

# **R2-1 Series**

# **SHOP MANUAL**

## PREFACE

Performances of a vehicle will inevitably fall with its component parts worn or deteriorated. To make a machine retain its original performances over a long operating hours without any troubles, correct handling and quality preventive maintenance are of vital importance. If a trouble occurs, its cause should be tracked down as soon as practicable.

This manual provides instructions on SPECIFICATIONS, STRUCTURE, OPERATION, INSPECTION, ADJUSTMENT and TROUBLE DIAGNOSIS of R2-1 Series Three-wheeled Rollers. For quick fault finding, this book uses diagnosis flow charts. Many diagnosis procedures are made available. Shown here represent typical examples. Other reasonable procedures will be usable. Depending upon conditions of troubles, the most suitable diagnosis procedures should be used.

The main purpose of this service literature is to serve as a guide for service personnel to acquire correct information on servicing the R2-1 Series Machines, passing a correct judgement on troubles, thus leading to quality servicing. Fully understand the instructions in this manual and make the best of it.

We will make this book more substantial through repeated revisions. Your opinions and advices will be particularly welcome and carefully considered.

For daily maintenance and periodical service schedule, refer to Operator's Instructions furnished separately.



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# ***SPECIFICATION DATA***

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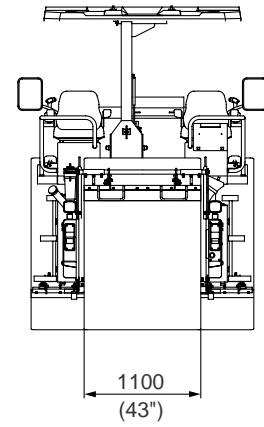
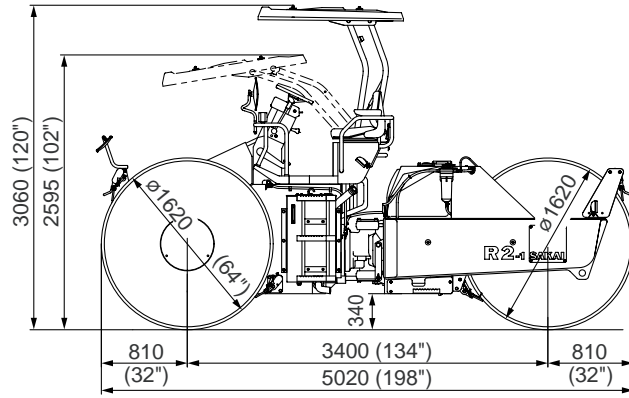
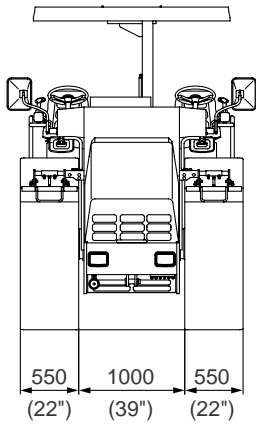
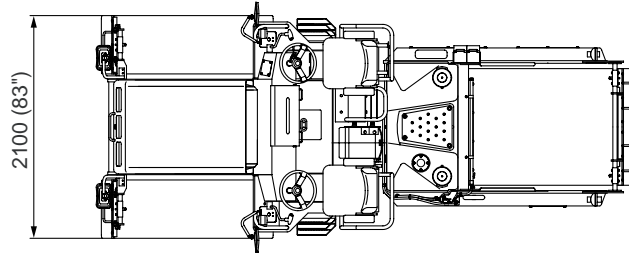
# SPECIFICATION DATA

## 1. External Views and Specification Data

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# 1. External Views and Specification Data

## 1-1. R2-1

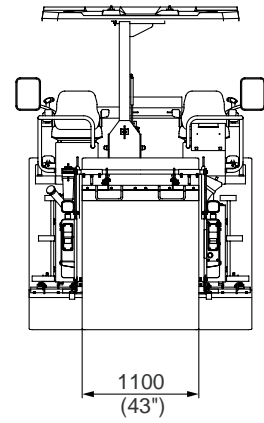
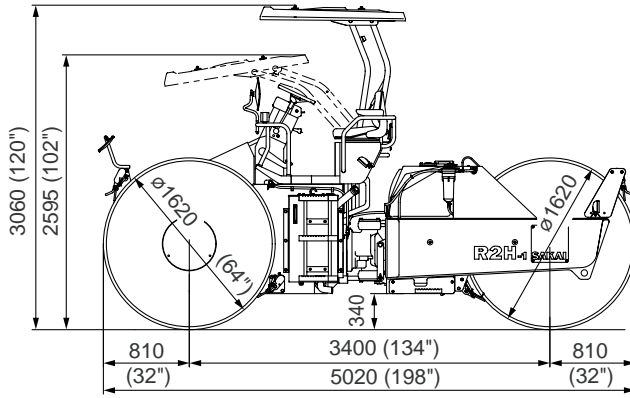
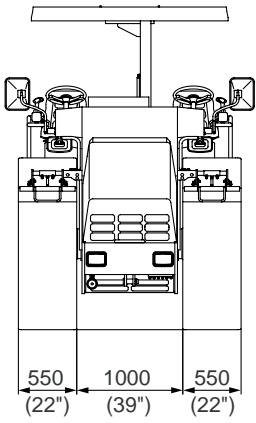
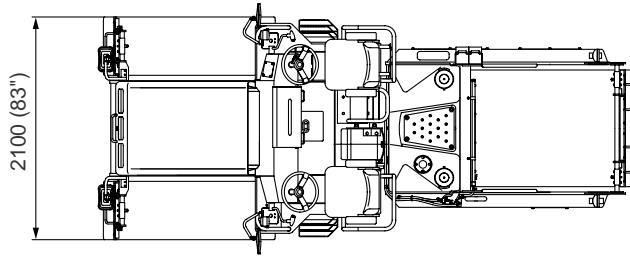


R21001



|                                       |                |         |   |
|---------------------------------------|----------------|---------|---|
| <b>WEIGHTS</b>                        |                |         |   |
| Gross                                 | kg (lbs)       |         | 12,300 (27,117)                                 |
| Load on front axle                    | kg (lbs)       |         | 5,990 (13,206)                                  |
| Load on rear axle                     | kg (lbs)       |         | 6,310 (13,911)                                  |
| Empty                                 | kg (lbs)       |         | 9,300 (20,502)                                  |
| Load on front axle                    | kg (lbs)       |         | 4,650 (10,251)                                  |
| Load on rear axle                     | kg (lbs)       |         | 4,650 (10,251)                                  |
| <b>LINEAR STATIC PRESSURE</b>         |                |         |   |
| Gross on front roll                   | kgf/cm (lb/in) |         | 54.5 (305)                                      |
| on rear roll                          | kgf/cm (lb/in) |         | 57.4 (321)                                      |
| Empty on front roll                   | kgf/cm (lb/in) |         | 42.3 (237)                                      |
| on rear roll                          | kgf/cm (lb/in) |         | 42.3 (237)                                      |
| <b>DIMENSIONS</b>                     |                |         |   |
| Overall length                        | mm (in)        |         | 5,020 (198)                                     |
| Overall width                         | mm (in)        |         | 2,100 ( 83)                                     |
| Overall height                        |                |         |   |
| without awning                        | mm (in)        |         | 2,310 ( 91)                                     |
| with awning                           | mm (in)        |         | 3,060 (120)                                     |
| Wheelbase                             | mm (in)        |         | 3,400 (134)                                     |
| Rolling width                         | mm (in)        |         | 2,100 ( 83)                                     |
| Min. Turning radius                   | mm (in)        |         | 6,300 (248)                                     |
| Ground clearance                      | mm (in)        |         | 340 (13.4)                                      |
| <b>GRADABILITY</b>                    |                |         | %   |
|                                       |                |         | 47 (25.9)                                       |
| <b>SPEEDS (Forward &amp; Reverse)</b> |                |         |   |
| Low                                   | km/h (mile/h)  |         | 0 ~ 8 (0 ~ 5)                                   |
| High                                  | km/h (mile/h)  |         | 0 ~16 (0 ~ 9.9)                                 |
| <b>ENGINE</b>                         |                |         |   |
| Model                                 |                |         | HINO "W04D-H" Diesel Engine                     |
| Type                                  |                |         | Water - cooled, 4-cycle                         |
| Displacement                          | L (cu.in)      |         | 4.009 (245)                                     |
| Rated output                          | kW (HP)/rpm    |         | 56 (75) / 2,050                                 |
| Battery                               |                |         | 12V 70Ah x 2 pcs (24V)                          |
| <b>POWER LINE</b>                     |                |         |   |
| Transmission                          | Type           |         | Hydrostatic transmission                        |
|                                       | Speed          |         | 2 speed shifts                                  |
| Final drive                           |                |         | Planetary gear                                  |
| <b>BRAKE SYSTEM</b>                   |                |         |   |
| Service brake                         |                |         | Hydrostatic and mechanical, multi-wet disc type |
| Parking brake                         |                |         | Mechanical, multi-wet disc type                 |
| <b>STEERING SYSTEM</b>                |                |         |   |
|                                       |                |         | Hydraulic type (Articulated type)               |
| <b>ROLL</b>                           |                |         |   |
| Use                                   | Front roll     |         | Drive   |
|                                       | Rear roll      |         | Drive   |
| Dimensions                            | Front roll     | mm (in) | 550 x 1,620 (22 x 64) x 2 Pieces                |
| width x dia                           | Rear roll      | mm (in) | 1,100 x 1,620 (43 x 64)                         |
| <b>WATER SPRINKLER SYSTEM</b>         |                |         |   |
|                                       |                |         | Water pressurized type                          |
| <b>FLUID CAPACITY</b>                 |                |         |   |
| Fuel tank                             | L (gal)        |         | 120 ( 32)                                       |
| Hydraulic oil tank                    | L (gal)        |         | 85 ( 22)  |
| Sprinkler tank                        | L (gal)        |         | 680 (180)                                       |

1-2. R2H-1



R21002

|                                       |                |         |   |
|---------------------------------------|----------------|---------|---|
| <b>WEIGHTS</b>                        |                |         |   |
| Gross                                 | kg (lbs)       |         | 14,030 (30,930)                                 |
| Load on front axle                    | kg (lbs)       |         | 6,820 (15,035)                                  |
| Load on rear axle                     | kg (lbs)       |         | 7,210 (15,895)                                  |
| Empty                                 | kg (lbs)       |         | 10,150 (22,377)                                 |
| Load on front axle                    | kg (lbs)       |         | 5,025 (11,078)                                  |
| Load on rear axle                     | kg (lbs)       |         | 5,125 (11,299)                                  |
| <b>LINEAR STATIC PRESSURE</b>         |                |         |   |
| Gross on front roll                   | kgf/cm (lb/in) |         | 62.0 (347)                                      |
| on rear roll                          | kgf/cm (lb/in) |         | 65.5 (367)                                      |
| Empty on front roll                   | kgf/cm (lb/in) |         | 45.7 (256)                                      |
| on rear roll                          | kgf/cm (lb/in) |         | 46.6 (261)                                      |
| <b>DIMENSIONS</b>                     |                |         |   |
| Overall length                        | mm (in)        |         | 5,020 (198)                                     |
| Overall width                         | mm (in)        |         | 2,100 ( 83)                                     |
| Overall height                        |                |         |   |
| without awning                        | mm (in)        |         | 2,310 ( 91)                                     |
| with awning                           | mm (in)        |         | 3,060 (120)                                     |
| Wheelbase                             | mm (in)        |         | 3,400 (134)                                     |
| Rolling width                         | mm (in)        |         | 2,100 ( 83)                                     |
| Min. Turning radius                   | mm (in)        |         | 6,300 (248)                                     |
| Ground clearance                      | mm (in)        |         | 340 (13.4)                                      |
| <b>GRADABILITY</b>                    | %              |         | 31 (17.9)                                       |
| <b>SPEEDS (Forward &amp; Reverse)</b> |                |         |   |
| Low                                   | km/h (mile/h)  |         | 0 ~ 8 (0 ~ 5)                                   |
| High                                  | km/h (mile/h)  |         | 0 ~16 (0 ~ 9.9)                                 |
| <b>ENGINE</b>                         |                |         |   |
| Model                                 |                |         | HINO "W04D-H" Diesel Engine                     |
| Type                                  |                |         | Water - cooled, 4-cycle                         |
| Displacement                          | L (cu.in)      |         | 4.009 (245)                                     |
| Rated output                          | kW (HP)/rpm    |         | 56 (75) / 2,050                                 |
| Battery                               |                |         | 12V 70Ah x 2 pcs (24V)                          |
| <b>POWER LINE</b>                     |                |         |   |
| Transmission                          | Type           |         | Hydrostatic transmission                        |
|                                       | Speed          |         | 2 speed shifts                                  |
| Final drive                           |                |         | Planetary gear                                  |
| <b>BRAKE SYSTEM</b>                   |                |         |   |
| Service brake                         |                |         | Hydrostatic and mechanical, multi-wet disc type |
| Parking brake                         |                |         | Mechanical, multi-wet disc type                 |
| <b>STEERING SYSTEM</b>                |                |         |   |
|                                       |                |         | Hydraulic type (Articulated type)               |
| <b>ROLL</b>                           |                |         |   |
| Use                                   | Front roll     |         | Drive   |
|                                       | Rear roll      |         | Drive   |
| Dimensions                            | Front roll     | mm (in) | 550 x 1,620 (22 x 64) x 2 Pieces                |
| width x dia                           | Rear roll      | mm (in) | 1,100 x 1,620 (43 x 64)                         |
| <b>WATER SPRINKLER SYSTEM</b>         |                |         |   |
|                                       |                |         | Water pressurized type                          |
| <b>FLUID CAPACITY</b>                 |                |         |   |
| Fuel tank                             | L (gal)        |         | 120 ( 32)                                       |
| Hydraulic oil tank                    | L (gal)        |         | 85 ( 22)  |
| Sprinkler tank                        | L (gal)        |         | 680 (180)                                       |



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# ***STRUCTURE & OPERATION***

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# STRUCTURE & OPERATION

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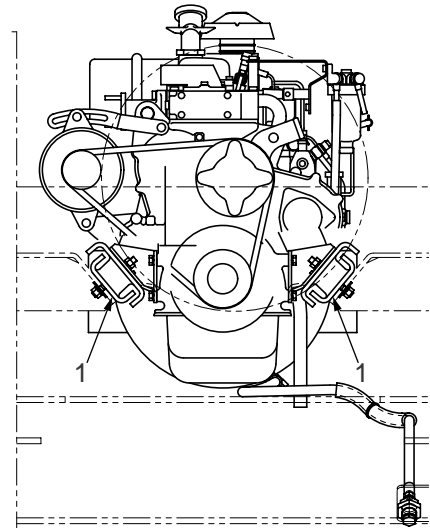
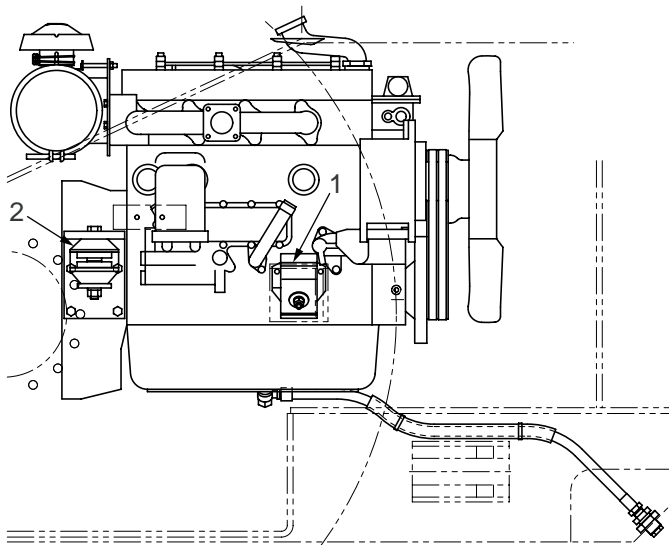
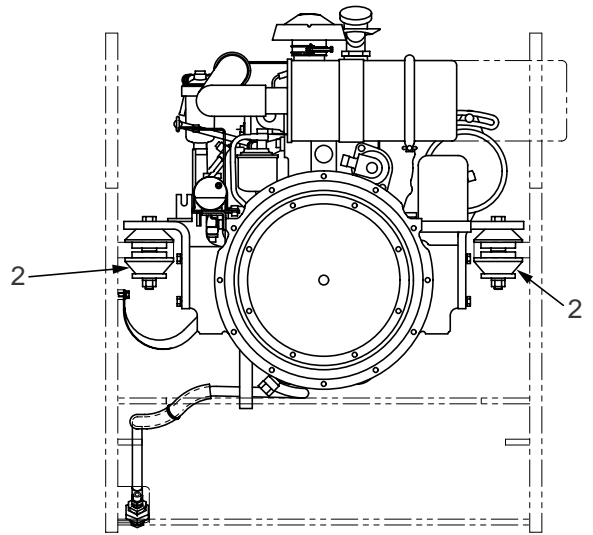
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# 1. Location of Engine-related Units

