TRUCK, FLATBED, HEAVY, MC3, GUN TRACTOR/AMMO TRANSPORTER, W/CRANE, W/WINCH, MACK

TECHNICAL DESCRIPTION

This instruction is authorised for use by command of the Chief of Army. It provides direction, mandatory controls and procedures for the operation, maintenance and support of equipment. Personnel are to carry out any action required by this instruction in accordance with EMEI General A 001.

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INTRODUCTION

1. This EMEI supplement contains the technical description of the crane and other ancillary components fitted to the Truck, Flatbed, Heavy, MC3, Gun Tractor/Ammo Transporter, W/Crane, W/Winch, Mack. All relevant weights, dimensions and performance figures are detailed in the Data Summary, EMEI Vehicle G 720. For further information on the base truck, refer to the relevant EMEI. For warranty provisions, refer to the User Handbook.

GENERAL INFORMATION

2. The Truck, Flatbed, Heavy, MC3, Gun Tractor/Ammo Transporter, W/Crane, W/Winch, Mack is equipped with an Ateco Olding model 24L winch for self-recovery, a HIAB model 090 AW crane for self-loading, a removable cab roof for air portability and two flat top tray bodies for the transportation of ammunition. All Gun Tractors and most of the Ammo Transporters are fitted with a front towing point to enable easy positioning of the gun. Both have been fitted with twist locks to enable mounting of the GTPCM (Gun Tractor Personnel and Cargo Modules). For information on the winch refer to EMEI Vehicle G 702.

ASSOCIATED PUBLICATIONS

3. Reference may be necessary to the latest version of the following documents:

a. Defence Road Transport Instruction;

b. Record Book for Service Equipment (GM 120);

c. Complete Equipment Schedule (CES);

(1) SCES 11848 – Truck, Flatbed, Heavy, MC3, Gun Tractor/Ammo Transporter, W/Crane, W/Winch, Mack; and

(2) SCES 12104 – Truck, Flatbed, Heavy, MC3, Gun Tractor/Ammo Transporter, W/Crane, W/Winch, Mack.

d. Repair Parts Scale (RPS) 02164;

e. Provisional Block Scale 2406/29;

f. EMEI Vehicle A 029 – Servicing of B Vehicles;

g. EMEI Vehicle A 119-21 – Repair of Vehicles under Warranty Agreement;

h. EMEI Vehicle G 720 – Data Summary (Gun/Ammo);

i. EMEI Vehicle G 702 – Technical Description (Cargo);

j. EMEI Vehicle G 703 – Light Grade Repair (Cargo);

k. EMEI Vehicle G 723 – Light Grade Repair (Gun/Ammo);

l. EMEI Vehicle G 704 – Medium Grade Repair (Cargo);

m. EMEI Vehicle G 704–1 – Heavy Grade Repair (Cargo);

n. EMEI Vehicle G 724 – Medium and Heavy Grade Repair (Gun/Ammo);

o. EMEI Vehicle G 709 – Servicing (All Variants); and

p. EMEI Vehicle G 729 – Servicing (Gun/Ammo – Crane).

ROTABLE ITEM IDENTIFICATION

4. Table 1 lists the identification location for rotable items.

Table 1 Rotable Item Identification

Item	Location
Chassis No.	Right hand rear frame, above intermediate axle
Chassis Nameplate	Left hand door inside cab
Engine No.	Right hand top of timing gear housing
Front Axle No.	Left rear of axle housing

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Table 1 Rotable Item Identification (continued)

Item	Location
Transmission No.	Left hand side
Transfer Case	Right hand rear
Intermediate Axle No.	Right hand front of carrier housing
Rear Axle No.	Right hand front of carrier housing
Injection Pump Identification	Side of the pump
Crane	Located on the crane body
Power Take-Off (Hydraulic Pump)	Right hand side
Power Take-Off (Winch)	Below the selector housing
Hydraulic Pump	Rear face of the pump
Cab Upper Section	Rear inner left hand upper panel
Cab Lower Section	Left hand door opening gusset

CARGO BODY

CARGO TRAYS

5. Both cargo trays are fitted with twist locks for securing TRICON containers and/or Gun Tractor Personnel / Cargo Modules, the coaming rails have been fitted with heavy duty cargo lashing rings (refer to Figure 1). In the Gun Tractor role, the Personnel Module and Stores Container are to be mounted on the front tray, while the rear tray is for the transportation of ammunition in Unit Load Ammunition Container (ULAC) and stores in the Unit Stores Container (USC) (if required).

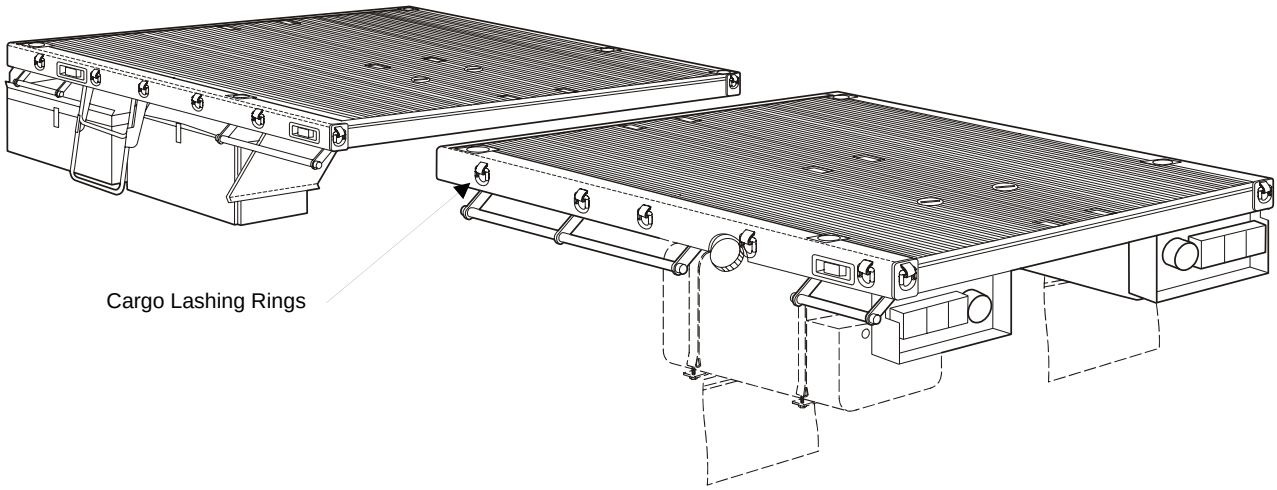

Figure 1 Cargo Body

STOWAGE BINS

6. Two tool boxes and a crew stowage bin have been mounted under the front tray for stowage of CES and crew personal equipment. In addition, a stowage tray for securing the AGLS (Automatic Gun Laying System) has been mounted above the hydraulic reservoir.

FUEL SYSTEM

7. The fuel system on the Gun Tractor/Ammo Transporter (Figure 2) incorporates two fuel tanks, each mounted under the rear tray. The tanks are connected via a crossover hose with isolation valves fitted to each tank. Fuel pick up is from the left hand tank which also houses the fuel sender. A wiring harness layout showing the sender unit wiring is illustrated at Figure 24. The remainder of the fuel system is the same as the base variant.

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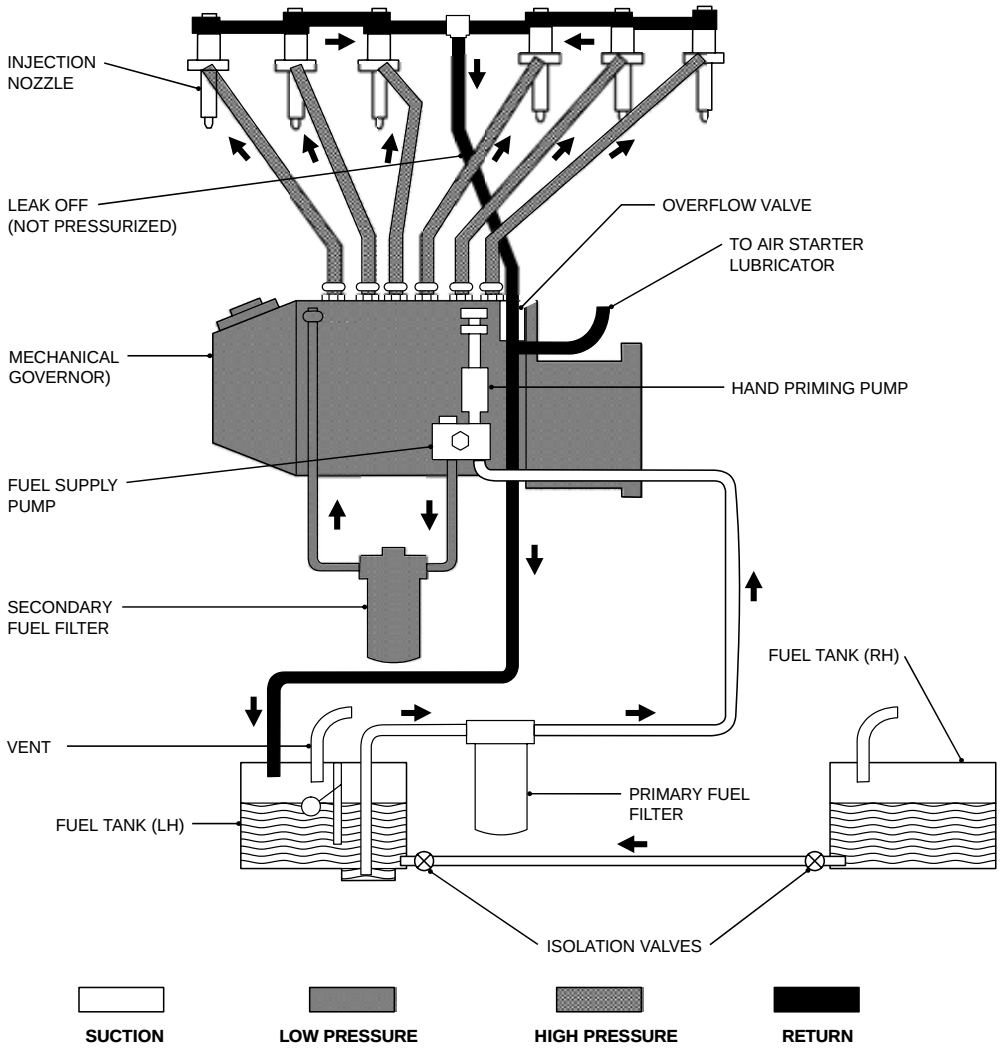

Figure 2 Fuel System Schematic

CRANE

GENERAL

8. The crane has a lifting capacity of 1170 kg at 7.0 metres. A label is affixed to the crane at each operator station adjacent to the controls. It depicts the maximum safe working load/radius for the crane.

9. A work lamp is fitted on the underside of the outer boom to allow illumination during night operations. A toggle switch for the lamp is located at each operator station on either side of the vehicle.

NOTE

The work lamp is wired into the park light circuit so that it is controlled under blackout conditions.

