100		5.2.04	A
R 912	147 LC-Undercarriage	Industrie Gooseneck Boom Bore II	26 520 2000 02 000		5.2.04	A
R 912	148 HD-Undercarriage	Adjustable Boom	26 127 3000 61 100		5.2.04	A
R 912	148 HD-Undercarriage	Gooseneck Boom	26 126 3000 61 100		5.2.04	A
R 912	148 HD-Undercarriage	Adjustable Boom Boom Rotator	26 127 8000 61 000		5.2.04	A

x UL = Overload-Warning-System

Type A/B see therefore description on page 5.2.02.01

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SUB GROUP-INDEX

5.3.01	HYDRAULIC CYLINDER - TORQUE VALUES	
5.3.02	REMOVING AND INSTALLING HYDRAULIC CYLINDERS	
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5.3.21	HYDRAULIC CYLINDER ARRANGEMENT	A/R 902
5.3.22	HYDRAULIC CYLINDER ARRANGEMENT	A/R 912
5.3.23	HYDRAULIC CYLINDER ARRANGEMENT	A/R 922
5.3.25	HYDRAULIC CYLINDER ARRANGEMENT	A/R 942

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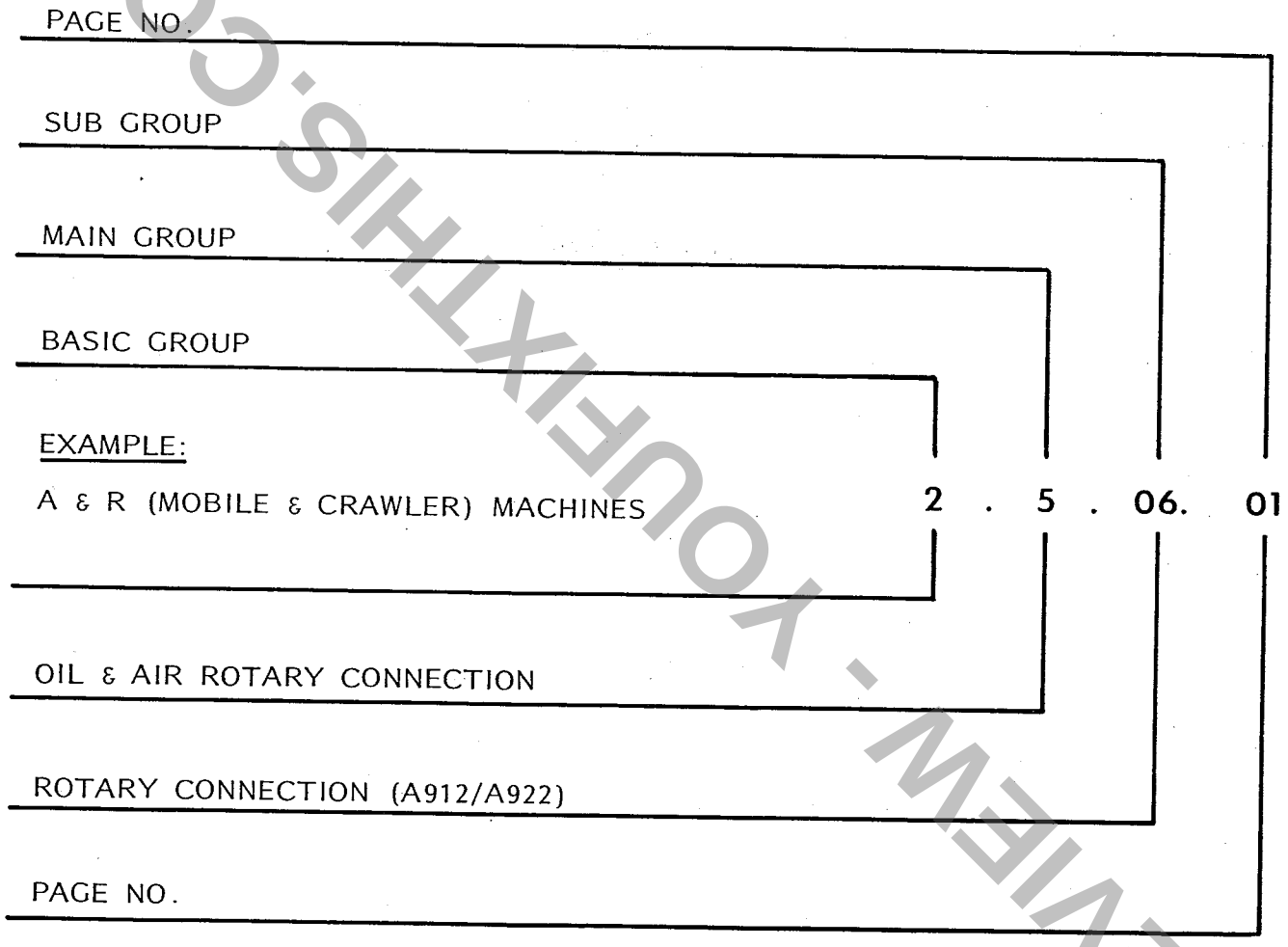
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EXPLANATION OF PAGE (INDEX) NUMBERS

