SECTION 21 – TRANSMISSIONS

BOOK 2 - 87043518

Chapter 2 – Reverser

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	Tightening Torques	3
	Tools	4
	Cross-sectional views	4
	Description and Operation	6
	Fault diagnosis	6
21 110 85	Clutch-reverser casing. Disassembly-Assembly	7

SECTION 21 – TRANSMISSIONS

BOOK 2 - 87043518

Chapter 3 – OVER DRIVE Unit

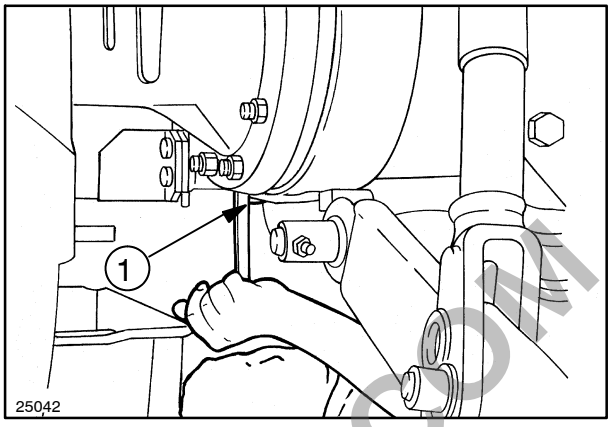
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	OVER DRIVE transmission data	1
	Tightening Torques	2
	Tools	3
	Cross-sectional views	3
	Description and Operation	5
	Fault diagnosis	5
21 110 10	OVER DRIVE Unit R.I.	6
21 110 87	OVER DRIVE Casing - Replacement	7

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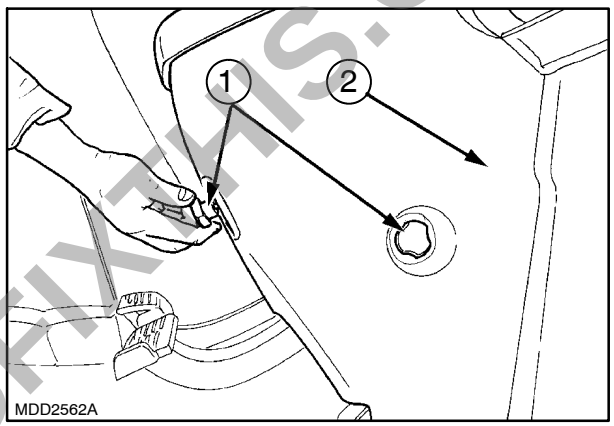
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28. Detach the FWD engagement distributor oil delivery line (1).



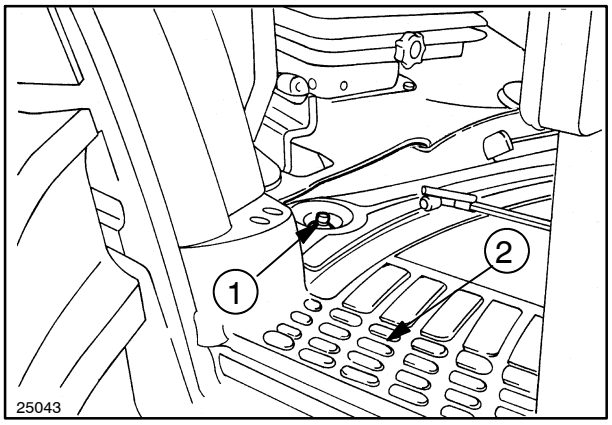
29

29. Remove the four knobs (1) and remove the two dashboard panels (2).



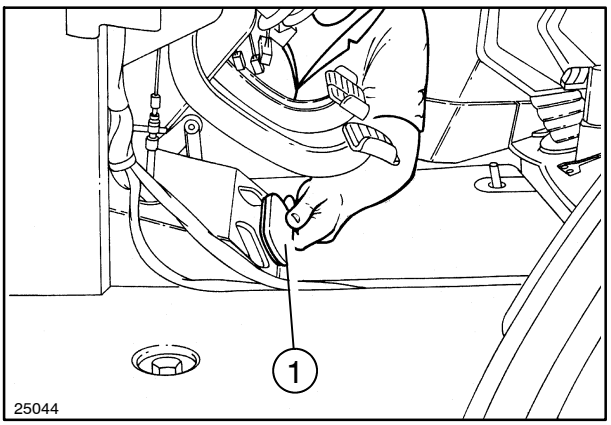
30

30. Extract the differential lock pedal retaining pin from the drive shaft (1), remove the pedal and footboard (2).



31

31. Remove the footboard and plugs (1) in order to gain access to the engine upper retaining bolts.



32

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Op. 10 246 14
BOSCH INJECTION PUMP R.I.

CAUTION

Handle all parts carefully. Do not put your hands or fingers between parts. Wear suitable safety clothing - safety goggles, gloves and shoes.

CAUTION

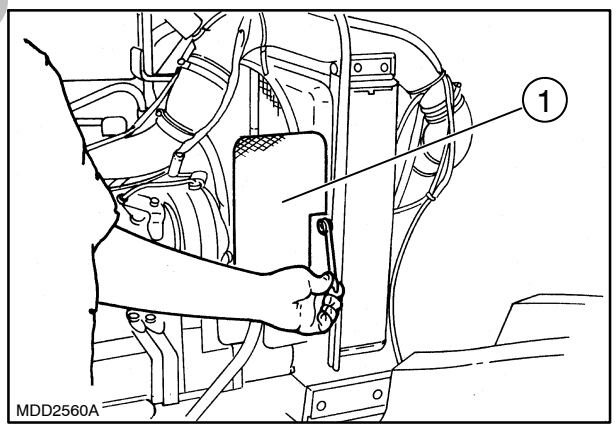
Always use appropriate tools to align fixing holes. NEVER USE FINGERS OR HANDS.

Proceed as follows:

1. Disconnect the battery negative cable (A).

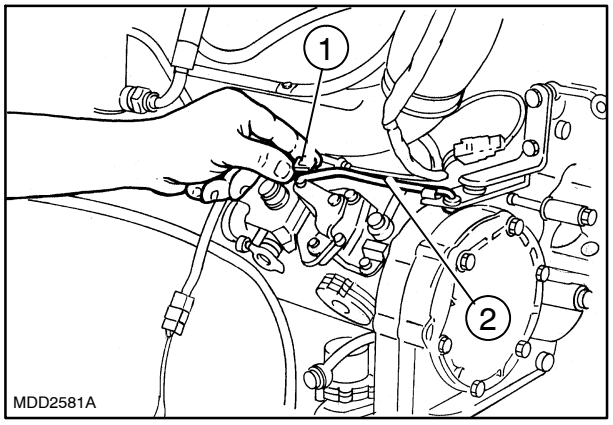
2. Remove the exhaust pipe and raise the bonnet.

3. Remove the RH lateral guard (1) by unscrewing the three retaining bolts.



209

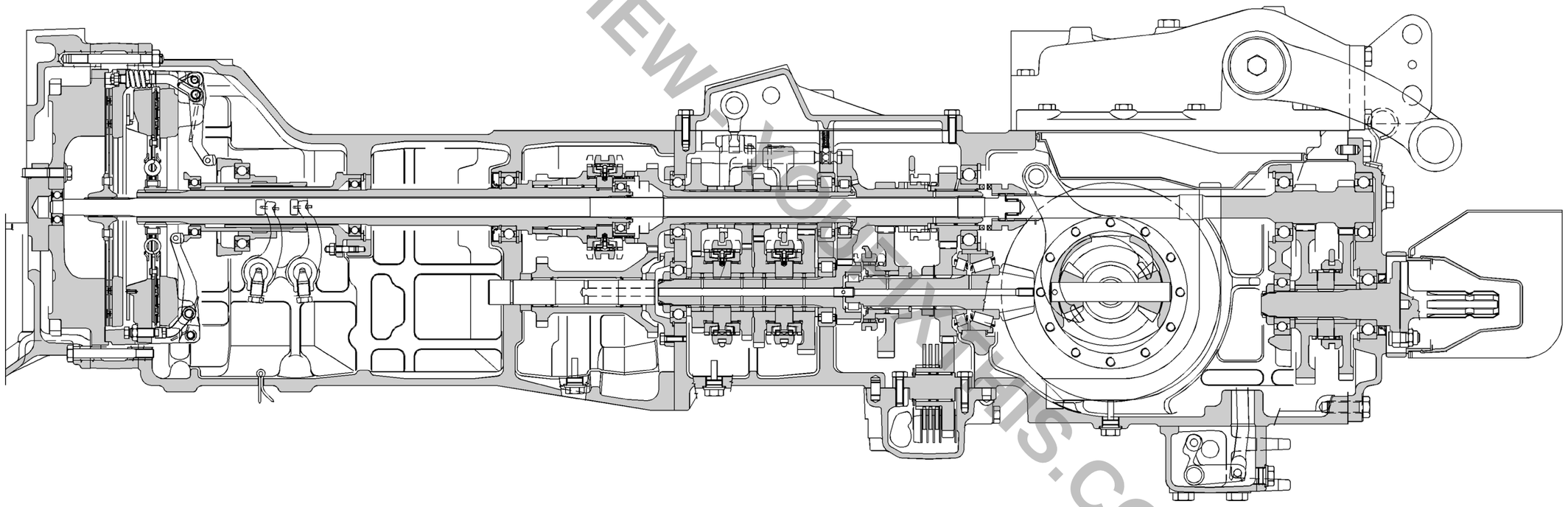
4. Remove the accelerator retaining spring (1) and extract the lever (2).