10. The crane comprises the following sub-assemblies (see Figure 3):

a. crane base (including tilting and slewing mechanisms);

b. crane body;

c. inner boom (and cylinder);

d. outer boom (and cylinder);

e. boom extensions (and cylinder);

f. outriggers;

g. manual control mechanisms;

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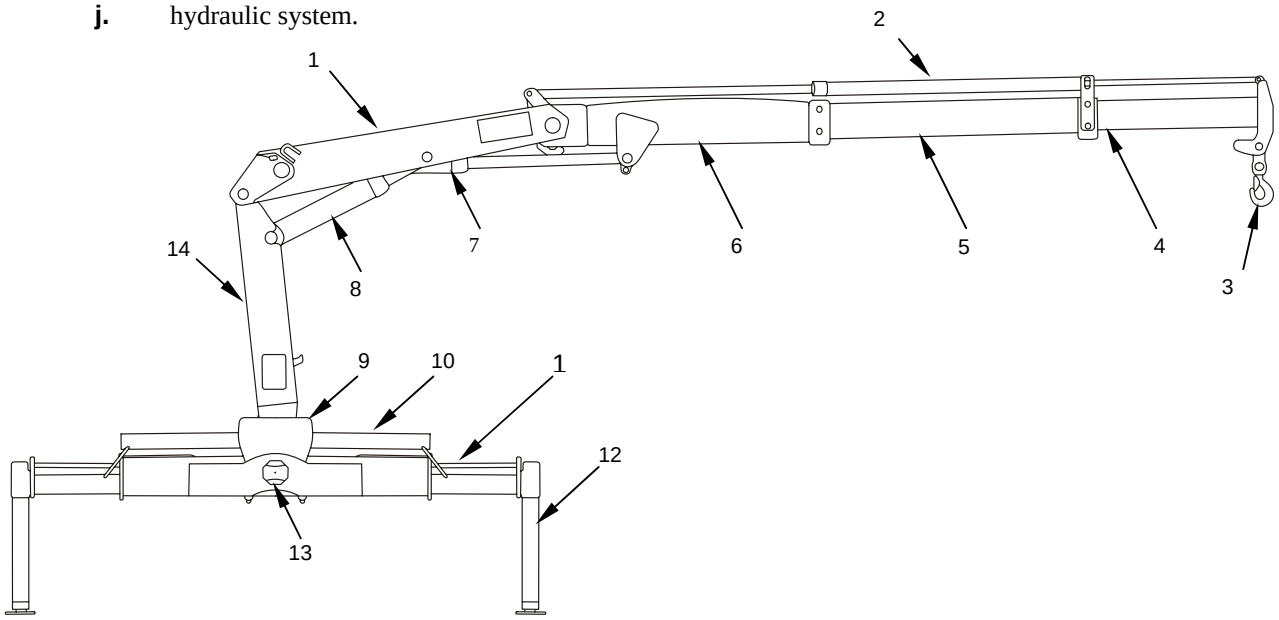
h. remote control system;

i. electronic safety control system; and

j. hydraulic system.



Item	Description	Item	Description
1	Inner Boom	8	Inner Boom Cylinder
2	Boom Extension Cylinder	9	Slewing Housing
3	Load Hook	10	Slewing Cylinder
4	Second Boom Extension	11	Outrigger Extension Cylinder
5	First Boom Extension	12	Outrigger Leg
6	Outer Boom	13	Tilt Cylinder (not illustrated)
7	Outer Boom Cylinder	14	Crane Body

Figure 3 Major Crane Components

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CRANE BASE

11. The crane base, which is bolted to the transverse mounted outrigger beam, consists of a slewing gearbox and its operating cylinder. The outrigger beam is attached to a tilt rocker shaft. This shaft is rotated by the tilt cylinder to lower the crane to the rear tray thus reducing the crane height for air transportability. (See Figure 4.)

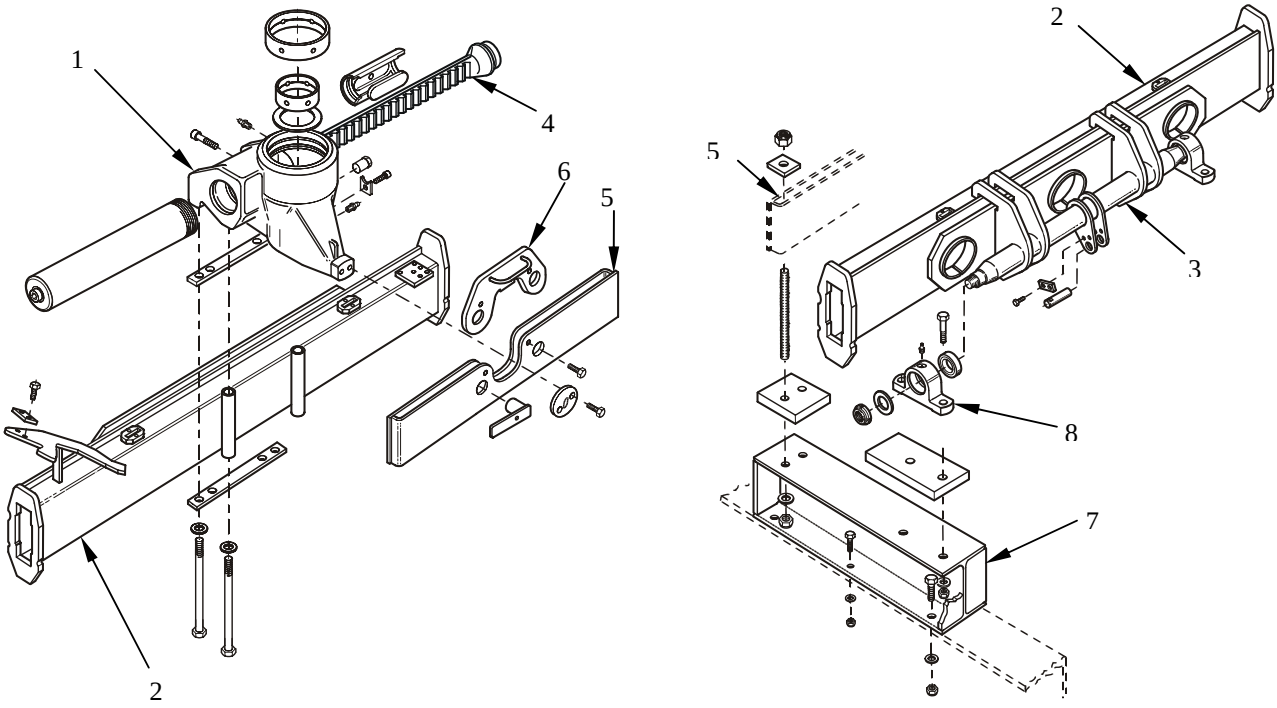
12. The slewing system of the crane is of rack and pinion type, i.e. two opposing single-acting cylinders with a common piston rod (gear rack) act on a cog wheel fixed to the lower part of the crane body. When oil is pumped into one of the cylinders the rack will move and make the cog wheel, and consequently the loader body, rotate. The slewing gearbox enables the crane to operate through an arc of approximately 400°.

13. Paragraphs 115 to 118 detail the complete operation of the slew cylinder's hydraulic circuit.

14. The rear of the slewing housing is secured to a three point bridge using a fixing yolk. The function of the three-point bridge is to absorb the twisting movements of the flexible truck chassis when the truck is running over uneven ground. Consequently, the crane base can be of a stiff and rigid design for a sturdy lodging of the crane body. The slewing housing is rigidly mounted to the transverse outrigger beam by six bolts. The tilt rocker shaft is fixed to the outrigger beam is by means of welded gussets. This shaft is mounted at either end to 'I' beams using pillow block bearings. These 'I' beams are bolted to the vehicle's chassis.

15. When the rocker shaft is rotated by the tilt cylinder, the crane is lowered to (or raised from) the rear tray of the vehicle.

16. Paragraphs 119 to 122 detail the complete operation of the tilt cylinder's hydraulic circuit.



Item	Description	Item	Description
1	Crane Base	5	Three Point Bridge
2	Outrigger Beam	6	Fixing Yolk
3	Tilt Rocker Shaft	7	'I' Beam
4	Gear Rack	8	Pillow Block Bearing

Figure 4 Crane Base and Mounting

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CRANE BODY

17. The crane body assembly consists of a body post with an integrally mounted pinion gear and it is supported in column bushings fitted to the slewing housing. The pinion gear indexes with the rack piston of the slewing cylinder. When the cylinder is operated, the movement of the rack imparts a turning motion on the post, enabling the crane to operate through an arc of approximately 400°. (See Figure 5.)

18. The body post is sealed into the slewing housing by means of an 'O' ring at the top and a seal at the bottom. The pinion gear/rack and the body post bearings need to be greased in accordance with current instructions (refer to EMEI Vehicle G 729).

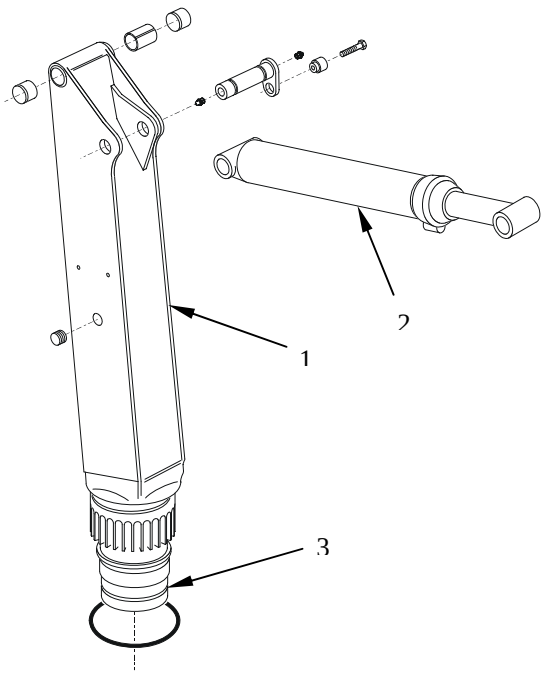
19. The body post is fitted with bushed mounting points for the inner boom and gussets for the fixed end of the inner boom cylinder. In addition, a parking support is welded to the body to accommodate the outer boom when it is at rest in the stowed position.

INNER BOOM CYLINDER

20. The function of the inner boom cylinder is to raise and lower the inner boom during crane operations. It is mounted on the upper section of the crane body and its piston rod end is mounted to the underside of the inner boom (see Figure 5 and Figure 6). A load holding valve is mounted on the underside of the cylinder to protect the load from lowering when the hydraulic system is inactive.

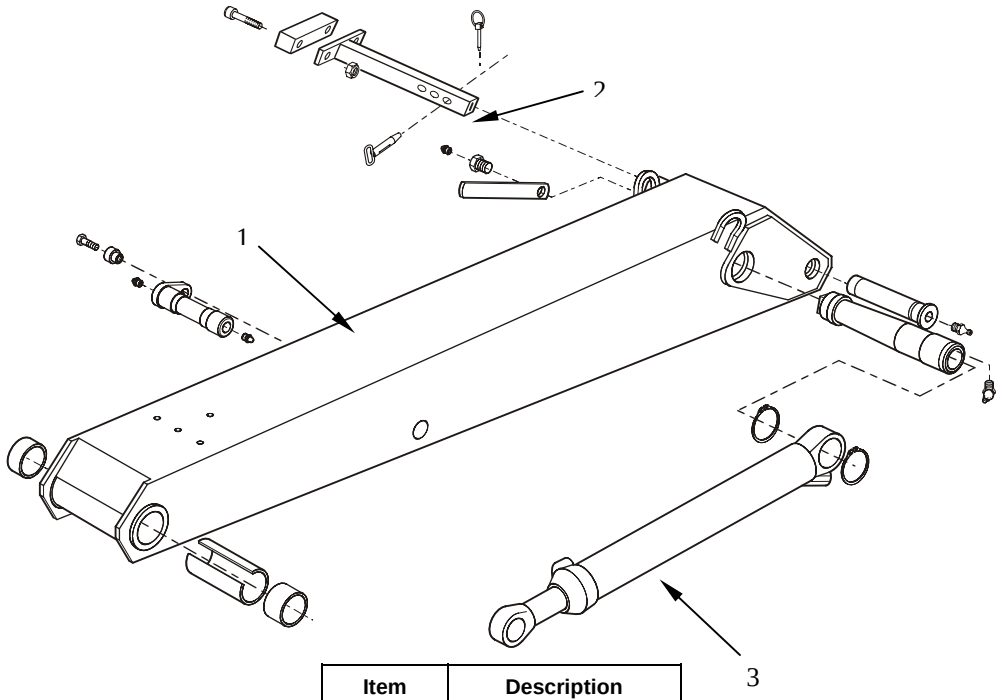
21. The cylinder is controlled by a spring loaded, self centring control lever mounted at the main control valve or the alternate control on the opposite side of the vehicle. It can also be controlled by the CombiDrive remote controller.

