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Service Manual

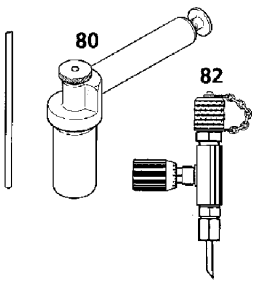
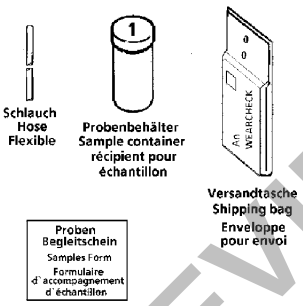
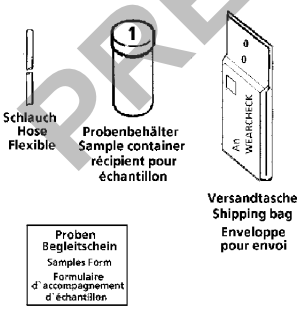
Hydraulic Excavator

A 309 - R 317 Litronic

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Picture	No.	Designation	Size	ID no.	Machine	Application
	65	Multimeter with digital display	Chauvin Arnoux	10018500	all types	Measuring of voltage, current and resistance in electric components and valves
	70 72	Thermometer non-contact (infrared) Thermometer with probe and sensor (magnetic)	GTH 1150	10024185 7020372	all types	Monitoring of temperature of a medium / outside temperature of a unit
	80 82	Hand pump Sampling valve for oil samples, alternative to hand pump 80		8145666 7019068	all types	Sampling of oil for analysis
	84 85 86 87	Mineral oil analysis kit * no. 1 *Analyses carried out by WAER CHECK Germany, lab report in German		8145660 10029626 7018368 7018369	all types	1 oil sample 4 oil samples 6 oil samples 12 oil samples
	88 89	Bio oil analysis kit * no. 3 *Analyses carried out by WAER CHECK Germany, lab report in German		7026817 7026088	all types	1 oil sample 6 oil samples

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Hydraulic system		20222	29170
Rotary connection 6 x	Typ	815.006	=
Boom cylinder (adjustable and gooseneck equipment) Ø piston / rod	mm	125 / 70	=
Stick cylinder with adjustable attachment Ø piston / rod	mm	100 / 70	=
Bucket cylinder Ø piston / rod	mm	90 / 60	=
Swivel cylinder	mm	90 / 50	=
Support cylinder with outrigger - blade support Ø piston / rod	mm	110 / 50	=
Regulating cylinder with boom attachment Ø piston / rod	mm	125 / 70	=
Additional cylinder		see group 7.33	=
Hydraulic pump / pilot control	Typ	Gear pump	=
Max. flow / pilot control	l/min	22	=
Hydraulic pump / brake system - swivel bearing and AS1	Typ	Gear pump	=
max. flow rate through flow distributor	l/min	53	=
Constant current for brake I residual current for swivel bearing and AS1	l/min	2 | 51	=
Hydraulic pump / fan drive (cooling)	Typ	Gear pump	=
Max. flow / fan drive (cooling)	l/min	50	=
Pilot control unit / working attachment / slewing gear	Typ	VG - 7 - 4	=
Pilot control unit / travel drive		VG - 7 - 1	=
Pilot control unit / support		VG - 7 - 2	=
Additional information		see group 6. / 7.	=

Elektrical system		20222	29170
Operating voltage	V	24	=
Battery capacity	Ah	2 x 92 (in series)	=
Alternator voltage / current	V / A	28 / 55	=
Starter	V / KW	24 / 4,0	=

Slewing gear mechanism		20222	29170
Gearbox	Typ	SAT 225 / 220	=
Oil motor	Typ	FMF 45	=
Max. slewing speed	min^{-1}	9,0	=
Oil volume in gearbox	l	4,4	=
Oil quality/oil viscosity and oil change intervals		see groups 1.50 and 3.29	=
Slewing gear brake	Typ	wet multi-disc brake (negative)	=
Additional information		see group 9.10	=

Transmission		20222	29170
Gearbox	Typ	2 HL 70	2 HL 270
Oil motor	Typ	DMVA 108	=

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Filling volumes (approx. values)		A 309-Li / 20221	A 311-Li / 20222
Lubricating oil in standard oil pan	l	max. 8,5 / min. 7,0	
Lubricating oil system (filter / cooler / channels)	l	10,0	
Filling volumes (for oil change with filter replacement)	l	15,5	
Cooling liquid including coolant	l	15,5 (Engine alone 9,3)	

Operating data		A 309-Li / 20221	A 311-Li / 20222
Coolant temperature	°C	110 max.	
Thermostat opening temperature	°C	87 -103	
Pressure in cooling system	bar	min. 1.4 in engine at operating temperature (coolant temperature > 110°C), measured at coolant pump outlet (connection to heating) at nominal engine speed	
Lubricating oil temperature	°C	max. 140	
Min. lubricating oil pressure	°C	at 900 min^{-1} 0,8 bar (oil temperature 120 °C)	
Injection nozzles		DLLA 151PV3 190588	
Injection pressure of injection nozzles: new at end of service life (3000 operating hours)	 bar bar	 220 $^{+8}$ at least 198 $^{+8}$	
Max. engine inclination towards right or left		right 45 ° / left 35 °	
Max. engine inclination towards front or rear		30 °	

Engine wear parts		A 309-Li / 20221	A 311-Li / 20222
Fuel filter	1 unit	10 µm prefilter	
Fuel filter	1 unit	3 µm fine filter	
Oil filter	1 units		
Air filter	1 unit 1 unit	Main element Safety element	
V-belt	2 unit	8PK 1850 NDIN 7867 8PK 1850 NDIN 7867	
Safety device: oil pressure sensor	1 unit	B16 Response pressure: 0.5 bar	
Coolant temperature sensor	1 unit	B2 Response temp. 100 $^{\pm 3}$°C	
Coolant level sensor	1 unit	B3	
For order numbers, see respective spare parts list and service packs			

Antifreeze agent / mixing ratio	Min. temperature for protection	Water content	Antifreeze content
	-37°C	50%	50%

Note!
Do not exceed an antifreeze concentration of 60%, as this tends to lead to reduced protection and cooling effect!

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2 Design and function of coupling

The flexible element **4** of the coupling **1** is fixed with screws to the flywheel **10** of the diesel engine. The four metal segments **3** of the internally toothed hub **2** are connected to the drive shaft of the double variable displacement pump **20**.

The segments **3** are aligned in a circle and mesh in the tooth spaces of the specially formed flexible element **4**, thus positively connecting the coupling sections with each other, allowing for limited flexibility.

The power from the diesel engine is applied to the double variable displacement pump **20** through the flywheel **10**, the mounting bolts **7**, the flexible element **4**, the segments **3** and the hub **2** to the pump's drive shaft **20**.

Torque impacts upon start-up of the diesel engine and load fluctuations are thus compensated, as the flexible element is deformed at the moment of impact and subsequently released.

Rotational vibration from the engine is also significantly dampened so that the pump **20** is only marginally affected.

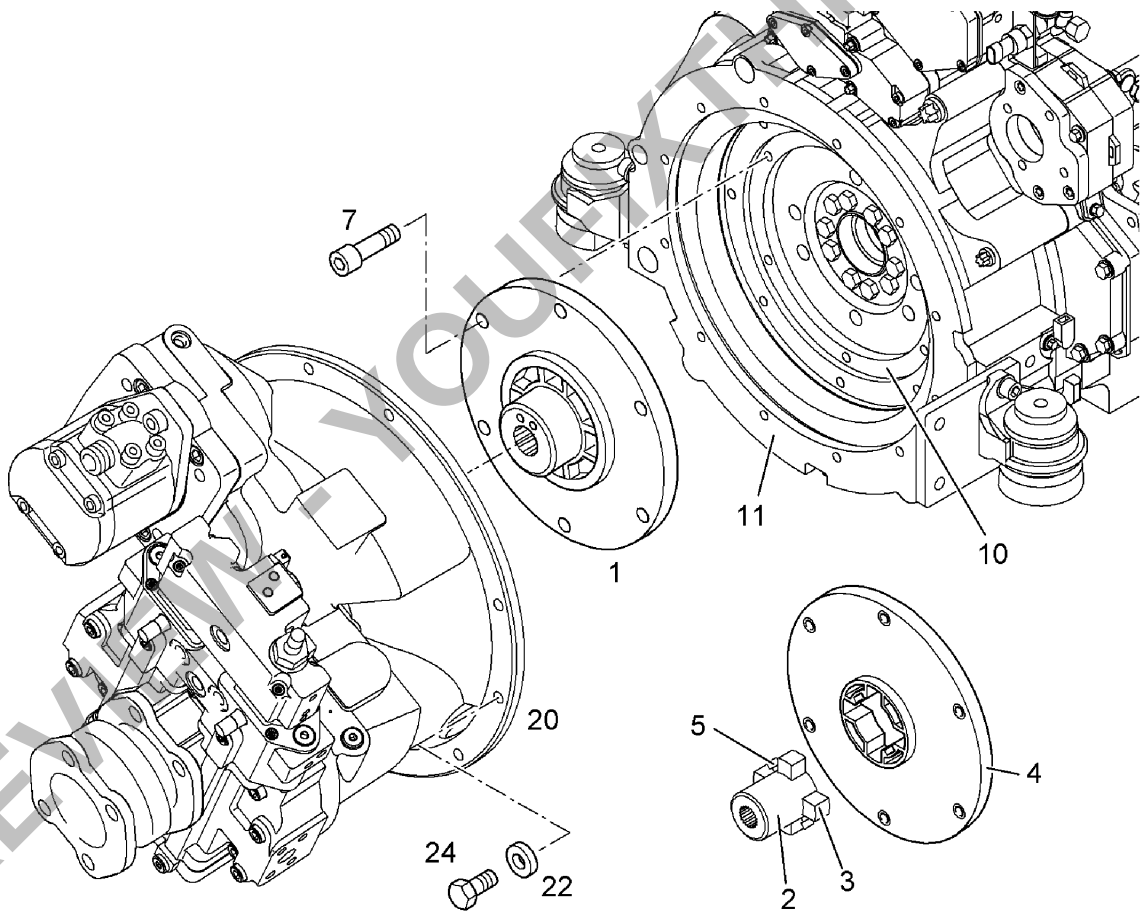
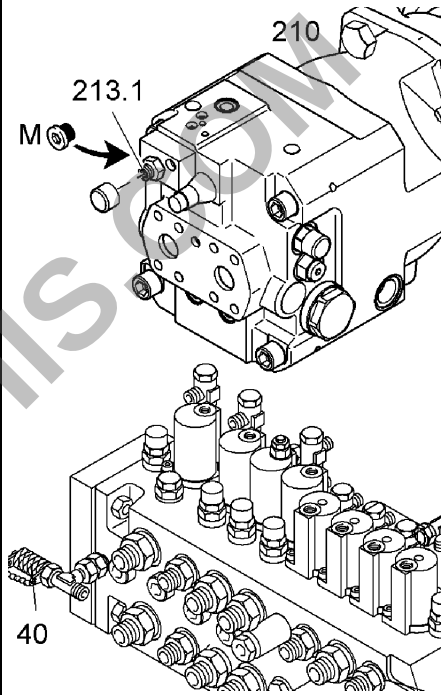
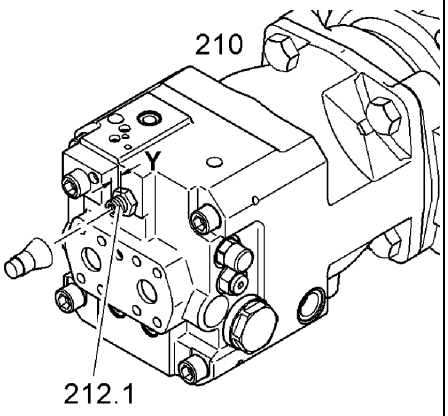