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26188

Longitudinal section of transmission with reverser, dual disk clutch and mechanical PTO.

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TOOLS

WARNING

The operations described in this section can only be carried out with the **ESSENTIAL** tools indicated by an **(X)**.

To work safely and efficiently and obtain the best results, it is also necessary to use the recommended specific tools listed below and certain other tools, which are to be made according to the drawings included in this manual.

List of specific tools required for the various operations described in this Section.

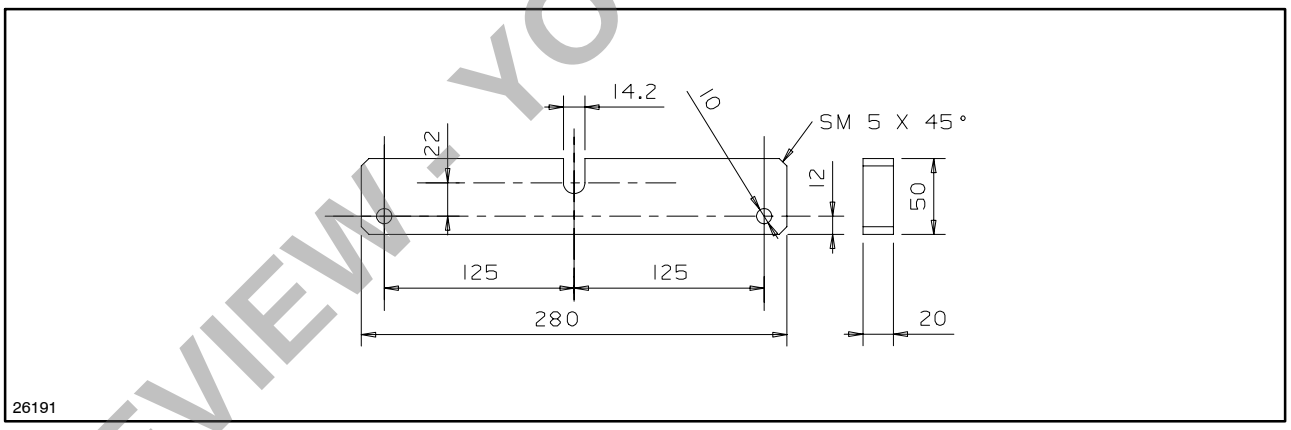
380000236 Tractor disassembly trolley.

380000227 Clutch casing lift hook.

380000301 Rotating stand for overhaul operations.

380000271 Front bracket (with **380000301**).

380000272 Rear bracket (with **380000301**).



2

Support bracket for fitting the transmission driving shaft seal (mark tool with no. 50043) (Measurements in mm).
Make in UNI C40 material.

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Channel (8) Clutch A PWM Solenoid

Key-switch – ON (engine running)
Engine – at idle
Gear select lever – first gear
Range lever – in II or III
Power Shuttle FNR lever – forward position
Unit of measure – ADC counts.

Value
A. Slowly release pedal. 450 (230-548)

Channel (9) Power Shuttle FNR Forward Switch

Key-switch - ON (engine off)
Unit of measure – ADC counts
Values
A. Neutral position 170 (21 to 323)
B. Forward position 480 (326 to 900)

Channel (10) Power Shuttle FNR Reverse Switch

Key-switch - ON (engine off)
Unit of measure – ADC counts

Values
A. Neutral position 170 (21 to 323)
B. Forward position 480 (326 to 900)

Channel (11) Wheel Speed Sensor

Key-switch – ON (engine running)
Gear select lever – first gear
Range lever – highest setting
Power Shuttle FNR lever – forward position
Unit of measure – ADC counts

Value
A. Stationary 600 (500-850)

WARNING

The tractor will move when checking channel (12) and (13), therefore, ensure the surrounding area remains free of by-standers and obstructions, or injury, death, or damage to equipment may occur.

IMPORTANT: *Readings may vary for channel (12) and (13), depending on the calibration values of the clutch.*

NOTE: *Allow at least six seconds for the CDU to indicate an accurate reading of channel (12) and (13).*

Channel (12) Clutch D PWM Solenoid

Key-switch – ON (engine running)
Engine – at idle
Gear select lever – first gear
Transmission – in HIGH
Range lever – in II or III
Power Shuttle FNR lever –forward position

Unit of measure – ADC counts

Value
A. Slowly release pedal 450 (230-548)

Channel (13) Clutch C PWM Solenoid

Key-switch – ON (engine running)
Engine – at idle
Gear select lever – first gear
Transmission – in LOW
Range lever – in II or III
Shuttle command lever – forward position
Unit of measure – ADC counts

Value
A. Slowly release pedal. 450 (230-548)

Channel (14) 5V Input Sensor Supply

Key-switch – ON (engine off)
Unit of measure – ADC counts

Value
A. 5 Volts 670 (521 to 849)

Channel (15) No function

Channel (16) Main Gear (G) Lever Position Switch

Key-switch – ON (engine off)
All control levers - neutral
Unit of measure – ADC counts

Values
A. Gear engaged 165 (21 to 323)
B. Gear disengaged (neutral) 470 (324 to 900)

NOTE: *When observing an incorrect value, check the function and shim adjustment of the gear lever status switch. Use the procedures outlined on page 104, Chapter 6, Section 21 "Obtaining the Correct Shim Adjustment for the Gear Lever Status Switch".*

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NOTE: *In this manual, the Power Shuttle ECM error codes are divided into two main pages which face each other. One page describes the error code, and the conditions, causes, tests, effects, recovery, and other pertinent information of the error code, while the second page displays a flow chart for troubleshooting. Becoming familiar with both the error code description page and the flow chart page, as well as using them together when performing diagnostic testing on the Power Shuttle, will improve repair capability, and reduce the time spent on troubleshooting.*

ERROR CODE 15 – Main (G) Gear Shift Switch signal voltage short to ground or open circuit.

NOTE: *On a 24x24 the Transmission Status Lamp is the Hi(Rabbit) and Lo(Turtle) lamps. They will flash in an alternating manner.*

Conditions:

1. While tractor is being driven, voltage at ECM connector 2, pin 2 goes below 0.7 volts.
2. While tractor is in neutral, voltage at ECM connector 2, pin 2 goes below 0.7 volts. Clutch Packs are at maximum pressure, (Wheel Speed Sensor signal not reliable or tractor is not moving).

Causes:

- Main (G) Gear Shift Switch Improperly Shim Adjusted. (See Status Switch Adjustment Procedure on Page 104)
- Faulty Main (G) Gear Shift Switch.
- Circuit is shorted to ground or circuit is open between Main (G) Gear Shift Switch and ECM connector 2, pin 2.
- Faulty ECM.

Tests:

- H9, Channel 16 value is below 143 counts.
- H5, doesn't display a transition between d0 and d33.

Effects of Condition 1:

- The Transmission Status Lamp is flashing.
- Main (G) Gear Shift neutral position can not be detected.
- Transmission is disabled, but can be re-enabled by cycling the Clutch Pedal.

Effects of Condition 2:

- Transmission is modified; Main (G) Gear Shift neutral position can not be detected, so ECM assumes position is in gear: If Wheel Speed Sensor signal is not reliable, (ERROR CODE 49) and transmission is critically disabled. If Wheel Speed Sensor signal is reliable, (no error), an attempt to move is conducted; (by releasing the Clutch Pedal while Power Shuttle FNR Lever is engaged or by engaging the PS FNR Lever while the Clutch Pedal is released). In this case, if the Wheel Speed Sensor doesn't see an increase in rotation when the Clutch Pack is at maximum pressure, then oil is dumped to sump

Recovery:

- Cause must be resolved and error must be cleared using the CDU or EST, HF Menu.

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NOTE: *In this manual, the Power Shuttle ECM error codes are divided into two main pages which face each other. One page describes the error code, and the conditions, causes, tests, effects, recovery, and other pertinent information of the error code, while the second page displays a flow chart for troubleshooting. Becoming familiar with both the error code description page and the flow chart page, as well as using them together when performing diagnostic testing on the Power Shuttle, will improve repair capability, and reduce the time spent on troubleshooting.*

ERROR CODE 37 – Clutch Pedal Switch open circuit.

NOTE: *This error may be triggered by ERROR CODE 11.*

NOTE: *On a 24x24 the Transmission Status Lamp is the Hi(Rabbit) and Lo(Turtle) lamps. They will flash in an alternating manner.*

Conditions:

- The Clutch Pedal Potentiometer indicates the clutch pedal is above 30%, while the Power Shuttle FNR Lever is not in neutral, with voltage being supplied to ECM connector 2, pin 18; and 12 volts not present at ECM connector 1, pin 15; all happening for 1 second or longer.

Causes:

- Faulty Clutch Pedal Switch.
- Faulty Clutch Pedal Switch adjustment.
- Faulty wiring; circuit open between ECM connector 1, pin 15 and Clutch Pedal Switch, (Neutral Detection).

Tests:

- H9, channel 4 is too low.
- H5 does not change from “d0” to “d21”.
- HA doesn’t display correct values.
- Effects:
- The Transmission Status Lamp is flashing.
- Transmission can not be neutralized.
- Transmission is disabled, but can be re-enabled by cycling the Power Shuttle FNR Lever.