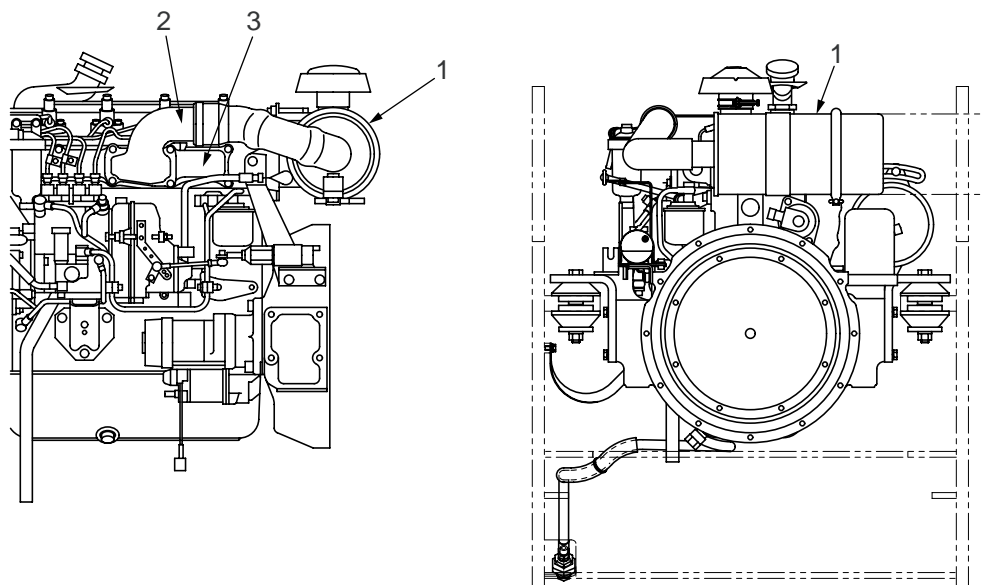
## 1-1. Engine mount



R22001

- 1. Engine mount (front)
- 2. Engine mount (rear)

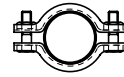
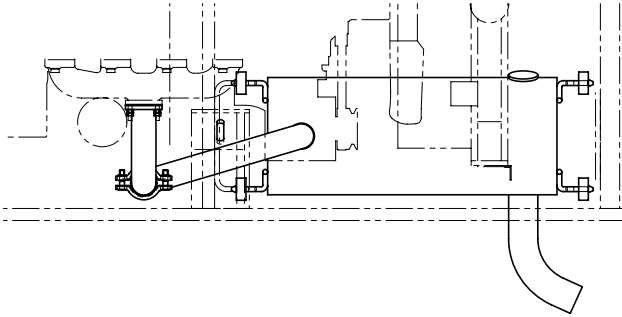
## 1-2. Intake system



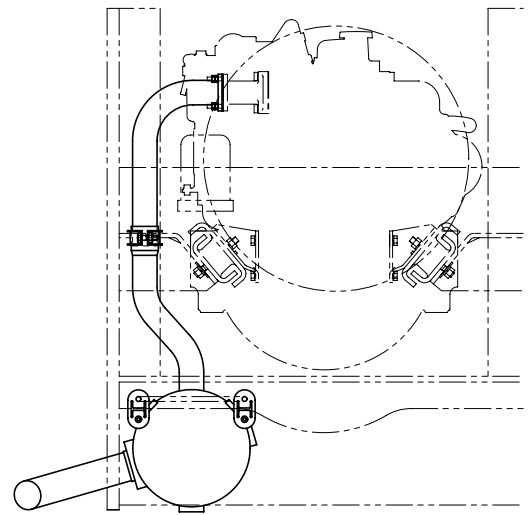
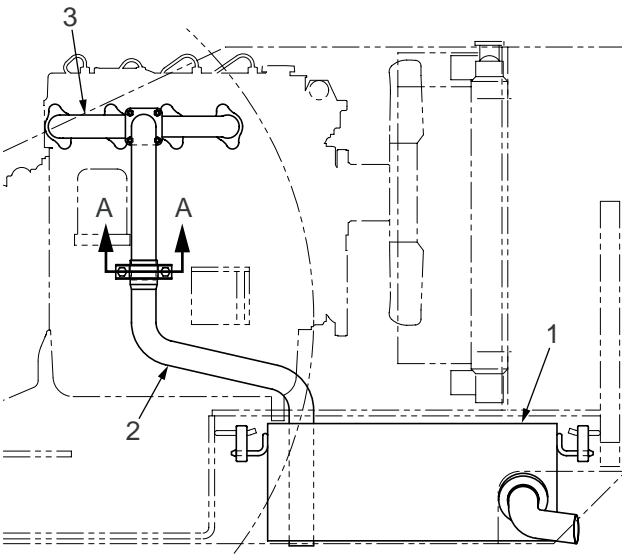
R22002

- 1. Air cleaner
- 2. Intake pipe
- 3. Intake manifold

### 1-3. Exhaust system



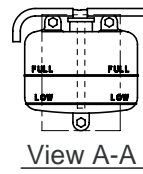
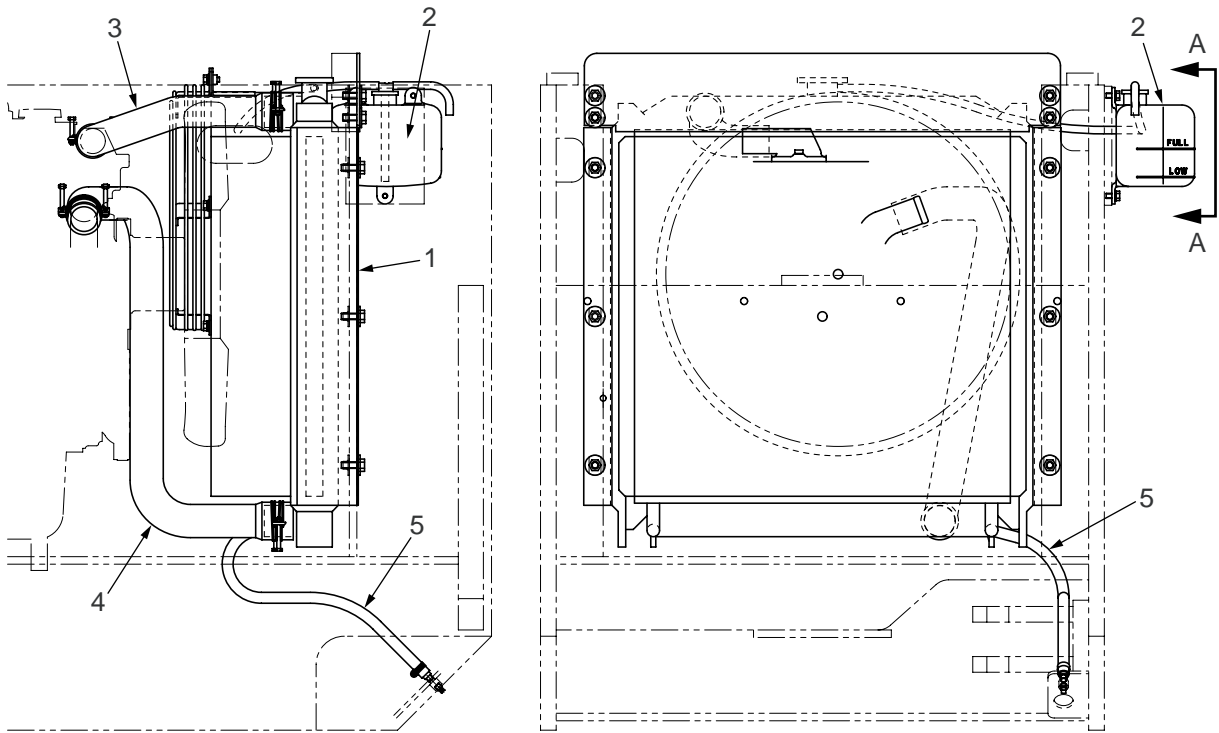
View A-A



- 1. Muffler
- 2. Exhaust pipe
- 3. Exhaust manifold

R22003

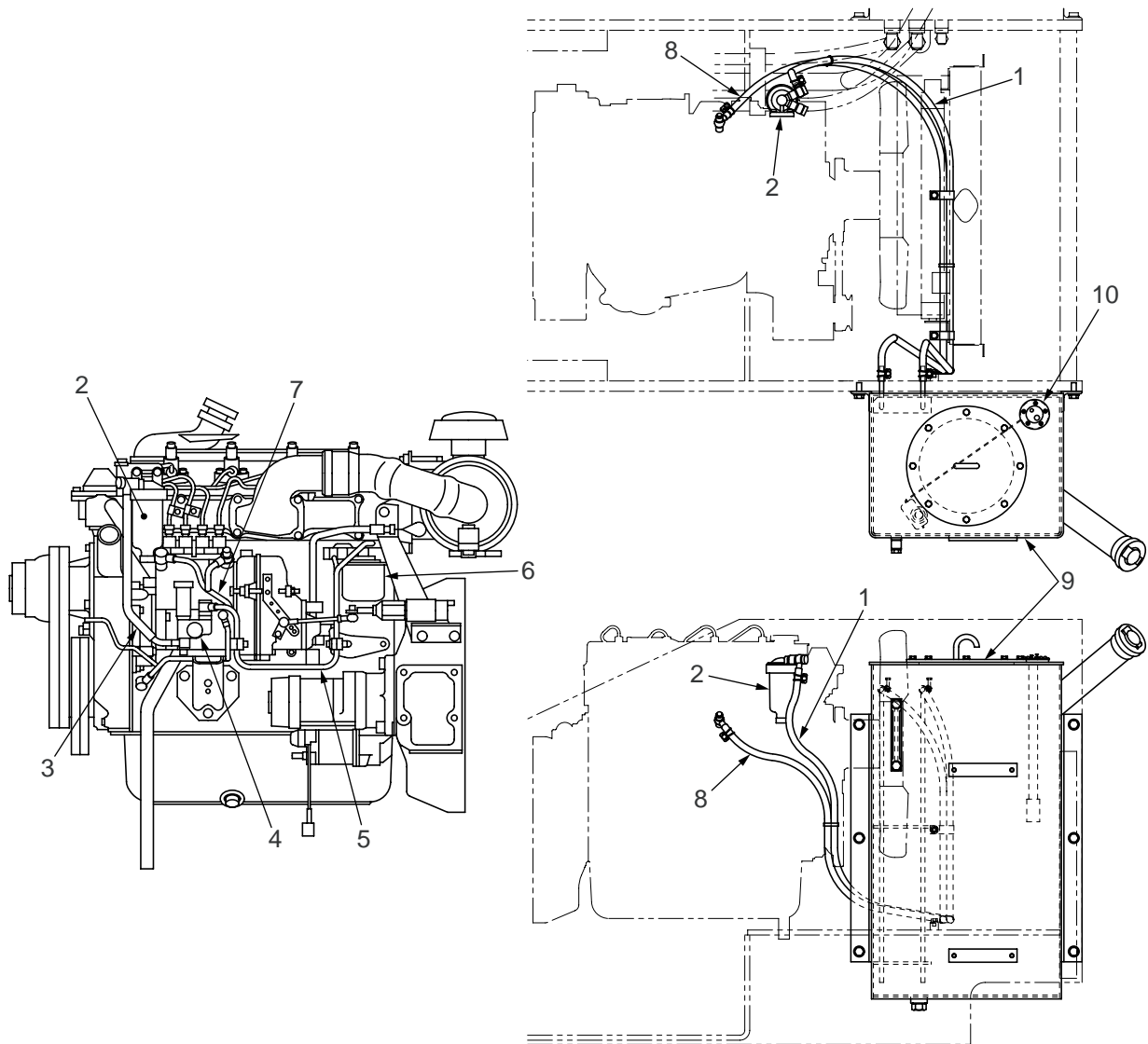
### 1-4. Coolant line & radiator



- 1. Radiator
- 2. Subtank
- 3. Radiator inlet hose
- 4. Radiator outlet hose
- 5. Drain hose (radiator)

R22004

## 1-5. Fuel line & fuel tank

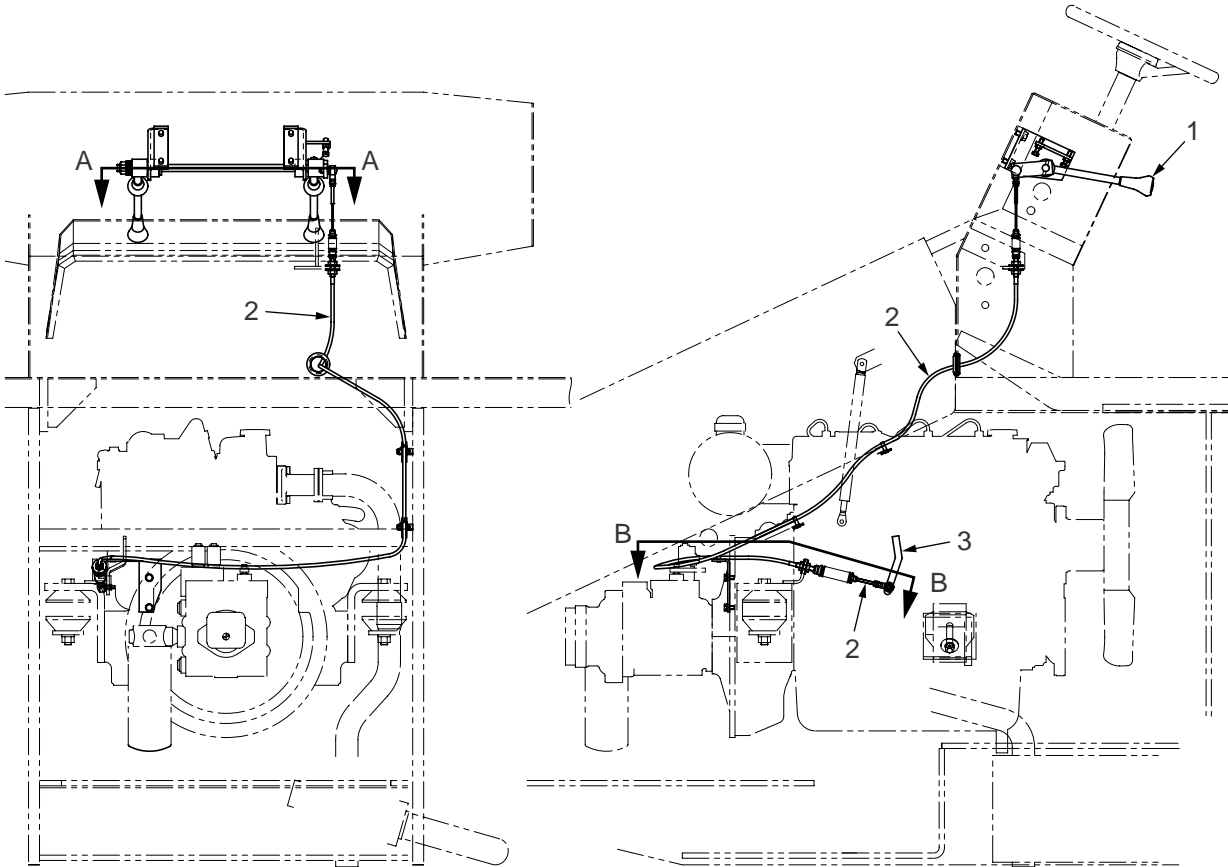
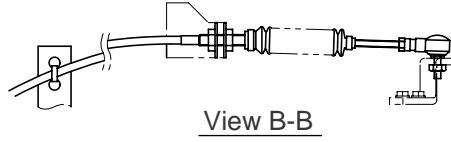
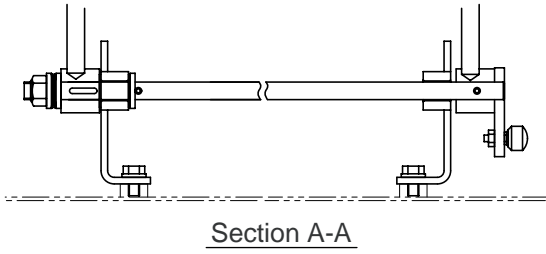


R22005

1. Suction hose (tank to sedimenter)
2. Sedimenter
3. Suction pipe (sedimenter to feed pump)
4. Feed pump
5. Pipe (feed pump to filter)