22. Paragraphs 107 to 110 detail the complete operation of the inner boom cylinder's hydraulic circuit.



Item	Description
1	Body Post
2	Inner Boom Cylinder
3	Pinion Gear

Figure 5 Crane Body and Inner Boom Cylinder



Item	Description
1	Inner Boom
2	Resting Post
3	Outer Boom Cylinder

Figure 6 Inner Boom and Outer Boom Cylinder

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INNER BOOM

23. The inner boom assembly has provision for four main attachments as follows (see Figure 6):

- **a.** Mounting point for fixture to the crane body – a pivot pin and bushes are used to mount the inner boom to the crane body.
- **b.** An external mounting point for the fixed end of the outer boom cylinder – a pivot pin is used to mount the cylinder.
- **c.** An internal mounting point for the piston rod end of the inner boom cylinder towards the leading end of the boom – a pivot pin is used to mount the cylinder.
- **d.** At the leading end of the boom, a mounting point for the outer boom – the outer boom has an integral offset mounting point which pivots in bushes in the inner boom.

24. In each case, either lock plates or circlips are used to secure the pivots. Similarly, all pivots are fitted with grease nipples for lubrication of the joints. Suitable hose restraints are employed to prevent fouling of the hoses during crane operations.

25. A rubber cushioned resting post is fitted to the inner boom, opposite the outer boom cylinder's fixed end mounting point. This post rests on the rear tray when the crane is tilted to the reduced height position. In addition, a parking support is mounted to the right-hand side of the outrigger beam to accommodate the inner boom when it is at rest in the stowed position.

OUTER BOOM CYLINDER

26. The function of the outer boom cylinder is to raise and lower the outer boom during crane operations. It is mounted on the outside of the upper section of the inner boom and its piston rod end is mounted to the underside of the outer boom (see Figure 6 and Figure 7). A load holding valve is mounted on the top of the cylinder to protect the load from lowering when the hydraulic system is inactive.

27. The cylinder is controlled by a spring loaded, self centring control lever mounted at the main control valve or the alternate control on the opposite side of the vehicle. It can also be controlled by the CombiDrive remote controller.

28. Paragraphs 107 to 110 detail the complete operation of the outer boom cylinder's hydraulic circuit.

OUTER BOOM AND BOOM EXTENSIONS

29. The outer boom is constructed of hollow cross section steel. It attaches to the inner boom by means of an offset pivot pin. The offset alignment allows for compact folding of the booms when stowing the crane. The outer boom is raised and lowered by the action of the outer boom cylinder. (See Figure 6 and Figure 7.)

30. The hollow construction of the outer boom allows for the internal retraction of the two boom extensions. The boom extensions are extended and retracted by a duplex cylinder mounted above the outer boom.

31. The formation of the outer boom and the extensions are of a hexagonal shape, which gives a lightweight profile with good lateral guidance. Slide pads are fitted between the extension profiles to centralise the booms and to reduce the friction effect when operating the extension function. These slide pads are manufactured of a self lubricating material, they are adjustable and can easily be replaced when they are worn out.

32. The leading end of the second boom extension incorporates a mounting point for the boom extension cylinder (the smaller piston rod end). In addition, the boom extension has a load hook attached at its leading end.

33. As illustrated in Figure 7, the outer boom assembly has two hydraulic cylinder mounting points, one on the underside of the trailing end of the boom for the outer boom cylinder and one on the top of the trailing end of the boom for the boom extension cylinder (the larger piston rod end). These cylinders are secured using lock plates and circlips and the outer boom cylinder pivot is fitted with grease nipples for lubrication of the joint.

34. Suitable hose restraints are employed on and around the outer boom to prevent fouling of the hoses during crane operations. A work lamp is fitted on the underside of the outer boom to allow illumination during night operations. In addition, a parking latch is fitted to the underside of the trailing end of the outer boom to act as a restraint for the boom extensions when the crane is at rest in the stowed position.

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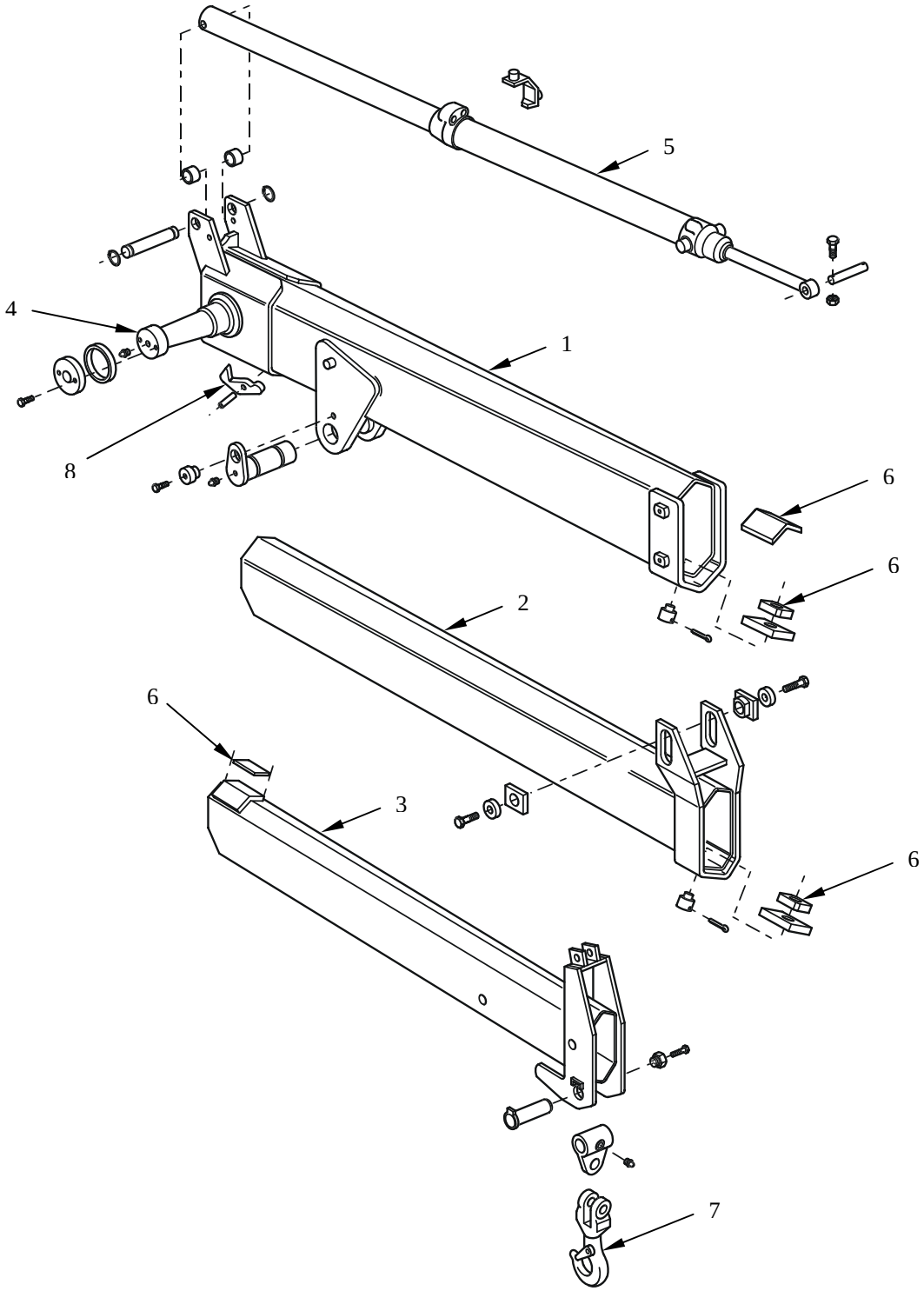

Item	Description	Item	Description
1	Outer Boom	5	Duplex Cylinder
2	First Boom Extension	6	Slide Pads
3	Second Boom Extension	7	Load Hook
4	Offset Pivot Pin	8	Parking Latch

Figure 7 Outer Boom, Boom Extensions and Extension Cylinder

BOOM EXTENSION CYLINDER

35. The function of the boom extension cylinder is to extend and retract the outer boom extensions during crane operations. It is mounted on top of the outer boom with the larger piston rod fixed to the outer boom adjacent to the offset pivot pin and the smaller piston rod anchored to the leading end of the second extension. The cylinder tube is mounted to the leading end of the first extension. (See Figure 7.) A cross sectional view of the duplex cylinder is shown at Figure 8.

36. The cylinder consists of an outer and an inner cylinder. The outer piston (larger piston rod) is intended to extend first and retract last.

37. The cylinder is controlled by a spring loaded, self centring control lever mounted at the main control valve or the alternate control on the opposite side of the vehicle. It can also be controlled by the CombiDrive remote controller.

38. Paragraphs 111 to 114 detail the complete operation of the boom extension cylinder's hydraulic circuit.

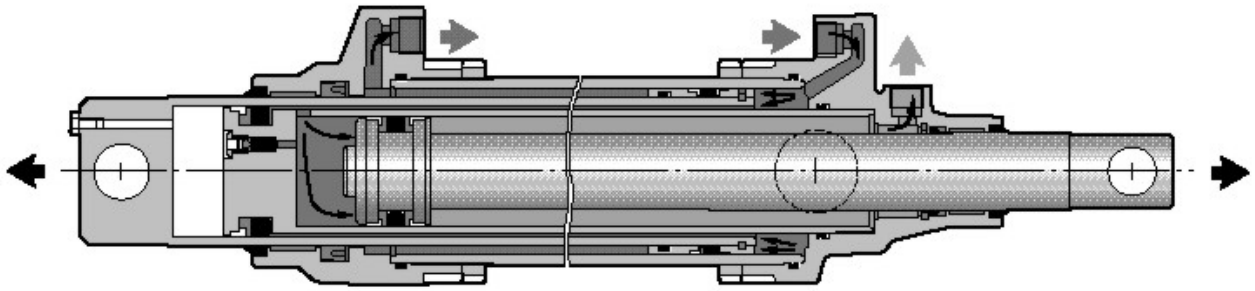

Figure 8 Boom Extension Cylinder

OUTRIGGERS

39. The crane is equipped with hydraulically operated outriggers, mounted either side of the vehicle. For extra stability, each outrigger can be extended further outboard using the hydraulic outrigger extension mechanism. Each leg is a hydraulic cylinder which is extended to touch the ground to create a stable platform for crane operations. Stability can be increased by use of dunnage or other base plate material.

40. The hollow outrigger beam, which is part of the crane base, houses the extension beams to which the outrigger legs are attached. These extension beams are extended and retracted as required using the accompanying hydraulic cylinders. The outrigger legs are stowed in the upside down position and are pivoted to the upright position by the movement of the leg's hydraulic piston acting against an external cam arrangement. The leg is fixed in either the up or down position by means of a spring loaded lock pin and handle.

41. The left hand outrigger control levers are mounted at the outrigger spool valve and a set of cable controlled levers are located on the right hand side of the crane.

42. Paragraphs 123 to 130 detail the complete operation of the outrigger leg cylinder and extension cylinder hydraulic circuits.

MANUAL CONTROL MECHANISMS

43. The manual control system fitted to the crane includes the following:

a. crane controls,

b. tilt controls, and

c. outrigger controls.

Crane Controls

44. The main crane control valve and its control levers are mounted on the left-hand side of the vehicle and are connected by transverse rods to a set of 'same sequence' cross controls on the right-hand side of the vehicle for convenience. These levers control the slew, inner boom, outer boom, boom extension, and tilt functions of the crane. The function of each of the control levers is indicated by means of a symbol located adjacent to the lever.

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WARNING

All of the above functions can be controlled from either side of the vehicle however, when folding and unfolding the crane always operate the crane from the left-hand side of the vehicle.

Outrigger Controls

45. A set of outrigger controls is mounted on either side of the vehicle. These levers are used to control the outrigger extension cylinders and the leg cylinders on each side of the vehicle. The function of each of the control levers is indicated by means of a symbol located adjacent to the lever.