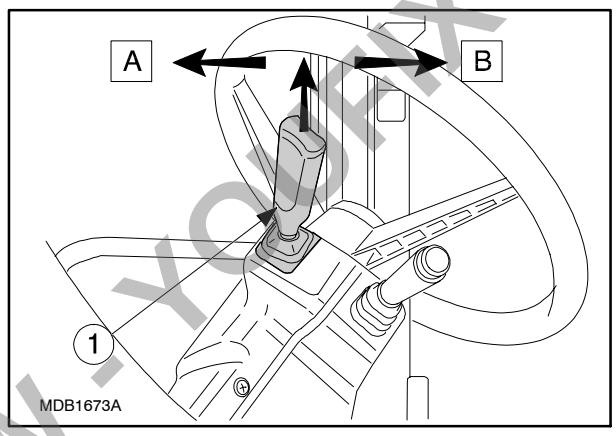
Recovery:

- Cause must be resolved and error must be cleared using the CDU or EST, HF Menu.

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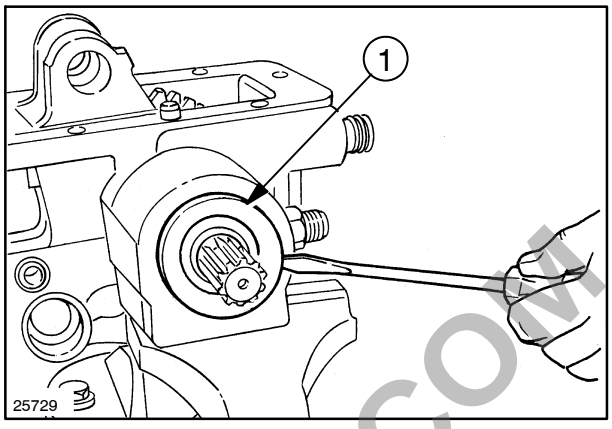
ERROR CODE 59



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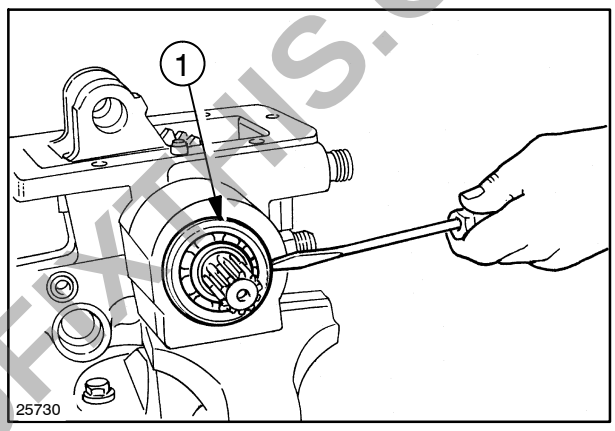
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4. Using a screwdriver, remove the dust ring (1).



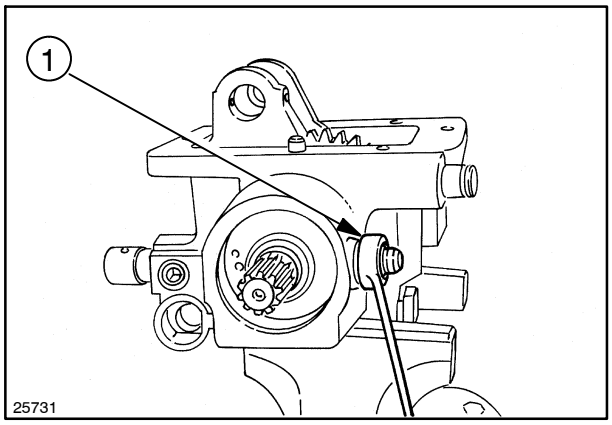
41

5. Remove the oil seal (1).



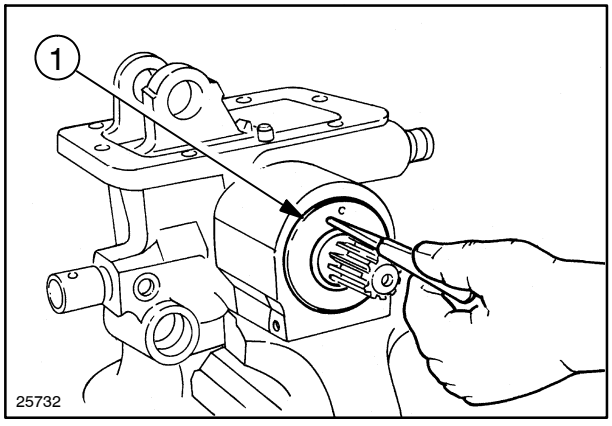
42

6. Remove the FWD drive gear disengagement oil delivery union (1).



43

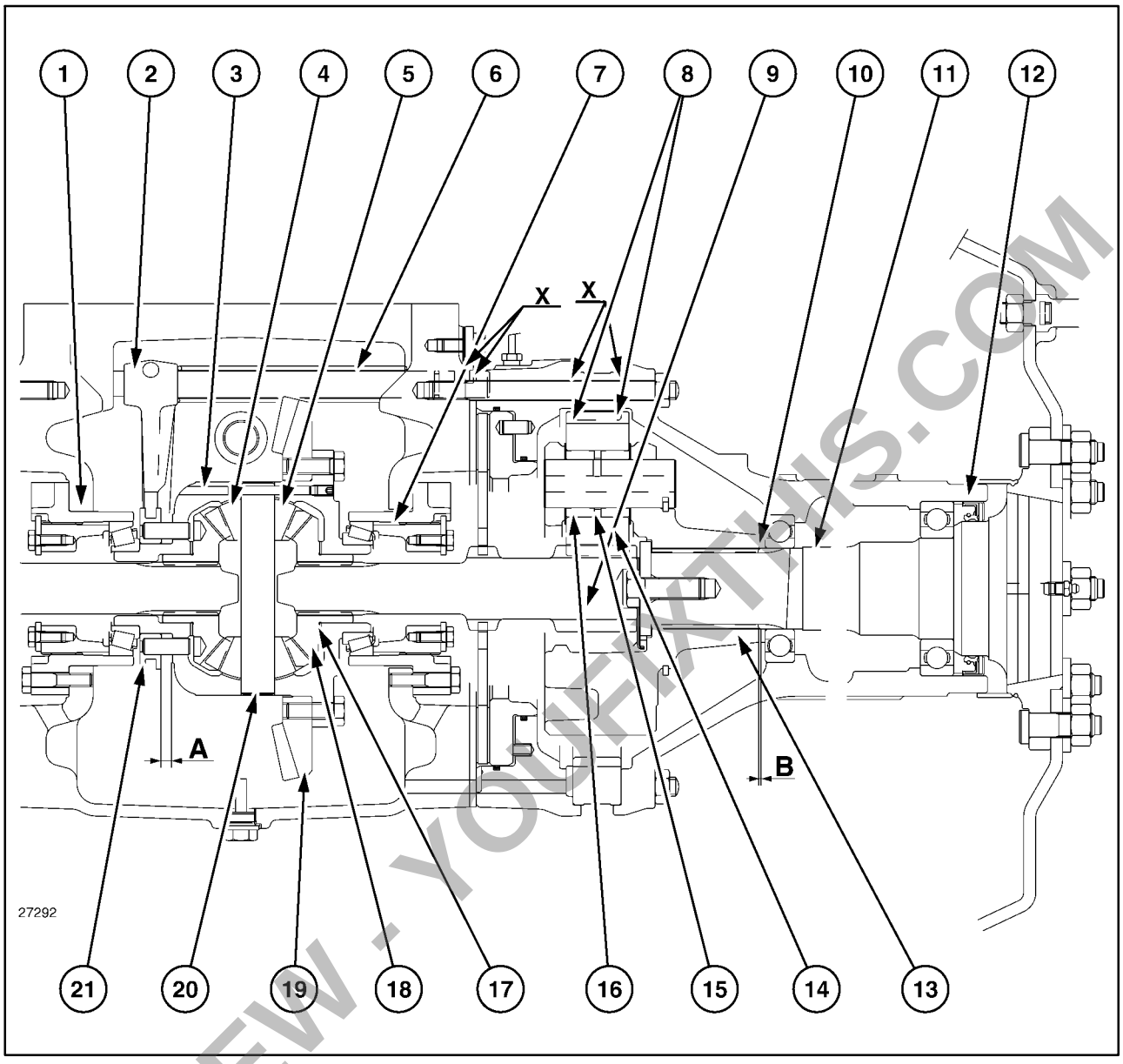
7. Remove the oil delivery manifold ring (1) with a suitable punch.



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13

Cross-sectional view of transmission (models TL80 and TL90)

A. 0.3188 to 0.3228 in. (8.1 to 8.2 mm). Differential lock engage sleeve travel.
B. 0.0078 to 0.0157 in. (0.2 to 0.4 mm). Final drive planet pinion support end float.
1. Bevel crown wheel bearing support with adjusting ring nut.
2. Differential lock control fork.
3. Differential casing.
4. Shim ring.
5. Planet gear.
6. Differential lock spring.
7. Bevel crown wheel bearing support.
8. Shim rings.
9. Differential output half-shaft.
10. Planet gear support (13) end float adjuster shim.
11. Wheel axle shaft.
12. Seal.
13. Final drive planet gear support.
14. Final drive planet gear.
15. Bearing.
16. Spacer.
17. Sun gear clearance adjuster ring.
18. Sun gear.
19. Bevel crown wheel.
20. Planet gear pin (5).
21. Differential lock engagement sleeve.