Fig. 2 *Fitting position of the coupling**1***

1	Coupling, complete (torsion damper)	**10**	Flywheel
2	Hub	**11**	Engine intermediate housing
3	Segment	**20**	Double variable-displacement pump
4	Flexible element	**22**	Retaining washer
5	Allen head screw	**24**	Hex head screw
7	Allen head screw		

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	Checks	Measuring point Specified value	Actual value	Possible Setting.	View Comment
12. **12.1**	**Travel motor** **Regulation** Begin of regulation End of regulation	Measuring point **40 / M** 240 bar 340 bar			Adjusting screw **213.1** on travel motor **210** 
12.2	**Output speed** (speed) Standard machine Speeder machine **Checking measurement Y** Standard machine Speeder machine	 1500 $^{\pm 25}$ min^{-1} 1930 $^{\pm 25}$ min^{-1} 23.8 mm 26.0 mm			on drive shaft, measured during on-road gear Qmin stop screw **212.1** 

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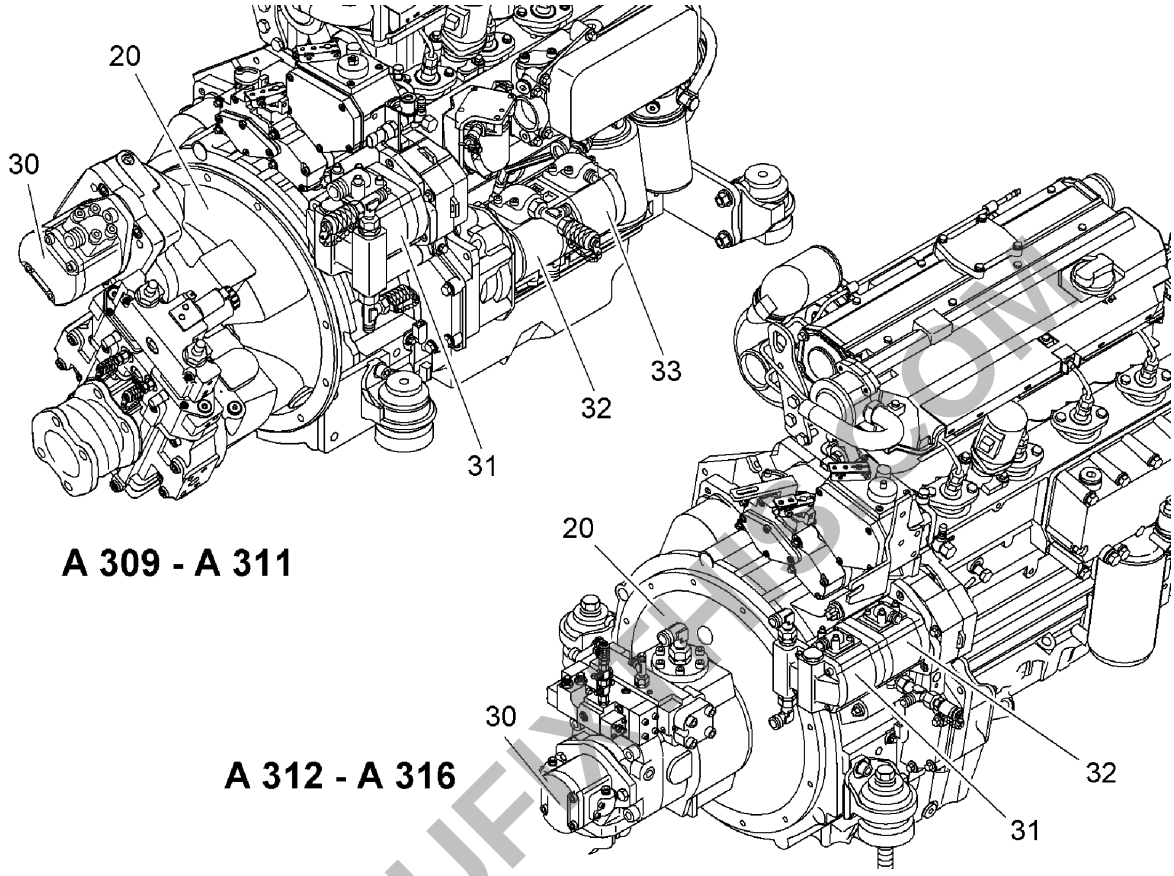


Fig. 2 *Variable-displacement pump / double variable-displacement pump* and gear pumps

20 Double variable-displacement pump A 309 - A 311
20 Variable-displacement pump (A 312 - A 316)
30 Gear pump
31 Gear pump with flow distributor
32 Gear pump
33 Gear pump

2.1 Dismantling

- ▶ Close stop cock on hydraulic tank.
- ▶ Place suitable oil pan under hydraulic pumps.
- ▶ Disconnect hoses / lines at pumps. Collect hydraulic oil.
- ▶ Remove hydraulic pumps.

2.2 Installation

- ▶ Install hydraulic pumps.
- ▶ Connect all hoses / lines at pumps.
- ▶ Before starting the system, fill the hydraulic tank all the way to full mark at the top. Open the stop cock.
- ▶ Check the screw fittings and lines for tightness.

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6 Overview of control console

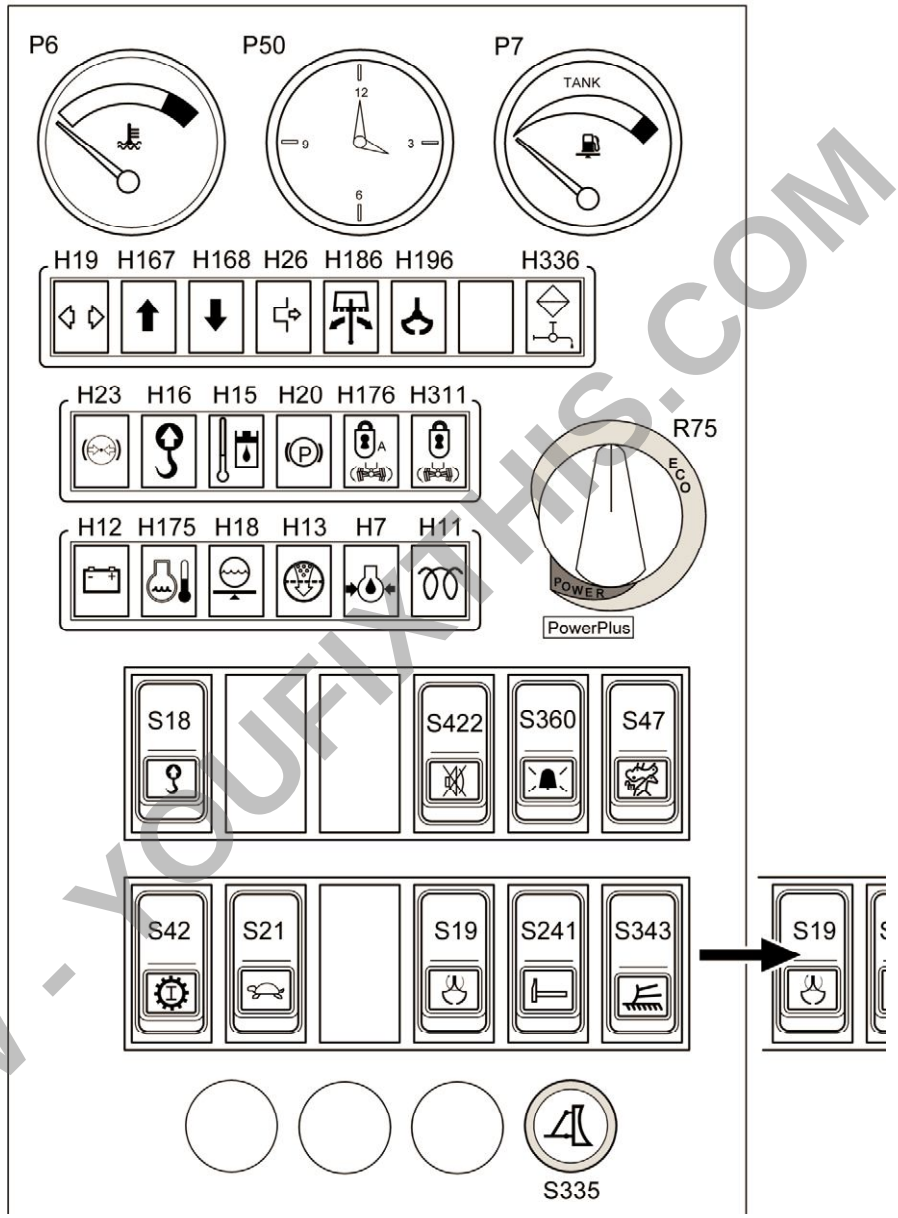


Fig. 17 *Control console **A** (front right)*

Indicating elements:

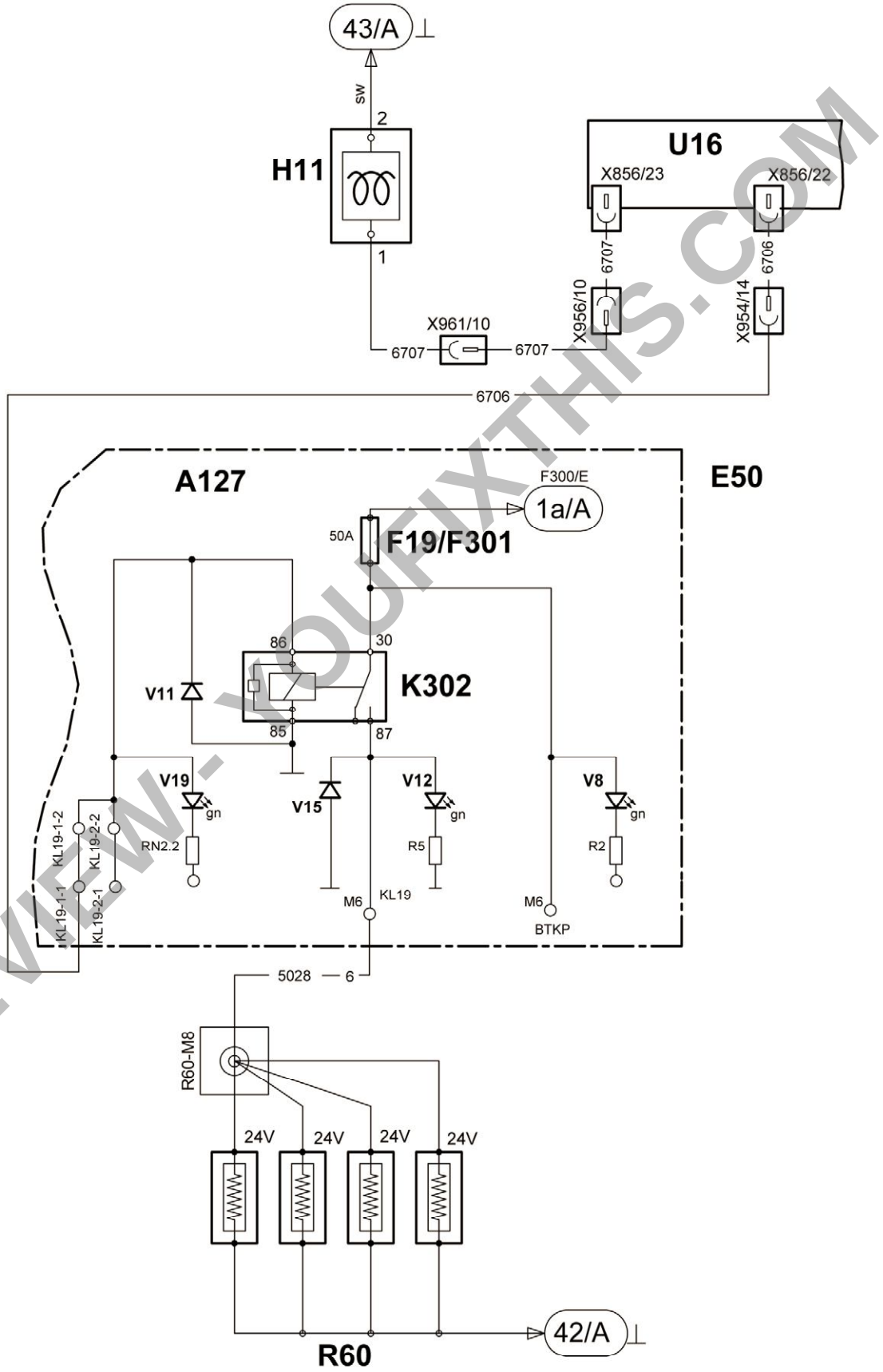
P6 Dial indicator / coolant temperature
P50 Clock
P7 Dial indicator / fuel reserve

Indicator lights:

H7 Engine oil pressure
H11 Pre-heating
H12 Battery charging
H13 Air filter contamination
H15 Hydraulic oil temperature
H167 Forward travel
H168 Reverse travel
H175 Engine overheating
H176 Oscillating axle automatic
H186 Offset boom bearing

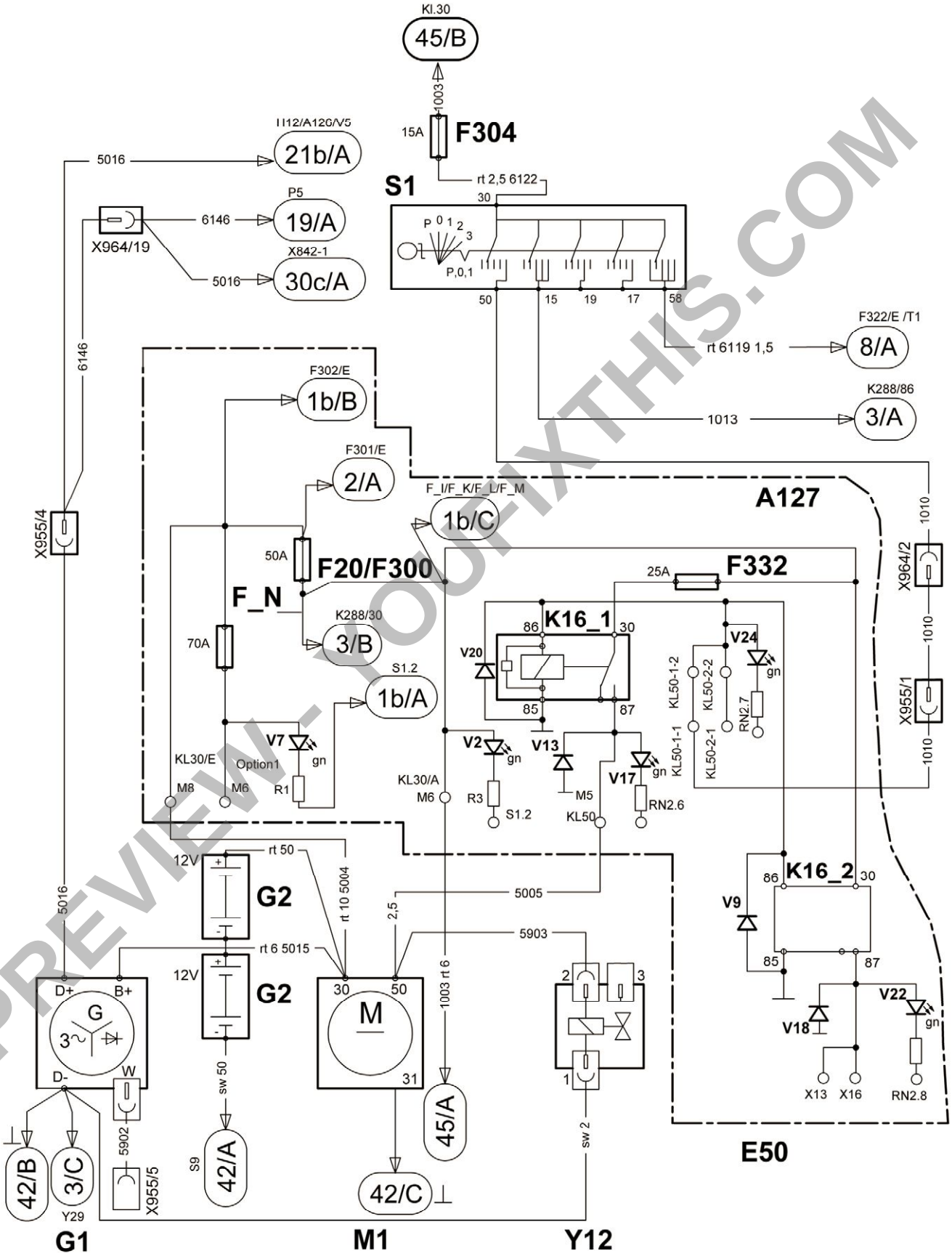
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2 Pre-heating