All Workshop manuals, as well as technical publications, are issued in accordance with the below listed numbering system. This system allows us to remove and/or add pages, in case of changes or improvements.

EXAMPLE: Page No. 2.5.06.01

Page No.



The Index for the basic and main group is found at the front of the book. At the beginning of each main group, you will find a sub group index. In case of minor changes or additions to a sub group, a notation will be made at the sub group index under supplements and a number will be added to the page number. Example: 2.5.06.01/01.

If a complete sub group is updated, a new sub group number will be assigned. Again a notation will be made at the sub group index under supplements.

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Troubleshooting for capacitive sensor control

Problem

The low idle automatic does not shift to the pre-selected engine speed when touching the joysticks 4/5 or when the foot pedal is depressed.

Test / **Remedy**

1 No function with the foot pedal 6 depressed.

2 Complete the circuit on plug 13, terminal 2/3. Any function?

- Yes → Adjust proximity switch 6, see paragraph 7/8. If defective, replace it.
- no → Servo control is defective, replace it.

3 No function when touching the left joystick 5.

4 Hold steel pin to terminal 9 in servo control 3. Any function?

- Yes → Check cable and joysticks. If defective, replace.
- No → Servo control 3 is defective, replace it.

5 No function when touching the right joystick 4.

6 Hold steel pin to terminal 9 in servo control 3. Any function?

- Yes → Check cable and joysticks. If defective, replace.
- No → Servo control 3 is defective, replace it.

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If the resistance which acts against the load in the hydraulic system was to rise to an undesirable and unacceptable level, the weakest point in the hydraulic system would be destroyed. To prevent this from happening, an artificial weak point (relief) kind of circuit breaker is added. The object is to locate this hydraulic component, which is initially held in a closed position by adjustable spring pressure, so the fluctuating system pressure of the hydraulic pressure circuit can act on it.

An increase in system pressure above the pressure setting of the relief valve lifts the poppet or piston off of its seat and directs the excess pressurized fluid, supplied by the pump but not accepted by the end user, back to the tank. The hydraulic energy produced in this process is converted into heat.

This hydraulic component is called a direct acting pressure relief valve.

1. Function and Operating Principle

With the valve in normal (at rest) position, as shown in the drawing, the spring pressure 4 keeps the guided poppet 6 in the closed position, cutting off the passage from the pressure connection P to the tank connection A/B. As soon as the system pressure exceeds the pressure setting of spring 4, the poppet 6 is lifted off of its seat, and fluid is relieved via connections A and B, to the tank. The poppet guide or piston at the end of the poppet 6 helps eliminate spring and poppet chatter, which keeps the relieving function quiet at any flow rate.

NOTE: Because these direct acting relief valves are sensitive to pressure/volume and viscosity, a correspondingly higher pressure results when large quantities of oil (or cold oil) are relieved.