NOTE: *During assembly apply sealing compound on surfaces marked with an* ***X*** *as shown in fig. 85.*

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Op. 31 112 45 e 31 112 48
MECHANICAL POWER TAKE-OFF
SHAFTS D.A.

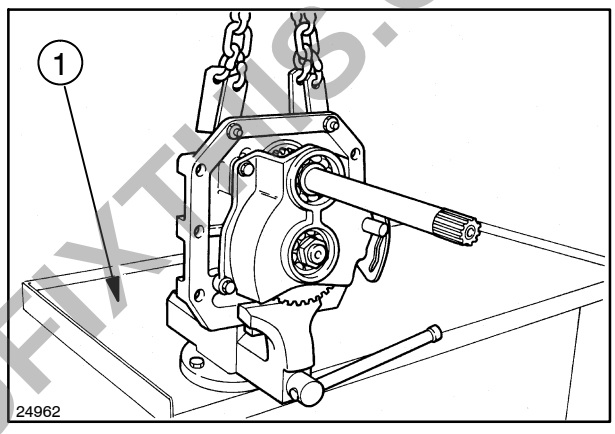
CAUTION

Handle all parts carefully.

Do not put your hands or fingers between parts.

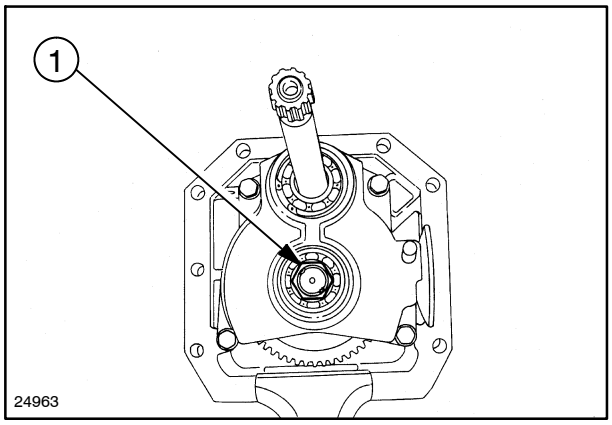
Wear suitable safety clothing – safety goggles, gloves and shoes.

1. Position the PTO unit in a vice on a workbench (1).



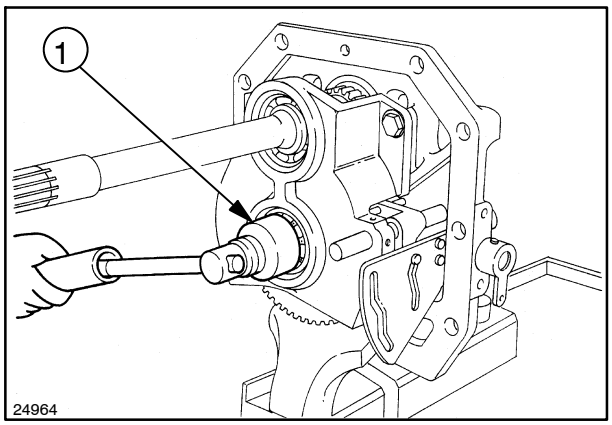
23

2. Using a punch, release the securing ring (1) on the driven shaft ring nut.



24

3. Remove the driven shaft ring nut (1).



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LOW PRESSURE, STEERING AND LUBRICATION SYSTEM

For a description of the Low-pressure hydraulic system, refer to the following Chapters:

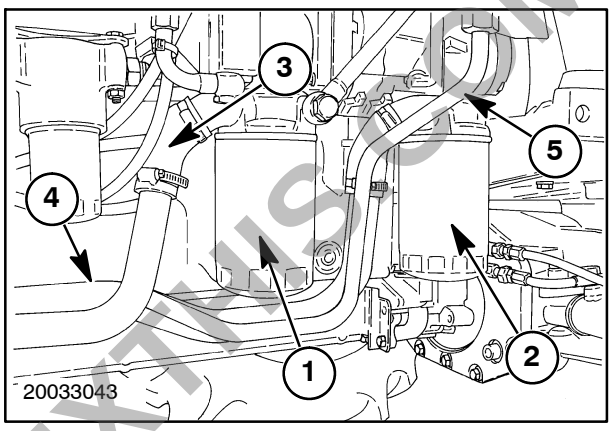
Chapter 6 – Low-pressure Hydraulic System

Chapter 7 – Low-pressure Hydraulic System Overhaul and Adjustments

HIGH PRESSURE SYSTEM DESCRIPTION AND OPERATION

The high-pressure system supplies pressurized oil for the operation of the auxiliary control valves, hydraulic power lift (HPL), and external equipment attached to the tractor.

The rear axle casing functions as a common reservoir for storage of the hydraulic oil. Driven by the engine timing gear, the C55 high-pressure pump delivers 14.5 g/m at 2150 engine rpm. The oil passes through a filter assembly (2) mounted on the pump at the right-hand side of the engine. Oil leaving the delivery side of the pump (5) flows through tubing routed along the right-hand side of the transmission, until reaching the components in the order listed in Table 2.



1

1. Steering pump filter
2. High-pressure pump filter
3. Supply to steering pump
4. Supply to high-pressure pump
5. [Deluxe Bosch] oil flow from high-pressure pump to unload valve in rear remote valve stack
   [Deluxe Rexroth] oil flow from high-pressure pump to unload valve on the transmission
   [Standard Kontak] oil flow from high-pressure pump to rear remote valve(s)

TABLE 2 OIL FLOW PRIORITY

Oil flow for tractors configured with the following components	Unload Valve	Auxiliary Control Valve	Mid-mount Valve	HPL Control Valve
Rear Remote Valve(s)	N/A	#1	N/A	#2
Rear Remote Valve(s) & Mid-mount Valve	N/A	#1	#2	#3
Rear Remote Valve(s) & Unload Valve	#1	#2	N/A	#3
Rear Remote Valve(s) & Unload Valve & Mid-mount Valve	#1	#2	#3	#4

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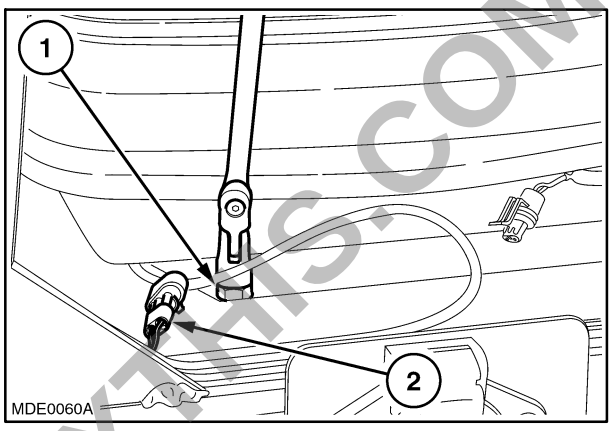
Op. 35 114 10
LIFT CONTROL VALVE R.I.

CAUTION

Handle all parts carefully. Do not put your hands or fingers between parts. Wear suitable safety clothing - safety goggles, gloves and shoes.

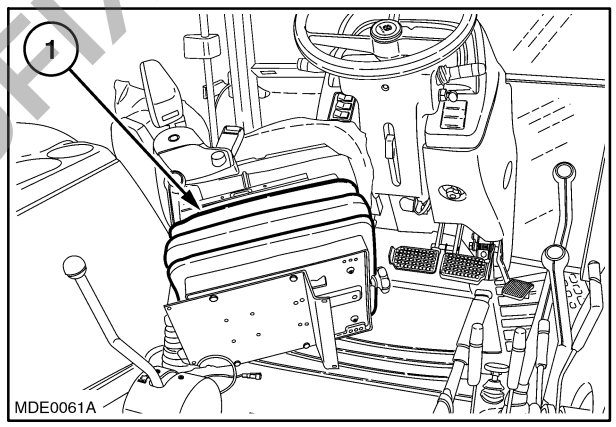
Proceed as follows.

1. Disconnect the driving seat occupied/safety and pneumatic seat height adjustment electric cable (2).
2. Take out the four bolts (1) securing the seat to the platform.



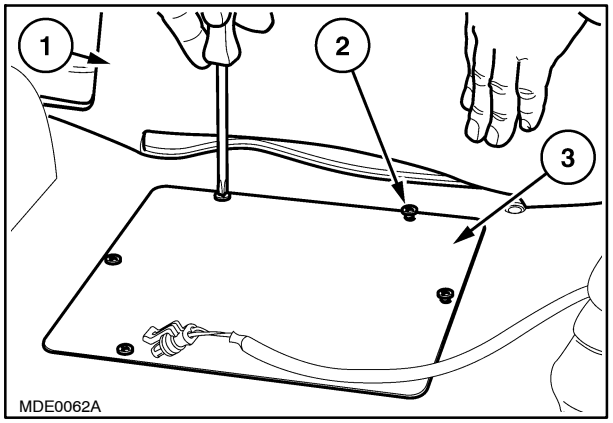
85

3. Move the seat (1) to the front part of the platform so that it does not obstruct the following disassembly operations.