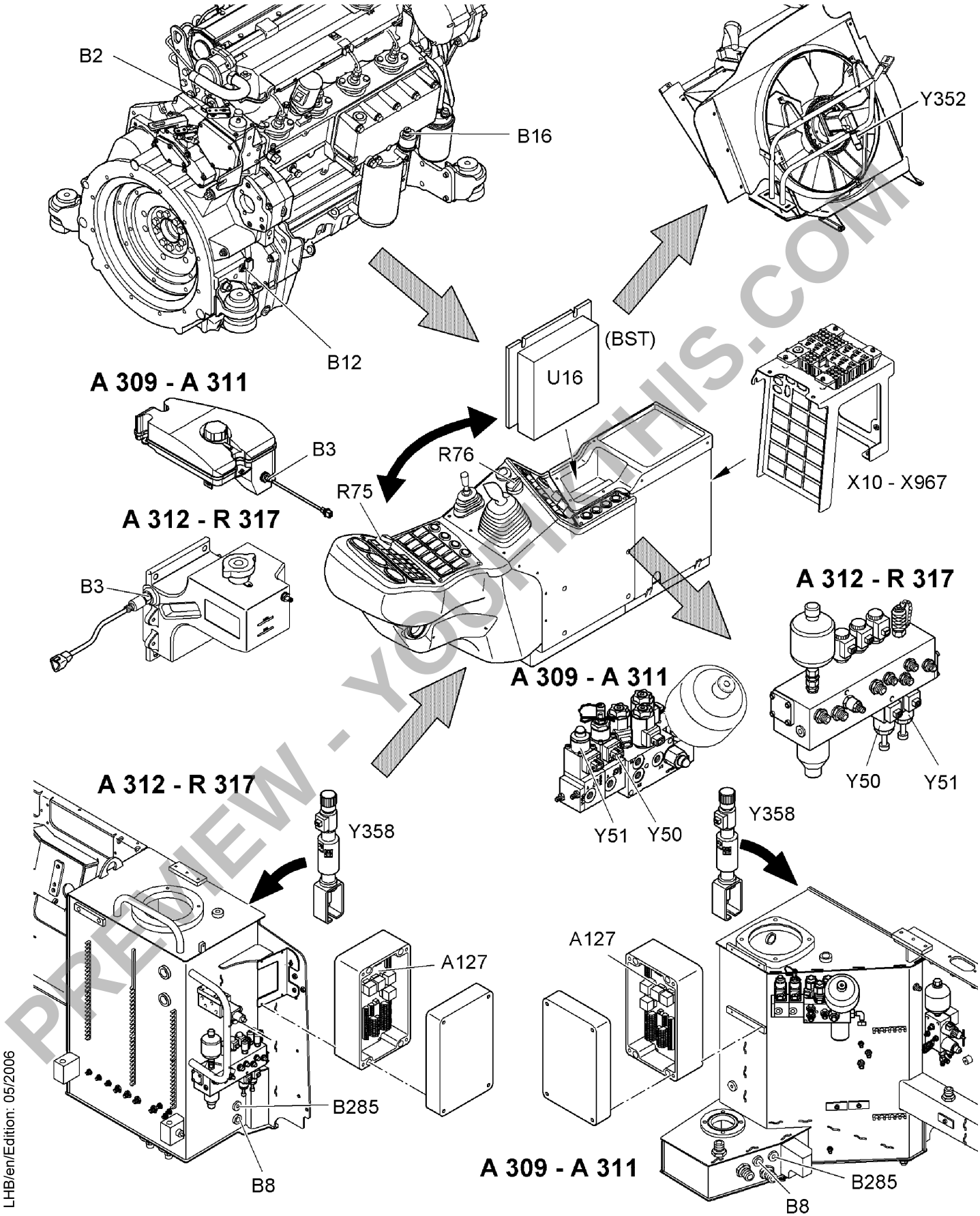


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1a power supply, board A127



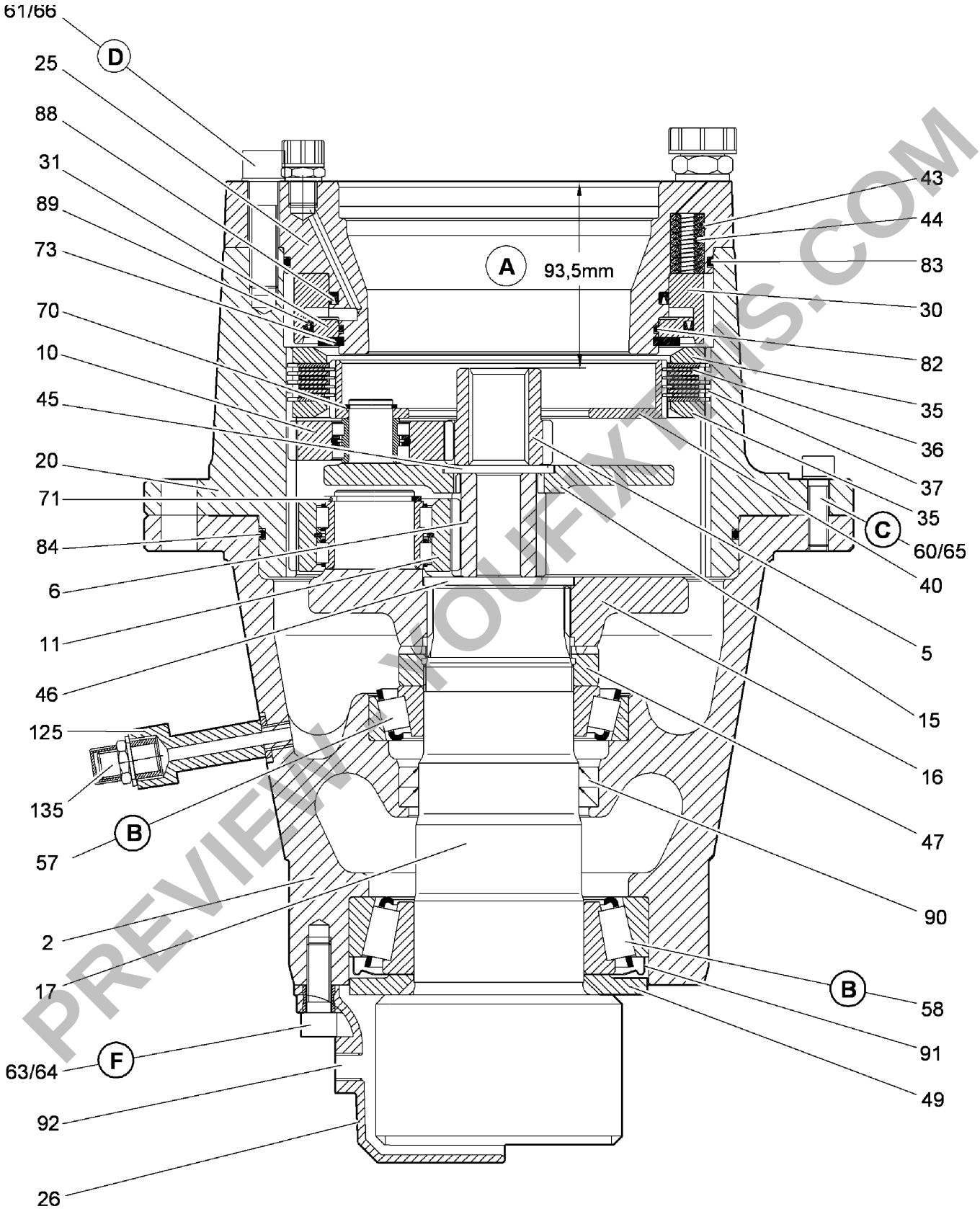
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Fig. 2 *Connections of* **BST**

10 Sectional drawing



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Fig. 6 *Sectional drawing of slewing gear mechanism*

Slewing ring

1 Design

The slewing ring is used as a connecting and bearing element between the undercarriage and the uppercarriage.

The slewing ring consists of a single-row axial rolling bearing with a large diameter.

It consists of an outer race and a geared inner race. For the bearing and connection of the races, large balls are located between the two precision bearing elements. Sealing lips protect the ball bearing against dirt.

To turn the uppercarriage, the slewing gear mechanism engages with the involute teething of the inner race of the slewing ring.