REMOTE CONTROL SYSTEM

General

46. The CombiDrive remote control system is an electronic-hydraulic system for remote control of the main control valve in the crane. Its digital electronic system contains a number of microprocessors that receive signals from the remote controller and converts them to commands to the operating hydraulic system that governs the crane valve spools.

47. The microprocessor in the controller transmits a ‘protocol’ 45 times per second to the digital amplifiers (DA modules). The signals in the microprocessor in each DA module are converted into a proportional current to the solenoids. This current to the solenoids will cause a corresponding movement of the spool valve to operate the appropriate crane function. A special safety check is performed each time the stop button on the controller is pulled out, and also continuously during operation.

48. The crane’s remote control system consists of the following components (see Figure 9):

- **a.** power box (PSBI);
- **b.** CombiDrive controller;
- **c.** DA modules;
- **d.** positioners;
- **e.** pressure reduction filter; and
- **f.** hydraulic system.

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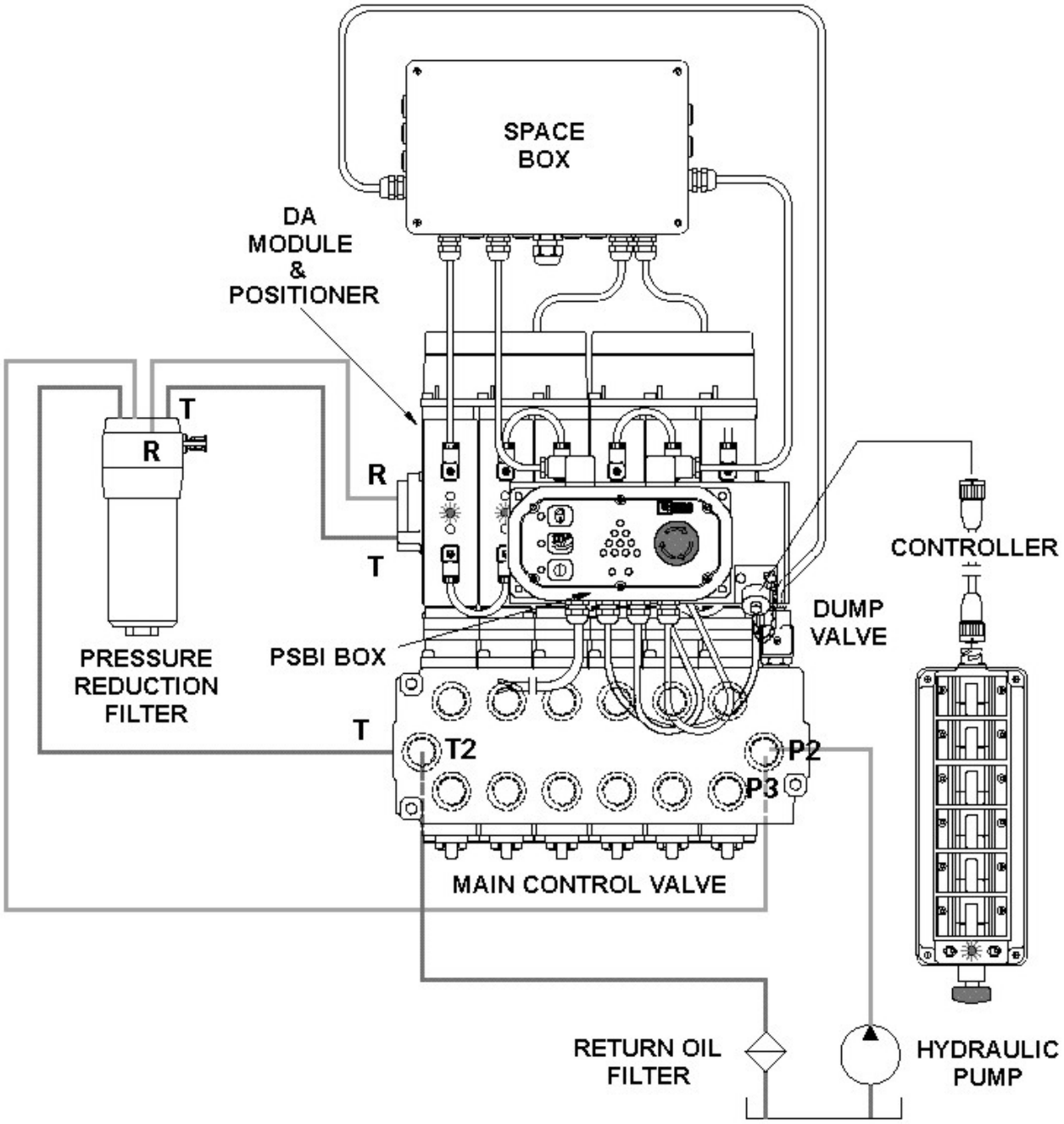


Figure 9 Remote Control System

Power Box (PSBI)

49. The PSBI box is used to prepare the crane's control system for either manual or remote operation and to control various other functions of the crane. It contains an emergency stop button, an ON/OFF button, a manual/remote selector button, an overload protection (OLP) release button, and a number of indicator lights. The power box is located at the operator's control station on the left-hand side of the vehicle.

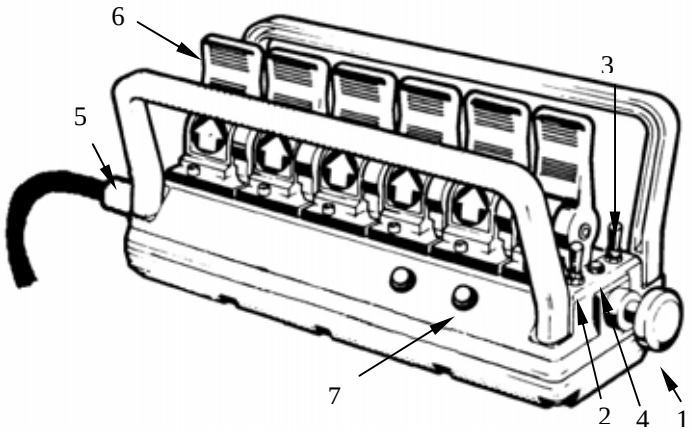
50. The PSBI box is discussed in greater detail at Paragraph 79.

Controller

51. The controller is used to allow remote control over the operations of the crane. A 15 metre cable is supplied to connect the controller to the crane control system. The connection is made on the left-hand side of the vehicle adjacent to the PSBI box. The controller is equipped with six proportional control operating levers to control the slewing, inner

boom, outer boom and boom extension functions of the crane. Two of the levers are not used. When not in use, the controller is stowed in a pouch, mounted on the back wall of the vehicle cab.

52. The controller is fitted with an emergency stop button, a three position crane speed toggle switch, an indicator light, a spring loaded toggle switch (not used) and two push buttons (horn button is not used) (see Figure 10).



Item	Description	Item	Description
1	Stop Button	5	Control Cable
2	Toggle Switch for Additional Functions	6	Control Levers
3	Switch for Speed Control	7	OLP Release Button
4	Indicator Lamp		

Figure 10 CombiDrive Controller

53. Stop Button (Item 1). When the button is pushed in, oil is dumped and there is no current supplied to the DA modules, disabling crane operation.

54. Toggle Switch (Item 2). Not used.

55. Speed Control Switch (Item 3). If the switch is placed in the centre position, maximum speed (100%) is maintained. When the switch is pushed away from the operator, only 20% of the maximum speed is available. When the switch is pulled toward the operator, 50% of the maximum speed will be available.

56. Indicator Lamp (Item 4). In normal operation, this lamp blinks continuously.

57. Control Cable (Item 5). This cable is a screened 2 core cable fitted with 'Cannon' connectors.

58. Control Levers (Item 6). Each control lever forms a module in the controller. Each module is connected to a circuit card in the base of the controller, and one of the functions of this card is to identify each lever location (there are 6 locations). The control lever is mounted using double sealed ball bearings. An inductive non-conductive sender is provided that gives a voltage which is proportional to the lever deflection. This voltage is then converted in the controller to a 'protocol' which is transmitted to the DA modules.

59. Release Button (Item 7). This button is used to momentarily override the OLP function in certain overload situations in order to correct the problem.

DA Modules

60. DA modules receive signals from the CombiDrive controller and relay them on to the solenoids in the positioners.

61. DA modules contain microprocessors and amplifiers which control the positioner's solenoids. The positioners are located directly above each valve unit and the DA modules are attached.

Positioners

62. Positioners are servo valves governing the control valve functions and thereby the crane functions (see Figure 11). Oil is supplied to the positioner from the pressure reduction filter. Supply pressure is 2.2 MPa.

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When no current is applied to the solenoid, the return spring forces the armature and servo spool rearward. The servo spool, will then be in the closed position.

63. When a pulse width modulated current of 0 to 500 mA is supplied to the solenoid, a magnetic force of 0 to 5 kp is generated proportional to the current. The armature and servo spool will be pulled toward the solenoid, allowing oil to flow into the positioner influencing the piston and thereby the main valve spool.

64. The main spool is forced forward by the oil pressure (2.2 MPa) and at the same time, the return spring is compressed. When the force of the return spring balances the armature force, the servo spool closes the pressure port in the positioner and the main spool ceases to move.

65. This enables a predetermined current to be converted to a proportional spool position in the valve by means of the armature force and a return spring. The angular deflection of the controller's control lever 'orders' the positioner to a certain position and this position is not influenced by flow included forces, spring pressure, friction forces on the valve spool, nor by the pressure of the oil supply to the positioner.

66. The positioner is carefully calibrated to enable a current of 200 mA to always give a deflection of 2 mm, and a current of 460 mA to give a deflection of 7 mm.

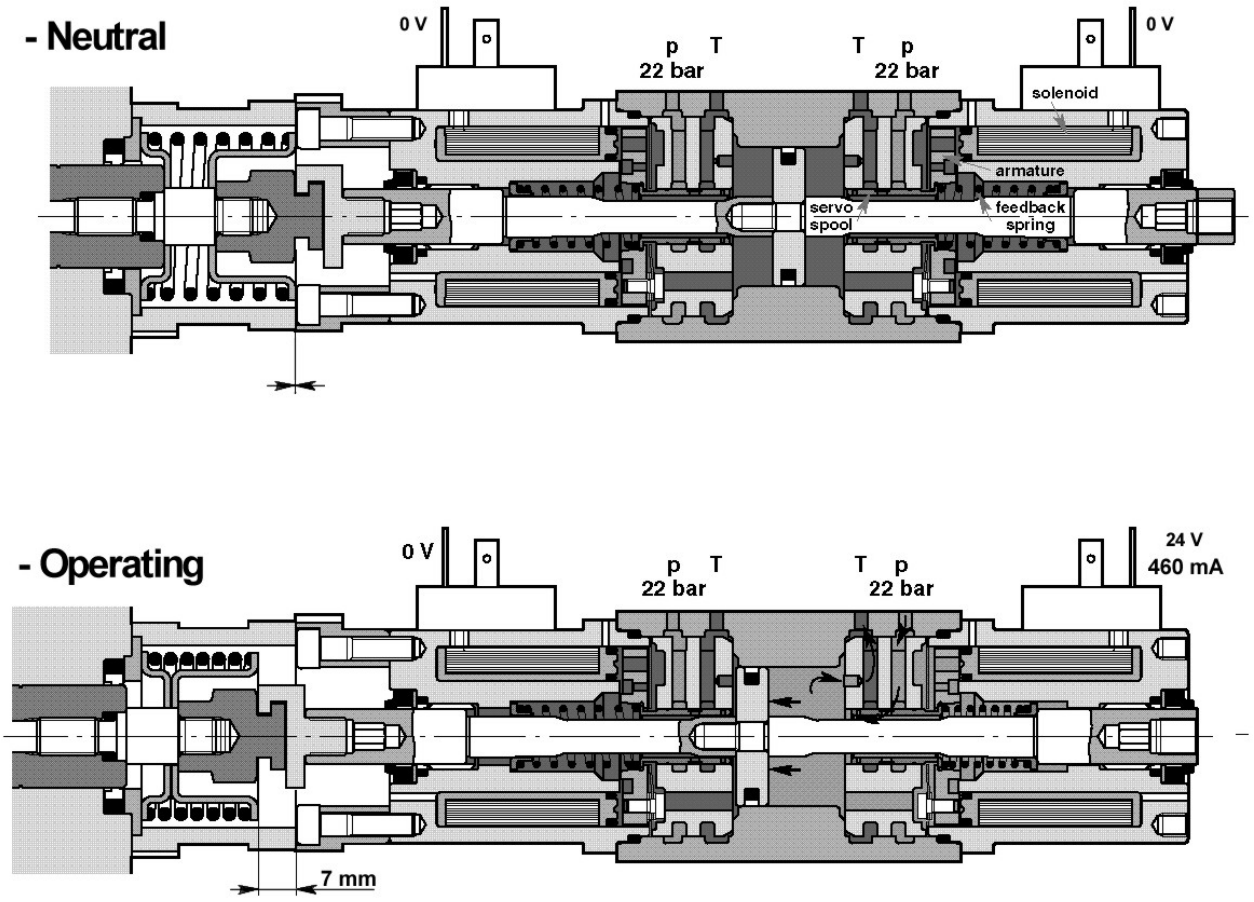

Figure 11 Positioner

Pressure Reduction Filter

67. The function of the pressure reduction filter is to supply the positioners of the remote control system with filtered oil at a working pressure of approximately 2.2 MPa. The filter is mounted on the left hand slew cylinder, adjacent to the main control valve.