86

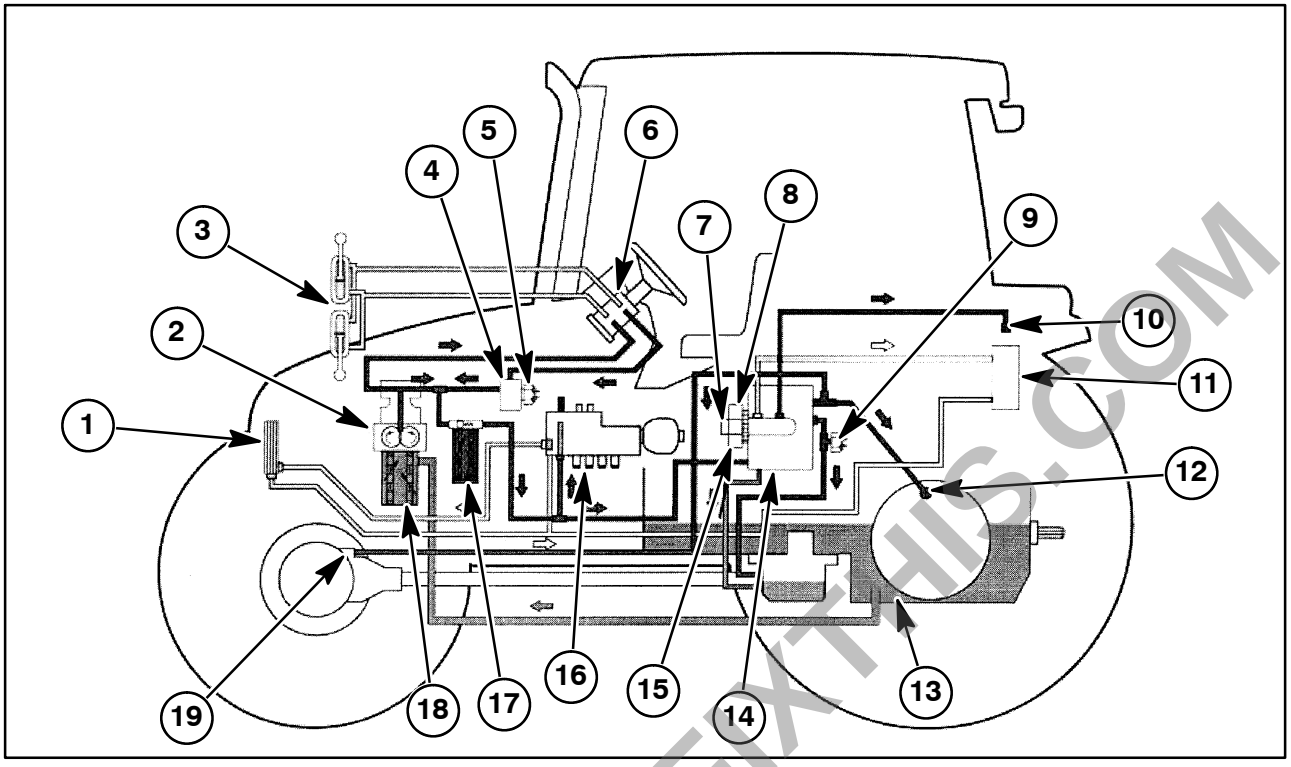
4. Lift the mat (1) located on the rear part of the platform.
5. Remove the retaining bolts (2) and the cover (3) installed on the platform.



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7

1. Oil Cooler
2. Steering Circuit Pump
3. Steering Cylinder(s)
4. Anti-cavitation Device
5. Low Pressure Switch (Normally closed)
6. Steering Motor and Relief Valve
7. PTO Solenoid (Energized – on)
8. Differential Lock Solenoid
9. FWD Control Switch (Disengage – open)
10. PTO Brake
11. Electro-Hydraulic PTO Clutch
12. Rear Differential Lock
13. Rear Axle Casing (Reservoir)
14. Services Control Valve (Low-pressure)
15. FWD Solenoid (Energized – off)
16. Dual Power and Power Shuttle Control Valve
17. Power Shuttle Filter
18. Filter Assembly
19. Front Differential Lock

24x24 Dual Command (HI-LO), Power Shuttle Transmission, Electro-Hydraulic FWD, Differential Lock, Hydraulic PTO

The engine timing gear drives the steering pump (2), located on the right-hand side of the engine, and aft of the high-pressure hydraulic pump. The steering pump draws supply oil from the rear axle casing (13) via tubing routed along the right side of the transmission, through a micron filter assembly (18). The pump contains a flow control valve. Pressurized oil exits the delivery side of the pump and flows to the steering motor (6), and to the anti-cavitation device (4). A relief valve installed in the steering motor operates at 165-170 bar (2393-2466 psi) for FWD, and 140-145 bar (2031-2103 psi) for 2WD to protect the circuit from over-load conditions. A check valve, also installed in the steering motor ensures the flow of oil in one direction only. A switch (5) (where installed) on the anti-cavitation device monitors oil pressure.

Turning the steering wheel transmits motion to the steering motor, which directs the hydraulic oil to the appropriate port of the steering cylinder(s) (3). Oil exhausts from the cylinder to the steering motor, where the metering valve directs the oil through tubing to the anti-cavitation device. It is combined with remaining unused oil from the pump. From the anti-cavitation device, oil flows through the power shuttle filter (17) to the dual power (HI-LO) and power shuttle control valve (16). In addition, the oil flows to the low-pressure services control valve (14). The positioning of the PTO solenoid (7), differential-lock solenoid (8), four-wheel drive control switch (9) and four-wheel drive solenoid (15) directs the oil to the appropriate component, or back to the reservoir depending on selection.

An open-center type circuit, the low-pressure/steering and lubrication circuit provides continuous oil flow with the engine operating.

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SECTION 35 – HYDRAULIC SYSTEMS

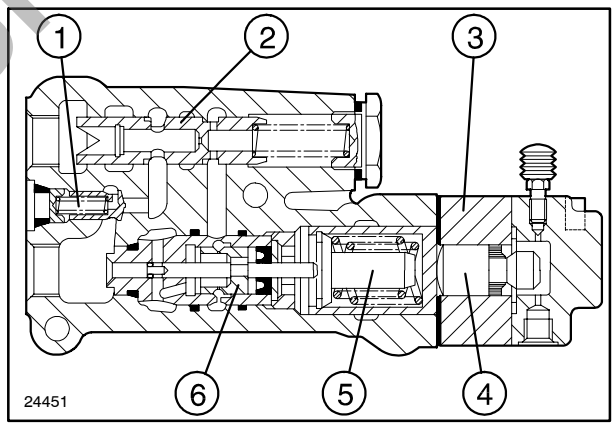
Chapter 8 – Trailer brake auxiliary control valves (ISO)

CONTENTS

Operation	Description	Page
	Cross-sectional views	1
	Description and Operation	1
	Trailer brake control valve hydraulic circuit diagram with KONTAK control valves	2
	Trailer brakes control valve hydraulic circuit diagram with BOSCH control valves	3
	Functional testing and troubleshooting	10

Cross-sectional view of auxiliary control valve for trailer brakes. (Open-centre circuit)

1. Non-return valve.
2. Flow control valve.
3. Pilot valve casing.
4. Pilot valve piston.
5. Pressure limiter.
6. Slide piston.



1

DESCRIPTION AND OPERATION

The trailer brake valve is located on the right-hand side of the rear transmission casing, controlled by the lift control pump and has priority over both the auxiliary control valves and the hydraulic lift.

The trailer brake valves mounted in the outfit with Kontak auxiliary control valves or in the outfit with Bosch auxiliary control valves are the same.

For the hydraulic operation of the trailer brake valve, see pages 4 and 5.

The ITALIA trailer brake valve provides the advantage and safety of having the trailer brakes applied even with:

- engine off;
- pump faulty (or with low delivery).

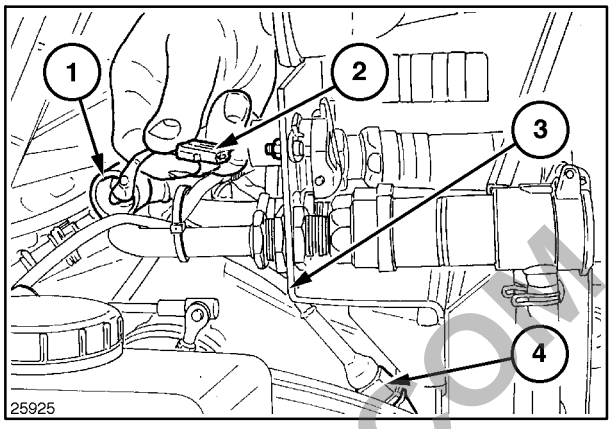
A description of the ITALIA trailer brake valve can be found on pages 6 to 9.

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12. Remove the guard (1), disconnect the single pole connections (2) and the ground cable on the quick-fit couplers support bracket (3).

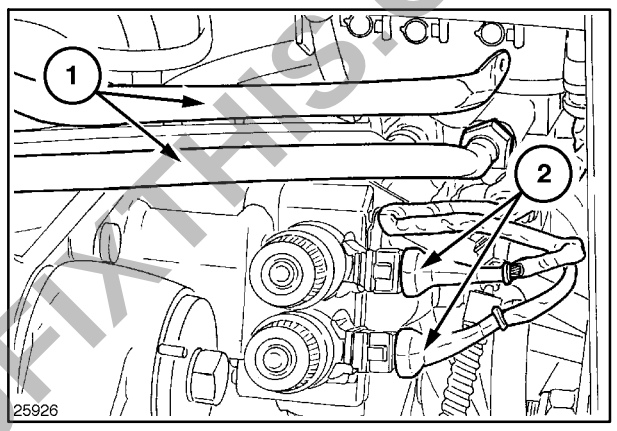
13. Disconnect the power take-off speed sensor connection (4).