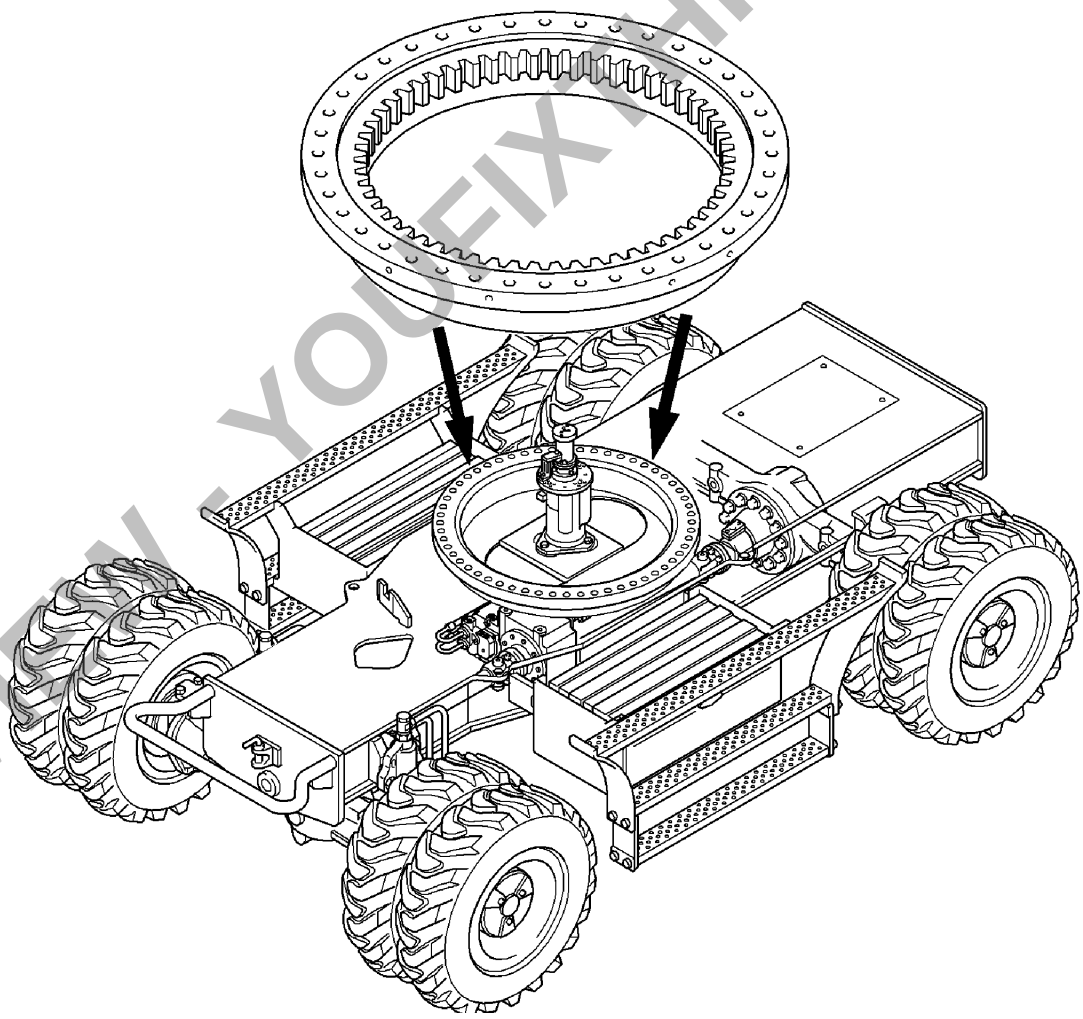
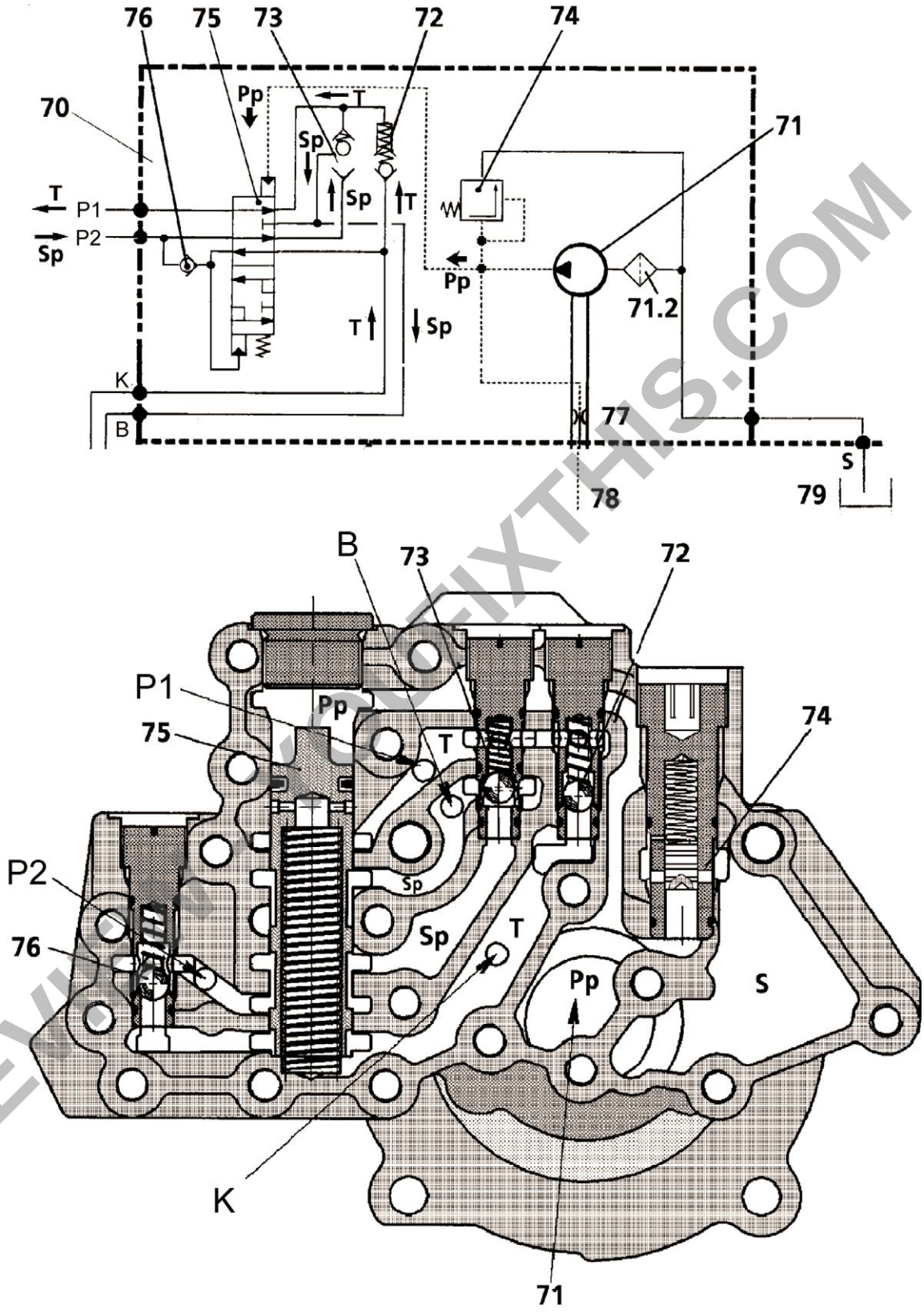


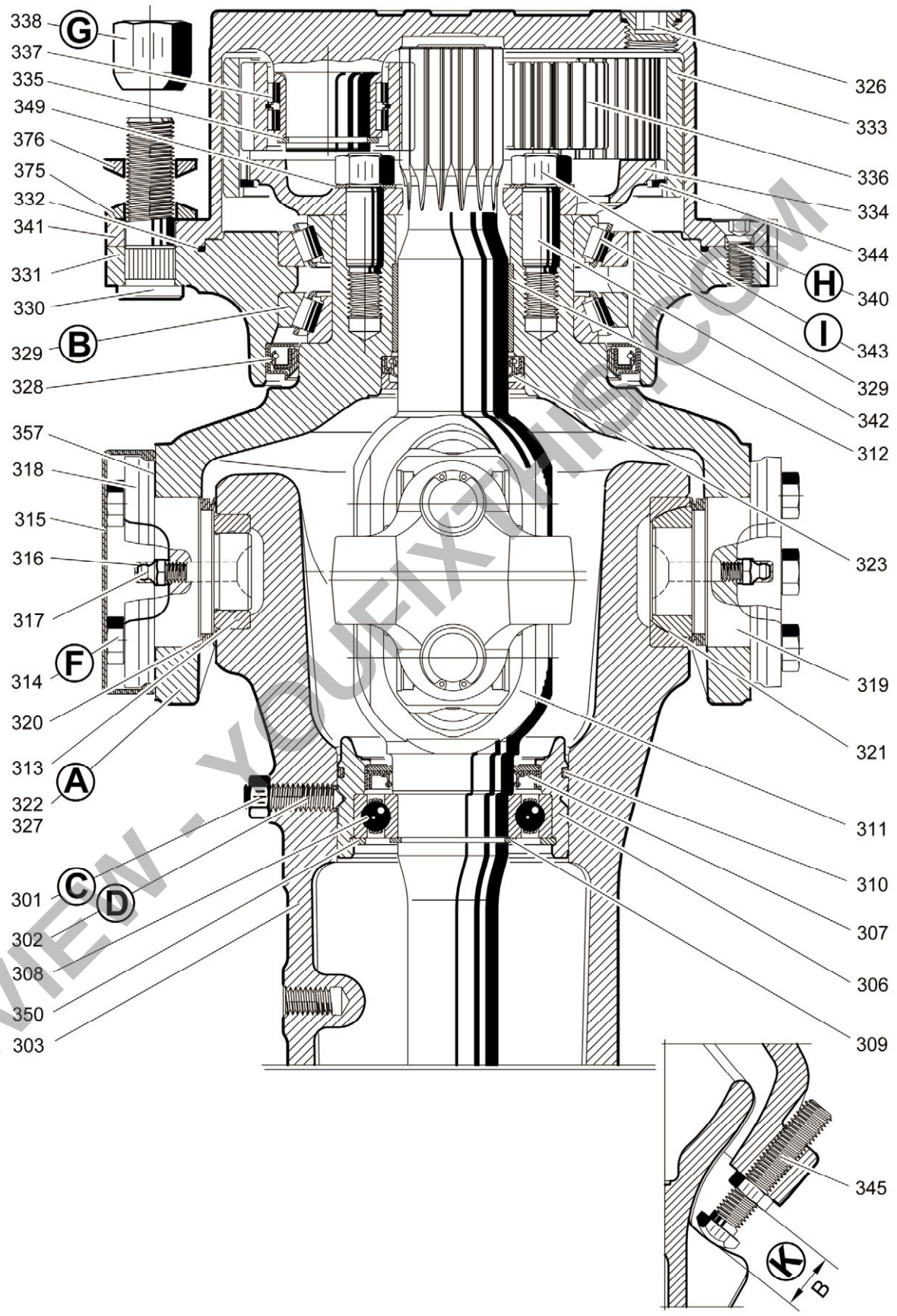
Fig. 1 *Location of the slewing ring in the undercarriage*

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Fig. 5 *Hydraulic diagram and sectional drawing of the transmission during travel in on-road gear – off-road gear preselected*



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Fig. 6 *Output end of the steering axle*

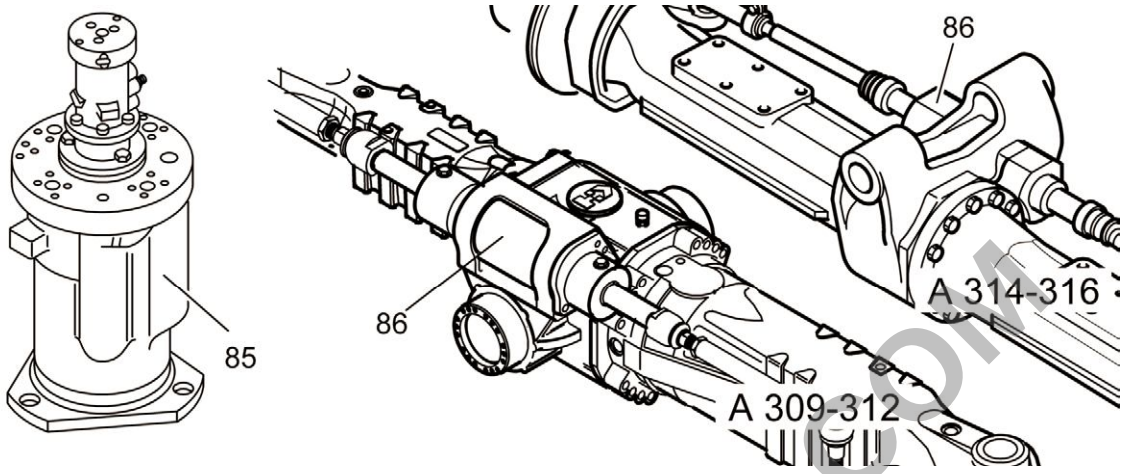


Fig. 3 *Rotary connection and steering cylinder*

85 Rotary connection 7 x

86 Steering cylinder

3 Function of the steering system

(see Fig. 6, page 7)

The gear pump **31** takes up oil from the tank **1** and transfers it to the Servostat / steering valve **84** port **P**. When the valve actuator in the Servostat / steering valve **84** is in neutral position (neutral position of the steering wheel), oil flows through port **T** back to the tank**1**.