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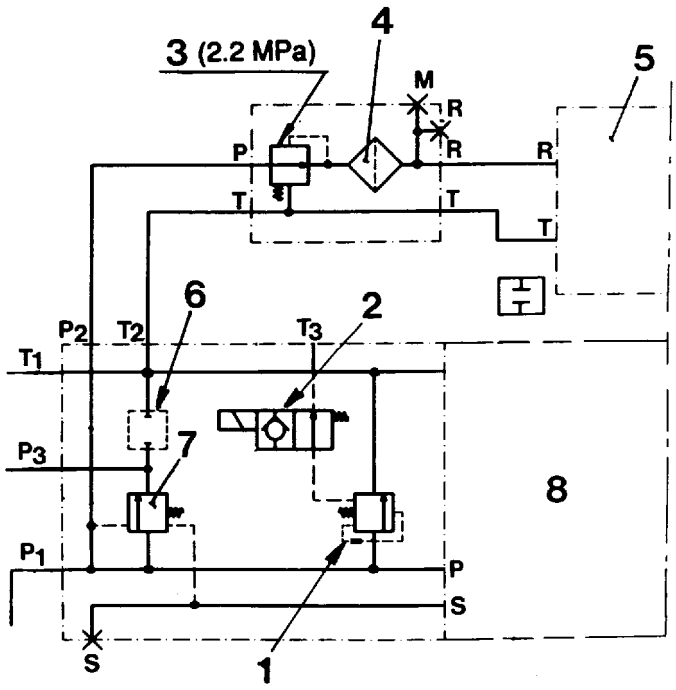
Remote Control Hydraulic System

68. A dump valve (1) in the valve block is controlled by the solenoid valve (2). (See Figure 12). When there is a voltage (24 V) on the solenoid, it is closed. The spring housing on the dump valve is then supplied with full pressure through a restriction in the dump valve piston. The dump valve spring closes the dump piston. When the voltage in the solenoid valve is broken, the spring housing is drained and the dump valve opens. This is an important safety function in the system.

69. The pressure reduction filter (3, 4) is fed from the pump line and supplies oil at a pressure of 22 bars to the positioners. Note that this oil supply is made through the filter which does not have any bypass valve. Consequently, a clogged or partially clogged filter will cause a deterioration of operational efficiency.



Item	Description	Item	Description
1	Dump Valve	5	Positioner
2	Solenoid Valve/Plug	6	Serial Connection Plug
3	Pressure Reducer	7	Shunt Valve
4	Filter 10 µm Absolute	8	Control Valve

Figure 12 Remote Control Hydraulic Circuit

ELECTRONIC SAFETY CONTROL SYSTEM

70. The electronic safety control system (SPACE) is fitted to the crane to control various safety aspects during operation of the crane. These system functions include:

a. overload protection;

b. automatic dumping function; and

c. height warning – inner boom.

Overload Protection (OLP)

71. The overload protection warns the operator when 90% of the crane's capacity is reached. When maximum capacity is reached, the OLP system stops all movements that can increase the crane's loading.

72. When the pressure in the inner or outer boom cylinders reaches 90% of permitted pressure, the triangle on the power supply box (PSBI) blinks. At 100% the OLP cuts in, stopping load increasing movements. The triangle has a steady light until the overload situation is rectified.

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73. To correct the OLP situation, press the RELEASE button (Item 2, Figure 13 or Item 7, Figure 10 if using the remote controller), while moving one control lever (select a crane function that will reduce the load). The triangle (Item 3, Figure 13) will light up in a circulating pattern. There is a 5 second time period in which to correct the OLP situation. There is a waiting time of 30 seconds before the release operation can be attempted again.

NOTE

In most cases, the OLP condition can be overcome without use of the release button by simply lowering the inner boom or reducing the load moment by any other means.

Automatic Dumping Function (ADO)

74. When the crane has not been operated for a few seconds, the safety control system will 'open' the dump valve. This will allow the oil to return directly to the tank, helping to keep the hydraulic oil temperature down. As soon as the operator moves a lever, the dump valve closes.

Height Warning – Inner Boom

75. This function warns the operator (via a red lamp in the cabin) if the crane, for some reason, is placed in a position with the boom system pointing upwards and the operator intends to drive the truck.

76. The high boom warning lamp in the cabin will also be lit at all times that the crane's SPACE system is switched on. The SPACE system will automatically switch off after 30 minutes of inactivity.

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ELECTRONIC SAFETY CONTROL SYSTEM COMPONENTS

77. The electronic safety control system (SPACE) consists of the following components (see Figure 14):

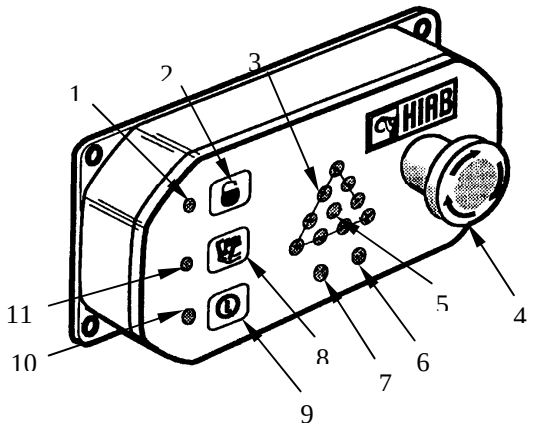
- **a.** microprocessor box (SPACE box);
- **b.** power supply box (PSBI);
- **c.** power connection box (MPCB);
- **d.** column box;
- **e.** spool sensors;
- **f.** pressure sensors;
- **g.** tilt indicators;
- **h.** dump valve; and
- **i.** diagnostic terminal connection.

Microprocessor Box (SPACE Box)

78. The SPACE box contains a microprocessor which is the system's 'brain'. On the crane there are various sensors and indicators which send signals to the microprocessor regarding the crane's load, position and movements. This then decides how the crane can be operated and stops/reduces invalid movements/speeds by changing signals to the DA modules.

Power Supply Box (PSBI)

79. A PSBI box is fitted at the main operator station. It contains a selector for remote and manual control. The main power supply is connected to the main power connection box (MPCB) and distributed to appropriate components in the system. The buttons and lamps fitted to the PSBI box are as follows (refer to Figure 13):



Item	Description	Item	Description
1	Release Lamp	7	Oil 1 Lamp
2	Release Button	8	Remote/Manual Button
3	Warning Triangle Lamps	9	On/Off Button
4	Stop Button	10	On Lamp
5	Fault Lamp	11	Remote Lamp
6	Oil 2 Lamp		

Figure 13 PSBI Box Buttons and Lamps

a. Release Lamp (Item 1). This lamp will be lit when the OLP system has been disengaged (via button 2).

b. Release Button (Item 2). This button is used to switch the automatic dump function on or off and to disengage the OLP function in certain overload situations.

c. Warning Triangle Lamps (Item 3). This triangle of lamps will blink (1 Hz) at 90% load and will be lit when the crane is overloaded. It will blink in a circulating pattern when the OLP function is disengaged (via button 2). When the inner boom height warning is activated and the system is switched off, the triangle will blink for five minutes.

d. Stop Button (Item 4). This button is used to terminate crane functions by cutting power to the dump valve (all hydraulic pump flow will be diverted back to the reservoir). It must be turned clockwise to reset.

NOTE

The stop button must always be pressed in when powering up the system.

e. Fault Lamp (Item 5). This lamp will blink (3 Hz) when SPACE indicates a fault (digital indicator). It will flash (1 Hz) when the system is turned off but 24 V power is available via the lamp kit.

f. Oil 2 Lamp (Item 6). This lamp will be lit when the stop button is pulled out and SPACE sends a signal confirming power to the dump valve. It will flash (1 Hz) when a connection with SPACE is broken (e.g. open circuit).

g. Oil 1 Lamp (Item 7). This lamp will be lit when the stop button is pulled out and power to the dump valve is supplied by this box.

h. Remote/Manual Button (Item 8). This button is used to switch between manual and remote operating modes.

i. On/Off Button (Item 9). The system is switched on by pressing this button momentarily. To switch off, press the button once.

j. On Lamp (Item 10). This lamp will be lit when the system is switched on.

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k. Remote Lamp (Item 11). This lamp will be lit when the system is in the remote control mode and will flash (1 Hz) when no signals are received by SPACE.

l. Indicator Lamp (Inside the Box). This lamp will blink (1 Hz) when remote control is engaged but no protocol arrives. It will flash (1 Hz) when the stop button is pressed. It will flash (2 Hz) when the stop button is pulled out and the system is in the manual operating mode.

m. Fuse (Inside the Box). This is a 7.5 A automotive type fuse.

Main Power Connection Box (MPCB)

80. A MPCB box is mounted below the PSBI box and is used to distribute 24 V power to different boxes and components within the system. The PSBI box (and consequently the SPACE system) receives power from the MPCB box. There are two separate circuits each protected by a 15A fuse. The SPACE system is connected to one of the circuits while other electrical components are connected to the second circuit.

Column Box

81. Information from pressure sensors, indicators etc. on the boom system is assembled in the column box on the crane body. A cable with several leads connects this box to the SPACE box.

Spool Sensors

82. Spool sensors are fitted above the main control valve's positioners and are responsible to register the position of the control valve spools.

Pressure Sensors

83. These analog sensors, fitted to the load holding valves of the inner and outer boom cylinders, provide continuous information regarding the pressure in the respective cylinder.

Tilt Indicators

84. Tilt indicators are fitted on the crane to show the position of crane parts such as the inner and outer boom. The following indicators are fitted:

a. Tilt Indicator (Outer Boom). This tilt indicator, a part of the OLP, registers the outer boom tilt, upward or downward from the horizontal position. An imaginary line between the indicator's two fixing points should be parallel to the outer boom. The indicator is marked with an arrow on the mounting face. This arrow should point to the crane's outer end.

b. Tilt Indicator (Inner Boom). This indicator, mounted on an adjustable plate, is fitted to the inner boom and registers the height of the inner boom for the high boom warning feature.

Dump Valve

85. The dump valve, fitted to the main control valve, controls the oil flow – when active, oil is directed to the control valve – when inactive (without power), the flow stops and all crane functions stop. The dump valve is controlled from the microprocessor box. When an emergency stop button is pressed, power to the dump valve is cut, stopping all crane functions.