30

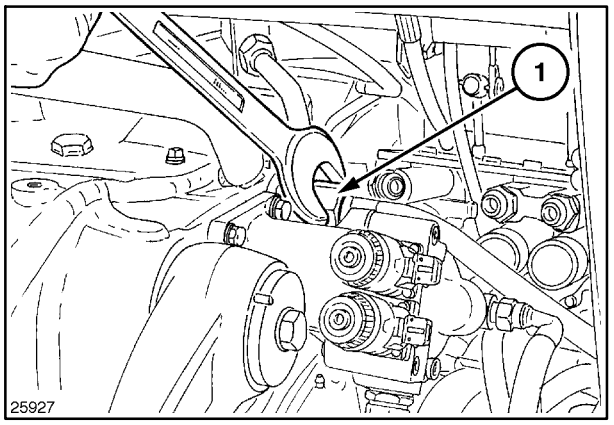
14. Disconnect: the control valve connections (2) and all auxiliary control valve piping (1).

15. Remove the auxiliary control valve quick-fit coupler support bracket and piping.



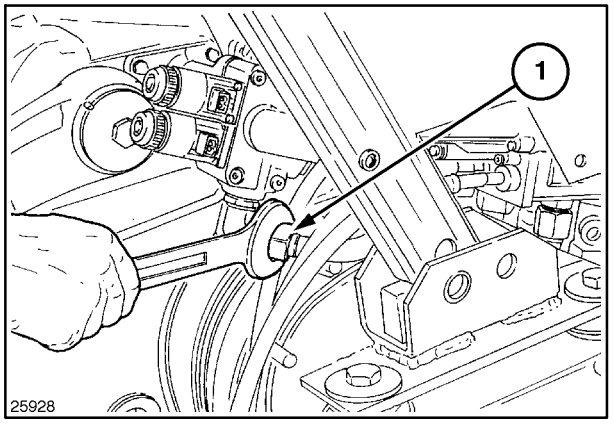
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16. Disconnect the lift oil discharge line (1) and, if necessary, remove it.



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17. Disconnect and remove the lift control valve oil delivery piping (1).



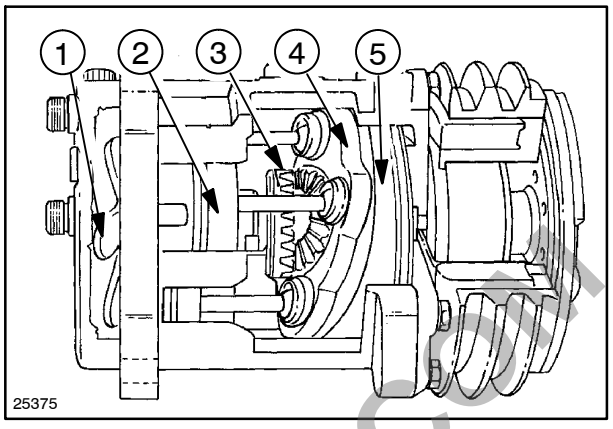
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MAIN COMPONENTS OF THE AIR CONDITIONING SYSTEM

Axial flow reciprocating piston compressor SANDEN SD 7H15



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1. Combined inlet and discharge valve.
2. Piston with seal ring.
3. Drive gear.
4. Connecting rod disk.
5. Cam rotor.

Compressor

The compressor serves to pressurise the refrigerant and force it through the system.

SANDEN SD 7H15 MODEL

Axial reciprocating piston type, driven by the engine crankshaft via a vee belt.

The operation of the compressor can be summarised as follows:

The swashplate (4), on which pivot the ball ends of the connecting rods of the pistons (2), rests on the cam rotor (5).

Driven by the compressor pulley, as the cam rotor (5) rotates it exerts a continuous thrust on the swashplate (4), which is prevented from rotating by the coupling with the fixed gear (3).

The angle of the rotor cam (5), in relation to the axis of rotation, causes the reciprocating movement of the pistons (2).

The piston head (2) is fitted with a reed valve (1) with seven lobes (one for each piston), and controls the inlet and discharge stages of the cylinders (2).

The valve opening and closing system is automatic, achieved by preloading of the shutter blades.

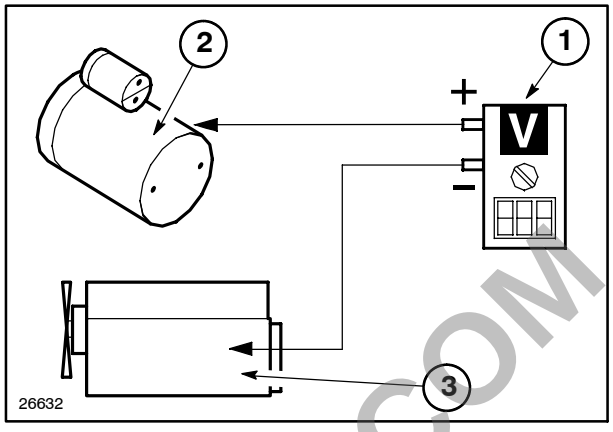
The rotating parts of the compressor are lubricated by special oil, inserted during assembly, some of which circulates through the system mixed with the refrigerant.

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STARTER MOTOR GROUNDING

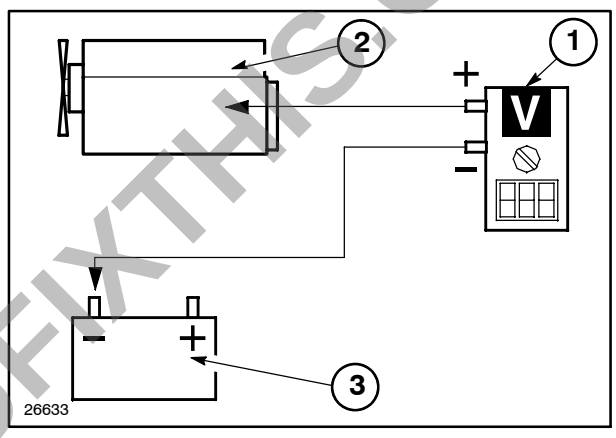
1. Connect the positive voltmeter point (1) to starter motor casing (2).
2. Connect the negative voltmeter point to the engine block (3).
3. Run the engine and check the readings on the voltmeter. If voltage is higher than 0.2 V, check grounding connections between motor flange and rear engine cover.



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BATTERY GROUND CABLE

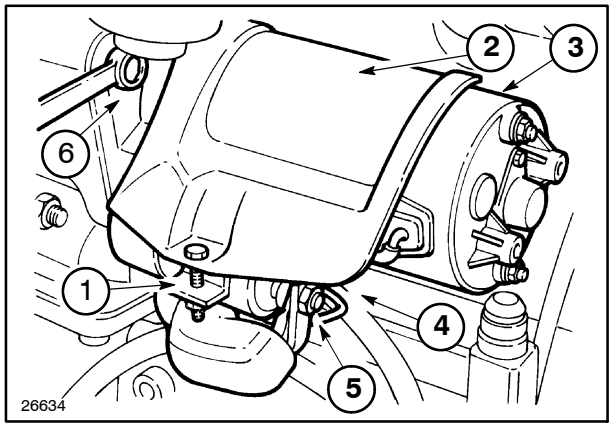
1. Connect the positive voltmeter point (1) to the engine block (2).
2. Connect the negative voltmeter point to the negative battery terminal clamp (3).
3. Run the engine and check the readings on the voltmeter. If voltage is higher than 0.2 V, check and tighten the grounding cable connections. Check the voltage again and if it is still higher, then install a new grounding cable.