When the steering wheel is turned to the left or right, pressure oil flows from the Servostat / steering valve **84** port **L** or port **R** and the rotary connection **85** to the corresponding side of steering cylinder **86**. The hand pump (metering pump) built into the Servostat / steering valve **84** is used for metering. The return oil flows from the steering cylinder **86** through the non-pressurised side back to the tank **1**.

The built-in hand pump of the Servostat **84** can also be used to pressurise the steering cylinder **86** in the event of a failure of the gear pump **32** (emergency steering).

By pressurising the steering cylinder **86**, the piston with the piston rod is moved in the corresponding direction, thus rotating the joint housing (steering knuckles) so that the axle is steered.

The integrated primary and secondary pressure relief valves of the Servostat / steering valve **84** protect the entire steering system against excess pressure.

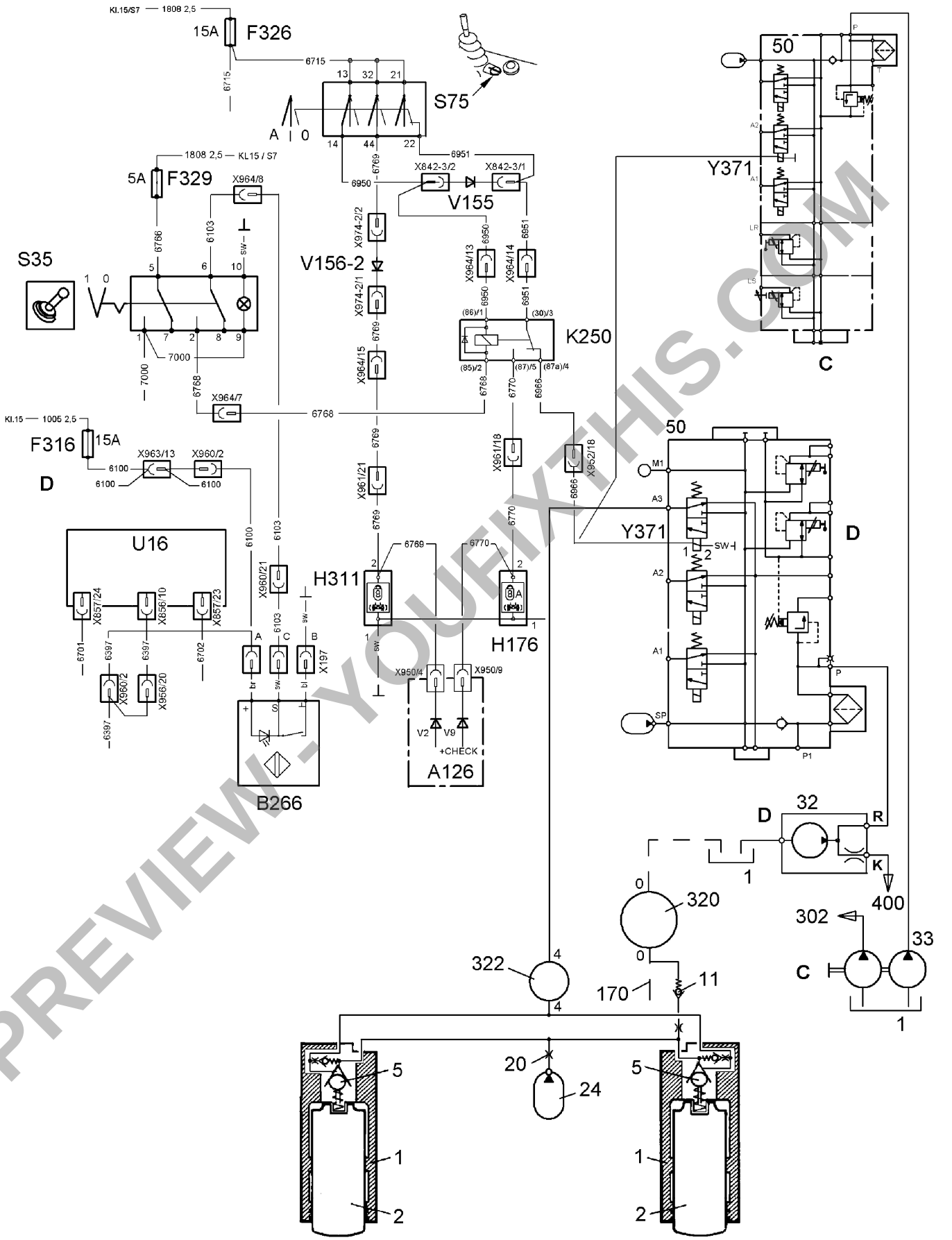
To protect the gear pump **31/32**, especially when cold oil is used, it is equipped with a pressure relief valve **88**.

3.1 Pressure check and adjustment of the steering system

3.2 Pressure check and adjustment of the pressure relief valve 88 at the gear pump 31 / 32, see Fig. 4

- ▶ Remove the cover cap at the measuring point **83** and connect the pressure sensor or pressure gauge (600 bar).
- ▶ Heat the hydraulic system to operating temperature.
- ▶ Start and run the diesel engine at its lower idle speed (level 1).

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Fig. 7 *Diagram of electric and hydraulic system for automatic oscillating axle support*

2.4 Multi-disc brakes 20 and 21, or drum brake 22 respectively, (see Fig. 4, page 4)

The axles of the various machines are equipped with brakes of the same or of different types. The steering axle is always equipped with a multi-disc brake. The rigid axle of the machine might feature a multi-disc brake or a drum brake.

When the brake is applied with the brake pedal **11**, the brake pistons and cylinders of the brakes **20** / **21 / 22** in the axles are pressurised with oil through the brake valve **10**.

When the multi-disc brakes are pressed together, or when the brake pads are pressed against the drum, the resulting friction slows down the vehicle.

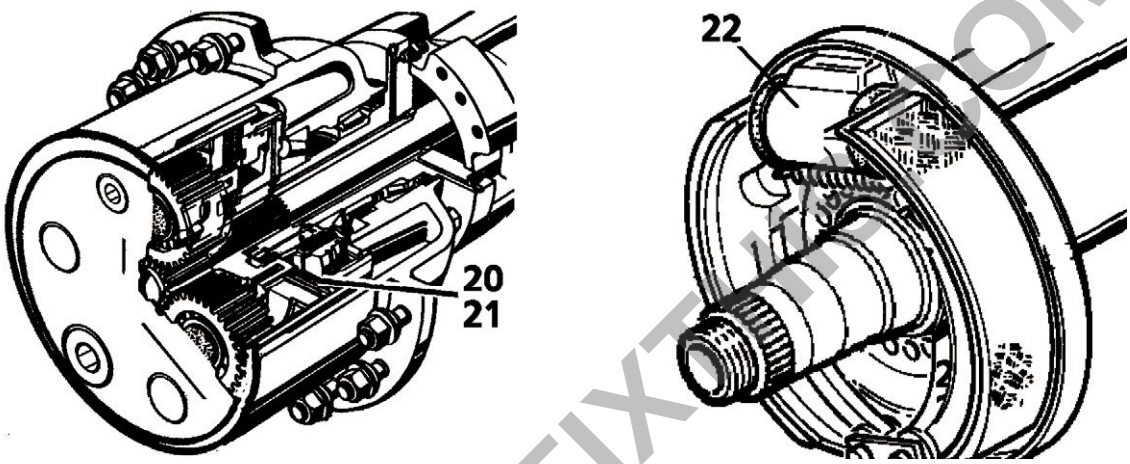


Fig. 4 *Multi-disc brake* **20/21** *and drum brake* **22**

3 Function of the brake system

see Fig. 5 and Fig. 10.

3.1 System not pressurised, or switch-on pressure reached

The gear pump **31/32** with flow distributor feeds the hydraulic oil through connection "**K**" directly to the compact brake block **4** connection "**P**". The hydraulic oil flows via the internal channels, the check valve **8** and the connections **S1/S2** into the connected brake accumulators **14** and **15**. The pressure in the accumulator circuit is thus increased.

The accumulator charge pressure is applied through the check valve **8** to the pilot control piston **135** of the pressure regulator and through the channels in the housing and the edges of the piston **72** to the two front faces of the pressure balance **6**. The pump **31 / 32** feeds the accumulator circuit through the double check valve **9** until the force resulting from the charging pressure exceeds the preload force of the adjusting spring **51**.

3.2 System charged, shut-off pressure reached

The piston **72** pushes against the spring **51**, shuts off the supply from the connection **P** to the spring-facing surface of the pressure balance **6** and also relieves this surface to the connection **T**. The pressure balance **6** is shifted towards the pressure spring **56** and opens the **P** channel to the tank through connection **N**.

That means, the pump flow flows at low **△-p** through accumulator charging valve **5** to the tank.

The check valve **8** closes. The pilot control piston **135** stabilises the shut-off function, as it has a larger effective surface than the spool **72**.