Diagnostic Terminal

86. In the SPACE box's microprocessor, there is a monitoring program for the different SPACE functions. To communicate with the SPACE system, a computer and interface cable is required. The interface cable is connected to the diagnostic terminal connection at the SPACE box. A laptop computer, loaded with the appropriate software, is used to check and set parameters and to carry out general troubleshooting operations. Access to the system is via an ID code and password system. There are two levels of access. The first level is assigned to service personnel and the second to HIAB system specialists. The ID code and password will assign the access level.

Lubrication

87. All the boxes, plinths and connections should be greased. Use a grease of type Statoil SG32W Grease way or Shell Grease 1398 Si2, a white oil with a non-organic additive for thickening.

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Bar Codes

88. Almost all SPACE components are marked with bar codes. All the boxes have two bar code stickers, one inside and one outside the box. On the sticker, there is one bar code and numerals representing the sub supplier, one barcode and numerals representing the serial number of the component/box and one bar code and numerals representing the part number of the component. The component's name or abbreviation is also listed.

Wiring Connections

89. Figure 14 illustrates the wiring connections for the SPACE components on the crane.

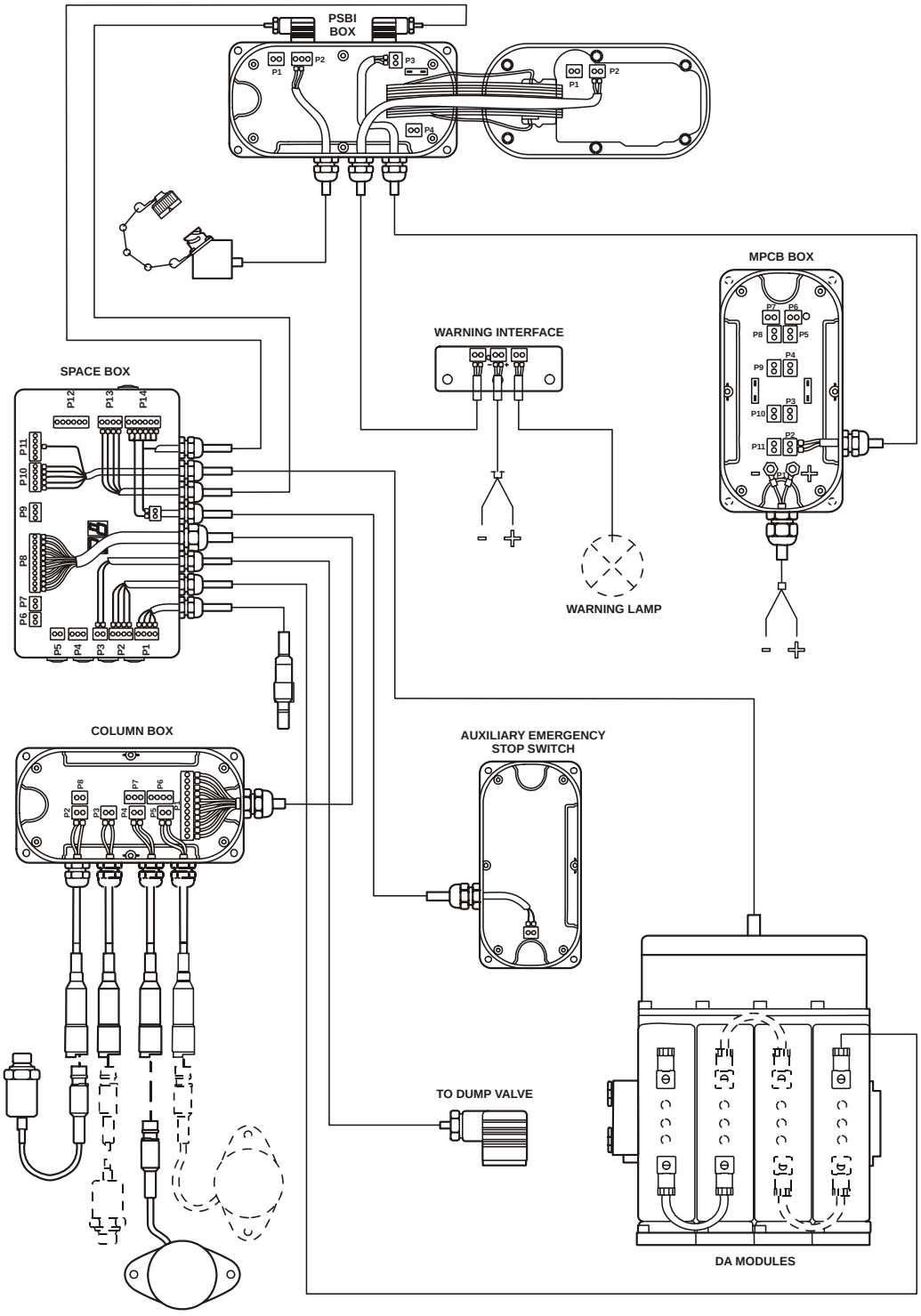

Figure 14 SPACE Components

HYDRAULIC SYSTEM

90. The hydraulic system consists of the following main components:

- **a.** power take-off (PTO);
- **b.** hydraulic pump;
- **c.** main control valve;
- **d.** outrigger control valve;
- **e.** load holding valves;
- **f.** sequencing valve;
- **g.** outrigger leg check valve;
- **h.** inline restrictor valve;
- **i.** hose rupture valve;
- **j.** operating cylinders;
- **k.** oil tank;
- **l.** return oil filter; and
- **m.** oil cooler.

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Power Take-off (PTO)

91. A mechanically driven Powauto AH23BR11 single speed PTO is mounted on the right-hand side of the vehicle's transmission. The PTO is pneumatically actuated and is controlled by the PTO ON/OFF switch mounted on the vehicle's dashboard. When this switch is placed in the ON position, compressed air is directed to the PTO selector mechanism, actuating a gear selector fork. This fork will engage the appropriate drive gears to transfer drive from the transmission to the PTO's hydraulic pump. The PTO is lubricated by oil from the vehicle's transmission.

Hydraulic Pump

92. The PZB XP36 hydraulic pump is flange mounted via an adaptor onto the drive output end of the PTO. The pump is a two-gear, constant displacement design which draws hydraulic fluid from the reservoir and provides pressurised hydraulic fluid to the crane controls.

93. When the pump is being driven, hydraulic fluid is drawn from the reservoir through the pump inlet port. The rotation of the gears forces the fluid through the outlet port under pressure. The hydraulic oil passing through the pump also lubricates the working components.

Main Control Valve

94. The main control valve (spool valve) is mounted on the left-hand side of the vehicle at the operator's station. It is an open centre valve system which features a dump valve and spool position sensors. The valve section has no load holding function since this is placed separately at the cylinders. The valve consists of a bank of six spools which control the slew, inner boom, outer boom, boom extension and tilt functions of the crane. One spool is not used.

95. The valve can be operated manually from either side of the vehicle or can be controlled using the CombiDrive remote controller. DA modules and spool positioners are fitted to enable remote operation.

Outrigger Control Valve

96. The outrigger control valve (spool valve) is mounted to the right side of the operator's station. The valve consists of a bank of four spools which control the left and right outrigger extensions and stabiliser legs. The valve is operated manually using the two levers fitted to the valve for the left side of the vehicle and two cable operated remote levers for the right side of the vehicle.

Load Holding Valves

97. Load-holding valves (LHV) are employed on inner and outer boom cylinders and the boom extension cylinder to provide creep-free holding of the boom position under load. In addition, they protect the system in the event of a hose failure. The boom cannot be lowered or the extension extended without pump pressure.

98. The inner and outer boom LHV are fitted with overload protection pressure sensors which relay data to the SPACE system to protect against overloading the crane.

Sequencing Valve

99. A sequencing valve is located on the boom extension cylinder to ensure that the boom extensions extend in the correct sequence. The return oil flow from the inner piston is restricted by the sequencing valve, forcing the outer piston to extend first. Once the outer piston is fully extended, the sequencing valve opens under increased pressure and allows the inner piston to extend. (Refer to Figure 15.)

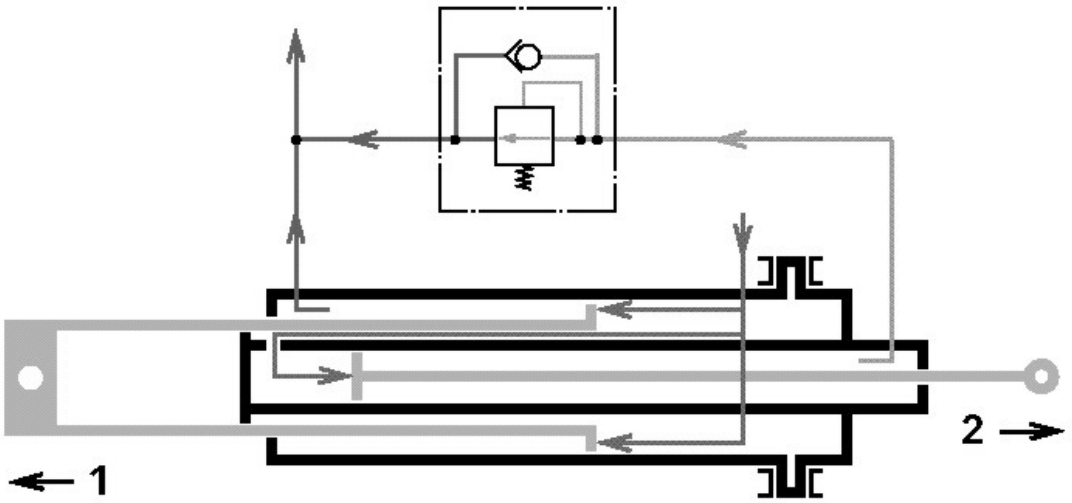

Figure 15 Sequencing Valve

Outrigger Leg Check Valve

100. This pilot operated check valve is located on the outrigger leg cylinder and is used to prevent the support leg from collapsing under load. It achieves this by preventing the oil on the piston side of the cylinder from escaping without a pilot pressure to lift the check ball from its seat. This pilot pressure only exists when the operator intentionally retracts the leg. (Refer to Figure 16.)

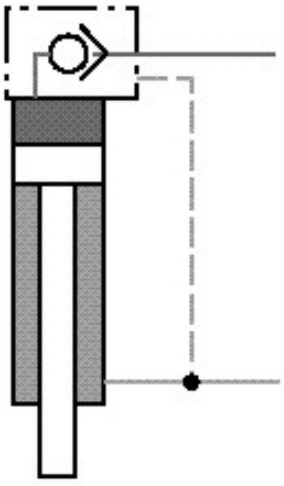

Figure 16 Outrigger Leg Check Valve

Inline Restrictor Valve

101. An inline restriction valve is fitted to the tilt circuit to regulate the speed of the tilting operation. The valve restricts the flow of oil in both directions, but more so in one than the other. The valve is installed so that the return oil is restricted more heavily than the pressurised oil. (Refer to Figure 17.)

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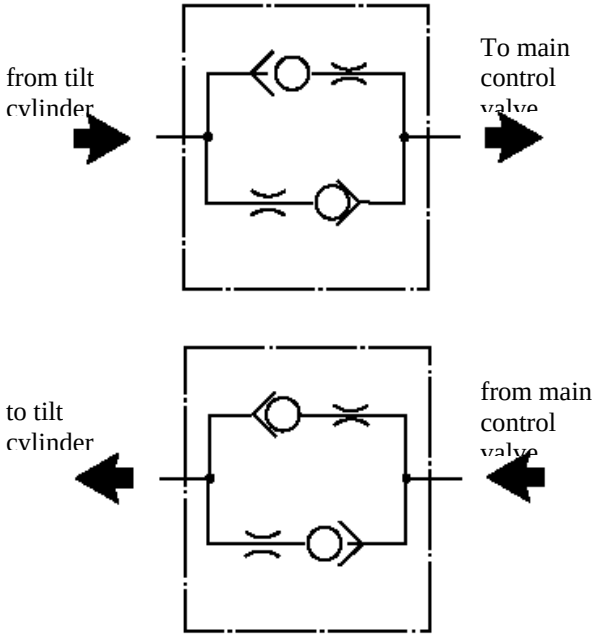

Figure 17 Inline Restrictor Valve

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Hose Rupture Valve

102. A hose rupture valve is incorporated in the tilt circuit to protect the system in the event of a hose failure. The valve is flow-controlled and acts as a safety valve in the event of a hose failure. The valve has a built-in pressure-relief function that damps the stop movement. The oil is free to flow through the valve as long as the thrust of the spring is strong enough to hold it open.