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STARTER MOTOR REMOVAL AND RE-INSTALLATION

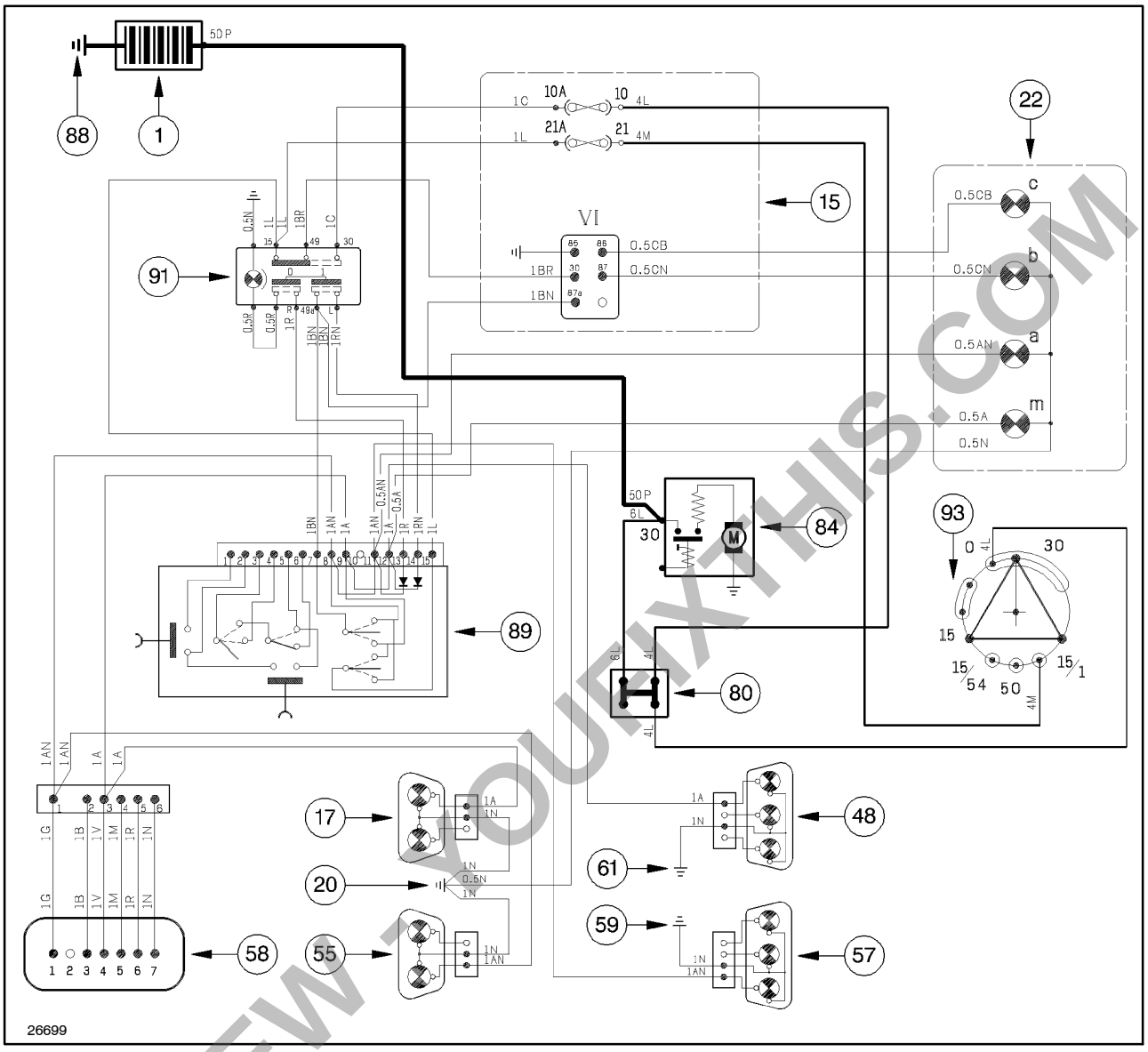
1. Disconnect ground (negative) battery cable.
2. Unscrew and remove starter motor (3) protection cover (2) nut and bolt (1).
3. Unscrew the nut and remove power clamp (5) and emergency switch clamp (4).
4. Remove starter motor fastening bolts (6) and remove the starter motor.
5. To re-install the starter motor, reverse the order of removal.



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DIRECTION INDICATOR AND HAZARD LIGHT CIRCUIT

1 - Battery

15 - Fuse and relay box

VI - Electronic flasher

17 - Front right side light and direction indicator light

20 - Control panel ground

22 - Control panel

a - Direction indicator

b - 1st trailer direction indicator

c - 2nd trailer direction indicator

m - Right tractor direction indicator

48 - Rear right headlight

55 - Front left side light and direction indicator light

57 - Rear left taillight

58 - Seven-pole socket

59 - Left side cab ground

61 - Digital instrument and main rear ground

80 - Four-pin shunt connection

84 - Starter motor

88 - Battery ground

89 - External lights control stick

91 - Hazard light control switch

93 - Ignition switch

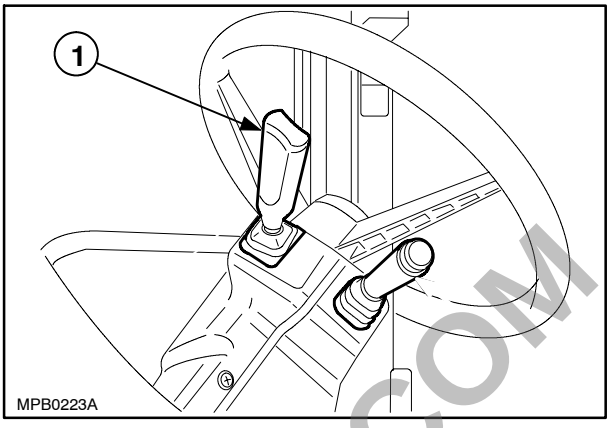
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Power Shuttle control lever (Fig. 9)

The Power Shuttle lever (1) inverts the direction of travel and has three settings:

- central position: neutral
- forward position: forward drive
- backward position: reverse



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FWD control switch (Fig. 10)

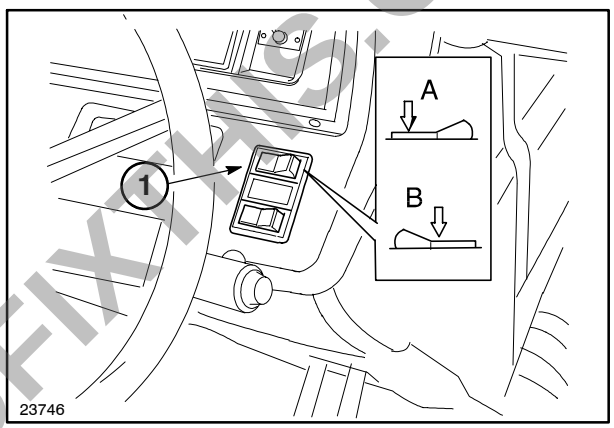
Front-wheel drive can increase the tractor's grip on the surface; the benefits of this are particularly noticeable when working on uneven, muddy or slippery ground, on ploughed ground or in difficult conditions. Front drive engagement is electro-hydraulic and can be automatic or manual:

- Automatic

  With the switch (1) pressed to position A and the brake pedals pressed: FWD is disengaged when the pedals are released.

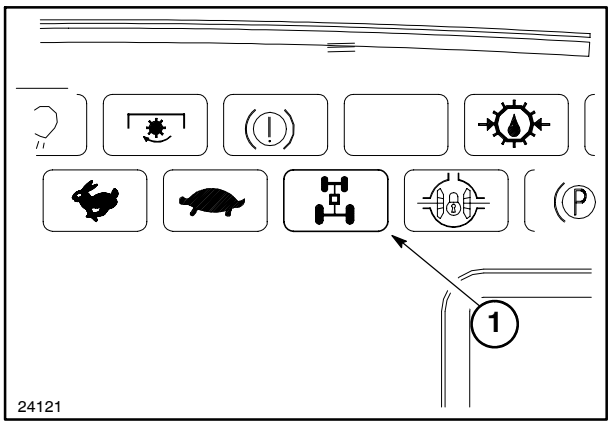
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  With the switch (1) pressed to position B, FWD is permanently engaged. To disengage, press the switch (1) to position A.



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In both cases, engagement is indicated by the illumination of warning light (1) (Fig. 11).



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GROUND LOCATION POINTS

IMPORTANT: *When troubleshooting a faulty electrical circuit, check for improper grounds, which often are the cause of the electrical system failure.*

A. Instrument Panel:
The instrument panel ground is located under the dash, and is accessible through the left-hand side panel.

B. Battery:
The negative ground cable connects to the front bolster behind the battery. The engine compartment ground (C) connects to the same bolt.

C. Engine Compartment:
The engine compartment ground connects to the front bolster behind the battery. The negative ground cable (B) connects to the same bolt.

D. Cab RH Upper Side:
The cab right-hand upper ground connects to the steel cross member that extends from side to side, and is accessible by removing the sunscreen and lowering the headliner

E. Cab RH Side:
The cab right-hand side ground is located below the gas strut of the right door, underneath the interior fender cover.

F. Main Rear (Transmission):
The main rear ground is located at the seven-pole electrical connector plate at the rear, outside end of the tractor.

G. Cab Frame/Body:
The cab frame to body ground is located at the outside; left-hand side, rear portion of the tractor, and connects to the frame post and to one axle housing mounting bolt.