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6 Hydraulic connections and links

6.1 Models A 309 - A 311

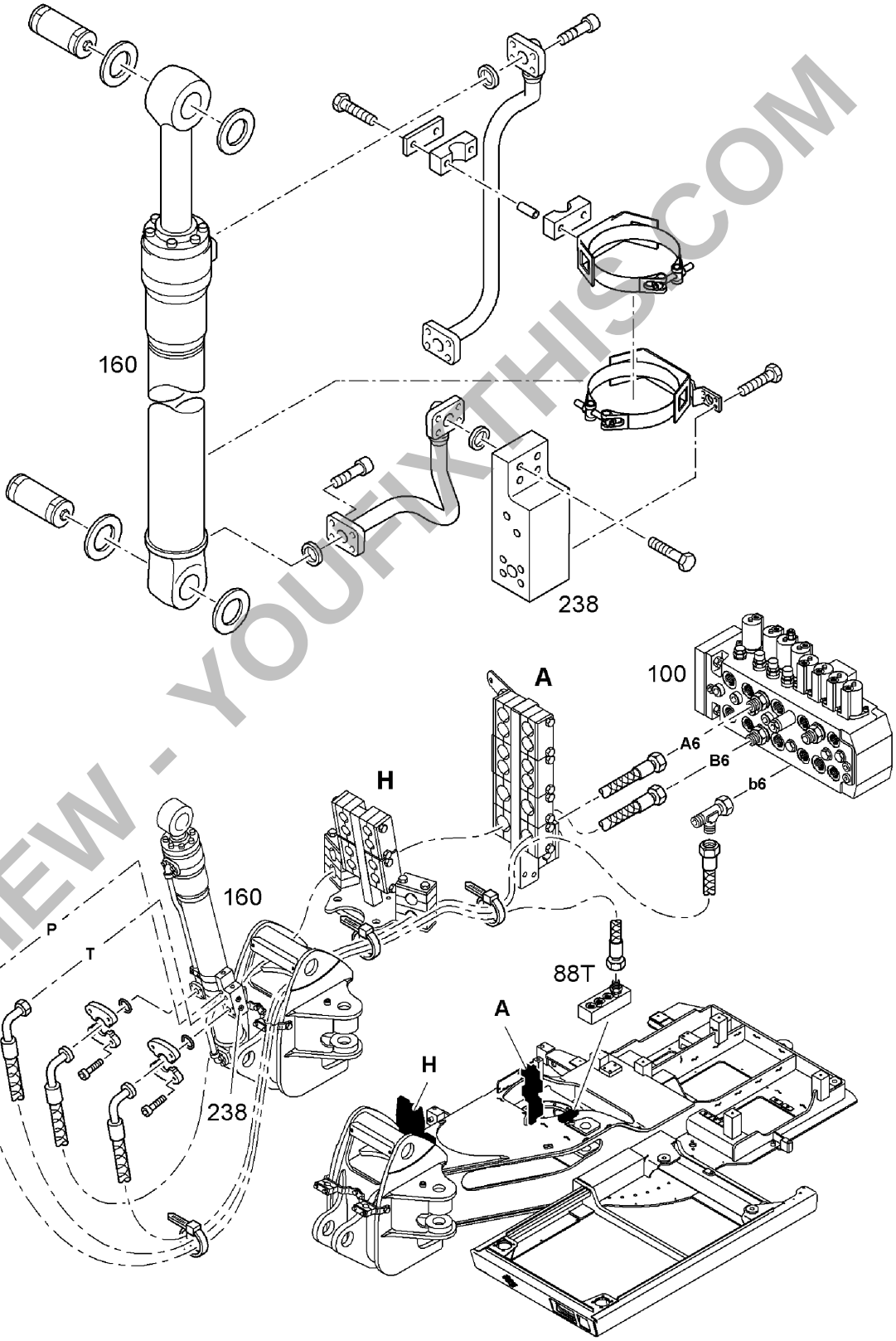


Fig. 5 *Hydraulic connections and lines in models A 309 - 311*

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6 Operation of air-conditioning system

The air-conditioning system is designed for cooling, heating and fan operation.

The cooled or heated air flows through the outlets to the left and right behind the operator's seat and through the openings below the seat and near the windscreen into the operator's cab.

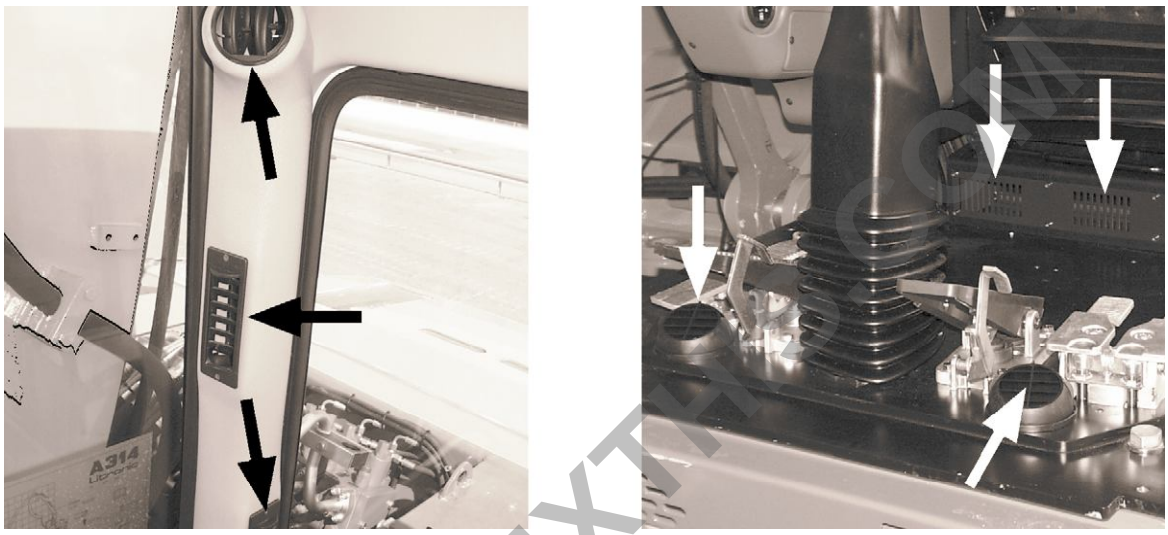


Fig. 6 *Air outlet*

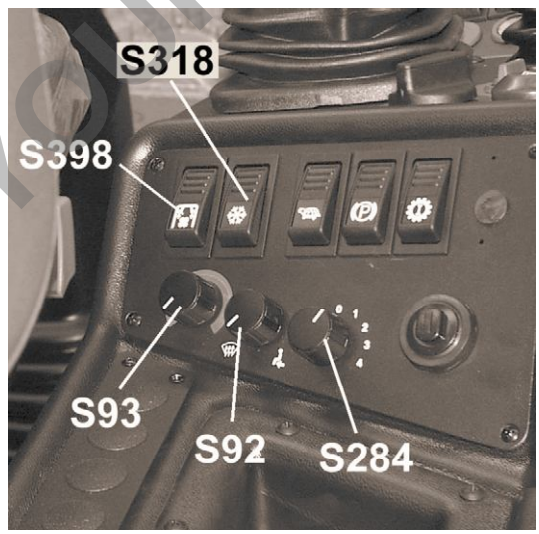


Fig. 7 *Control elements of the air-conditioning system*

S92	Rotary potentiometer for air distribution control	**S318**	Air-conditioning switch
S93	Rotary potentiometer for heating/air-conditioning control	**S398**	Switch for the assignment of the blower motor (change of direction of air flow from rear to front)
S284	Switch for blower level 1 – 4/ warm – cold		

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Passfix bolts

1 Function

Certain bearings of the attachments of the compact excavator models A 309 and A 311 are equipped with Passfix bolts. They reduce wear at the bearing points.

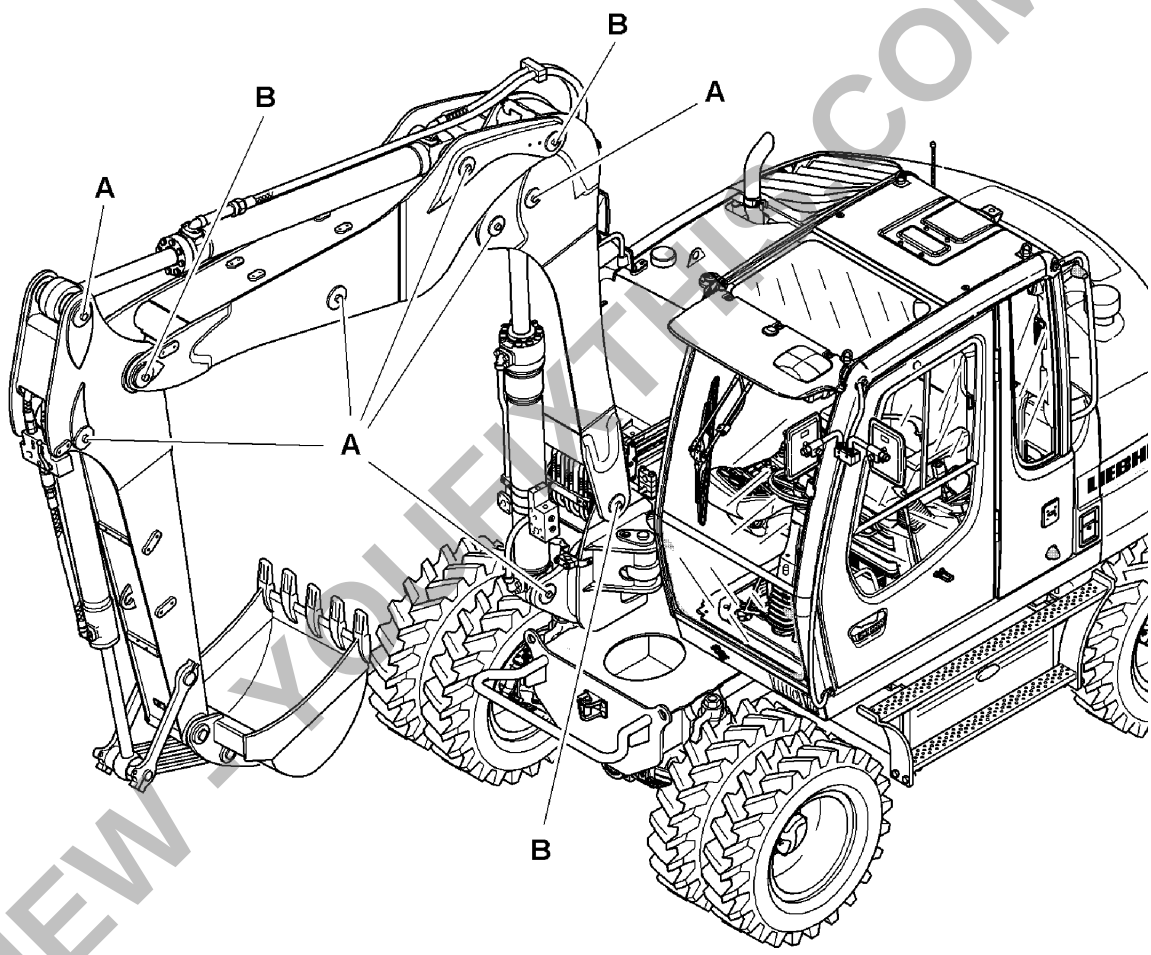


Fig. 1 *Passfix bolts* **A** */* **B** *at the attachment*

A General bearing points with Passfix bolts

B Main bearing points
Machine model A 309 from serial no. 20221 and model A 311 from serial no. 20222 with Passfix bolts.
Machine model A 309 from serial no. 27369 and model A 311 from serial no. 27373 with tab/locking nut bolts.