6. Filter
7. Pipe (filter to injection pump)
8. Return hose (injection pump to fuel tank)
9. Fuel tank
10. Fuel unit

### 1-6. Fuel controls



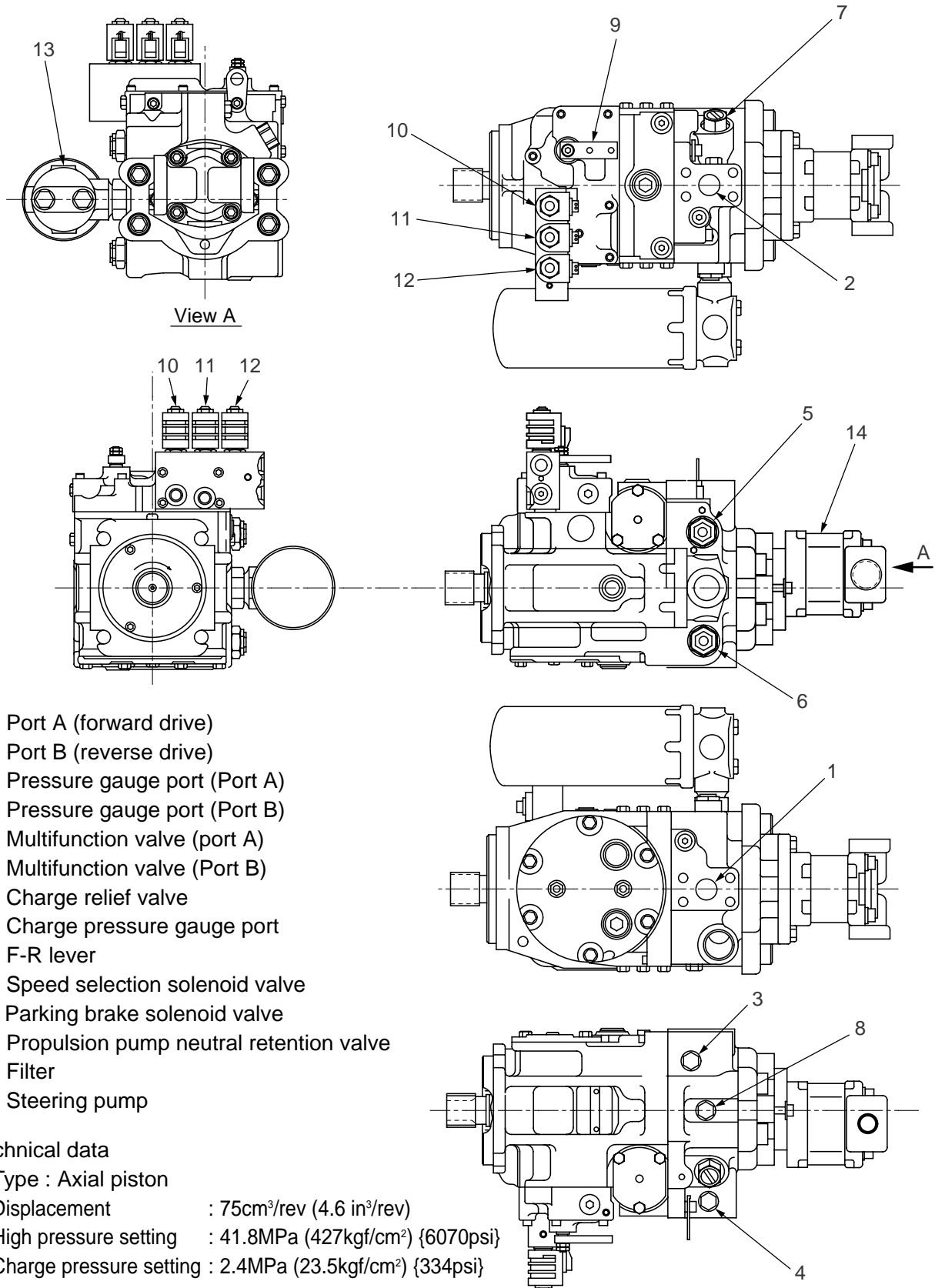
R22006

1. Throttle lever
2. Throttle cable
3. Control lever (injection pump)

## 2. Description and Operation of Hydraulic System

### 2-1. Structure of hydraulic pump and motor

#### 2-1-1. Hydraulic pump assembly



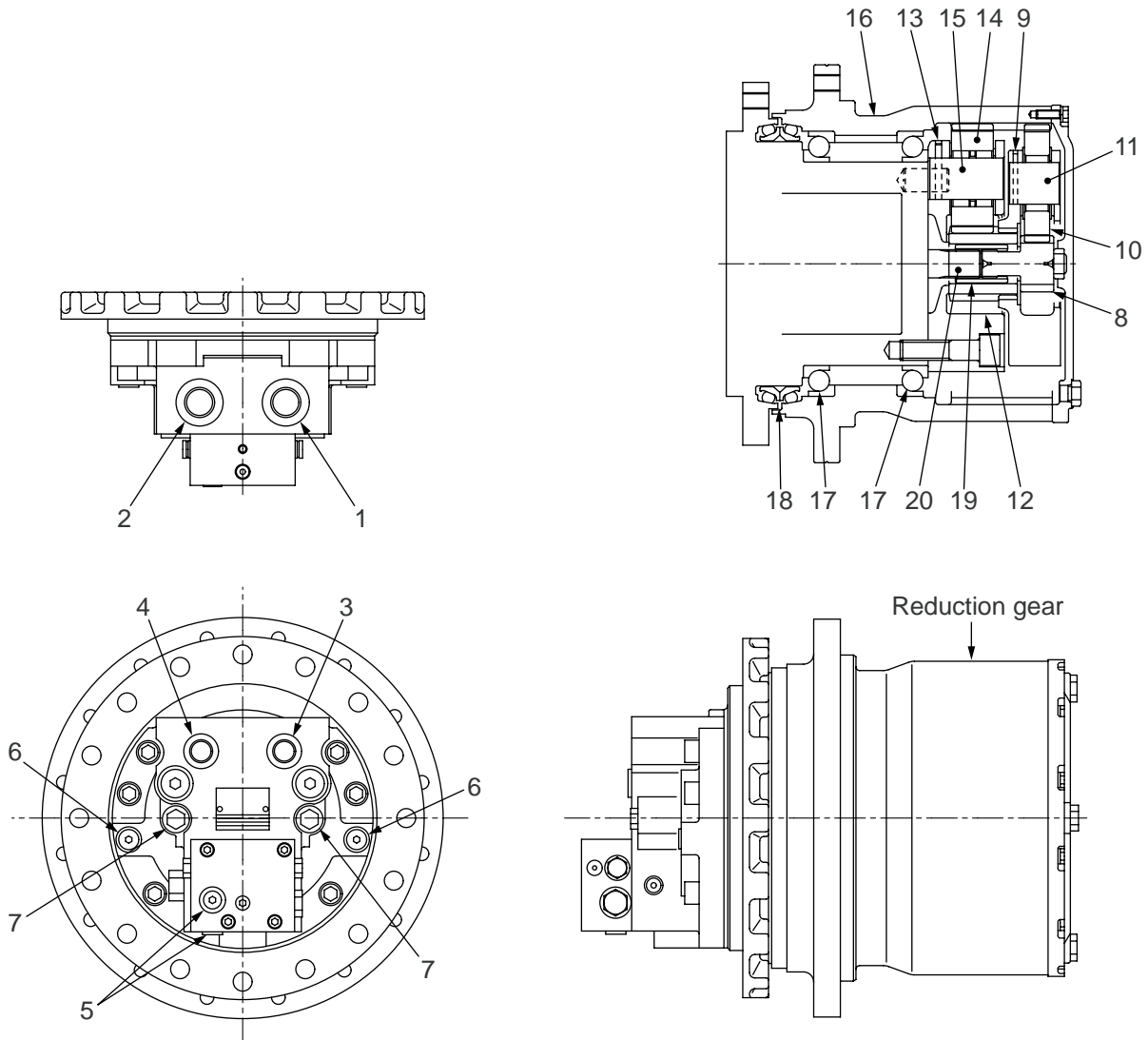
1. Port A (forward drive)
2. Port B (reverse drive)
3. Pressure gauge port (Port A)
4. Pressure gauge port (Port B)
5. Multifunction valve (port A)
6. Multifunction valve (Port B)
7. Charge relief valve
8. Charge pressure gauge port
9. F-R lever
10. Speed selection solenoid valve
11. Parking brake solenoid valve
12. Propulsion pump neutral retention valve
13. Filter
14. Steering pump

#### Technical data

- Type : Axial piston
- Displacement : 75cm<sup>3</sup>/rev (4.6 in<sup>3</sup>/rev)
- High pressure setting : 41.8MPa (427kgf/cm<sup>2</sup>) {6070psi}
- Charge pressure setting : 2.4MPa (23.5kgf/cm<sup>2</sup>) {334psi}

R22007

## 2-1-2. Propulsion motor (Front)



R22008

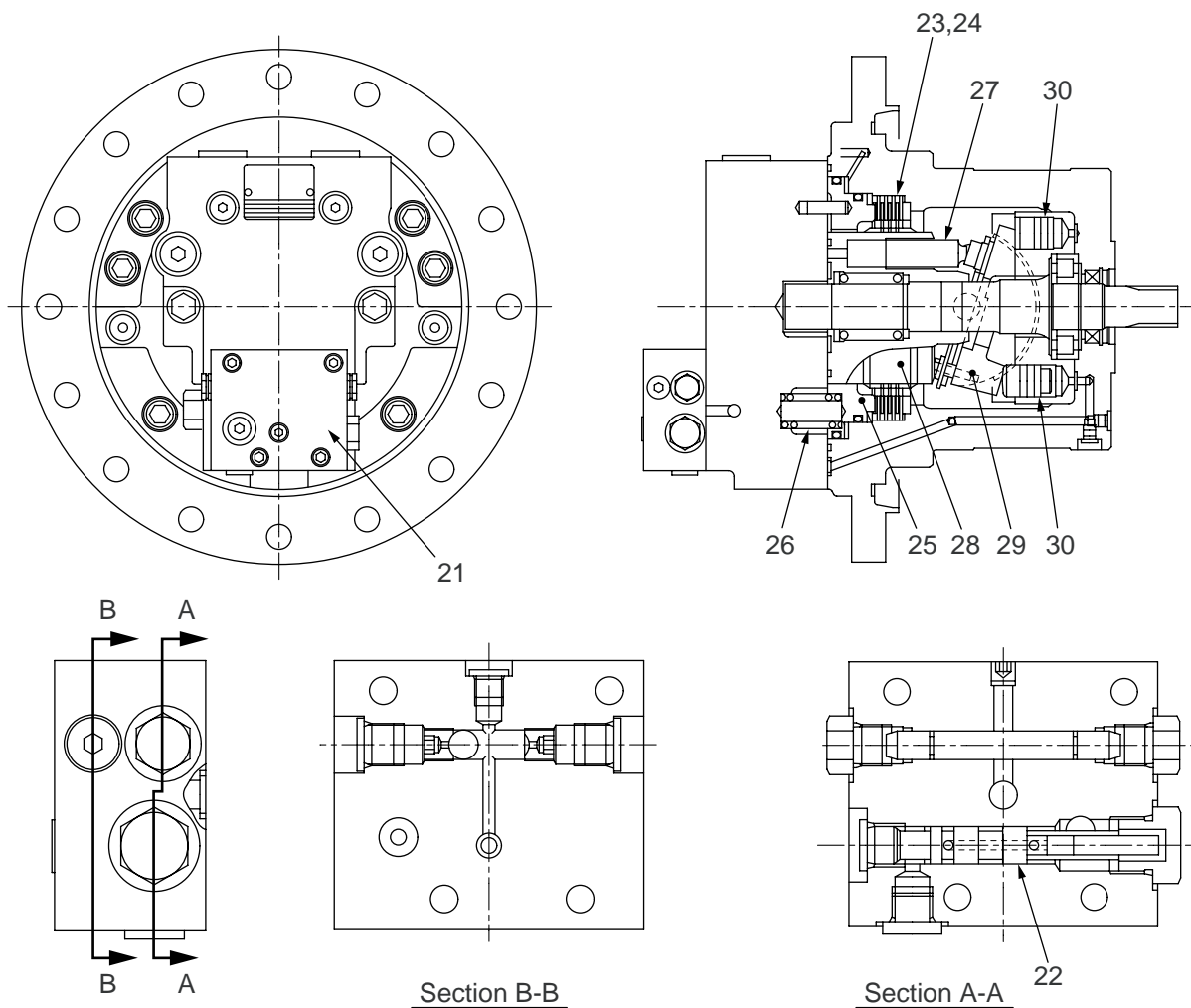
- 1. Port A1
- 2. Port B1
- 3. Port A2
- 4. Port B2
- 5. Speed selection circuit port
- 6. Brake circuit port
- 7. Brake release port

### Reduction gear ass'y

- 8. Sun gear A
- 9. Carrier A
- 10. Planetary gear A
- 11. Shaft A
- 12. Sun gear B
- 13. Carrier B

- 14. Planetary gear B
- 15. Shaft B
- 16. Gear case
- 17. Ball bearing
- 18. Floating seal
- 19. Coupling
- 20. Motor output shaft





R22009

**Valve / Brake**

- 21. Valve housing
- 22. Speed selection valve
- 23. Disc
- 24. Plate
- 25. Brake piston
- 26. Brake spring

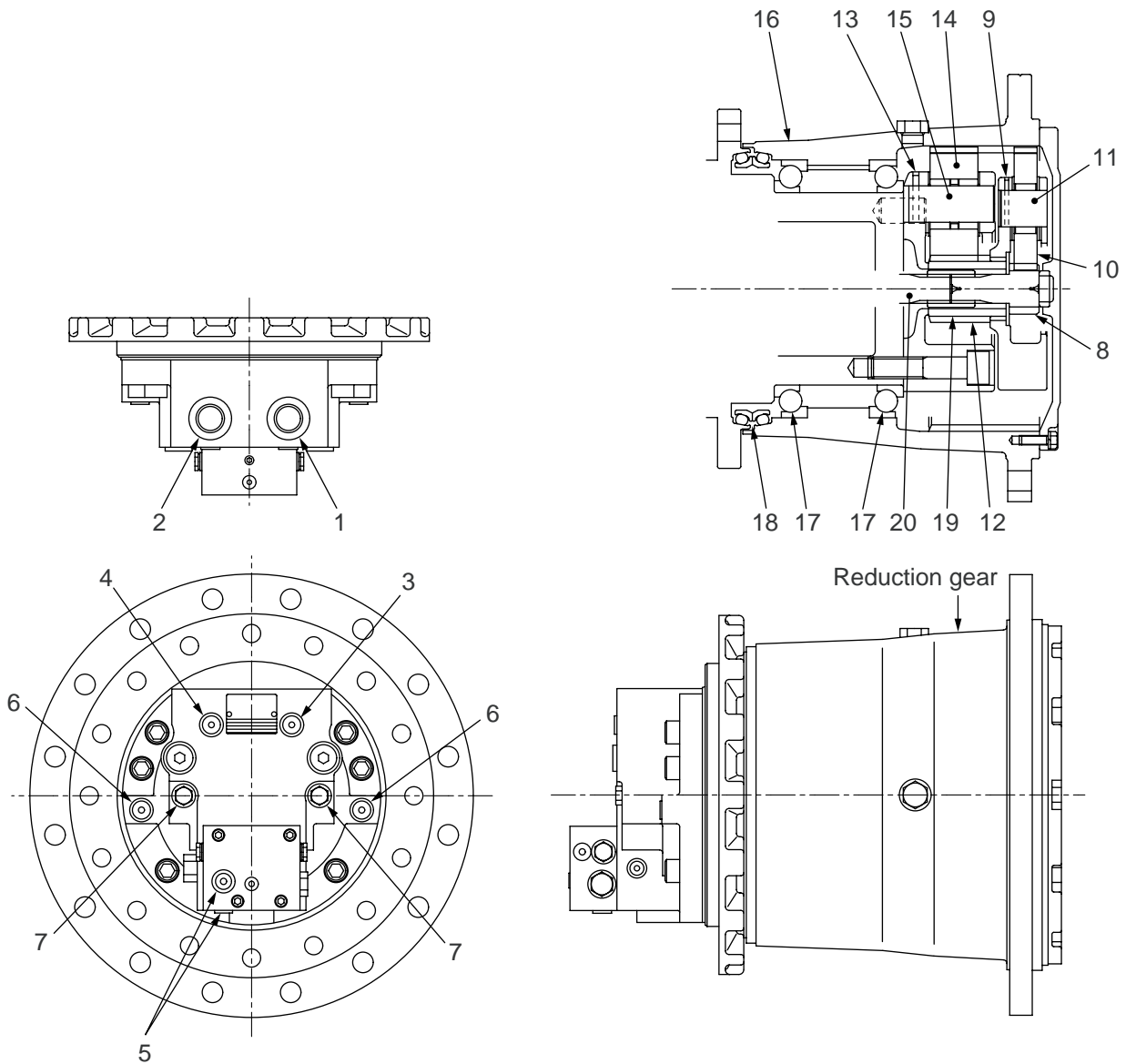
**Motor**

- 27. Piston
- 28. Cylinder block
- 29. Swashplate
- 30. Speed selection piston

**Technical data**

- Type : Axial piston
- Displacement : 55.1 ~ 28.5cm<sup>3</sup>/rev (3.4~1.7 in<sup>3</sup>/rev)
- Pressure setting : 41.8MPa (427kgf/cm<sup>2</sup>) {6070psi} (to be measured on motor side)

### 2-1-3. Propulsion motor (Rear)



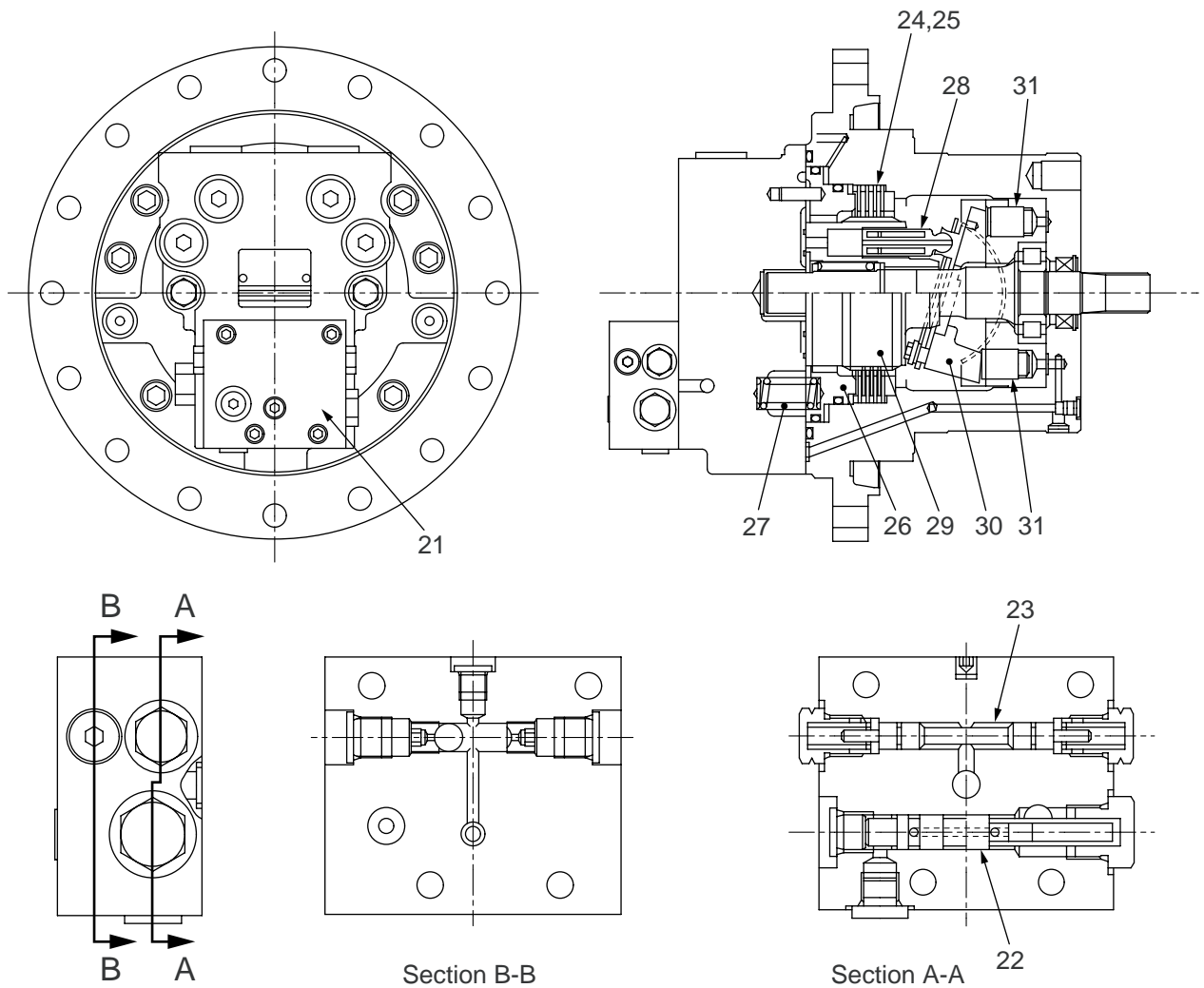
R22010

- 1. Port A1
- 2. Port B1
- 3. Port A2
- 4. Port B2
- 5. Speed selection circuit port
- 6. Brake circuit port
- 7. Brake release port