2. Pressure Adjustment (see also Index in Sub Group 2.3)

NOTE: The pressure setting on this type of valve can only be changed by removing or adding shims 5.

2.1 To change the pressure, remove end cap 3. Remove spring and poppet 4 and 6. Carefully check and clean parts. Reinstall spring and poppet.
To increase pressure - increase shim 5 thickness.
To decrease pressure - decrease shim 5 thickness.
Reinstall and torque cap 3 using a new o-ring 9. Check pressure as outlined in the Hydraulic Section (see Index in Sub Group 2.3).
CAUTION: Use only original replacement parts and o-rings.

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1. General Information

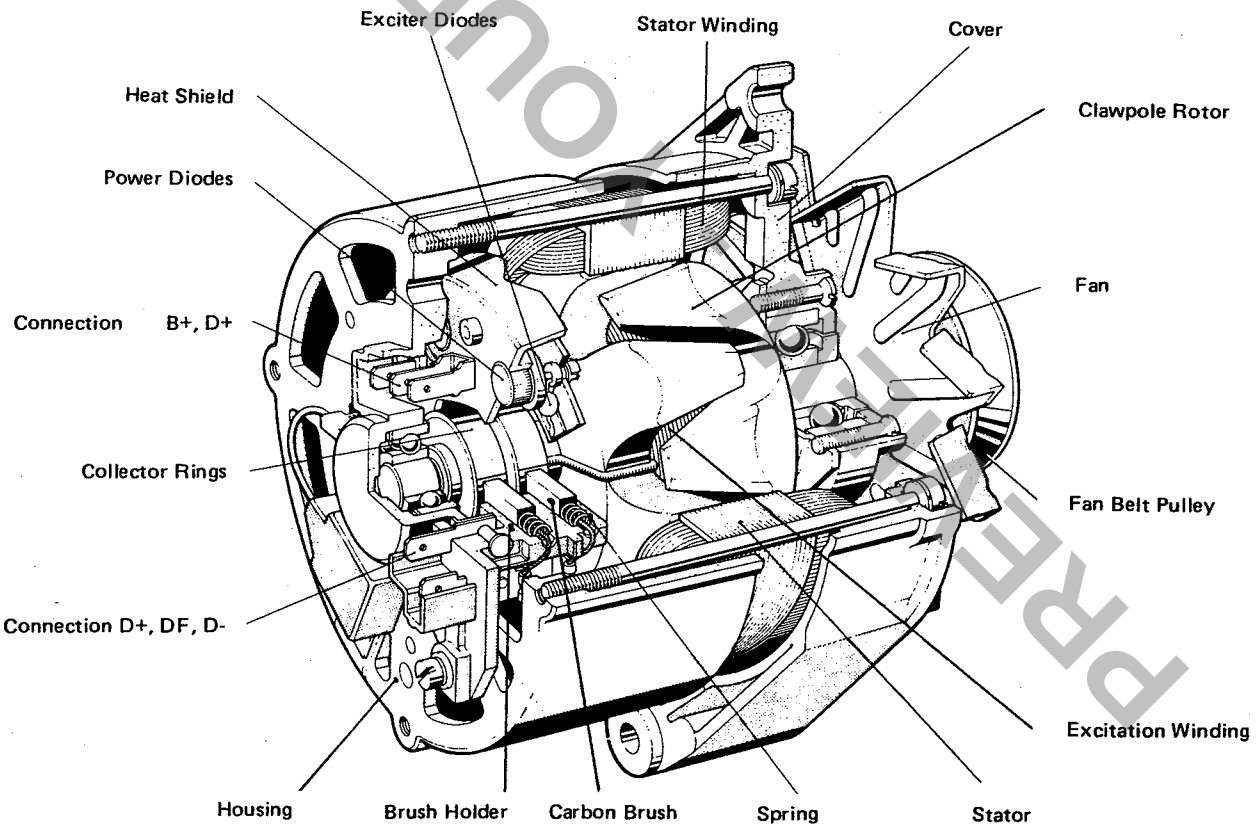
1.1 Equipment generators and alternators have to meet the following demands:

- Reliability
- Maintenance-free operation
- Long life-expectancy
- Constant voltage supply under all operating and load conditions. Large speed range, which means battery charging even at low speeds (idling).
- Insensitivity to vibration, temperature variations, moisture, dirt, gasoline and oil.