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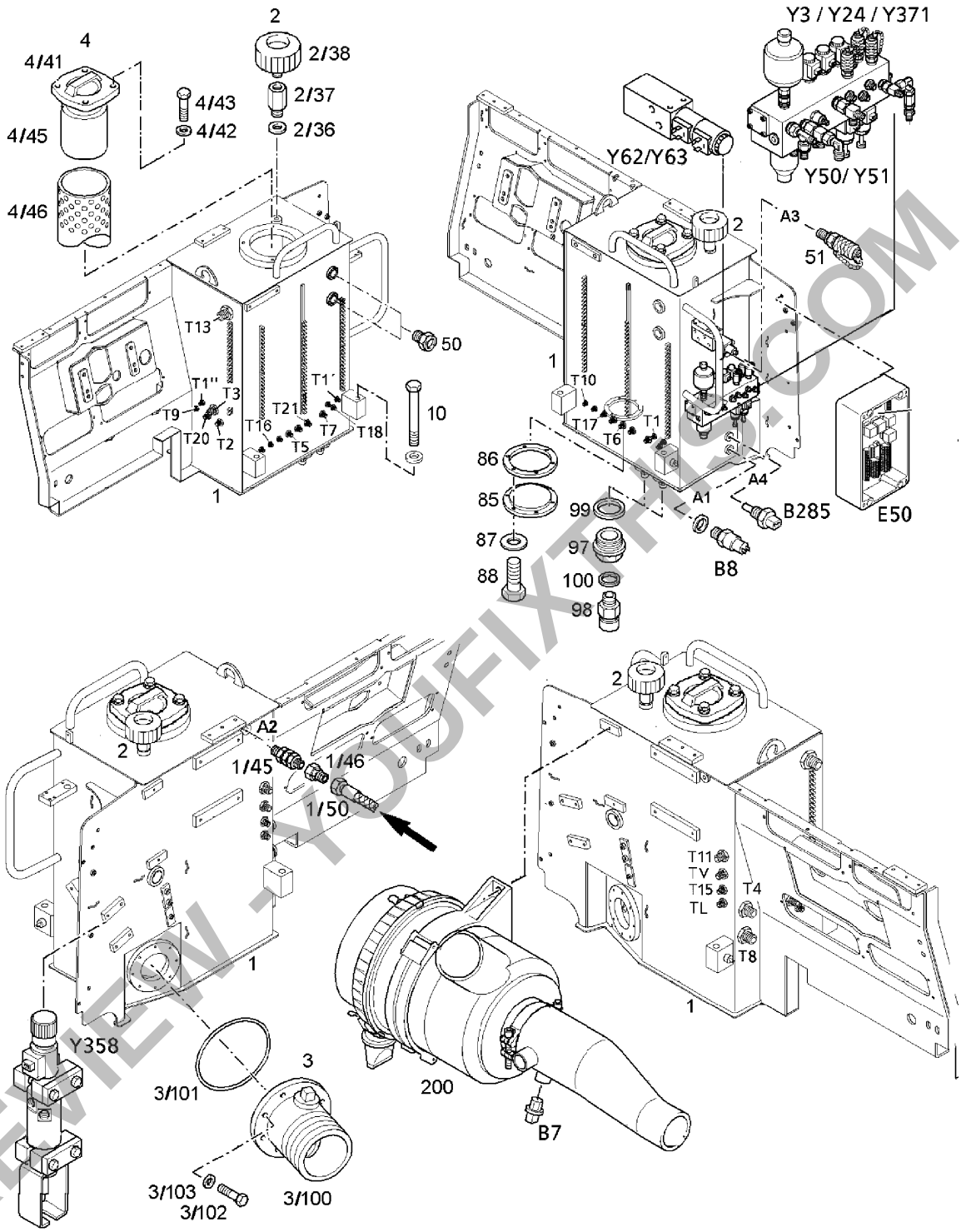


Fig. 5 *Hydraulic tank, complete*

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F329	5 A	Servo control
F330	7.5 A	AHS / AS1
F331	15 A	Reserve
F336	15 A	External fuse for lighting
F337	15 A	Support / solenoid
F338	15 A	Horn
F339	20 A	A/c condenser (kit)

6 Overview of control console

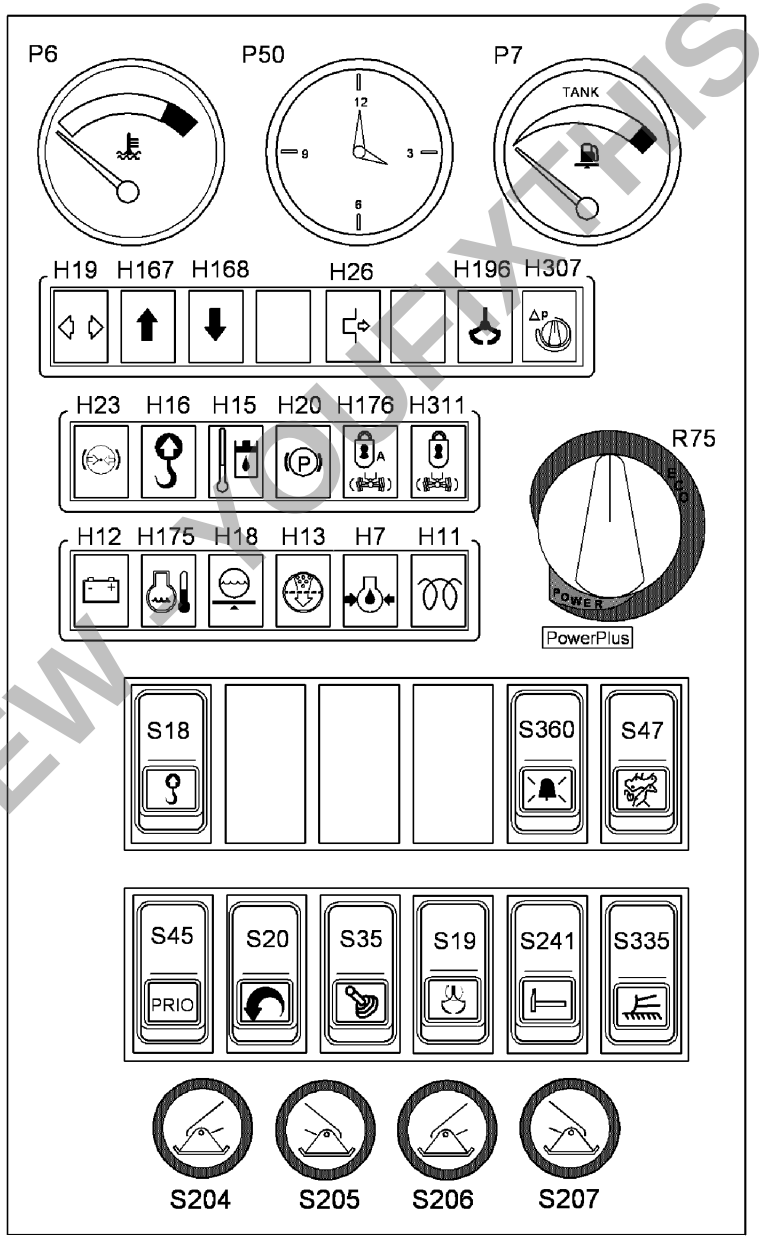


Fig. 21 *Control console **A** (front right) in model A 312 to serial no. 20432, A 314 units to serial no. 20333 and A 316 units to serial no. 20339.*

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3 Design

see Fig. 2

The 2 HL 270 / 290 transmission is designed as a powershift transmission with a planetary and a spur gear. The powershift transmission of the planetary drive consists of a rotating multi-disc clutch and a multi-disc brake mounted in a housing attached at the top of the planetary drive. Both the clutch and the brake are applied by spring force (disc springs) and hydraulically released (control pressure).

When in on-road gear, the multi-disc brake is hydraulically released, and the multi-disc clutch is mechanically engaged. In off-road gear, control pressure is applied to the multi-disc clutch, which is thus disengaged, and the multi-disc brake is applied by means of the spring force and the hydraulic pressure.

The transmission is driven by an axial piston regulating motor with brake valve. For a description of the complete hydraulic system, the regulating motor and the brake valve, see **groups 6** and **7**.

The hydraulic shift lock mounted on the gearbox prevents shifting down at high speeds. It is operated by the flow produced to pressurize a spool through a gear pump driven by the transmission. Depending on the machine speed, the spool is set to neutral or working position respectively, i.e. the preselected off-road speed cannot be chosen when the vehicle is driven at high speed.

During gear shifting, the multi-disc brake or clutch is supplied with oil from the control valve block so that it is released and is kept in this position by a constant control pressure.
Excessive speeding of the gear and oil motor in overrun conditions (rolling down a slope) is not prevented by the shift lock, but by the brake valve that is flange-mounted to the oil motor.

The spur gear transmission section is equipped with an oil reservoir from where oil is sucked by the gear pump. Bearings, shafts and gears are lubricated with gear oil from the oil sump (splash and centrifugal lubrication). The moving clutch parts are supplied with lubricating oil fed through the lubrication channel.

The emergency activation device is designed to disrupt the power transmission between input and output in the event of failure of the control pressure or if there is a defect at the oil motor / hydraulic circuit. This is necessary to allow for the machine to be towed in such a situation. For this purpose, press grease into the lubrication nipple at the emergency activation device, using a standard grease gun (included in machine toolbox) until the grease escapes at the pressure relief valve of the emergency activation device. The two pistons of the multi-disc brake and clutch are now released so that the output shaft can be rotated freely and towing is possible.

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