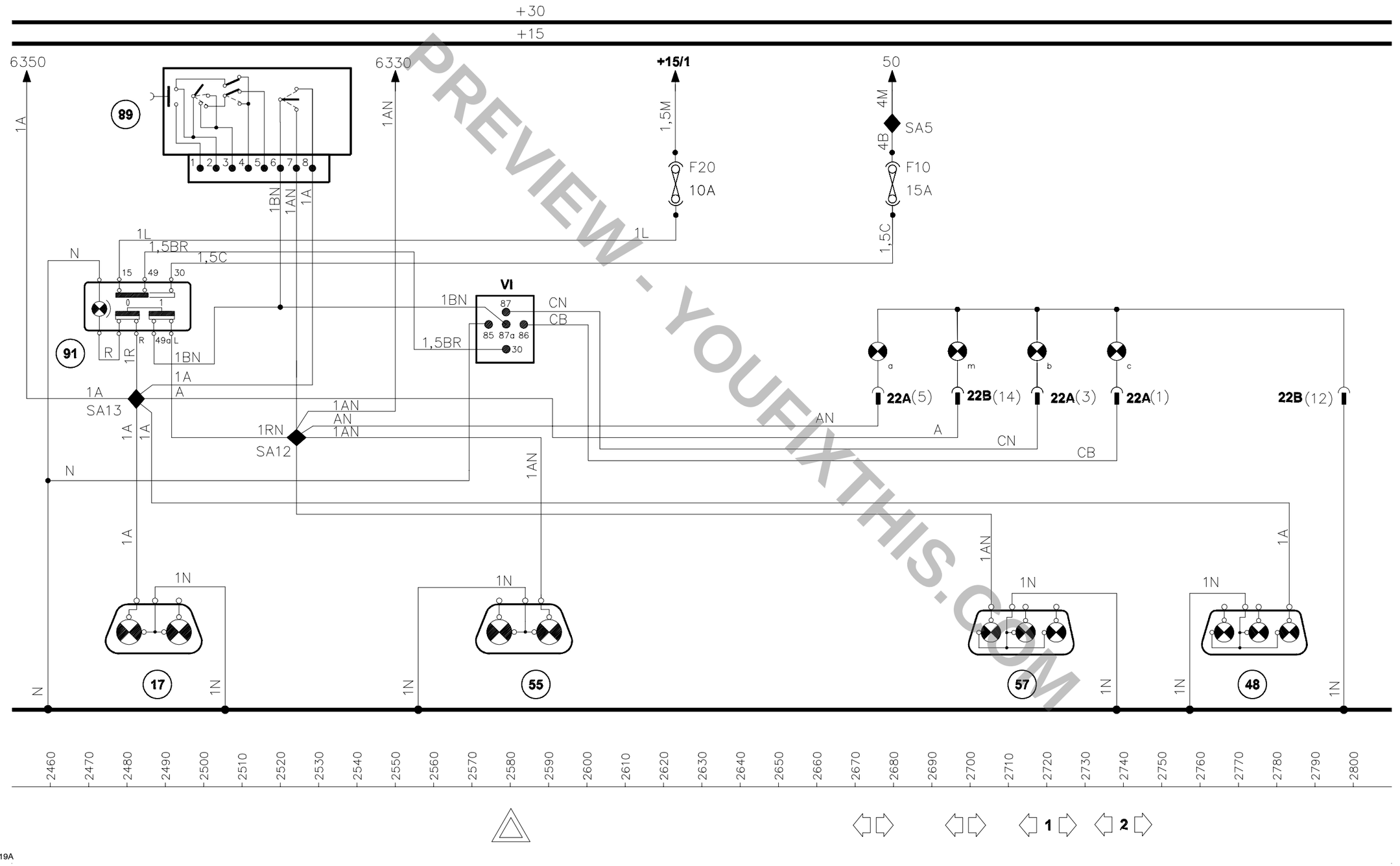
H. Cab LH Side:
The cab left-hand side ground is located below the gas strut of the left door, underneath the interior fender cover.

NOTE: *The over-voltage protection device ground (not shown) is located below the alternator, and connects to the over-voltage protection device mounting bolt.*

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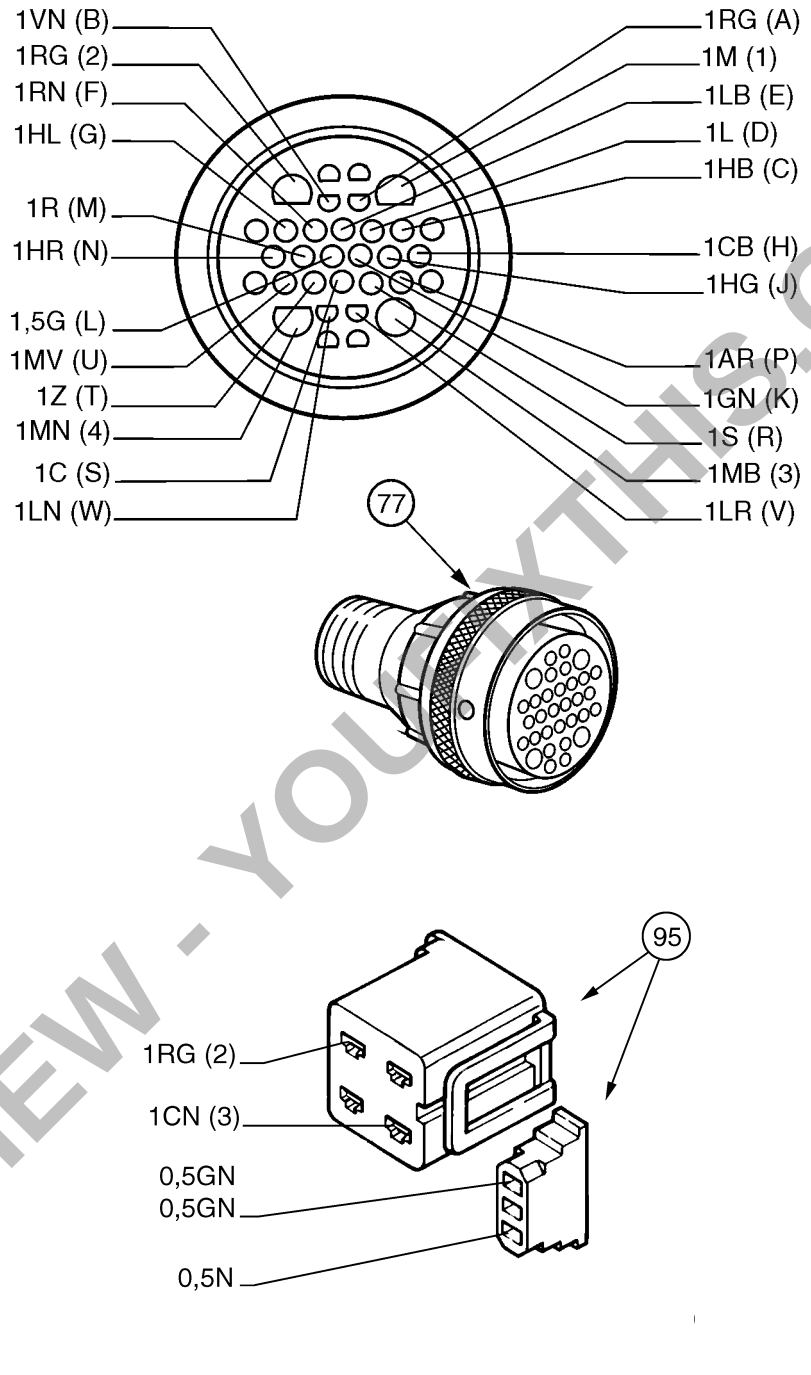
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DIAGRAM G - DIRECTION INDICATOR AND HAZARD LIGHTS CIRCUIT (ROPS (ISO))



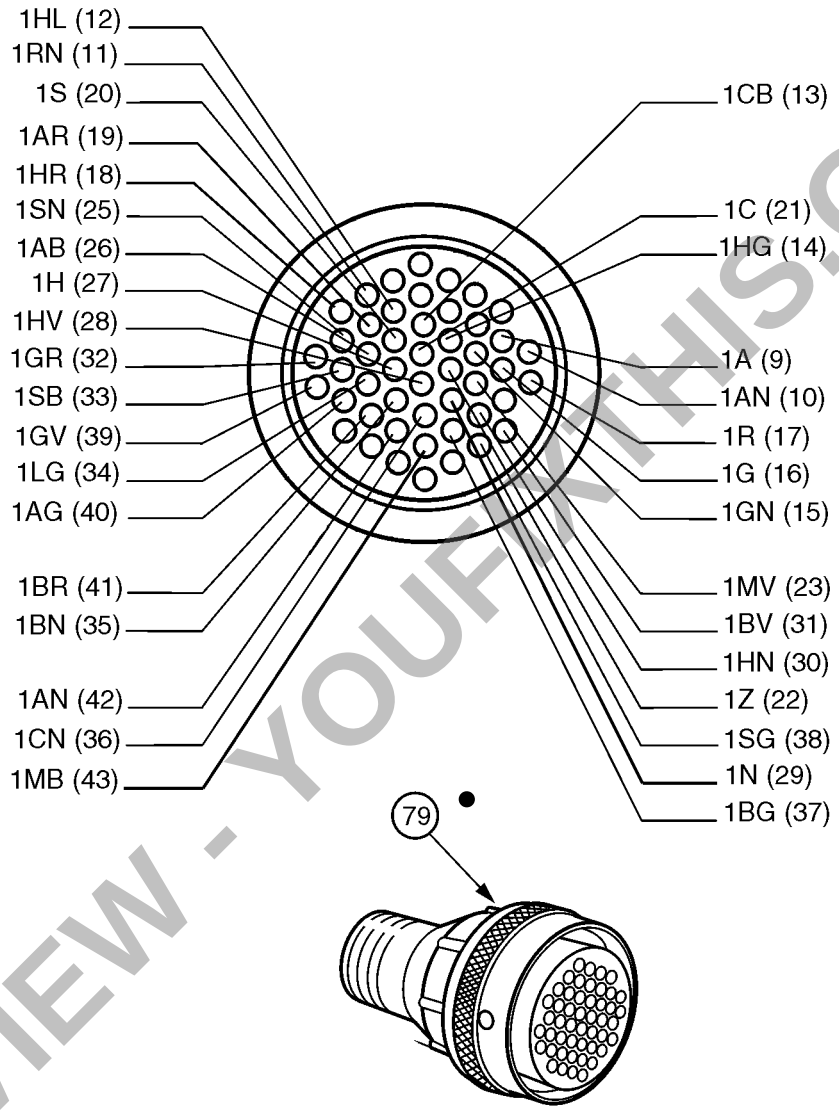
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