These requirements are best met by the alternator with rectifier, which has largely replaced the DC Generator.

1.2 Optimum matching of the speed ranges between the engine and alternator means that the battery can be kept well charged in sub-zero temperatures, during prolonged in-town driving or even with the engine idling.

The three-phase AC current is taken from the fixed three-phase stator winding and is rectified by static silicone diodes which are built into the unit and are located in the cooling air stream of the alternator. The comparatively small field current is fed to the rotating field winding via carbon brushes and collector rings. The diodes also assume the function of the cutout relay i.e. they separate the alternator from the battery and the vehicles electrical system when the alternator voltage drops below the battery voltage.



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1. Operating Principle

1.1 The axle stabilizer is a hydraulic blocking device for the front axle. The free-moving front axle can be locked by the stabilizer cylinders 2/3.

1.2 By actuating the turn switch in the cab, air pressure will open valves, 8, and the crossover line between the cylinders, 2/3. The oil will equalize by the movement of the axle while the machine is in operation.

2. Function of Stabilizers - See Figure 1

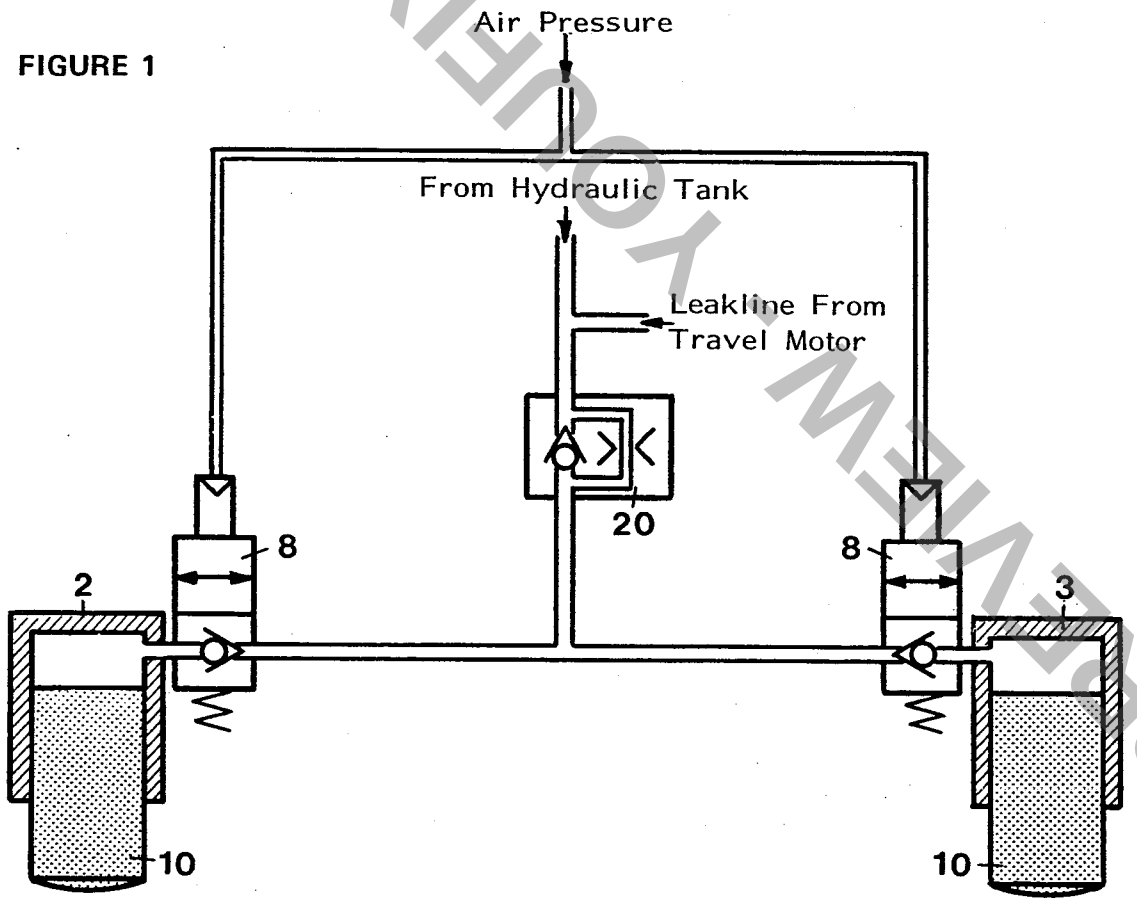
2.1 With the turn switch in the neutral position, the hydraulic oil in the cylinders, 2/3, is trapped and the pistons, 10, and front axle are blocked.