**Reduction gear ass'y**

- 8. Sun gear A
- 9. Carrier A
- 10. Planetary gear A
- 11. Shaft A
- 12. Sun gear B
- 13. Carrier B

- 14. Planetary gear B
- 15. Shaft B
- 16. Gear case
- 17. Ball bearing
- 18. Floating seal
- 19. Coupling
- 20. Motor output shaft



**Valve / Brake**

- 21. Valve housing
- 22. Speed selection valve
- 23. Flushing valve
- 24. Disc
- 25. Plate
- 26. Brake piston
- 27. Brake spring

**Motor**

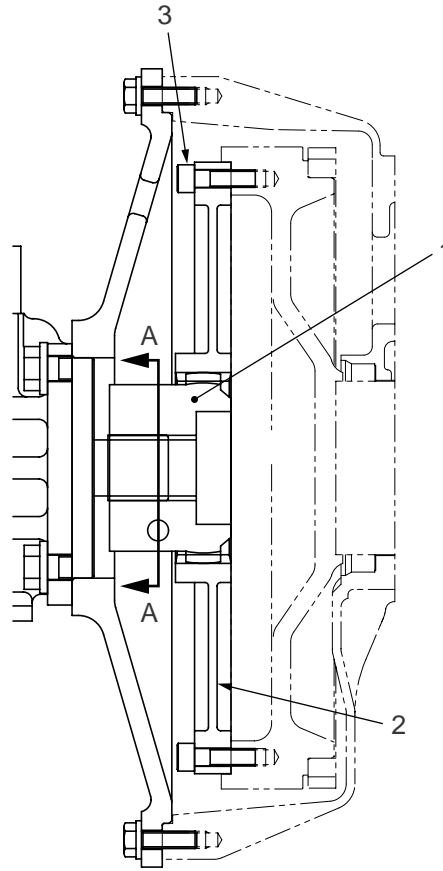
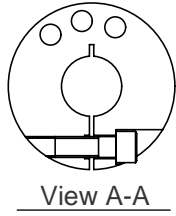
- 28. Piston
- 29. Cylinder block
- 30. Swashplate
- 31. Speed selection piston

**Technical data**

- Type : Axial piston
- Displacement : 75 ~ 28cm<sup>3</sup>/rev (4.6 ~1.7in<sup>3</sup>/rev)
- Pressure setting : 41.8MPa (427kgf/cm<sup>2</sup>) {6,070psi} (to be measured on pump side)

R22011

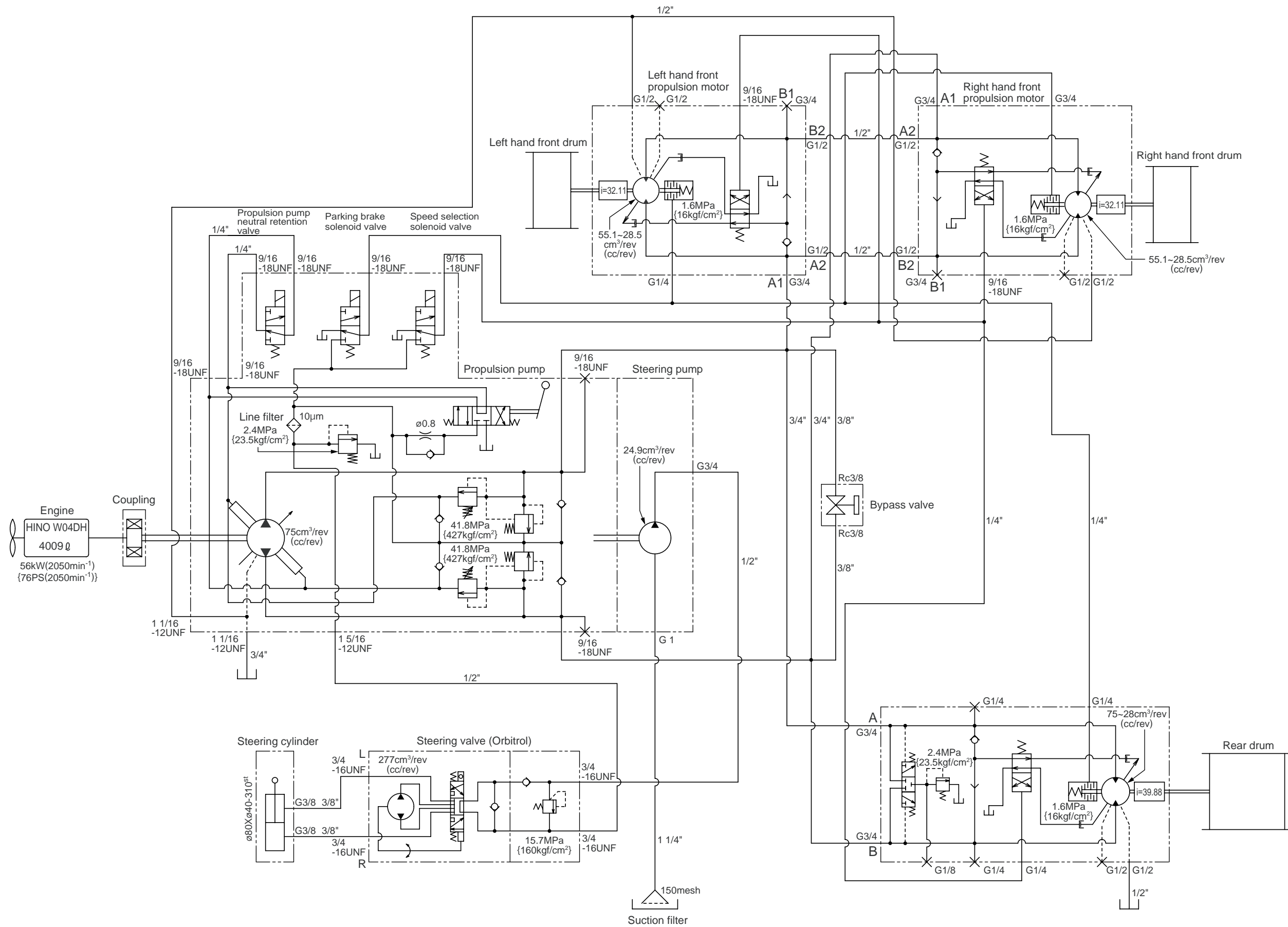
## 2-1-4. Coupling



- 1. Hub
- 2. Flange
- 3. Bolt

R22012

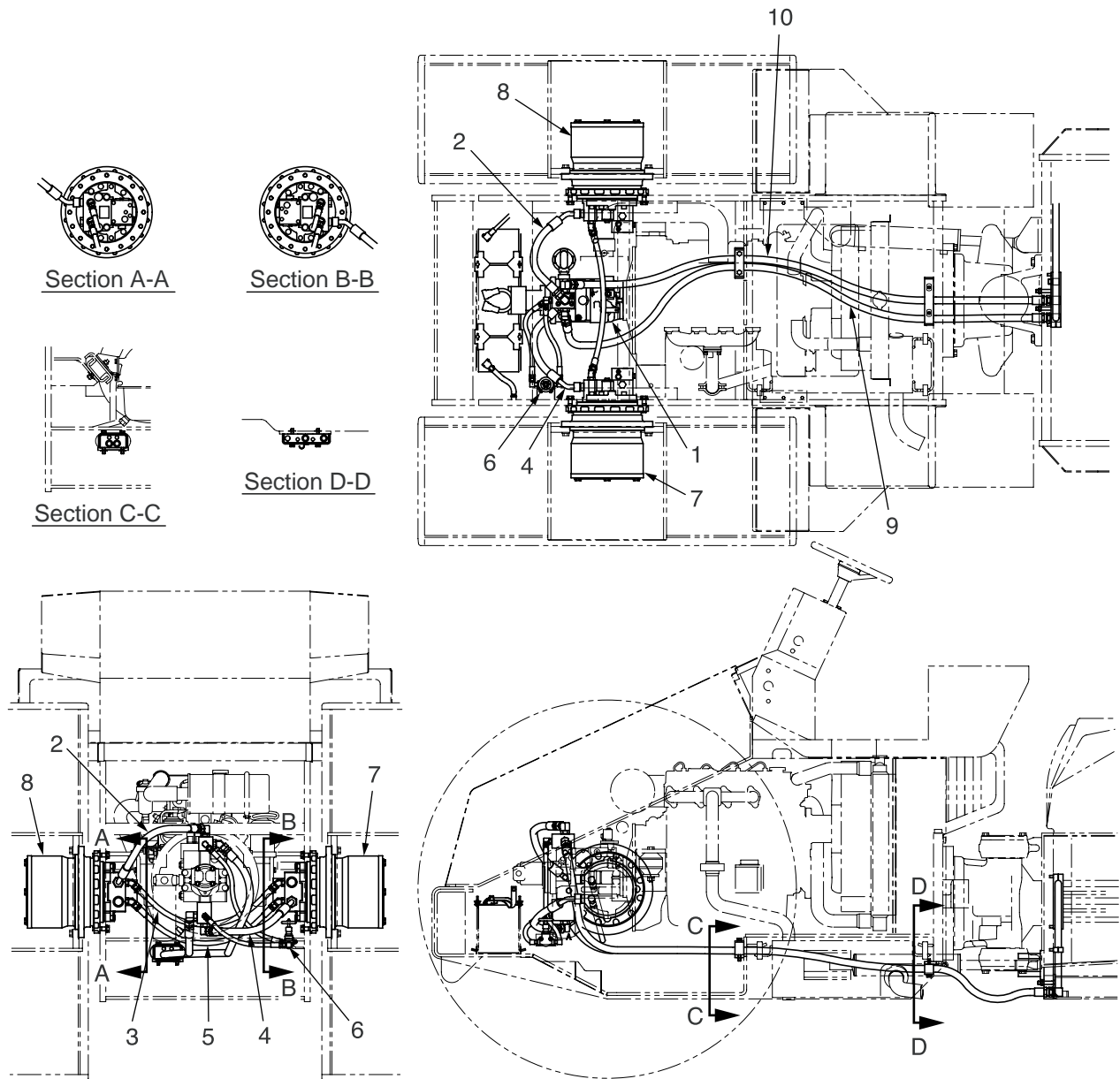
2-1-5. Hydraulic circuit diagram





## 2-2. Drive line

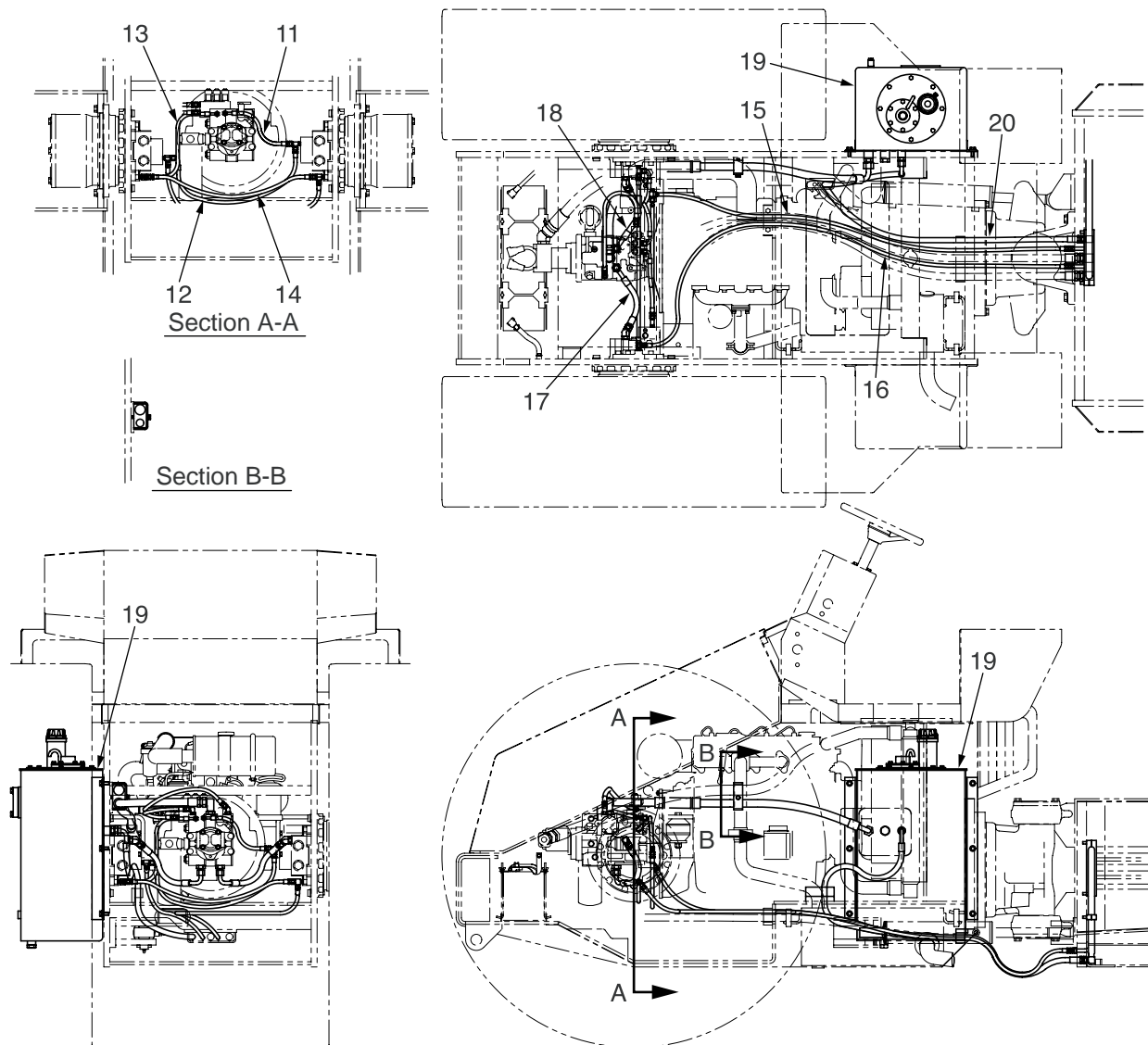
### 2-2-1. Hydraulic line [ I ] (Front drum)



R22013

- |   |   |
|---|---|
| 1. Propulsion pump  | 6. Bypass valve   |
| 2. High pressure hose (pump port B to port A1 in right hand front motor)                      | 7. Propulsion motor (left hand)                           |
| 3. High pressure hose (port A2 in right hand front motor to port B1 in left hand front motor) | 8. Propulsion motor (right hand)                          |
| 4. High pressure hose (pump port A to port A1 in left hand front motor)                       | 9. High pressure hose (pump port B to rear motor port B)  |
| 5. High pressure hose (port A2 in left hand front motor to port B1 in right hand front motor) | 10. High pressure hose (pump port A to rear motor port A) |