103. In the event of a hose failure, the pressure drops rapidly and the speed of flow of the oil forces the poppet down onto its seat. An over pressure arises when the poppet closes, but the ball rises from its seat and allows it to drain away providing a damping effect. The ball then closes, and the valve is tight. (Refer to Figure 18.)

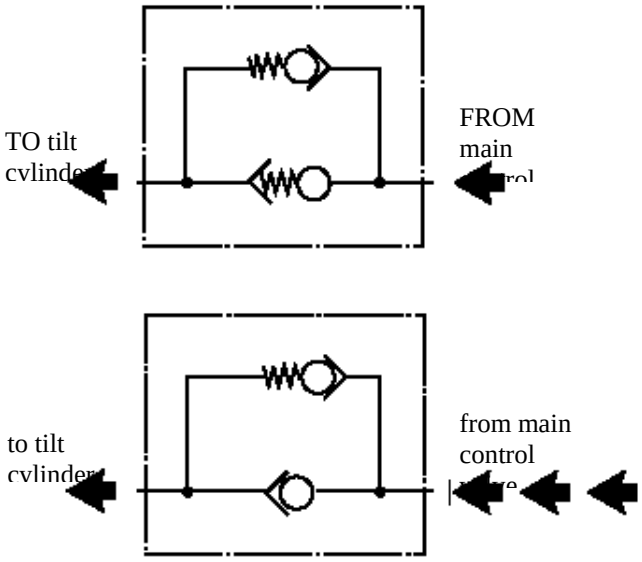

Figure 18 Hose Rupture Valve

Oil Tank and Return Filter

104. The steel construction oil tank is mounted at the rear of the cab on the driver's side and has a capacity of 105 litres. The tank is fitted with a sight gauge to ascertain the level of hydraulic oil in the tank, a temperature gauge to monitor the temperature of the hydraulic oil, a return line oil filter mounted in the top of the tank, and an air filter and fouling indicator incorporated in the filler cap.

Oil Cooler

105. The oil cooler is mounted beneath the tray above the truck's battery box and is fitted with a thermostatically controlled fan used to control the hydraulic oil temperature within an acceptable operating range. It also incorporates a soft start mechanism to reduce the current draw when the cooler fan starts.

HYDRAULIC CIRCUITS

106. The following paragraphs describe the main hydraulic circuits of the HIAB 090 AW crane. See the hydraulic circuit diagram shown at Figure 19.

Inner and Outer Boom

107. The hydraulic circuits for the inner and outer booms are identical and comprise the main control valve, a load holding valve, the boom cylinder and a one way restriction valve.

108. When the control lever is moved up (or away from the operator on the CombiDrive), pressurised oil is directed to the boom cylinder's load holding valve (LHV) check valve. The check valve is lifted off its seat, allowing oil to pass through the relief valve and on to the piston side of the boom cylinder. Oil pressure exerted on the piston will move the piston and consequently raise the boom. Displaced oil on the piston rod side of the cylinder returns through the one-way restriction valve then, via the spool, to the return channel. The load holding valve prevents the crane boom from sinking. The boom cannot be lowered without pump pressure.

109. When the control lever is released and allowed to return to its central position, the control valve is closed and all fluid flow within the circuit is checked. The piston remains rigidly in place.

110. When the control lever is moved down (or toward the operator on the CombiDrive), pressurised oil is carried by a separate line to the piston-rod side of the cylinder. The return oil from the piston side of the cylinder is stopped by the check valve in the LHV. A pressure build-up takes place, causing the pilot piston to open the passage to the tank by lifting the poppet in the relief valve.

Boom Extensions

111. The hydraulic circuit for the boom extension comprises the main control valve, a load holding valve, a sequencing valve, and the extension cylinder (see Figure 20). The duplex cylinder consists of an outer and an inner cylinder. The outer piston (larger piston rod) is intended to extend first and retract last.

112. When the control lever is moved up (or away from the operator on the CombiDrive), pressurised oil acts concurrently on the outer and inner pistons. The return oil flow from the inner piston is restricted by a sequencing valve, forcing the outer piston to extend first. Once the outer piston is fully extended, the sequencing valve opens under increased pressure and allows the inner piston to extend. A load holding valve is mounted on the cylinder to prevent the load from affecting the boom (retracting or extending) when the hydraulic system is inactive.

113. When the control lever is released and allowed to return to its central position, the control valve is closed and all fluid flow within the circuit is checked. The piston remains rigidly in place.

114. When the control lever is moved down (or toward the operator on the CombiDrive), the pressurised oil (through two connections) actuates the outer and inner pistons at the same time. The inner piston retracts first, due to its larger area, after which the outer piston retracts. A check valve (B) is included in order to drain space (A) in the event of a leakage across the seal of the outer piston. When the cylinder is all but fully retracted, any leakage oil that may be present is forced to the return line via the check valve.

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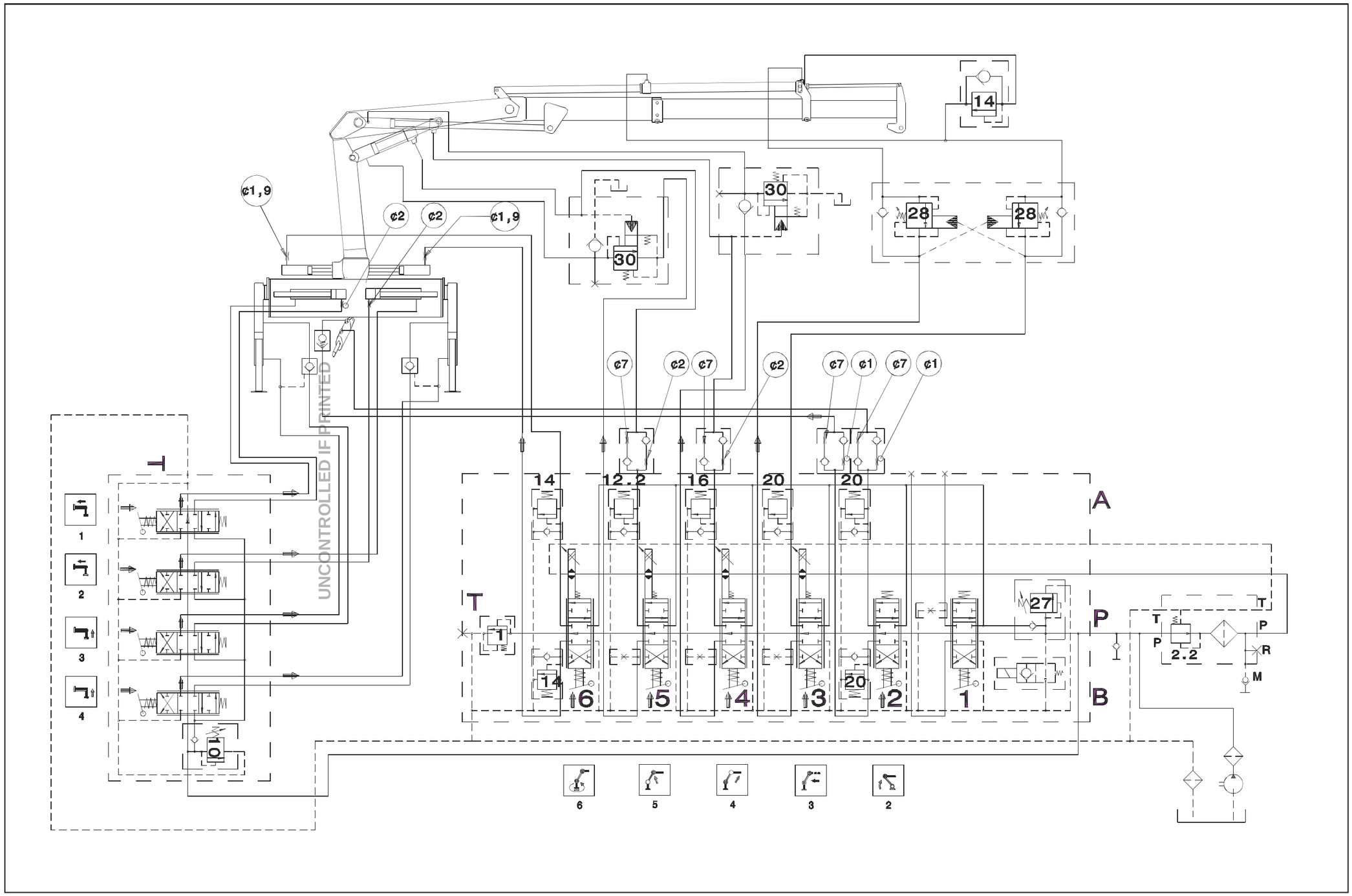

Figure 19 Hydraulic Circuit Diagram

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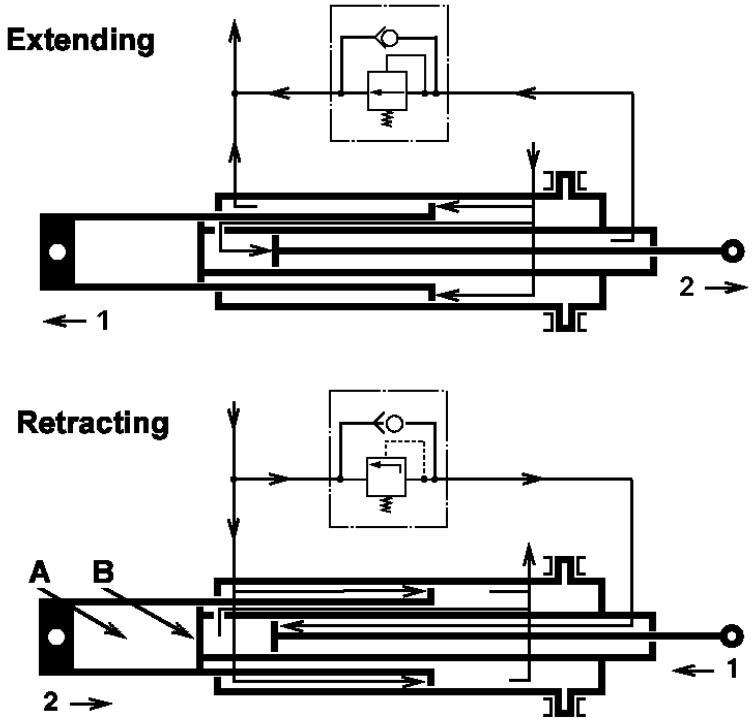

Figure 20 Boom Extension Cylinder Operation

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Slew

115. The hydraulic circuit for the slew function comprises the main control valve, restriction valves, and the slewing cylinder (see Figure 21).

116. When the control lever is moved up (or away from the operator on the CombiDrive), oil under pressure is directed via the control valve and further via the one-way restriction valve to the slew cylinder. The crane body will slew in a clockwise direction. Displaced oil is flow limited in the one-way restriction valve before it returns to the tank channel under return pressure. When slewing downhill the slew cylinder can never be emptied quicker than oil is being replenished on the opposite side because of the separate load holding function. This will prevent hydraulic play. In addition, it is not possible to slew without pump pressure.

117. When the control lever is released and allowed to return to its central position, the control valve is closed and all fluid flow within the circuit is checked. The piston remains rigidly in place.