2.2 If the turn switch is actuated, air pressure will go to the two valve blocks of the stabilizer cylinders. The pneumatic operated valves, 8, will open, hydraulic oil is flowing freely between the two cylinders, 2/3.

2.3 By oscillating the axle, the check valve, 20, the oil flow to the hydraulic tank is cut off. Should any loss of oil occur in the cylinders, 2/3, this will be replaced immediately due to the pressurization of the hydraulic tank.

2.4 If pressure increased due to heat in the crossover line, the pressure will be released over the 1mm restrictor built in the check valve, 20.

FIGURE 1



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1 Hydraulic Oil Tank
2 Shutoff Valves
3 Return Oil Filter
4 Collector Pipe
5 Expansion Pipe
6 Return Oil Check Valve
7 Hydraulic Oil Cooler
10 Variable Double Pump
35 Test Point/Pump P1
36 Test Point/Pump P2
40 Left Pilot Control Valve (Joystick)
41 Right Pilot Control Valve (Joystick)
42 Pilot Control Valve (Pedal)
43 Pilot Control Valve Left (Pedal)
45 Pilot Control Valve (Pedal)
50 Solenoid Valve - Servo Pressure
51 Solenoid Valve - Outrigger in
52 Solenoid Valve - Outrigger out
53 Solenoid Valve - Travel fwd/rev.
54 Solenoid Valve - Cylinder in
55 Solenoid Valve - Cylinder out
60 Control Valve - Left
61 Control Valve - Center
62 Control Valve - Right
64 Additional Control Valve
65 Spool - Swing Motor
66 Spool - Outrigger Cylinder
67 Spool - Travel Motor
68 Spool - Travel Motor Left
69 Spool - Hoist Cylinder
70 Spool - Bucket Cylinder
71 Spool - Stick Cylinder
72 Spool - Stick Cylinder
73 Spool - Hoist Cylinder
74 Spool - Bucket Cylinder
75 Spool - Travel Motor
76 Spool - Travel Motor Right
77 Spool - Cylinder 162
79 Spool - Hydraulic Hammer
80 Primary Relief Valve - Left Control Valve
81 Primary Relief Valve - Center Control Valve
83 Primary Relief Valve - Addl. Control Valve
110 Swing Motor
111 Outrigger Cylinder
112 Hoist Cylinder
113 Bucket Cylinder
114 Stick Cylinder
115 Travel Motor
116 Travel Motor - Left
117 Travel Motor - Right
120 Rotary Connection
130 Brake Valve
150 Secondary Relief Valve, Cylinder 162 out
151 Secondary Relief Valve, Cylinder 162 in
154 Primary Relief Valve/Hydraulic Hammer
155 Relief Valve
160 Hydraulic Hammer
162 Cylinder for Additional Attachment
166 Test Point/Pump P2
184 Rockerswitch

Hydraulic Schematic for R 902, see back of page 5.2.26.05

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