## 2-2-2. Hydraulic line [ II ] (Front drum)

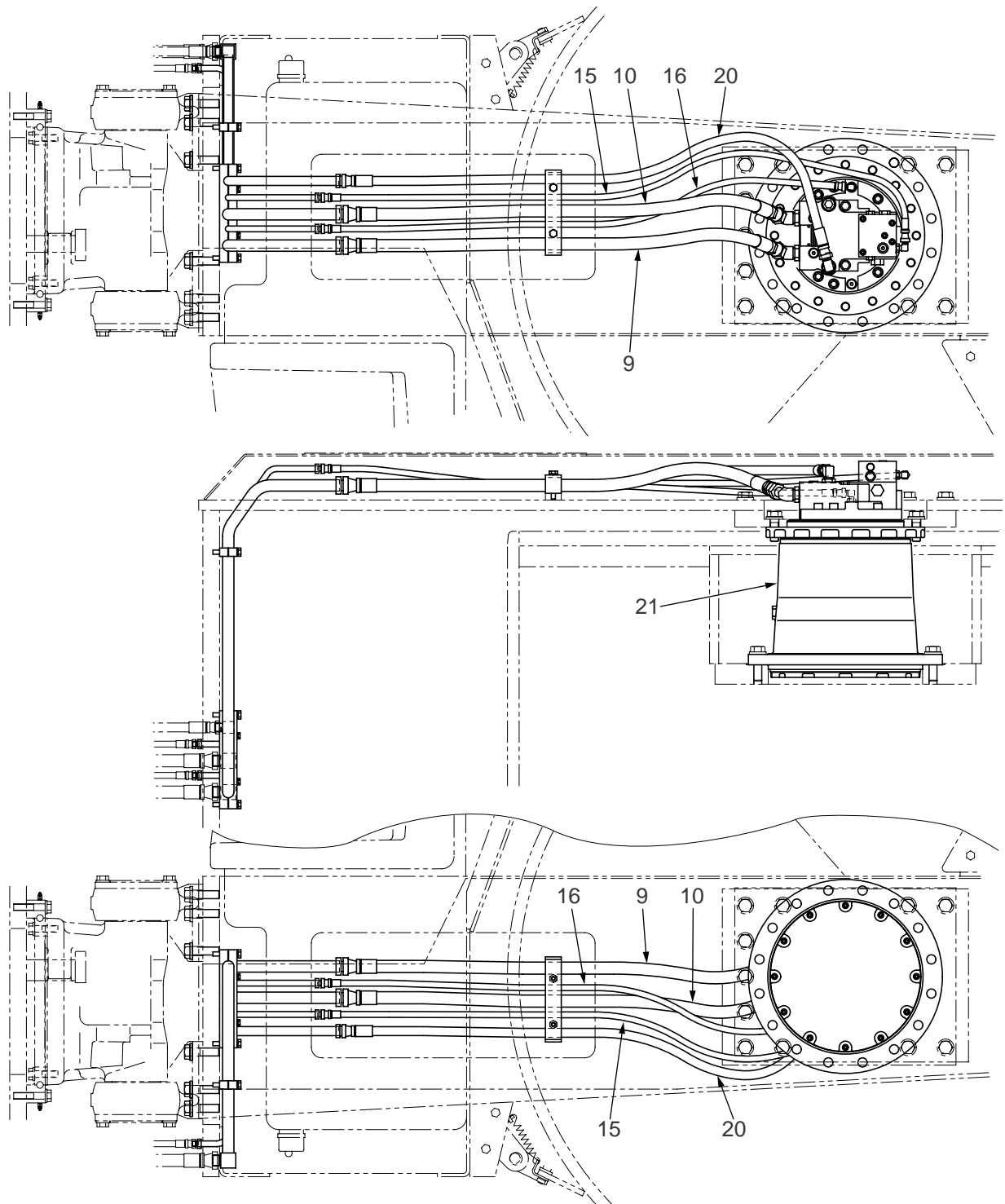


R22014

- |  |  |
|--|--|
| 11. Hose (speed selection line)            | 16. Rear motor hose (brake release line) |
| 12. Hose (speed selection line)            | 17. Drain hose                           |
| 13. Hose (brake release line)              | 18. Drain hose                           |
| 14. Hose (brake release line)              | 19. Hydraulic tank                       |
| 15. Rear motor hose (speed selection line) | 20. Drain hose                           |



### 2-2-3. Hydraulic line [ III ] (Rear single drum)

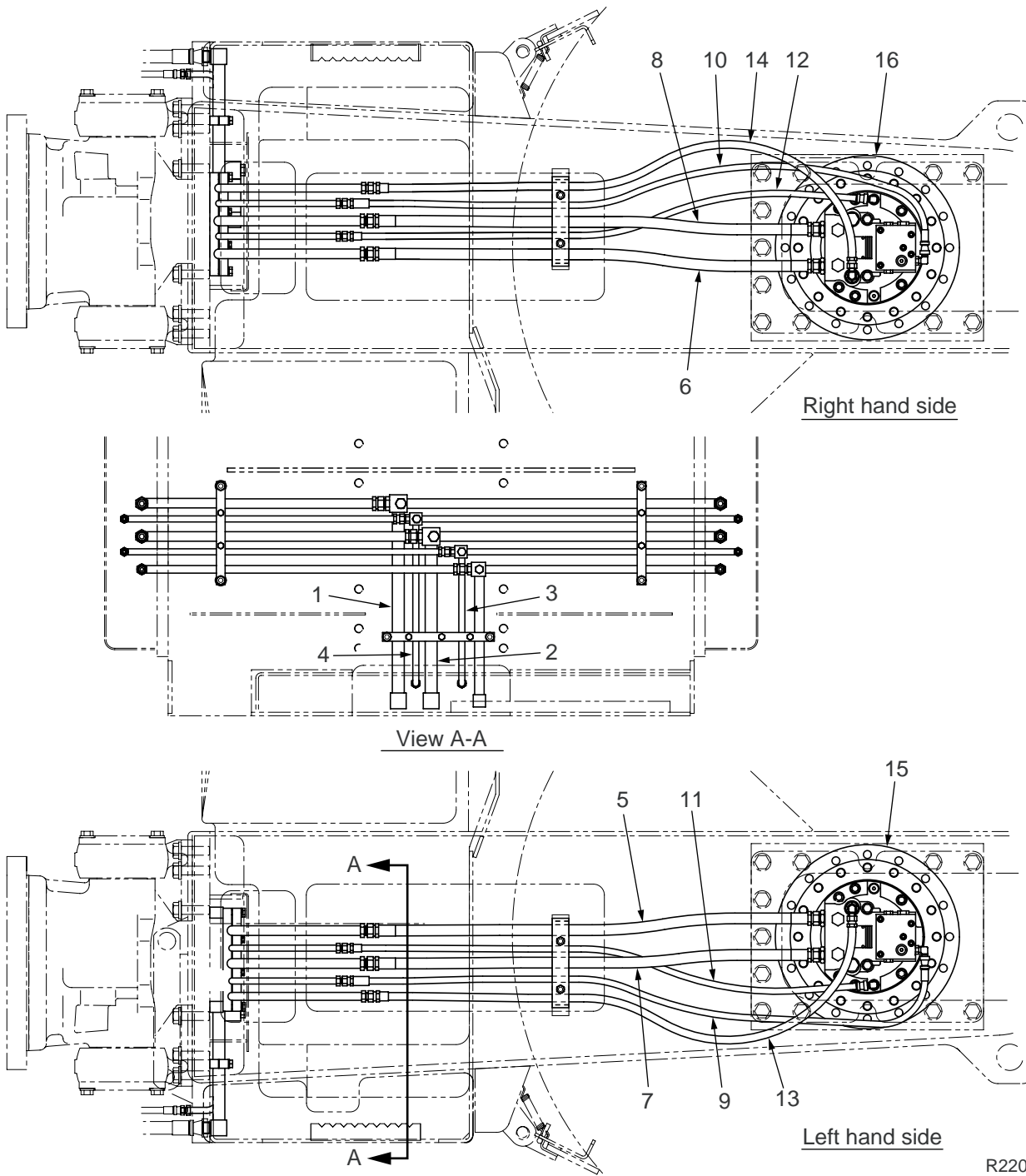


R22015

- 9. High pressure hose  
(pump port B to rear motor port B)
- 10. High pressure hose  
(pump port A to rear motor port A)
- 15. Hose (speed selection line)

- 16. Hose (brake release line)
- 20. Drain hose
- 21. Propulsion motor

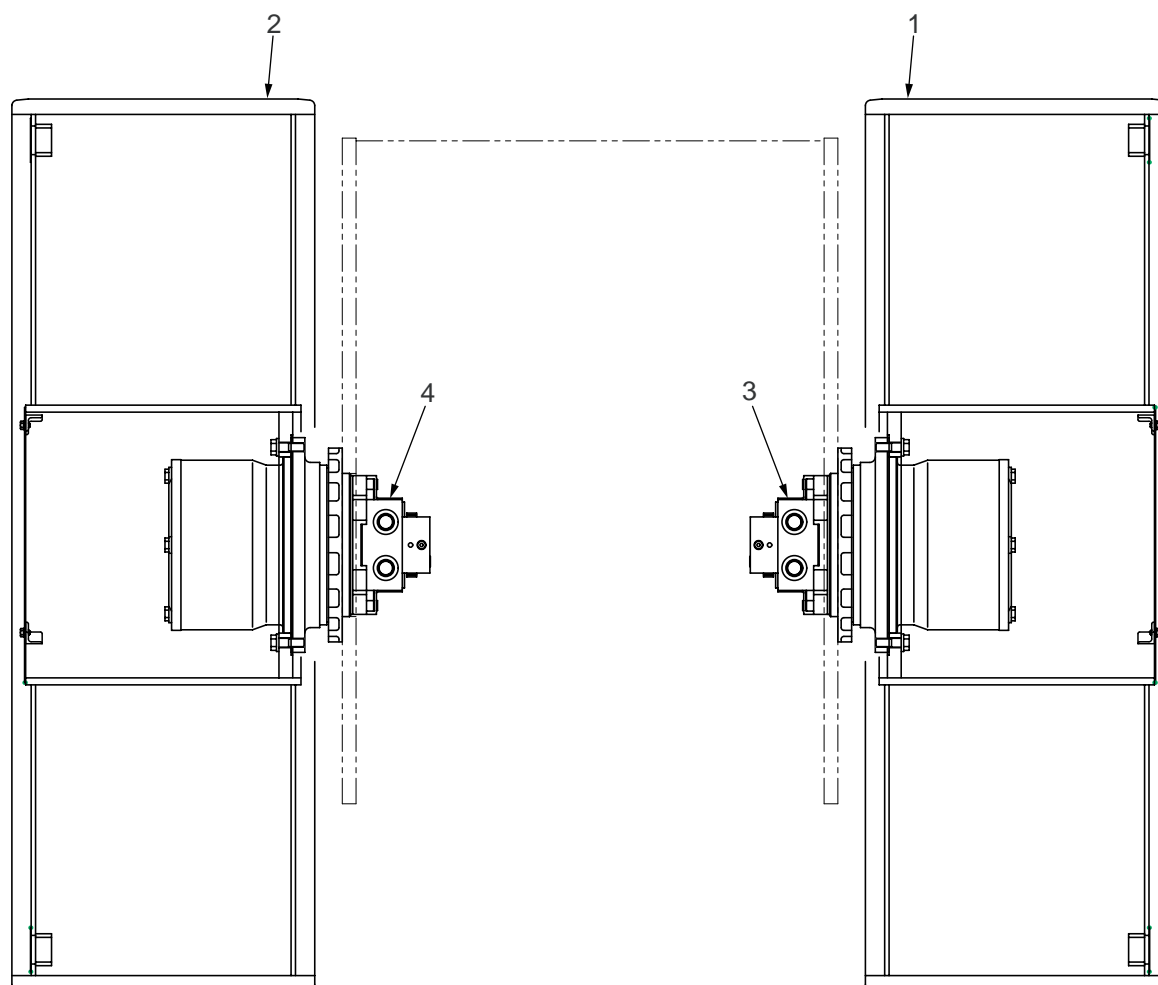
### 2-2-4. Hydraulic line [IV] (Rear split drum)



1. High pressure hose (from pump port B)
2. High pressure hose (from pump port A)
3. Pipe (speed selection line)
4. Pipe (brake release line)
5. High pressure hose  
(pump port B to left hand motor port A)
6. High pressure hose  
(pump port B to right hand motor port B)
7. High pressure hose  
(pump port A to left hand motor port B)

8. High pressure hose  
(pump port A to left hand motor port A)
9. Hose (speed selection line in left hand motor)
10. Hose  
(speed selection line in right hand motor)
11. Hose (brake release line in left hand motor)
12. Hose (brake release line in right hand motor)
13. Drain hose (left hand motor)
14. Drain hose (right hand motor)
15. Propulsion motor
16. Propulsion motor

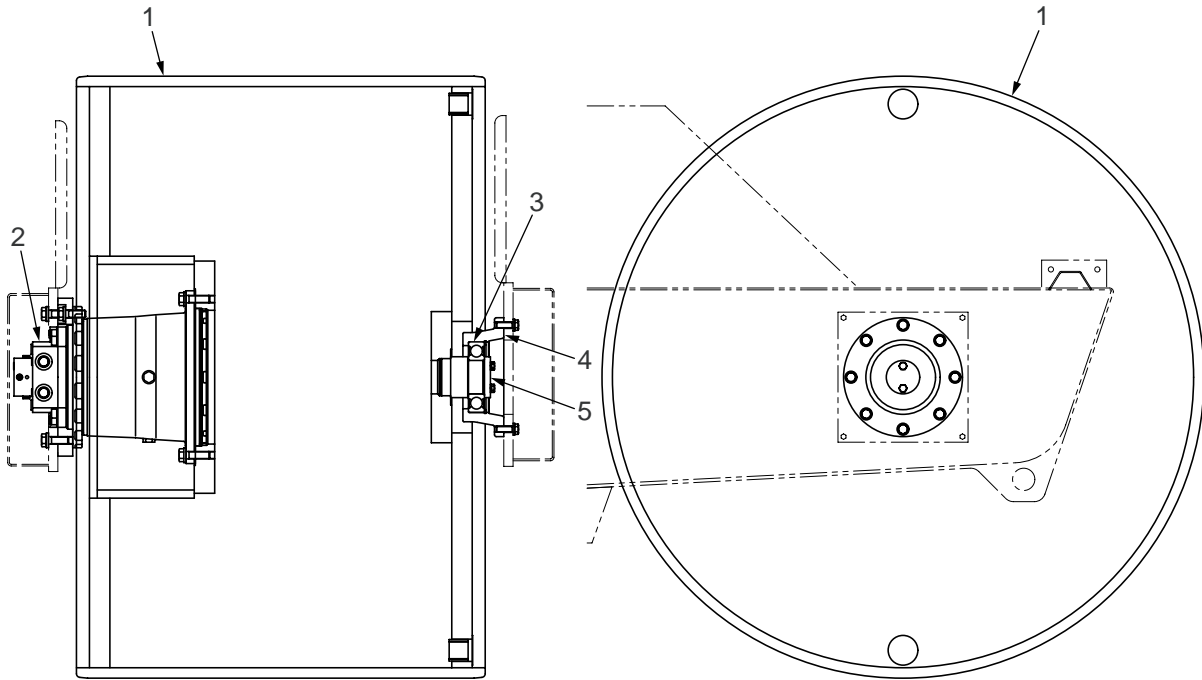
### 2-2-5. Front drum



R22017

- 1. Drum (left hand)
- 2. Drum (right hand)
- 3. Propulsion motor (left hand)
- 4. Propulsion motor (right hand)

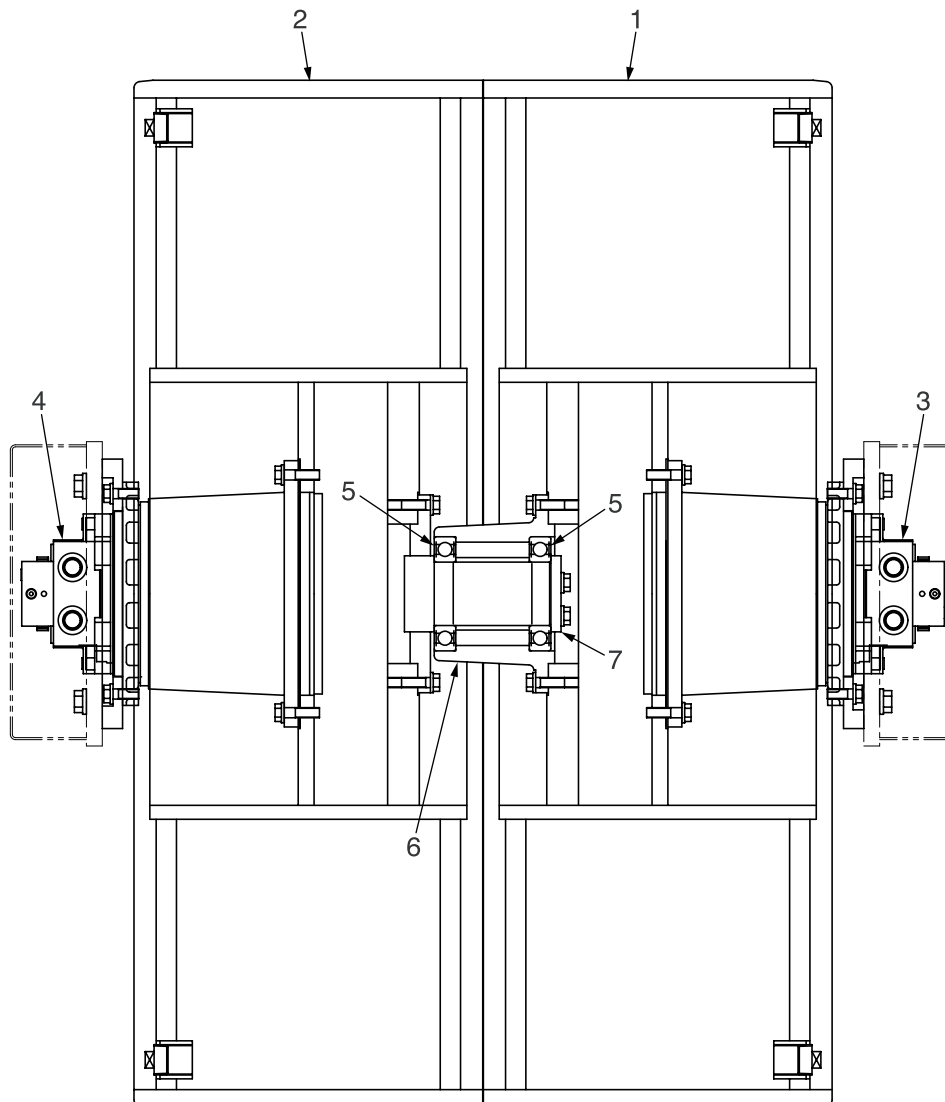
## 2-2-6. Rear drum (Single drum)