118. When the control lever is moved down (or toward the operator on the CombiDrive), oil under pressure is directed via the control valve and further via the one-way restriction valve to the left side of the slew cylinder. The crane body will slew in a counter clockwise direction. Displaced oil is flow limited in the one-way restriction valve before it returns to the tank channel under return pressure.

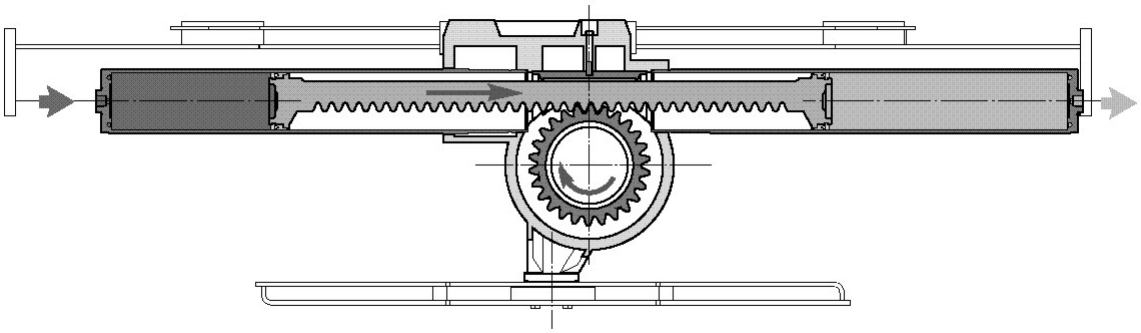

Figure 21 Slew Cylinder Operation

Tilt

119. The hydraulic circuit for the tilt function comprises the main control valve, a hose rupture valve, an inline restrictor and the tilt cylinder.

120. When the control lever is moved up (or away from the operator on the CombiDrive), pressurised oil is directed to the piston side of the tilt cylinder via the inline restrictor. Oil pressure exerted on the piston will move the piston and consequently lower the crane toward the vehicle's rear tray. Displaced oil on the piston rod side of the cylinder returns to the spool via the inline restrictor then to the tank's return channel.

121. When the control lever is released and allowed to return to its central position, the control valve is closed and all fluid flow within the circuit is checked. The piston remains rigidly in place.

122. When the control lever is moved down (or toward the operator on the CombiDrive), pressurised oil is directed to the piston rod side of the tilt cylinder via the inline restrictor. Oil pressure acting on the underside of the piston will move the piston and consequently raise the crane from the vehicle's rear tray. Displaced oil on the piston side of the cylinder returns to the spool via the inline restrictor then to the tank's return channel.

Outrigger Extensions

123. The hydraulic circuit for the outrigger extension comprises the outrigger control valve and the outrigger extension cylinder.

124. When the control lever is moved to the left, pressurised oil is directed to the piston side of the outrigger extension cylinder. Oil pressure exerted on the piston will move the piston and consequently extend the outrigger extension. Displaced oil on the piston rod side of the cylinder returns to the outrigger spool valve then to the tank via the return channel.

125. When the control lever is released and allowed to return to its central position, the control valve is closed and all fluid flow within the circuit is checked. The piston remains rigidly in place.

126. When the control lever is moved to the right, pressurised oil is directed to the piston rod side of the outrigger extension cylinder. Oil pressure acting on the underside of the piston will move the piston and consequently retract the outrigger extension. Displaced oil on the piston side of the cylinder returns to the outrigger spool valve then to the tank via the return channel.

127. The hydraulic circuit for the outrigger leg comprises the outrigger control valve, a pilot controlled check valve and the outrigger leg cylinder.

128. When the control lever is moved to the left, pressurised oil lifts the check valve off its seat and passes through to the piston side of the outrigger leg cylinder. Oil pressure exerted on the piston will move the piston and consequently extend the outrigger leg. Displaced oil on the piston rod side of the cylinder returns to the outrigger spool valve then to the tank via the return channel.

129. When the control lever is released and allowed to return to its central position, the control valve is closed and all fluid flow within the circuit is checked. The piston remains rigidly in place. In addition, the pilot operated check valve prevents oil from escaping from the piston side of the cylinder, ensuring that the cylinder cannot collapse under load.

130. When the control lever is moved to the right, pressurised oil is directed to the piston rod side of the outrigger leg cylinder. No movement can take place in the cylinder because the pilot operated check valve prevents oil on the piston side of the cylinder from returning to tank. A pressure build-up takes place. When sufficient pressure is built up in the pilot line to overcome spring pressure and open the check valve, oil pressure acting on the underside of the piston will move the piston and consequently retract the outrigger leg. Displaced oil on the piston side of the cylinder returns via the check valve to the outrigger spool valve then to the tank via the return channel.

BODY

131. The body consists of two individually mounted flat tray sections between which the crane is mounted. The body sections are mounted to the chassis using the same mounting technique as the other cargo variants (refer to EMEI Vehicle G 702). Each tray section has a set of four twistlocks to enable mounting of the GTPCM (Gun Tractor Personnel and Cargo Modules) as well as numerous tie down anchor points for cargo restraint.

132. The front body section incorporates folding steps for ease of access to the cargo tray when not fitted with the Personnel Module. Two tool/CES boxes have been mounted under the front right and left hand sides of the tray and a larger box has been fitted behind the left hand tool/CES box for stowage of the crew's personal equipment.

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TRUCK CAB

GENERAL

133. The cab of the Gun Tractor has a removable roof (cab upper section) and removable doors (see Figure 22) to enable reduction of the vehicle's height for air transportation by C130.

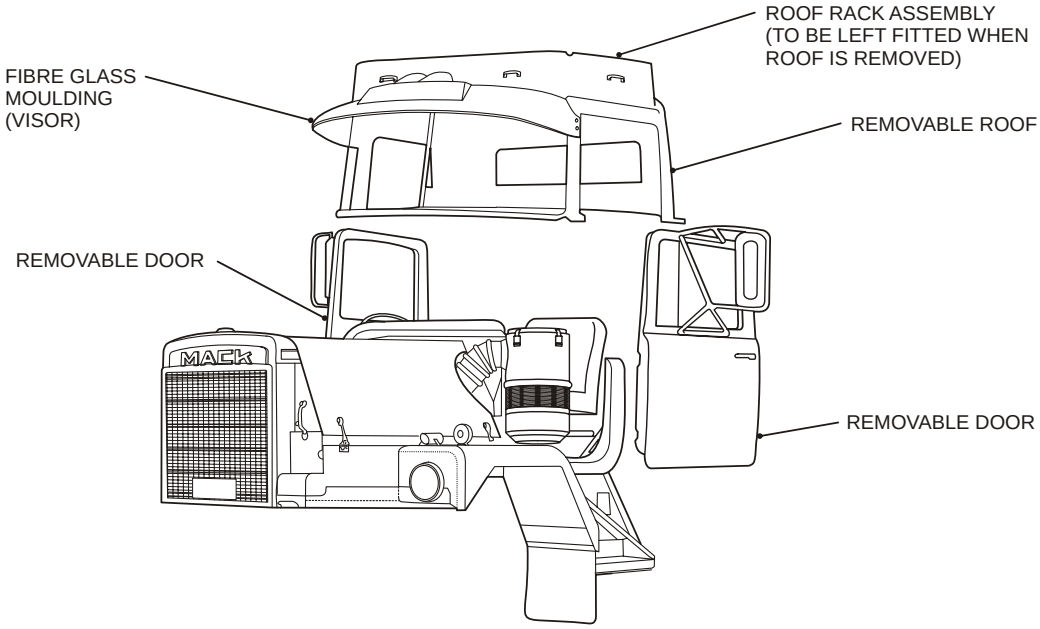


Figure 22 Modified Truck Cab

REMOVABLE ROOF

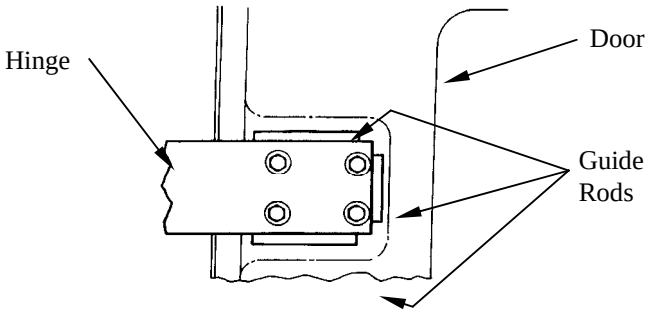
134. The roof, or upper section of the cab, is flange bolted to the lower cab section at the rear, and bolted at the two cab pillars at the front. The two windscreen sections are held in position in the upper cab section by a fibre glass moulding which is screwed to the inside of the windscreen pillars (see Figure 22). Sealing strips are fitted between the underside of the windscreen moulding and the lower cab section to prevent the ingress of moisture.

135. The upper and lower cab sections are matched pairs and are identified by number plates affixed to each section internally, on the passenger's side.

REMOVABLE DOORS

136. The doors are mounted in the same manner as on a standard cab, except that locating or guide rods are welded to the doors, around each hinge, to facilitate door relocation and alignment on refitting. Figure 23 illustrates the hinge guide rods.

137. The mirror mounted clearance light wiring is fitted with bullet connectors, which are disconnected to facilitate cab door removal.



Detail of Hinge Location +

Figure 23 Door Hinge Guide Rods

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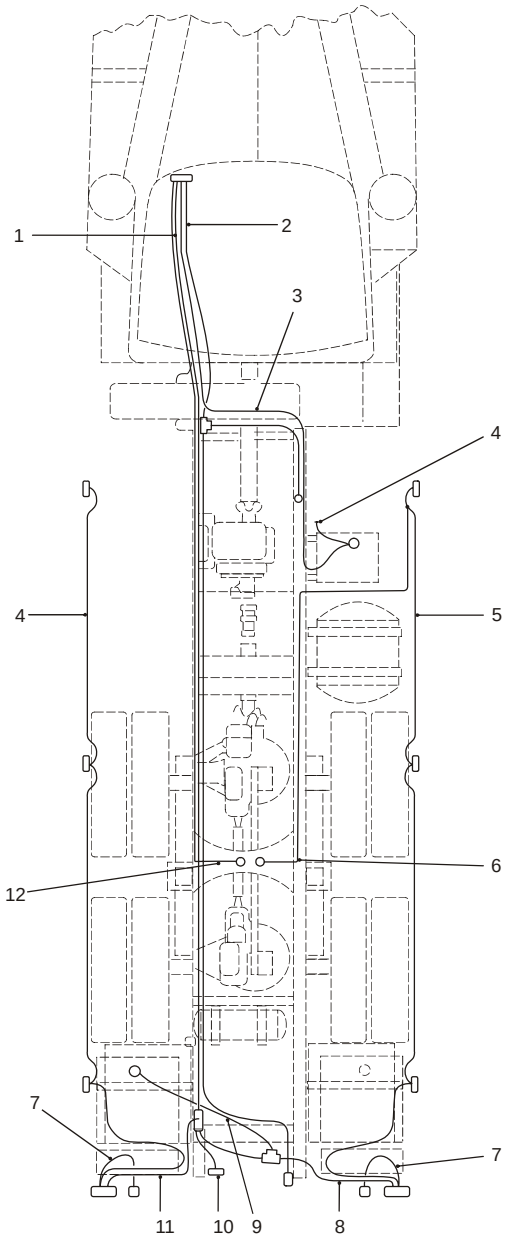
REAR WIRING HARNESSES

138. The rear wiring harness is illustrated at Figure 24.



Item	Description	Item	Description
1	Main Chassis	7	Blackout Lamp
2	Auxiliary Chassis	8	Right-hand Tail Lights
3	Battery	9	Fuel Tank Sender Extension
4	Oil Cooler	10	12-pin NATO Socket
5	Side Marker Lamps	11	Left-hand Tail Lights
6	Work Lamp	12	High Boom Warning

Figure 24 Rear Wiring Harnesses

END

Distribution List: **VEH G 56.0 – Code 1** (Maint Level)
(Sponsor: LV SPO, Mdm/Hvy B Veh Sect)

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