R22018

- 1. Drum
- 2. Propulsion motor
- 3. Ball bearing
- 4. Case
- 5. End plate

## 2-2-7. Rear drum (Split drum)

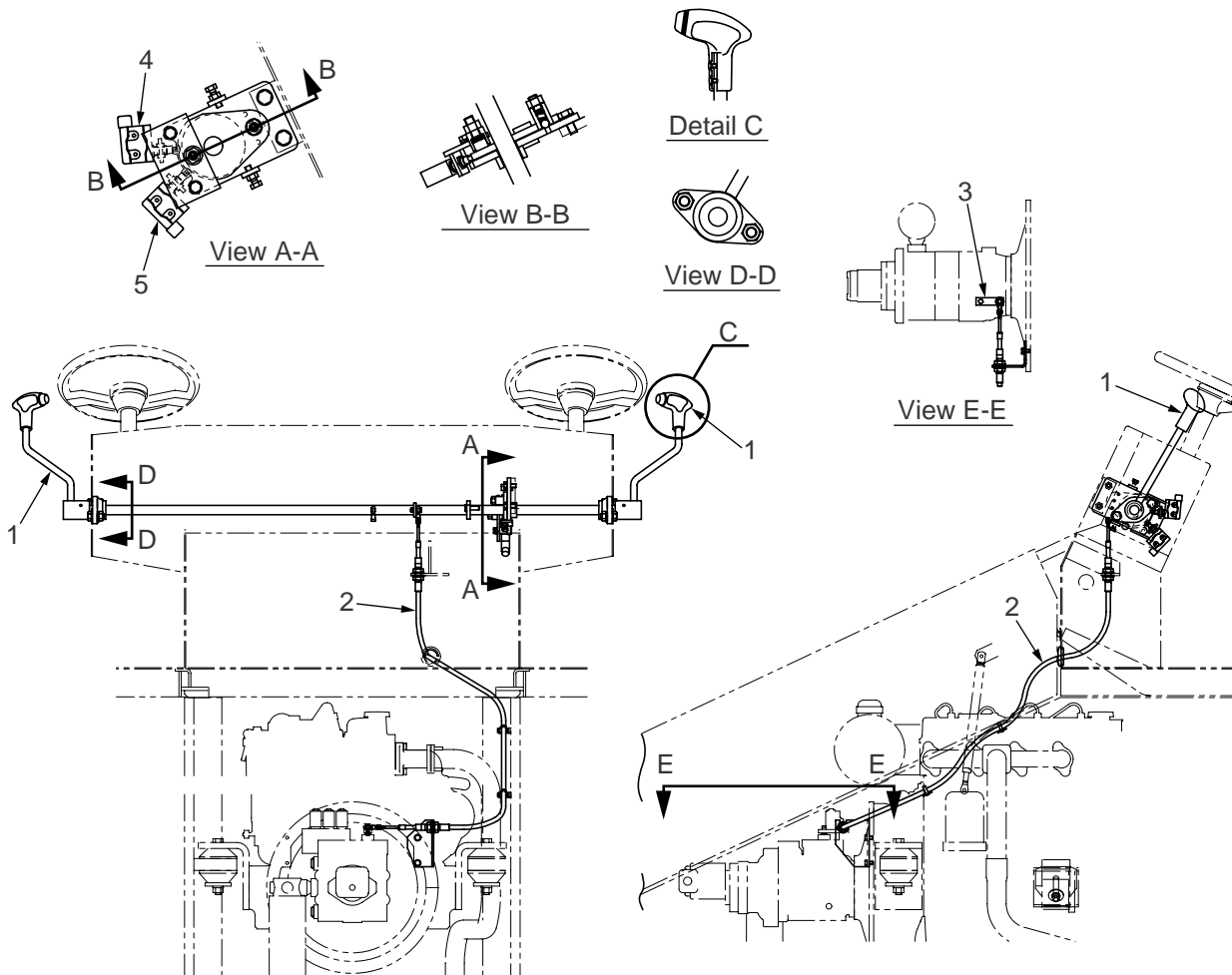


R22019

- 1. Drum (left hand)
- 2. Drum (right hand)
- 3. Propulsion motor (left hand)
- 4. Propulsion motor (right hand)

- 5. Ball bearing
- 6. Case
- 7. End plate

## 2-2-8. Propulsion controls

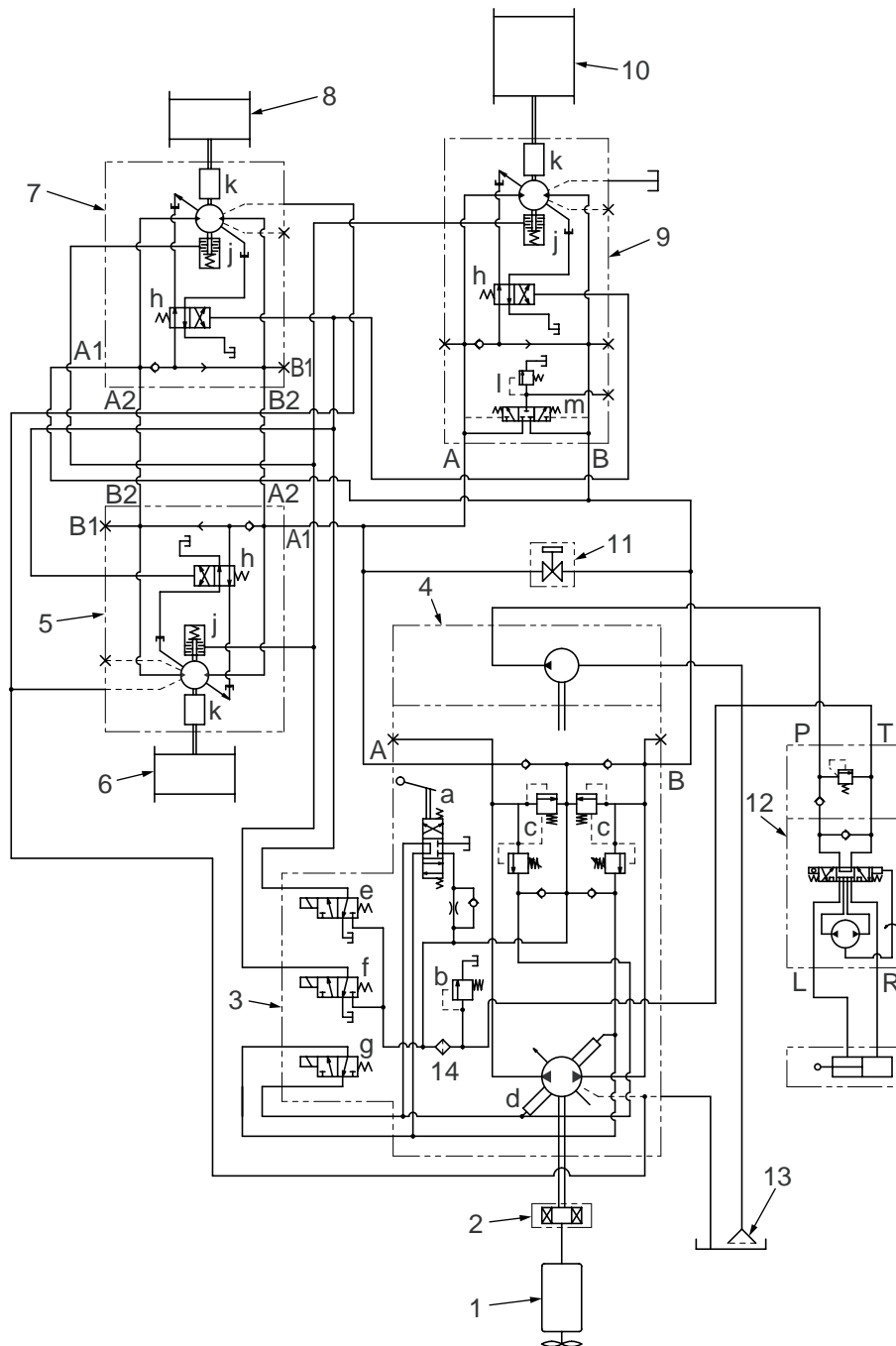


- 1. F-R lever
- 2. Control cable
- 3. Control lever (pump)

- 4. Interlock switch
- 5. Backup buzzer switch

R22020

### 2-2-9. Hydraulic circuit diagram for propulsion



R22021

- |  |                                      |                               |
|--|--------------------------------------|-------------------------------|
| 1. Engine                                  | 4. Steering pump                     | 9. Rear propulsion motor      |
| 2. Coupling                                | 5. Left hand front propulsion motor  | h. Speed selection valve      |
| 3. Propulsion pump                         | h. Speed selection valve             | j. Parking brake              |
| a. Control valve                           | j. Parking brake                     | k. Reduction gear             |
| b. Charge relief valve                     | k. Reduction gear                    | l. Low pressure relief valve  |
| c. Multifunction valve                     | 6. Left hand front drum              | m. Flushing valve             |
| d. Servo piston                            | 7. Right hand front propulsion motor | 10. Rear drum                 |
| e. Speed selection solenoid valve          | Speed selection valve                | 11. Bypass valve              |
| f. Parking brake solenoid valve            | j. Parking brake                     | 12. Steering valve (Orbitrol) |
| g. Propulsion pump neutral retention valve | k. Reduction gear                    | 13. Suction filter            |
|  | 8. Right hand front drum             | 14. Line filter               |

## 2-2-10. Description and operation of drive line

See the hydraulic circuit on page 2-025.

### Description of drive line

- Made up of propulsion pump (3), left hand front propulsion motor (5), right hand front propulsion motor (7), left hand front drum (6), right hand front drum (8), rear propulsion motor (9) and rear drum (10). Speed selection solenoid valve (e), parking brake solenoid valve (f) and propulsion pump neutral retention valve (g) are mounted in propulsion pump (3).

### Basic function of propulsion pump and motor

#### Propulsion pump

- A variable displacement piston pump is used which selects forward drive, neutral and reversing by varying the swashplate angle, and thus varying the piston stroke. The travel speed is infinitely variable by the operation of F-R lever (traction lever).

#### Propulsion motor

- A fixed displacement piston motor is used in which the piston stroke is not variable.

### Operation (It is assumed that forward drive is selected in the standard machine.)

The parking brake is supposed to stay released.

Assemblies such as pump assembly and motor assembly are indicated by numbers such as '1' and '2', while component parts of assemblies are represented by small letters like 'a' and 'b'.

- Front motors (5) and (7) connect to rear motor (9) in a parallel circuit.
- When the F-R lever is moved forward, control valve (a) functions to feed pressurized oil to servo piston (d), which tilts the pump swashplate in the forward drive direction.
- Propulsion pump (3) feeds oil from its port A into the forward drive circuit, then the oil flow is divided into two lines; one connecting to port A1 in left hand front motor (5) and the other connecting to port A in rear motor (9). Port A1 leads to port A2 through an oilway running through left hand front motor (5). Port A2 connects to port B2 in right hand front motor (7). Through these passages, pump flow goes to the front and rear motors.
- The oil supplied to the front motors drives them, flowing out from opposite side port B2 in left hand front motor (5) and port A1 in right hand front motor (7). The oil displaced from port B2 in motor (5) enters port A2 in motor (7), joins with the oil from front motor (7) and flows out from port A1 in motor (7), then returns to pump (3).
- On the other hand, in rear motor (9), the oil from pump (3) is displaced from port B and returns to port B in pump (3) after joining with the oil flowing out from motors (6) and (7).

**NOTE :** Because the propulsion circuit is a closed loop circuit, the suction port turns to the supply port while the discharge port serves as the suction port when the travel direction is reversed. (The direction of oil flow is reversed.)

### Speed range selection

- When energized, speed selection solenoid valve (e) feeds oil from the charge line to speed selection valve (h).
- Valve (h) admits oil from the main circuit into the speed selection pistons built in propulsion motors (5), (7) and (9), shifting the motor swashplate angle. Desired speed range is selected.



### **Propulsion pump neutral retention**

- A careless attempt to propel the machine with the parking brake applied can cause an adverse effect on the machine. The propulsion pump neutral retention valve solves this problem.
- This solenoid valve is connected to the parking brake solenoid valve in a parallel circuit. With the parking brake applied, both solenoid valves are deenergized. Then the servo cylinders in the swashplate angle shift mechanism in the propulsion pump lead with each other through a circuit to retain the swashplate in the neutral position. In this condition, even if an erroneous attempt is made to move the F-R lever forward or backward with the brake applied, the pump swashplate stays in neutral, preventing the traction motor from being driven.

With the parking brake released by the actuation of the parking brake switch, both solenoid valves are energized to block the circuit connecting one servo cylinder to the other. The machine is put into motion if the F-R lever is shifted forward or backward.

### **Disengaging the parking brake**

- When energized, brake solenoid valve (f) feeds oil from the charge circuit to the brake port in the propulsion motors.
- The oil then pushes the brake piston in parking brakes (j) against the spring pressure, relieving the spring pressure on the brake discs. The brake is freed.

### **Circuit protection against high pressure**

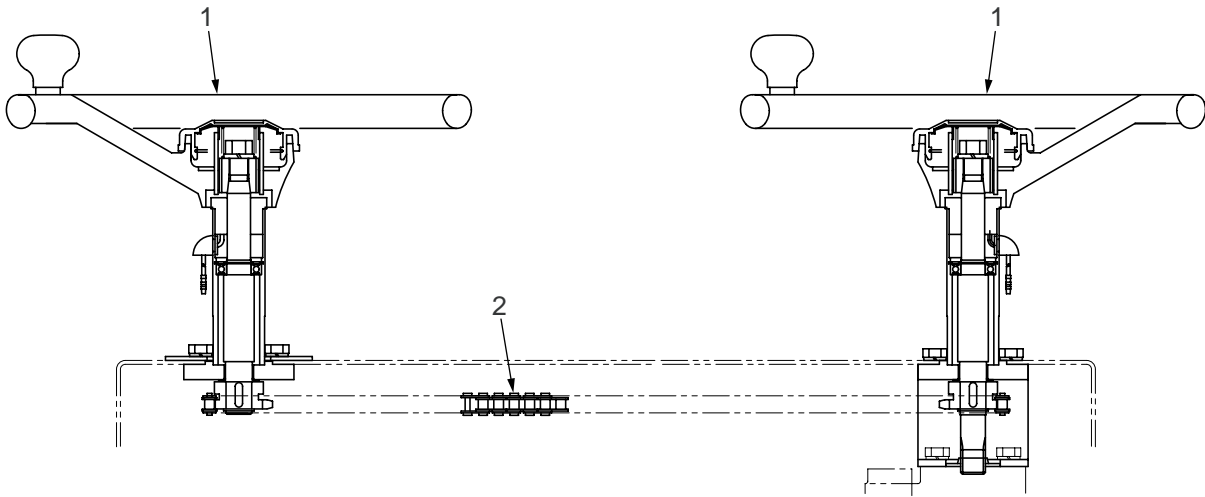
- Multifunction valve (c) fitted in the propulsion pump relieves the pressure if the circuit pressure exceeds its setting, thus protecting the circuit.

### **Charge circuit**

- The propulsion main circuit is of a closed circuit, which needs feeding of oil into it for compensation of oil loss and for other purposes such as cooling the oil.
- In the charge circuit, oil from steering pump (4) flows into steering valve (12) (Orbitrol), then the full pump flow goes to propulsion pump (3) via line filter (14) built in pump (3) irrespective of the steering wheel operation.  
If the charge pressure exceeds the preselected setting, charge relief valve (b) built in propulsion pump (3) opens to release the pressure.

### 3. Steering System

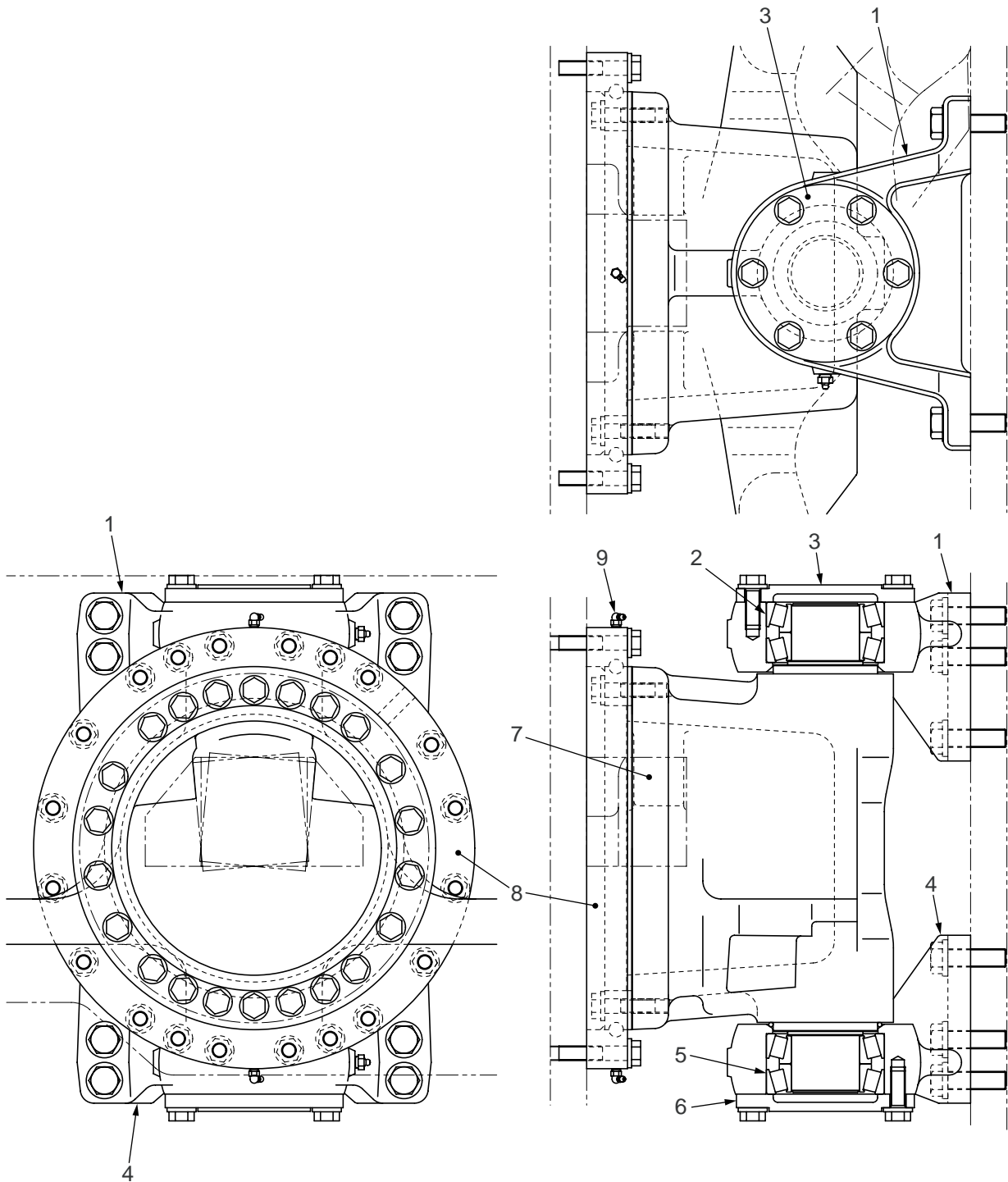
#### 3-1. Steering wheel



R22023

- 1. Steering wheel
- 2. Chain

3-2. Center pin (King pin)



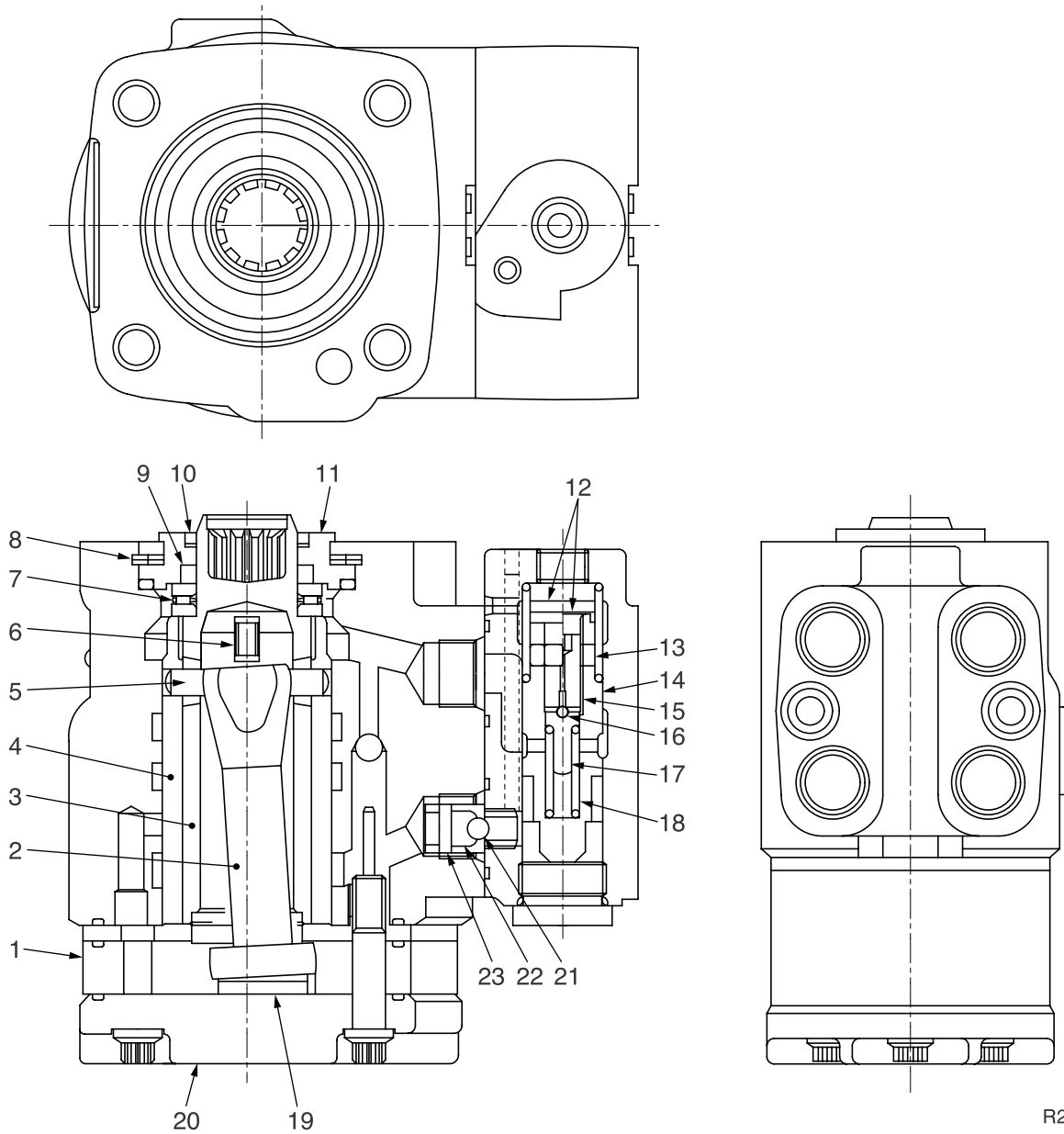
R22024

- 1. Bracket (upper)
- 2. Roller bearings
- 3. Cover (upper)

- 4. Bracket (lower)
- 5. Roller bearings
- 6. Cover (lower)

- 7. Yoke
- 8. Bearing ass'y
- 9. Grease fitting

### 3-3. Steering valve (Orbitrol)



- |                     |                     |                        |
|---------------------|---------------------|------------------------|
| 1. Geroler set      | 9. Oil seal         | 17. Ball guide         |
| 2. Drive shaft      | 10. Dust seal       | 18. Inner valve spring |
| 3. Spool            | 11. Seal gland bush | 19. Spacer             |
| 4. Sleeve           | 12. Filter subass'y | 20. End cap            |
| 5. Pin              | 13. Lock nut        | 21. Ball               |
| 6. Centering spring | 14. Spool           | 22. Orifice check body |
| 7. Thrust needle    | 15. Valve seat      | 23. Pin                |
| 8. Retaining ring   | 16. Ball            |                        |

#### Technical data

- Valve system : Open center non-load reaction type
- Displacement : 277 cm<sup>3</sup>/rev {16.9 cu.in/rev}
- Setting : 15.7 MPa (160 kgf/cm<sup>2</sup>) {2,275 lbf/in<sup>2</sup>}

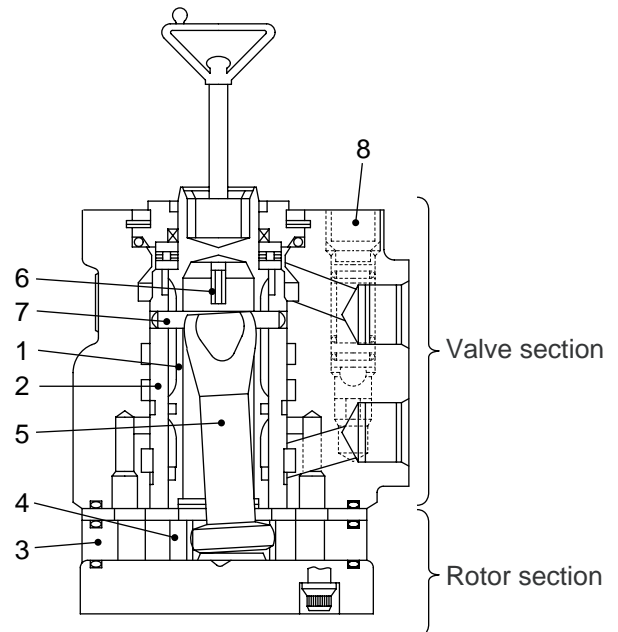
### 3-4. Description and operation of steering valve (Orbitrol)

The steering valve (Orbitrol) is of a load-sensing type which makes the steering pump feed an amount of oil into the valve corresponding to the speed at which the steering wheel is rotated.

#### Description

##### \* Valve section

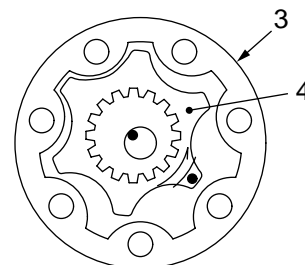
- The valve section makes itself a rotary type direction control valve consisting of spool (1) and sleeve (2) as main components. The steering wheel is spline-connected to spool (1).
- When the steering wheel is not being operated, spool (1) and sleeve (2) stay in the neutral position with each other due to centering springs (6) with the oil grooves in spool (1) and oil holes in sleeve (2) not aligned. This blocks oil flow to the steering cylinder.
- When the steering wheel is turned, the oil grooves in spool (1) and oil holes in sleeve (2) are aligned to feed oil into the cylinder.



SV4002042

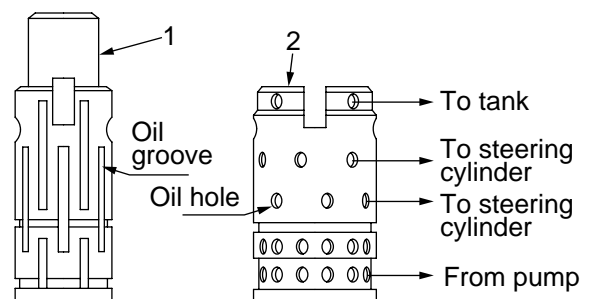
##### \* Rotor section

- The rotor is an external gear which meshes with the internal gear portion of stator (3). When the valve section (spool-sleeve ass'y) opens, the rotor-stator ass'y acts as a hydraulic motor.
- The rotation of rotor (4) is conveyed to the valve section via drive shaft (5) spline-connected to rotor (4). An extent to which the valve opens is determined by the speed at which the steering wheel is rotated.



SV4002043

- |           |                       |
|-----------|-----------------------|
| 1. Spool  | 5. Drive shaft        |
| 2. Sleeve | 6. Centering spring   |
| 3. Stator | 7. Cross pin          |
| 4. Rotor  | 8. Relief valve ass'y |



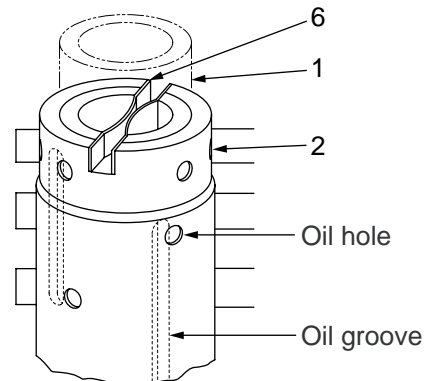
SV4002044

**Operation**

**\* Neutral state (Steering wheel not operated)**

- Centering springs (6) (flat springs) are located in the notches provided at end of spool (1) and sleeve (2).
- With the steering wheel not operated, centering springs (6) make the spool-sleeve ass'y stay in neutral.

The steering valve (Orbitrol) is of a load-sensing, non-load reaction, normal close type. In the neutral position, the oil grooves and oil holes are not aligned, blocking oil flow to the steering cylinder.



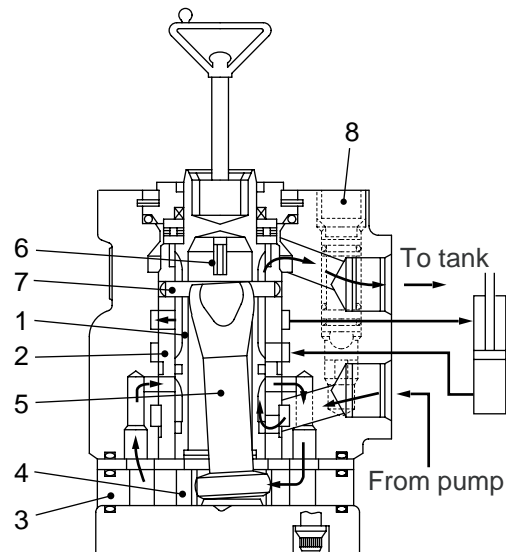
Oilways blocked

SV4002045

**\* Making a turn (Steering wheel operated)**

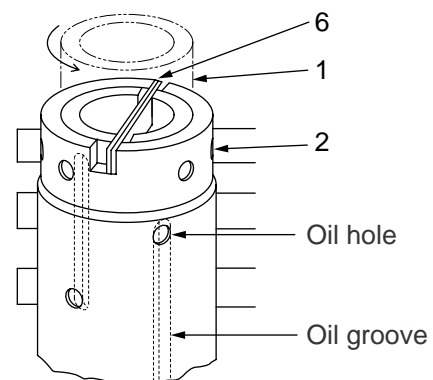
In neutral, all the valve holes stay closed and oil remains trapped in the space between rotor (4) and stator (3). Then rotor (4) is in a fixed state being unable to rotate in any direction. Sleeve (2) is also unable to rotate, as it is connected with rotor (4) through cross pin (7) and drive shaft (5).

- When the steering wheel is spun, the rotating force is conveyed to spool (1). Spool (1) compresses centering springs (6). Then, a relative movement develops between spool (1) and sleeve (2). This aligns the oil grooves with oil holes.
- As a result, the whole ports (pump port, tank port and cylinder ports) open, allowing oil flow to relevant components. Rotor (4) spins.



SV4002046

- |           |                       |
|-----------|-----------------------|
| 1. Spool  | 5. Drive shaft        |
| 2. Sleeve | 6. Centering spring   |
| 3. Stator | 7. Cross pin          |
| 4. Rotor  | 8. Relief valve ass'y |

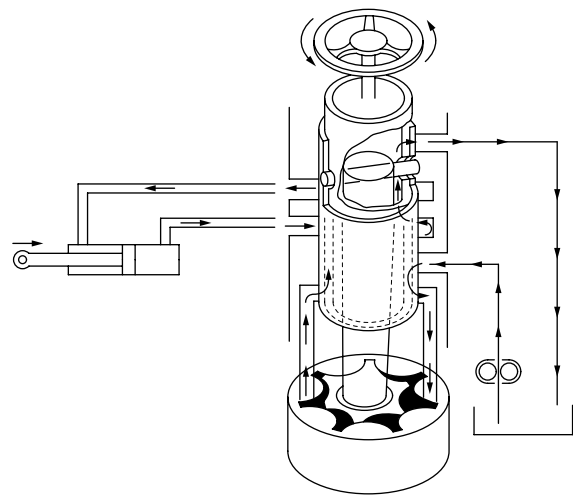


Oilways open

SV4002047

### Operation of feed back mechanism

- Operation of the steering wheel creates an angular divergence in circumferential directions between spool (1) and sleeve (2) due to centering springs (6). This makes the oil grooves align with the oil holes, allowing the pump flow into the steering valve (Orbitrol). Rotor (4) spins and feeds oil into the steering cylinder.
- As a result, sleeve (2) rotates while trailing spool (1) with an angular divergence maintained between the two components. This enables spool (1) to spin continuously with the rotation of the steering wheel. The machine makes a turn continuously.
- Stopping the steering wheel operation brings spool (1) rotation to an instant halt. However, the spool-sleeve ass'y does not get back to the neutral condition instantly. Oil continues to flow into Orbitrol, allowing rotor (4) to continue rotation. This rotating motion lets sleeve (2) catch up to spool (1), blocking the hydraulic circuit to stop oil flowing. Finally, centering springs (6) restore the spool-sleeve ass'y to the neutral position, stopping the oil flow completely.

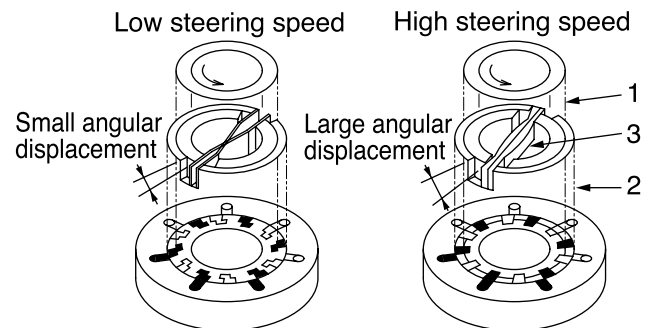


SV4002048

### Steering wheel rotating speed and controlling the fluid flow

In the steering mechanism, it is essential to increase or decrease oil flow into the steering cylinder according to the rotating speed of the steering wheel.

- The steering valve (Orbitrol) controls the oil flow by varying the angular displacement between spool (1) and sleeve (2) as stated below: With the steering wheel rotated, sleeve (2) runs after spool (1) attempting to block the hydraulic circuit.
- The angular displacement between spool (1) and sleeve (2) increases with increasing rotating speed of the steering wheel. The oil flow increases.



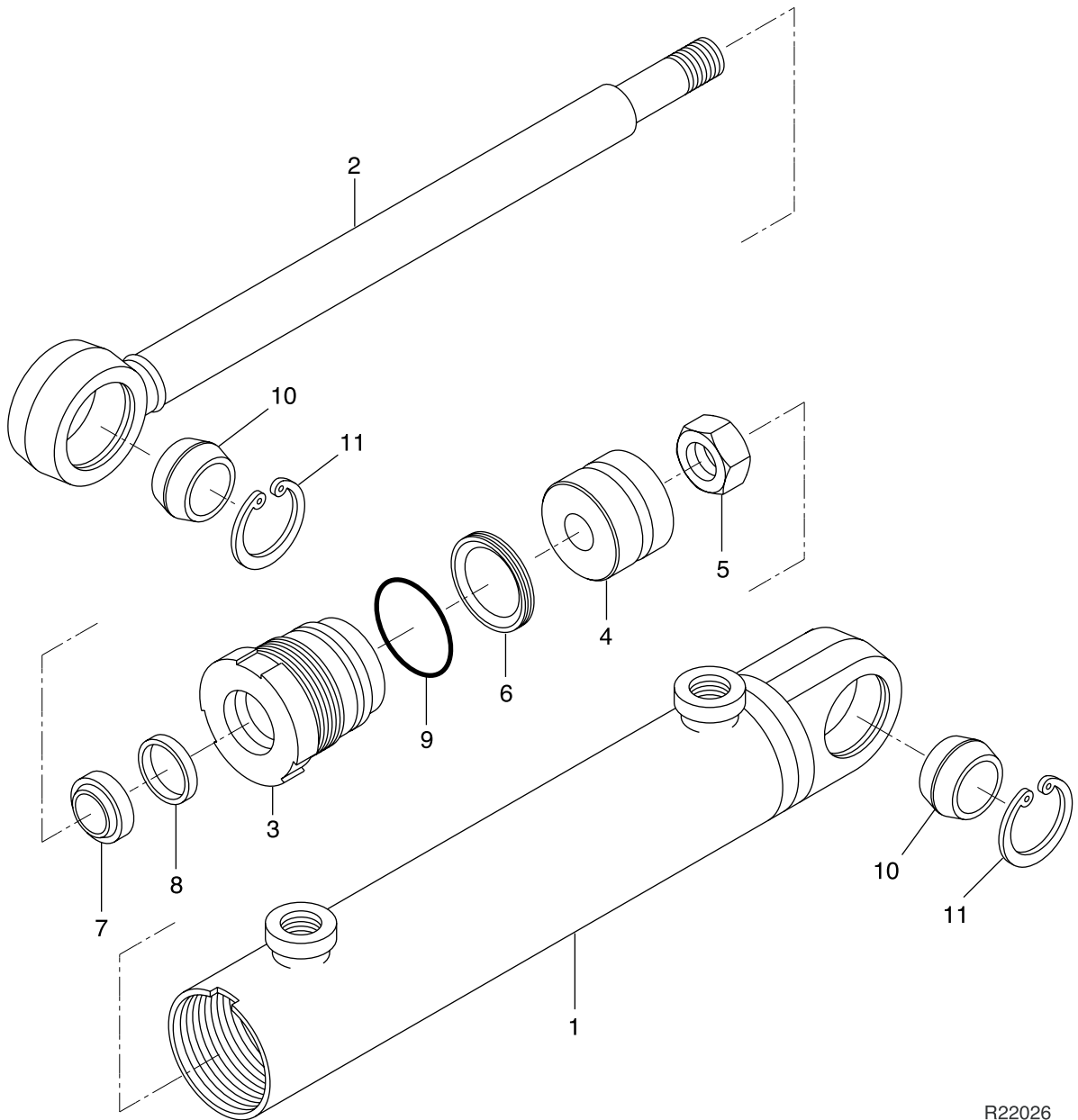
SV4002049

### Pump flow and force required to rotate steering wheel

- When the pump allows sufficient oil flow, the force to rotate the steering wheel equals the sliding resistance offered by sleeve (2) and rotor (4), etc. The steering wheel is light to rotate.
- If pump flow is insufficient, the angular displacement between spool (1) and sleeve (2) stays maximum. The amount of oil fed to rotor (4) from the pump is small. Rotor (4) spins slowly.
- For this reason, spool (1) rotates faster than rotor (4), making the angular displacement maximum. Spool (1) drives rotor (4) via cross pin (7) and drive shaft (5). Then, rotor (4) acts as a hydraulic pump. The steering wheel is heavy to turn.



### 3-5. Steering cylinder



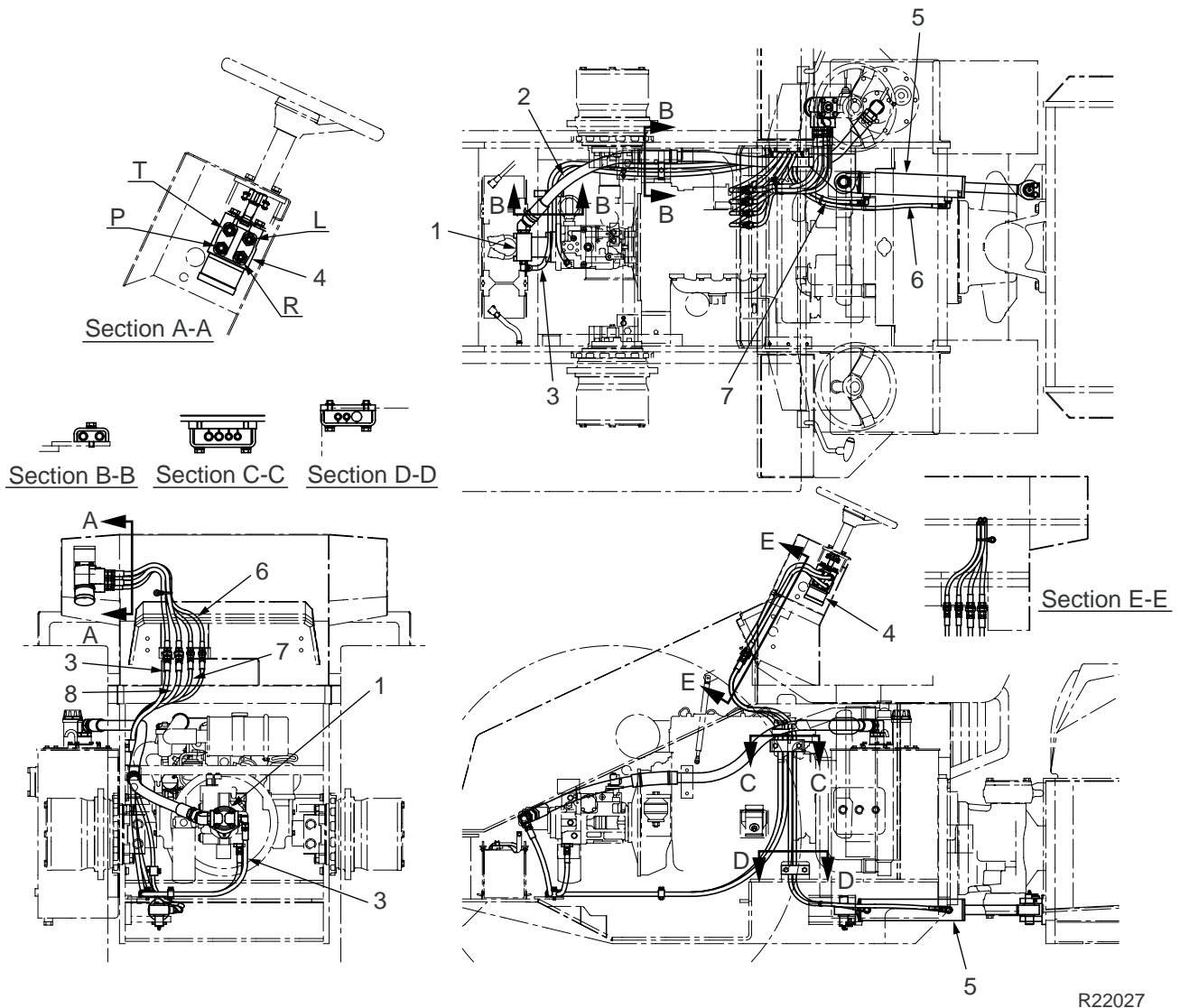
R22026

- 1. Cylinder
- 2. Piston rod
- 3. Bush
- 4. Piston

- 5. Nut
- 6. Piston seal
- 7. Dust seal
- 8. Packing

- 9. O-ring
- 10. Spherical bearing
- 11. Lock ring

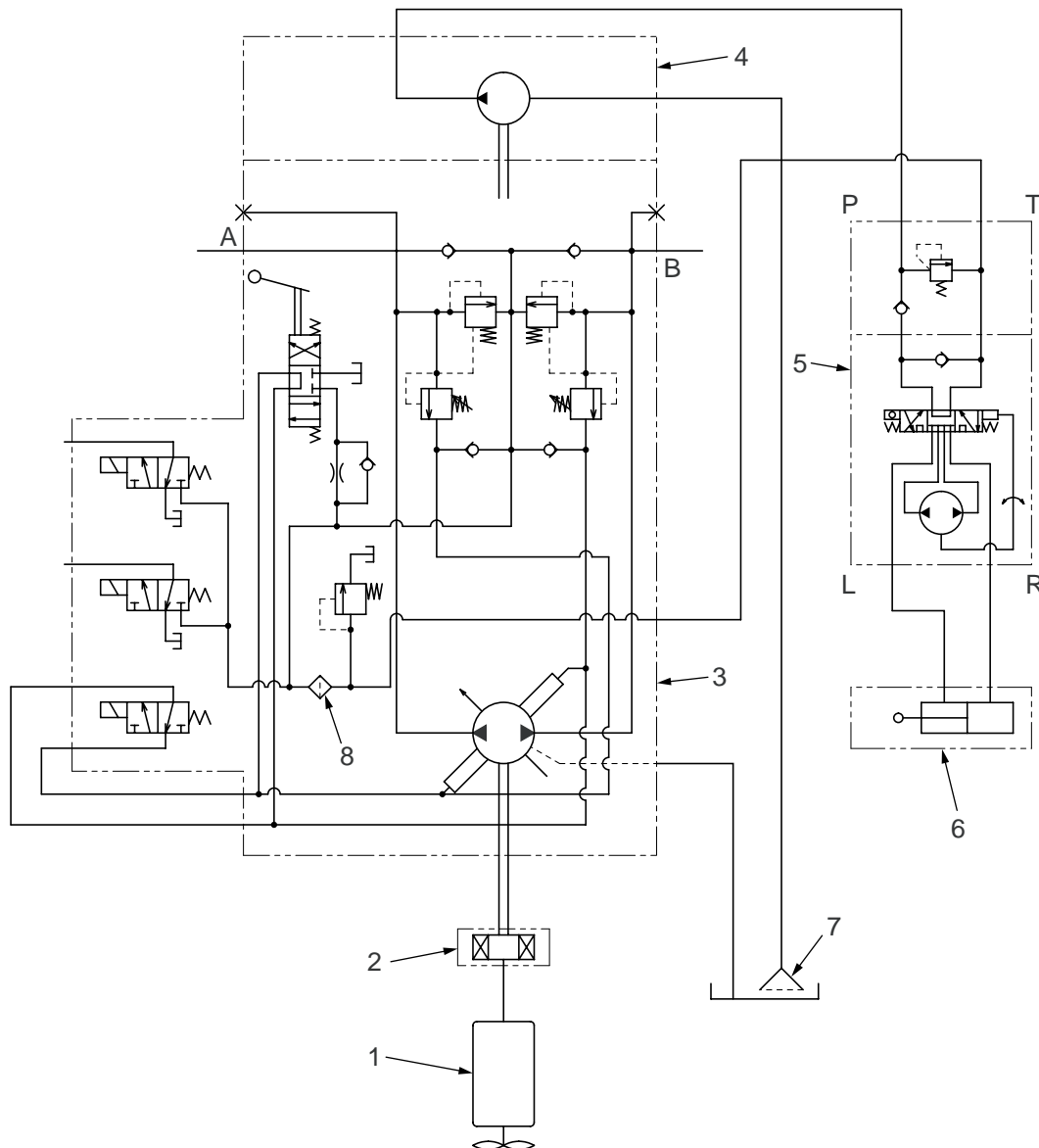
### 3-6. Hydraulic line



1. Steering pump
2. Suction hose
3. Feed hose
4. Steering valve (Orbitrol)

5. Steering cylinder
6. Hydraulic hose (left turn)
7. Hydraulic hose (right turn)
8. Return hose  
(to charge line in propulsion pump)

### 3-7. Hdraulic circuit diagram for steering



R22028

- |                              |                      |
|------------------------------|----------------------|
| 1. Engine                    | 6. Steering cylinder |
| 2. Coupling                  | b. Piston rod        |
| 3. Propulsion pump           | 7. Suction filter    |
| 4. Steering pump             | 8. Line filter       |
| 5. Steering valve (Orbitrol) |                      |
| a. Pressure relief valve     |                      |

### 3-8. Description and operation of steering system

#### Description

- The steering system is made up of steering pump (4), steering valve (Orbitrol) (5) and steering cylinder (6).

#### Operation

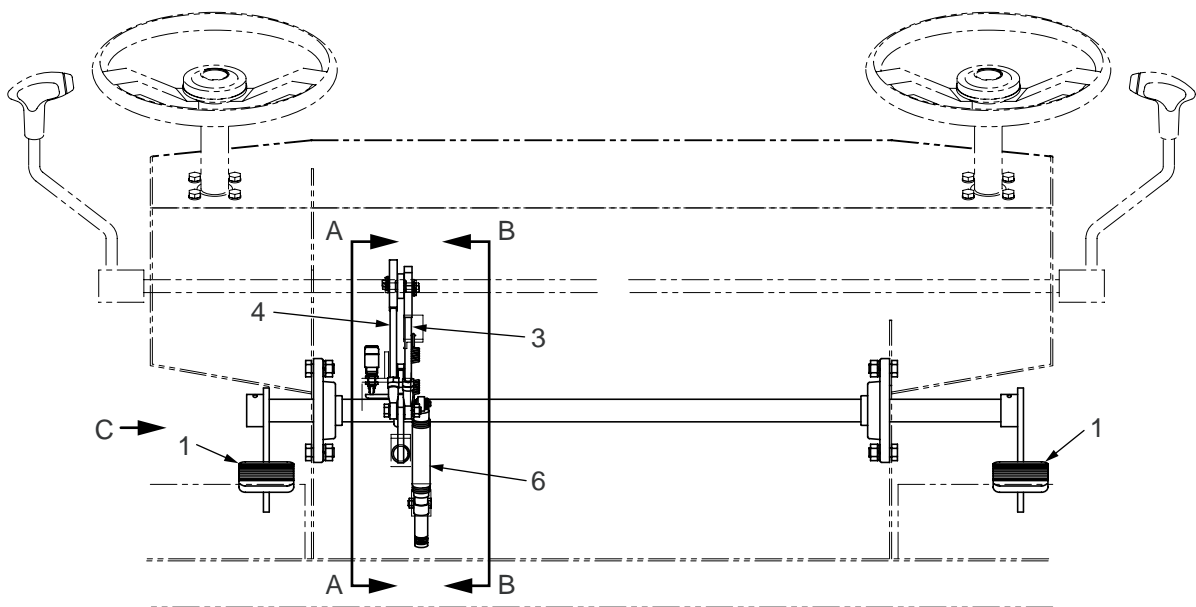
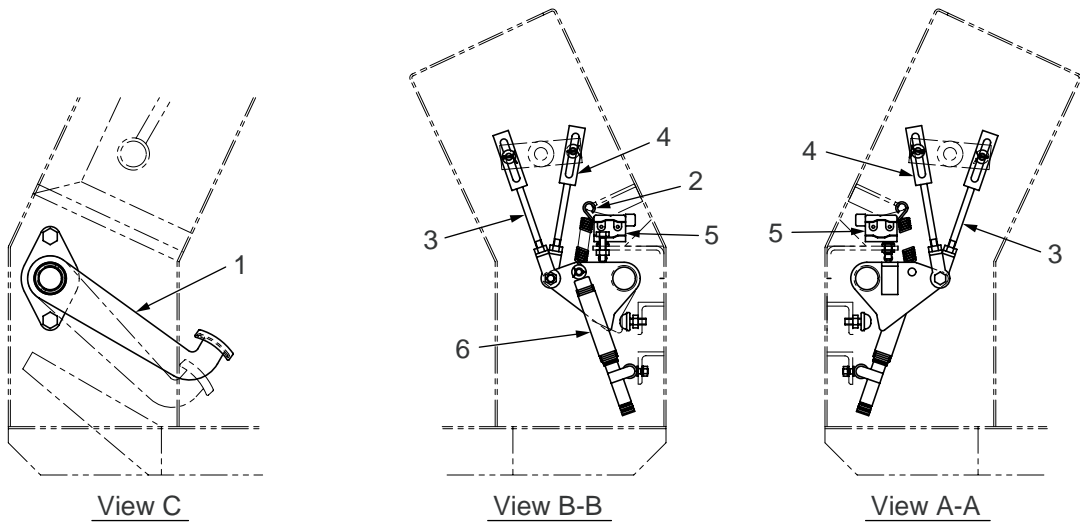
- Oil from pump (4) enters steering valve (5). The valve feeds an amount of oil to steering cylinder (6). The amount of oil needed varies with the direction in which the steering wheel is rotated and the speed at which the steering wheel is turned.
- The fluid fed into steering cylinder (6) moves the piston rod (c) to achieve steering. The oil displaced from the opposite side of the piston flows, through steering valve (5) and line filter (7), into the charge circuit for propulsion.

**Refer to "Charge circuit" under "Description and operation of propulsion system".**

- Relief valve (a) built in steering valve (5) opens to relieve the pressure if the system pressure exceeds the setting of the valve, thus protecting the circuit.

## 4. Brake System

### 4-1. Brake pedal & linkage



R22029

- 1. Brake pedal
- 2. Return spring
- 3. Rod (to bring F-R lever to neutral)

- 4. Rod (to bring F-R lever to neutral)
- 5. Brake pedal switch (for stop lamp)
- 6. Damper

## 4-2. Description and operation of brake system

### Description

- Consists of brake pedal (1), brake pedal switch (2), rods (3) and (4) which bring F-R lever to neutral and parking brakes (8), (9) and (10).

The foot brake switch is ON when the brake pedal is not depressed, and OFF if the pedal is pushed down on.

### Operation

#### Parking brake switch set to position PARKING

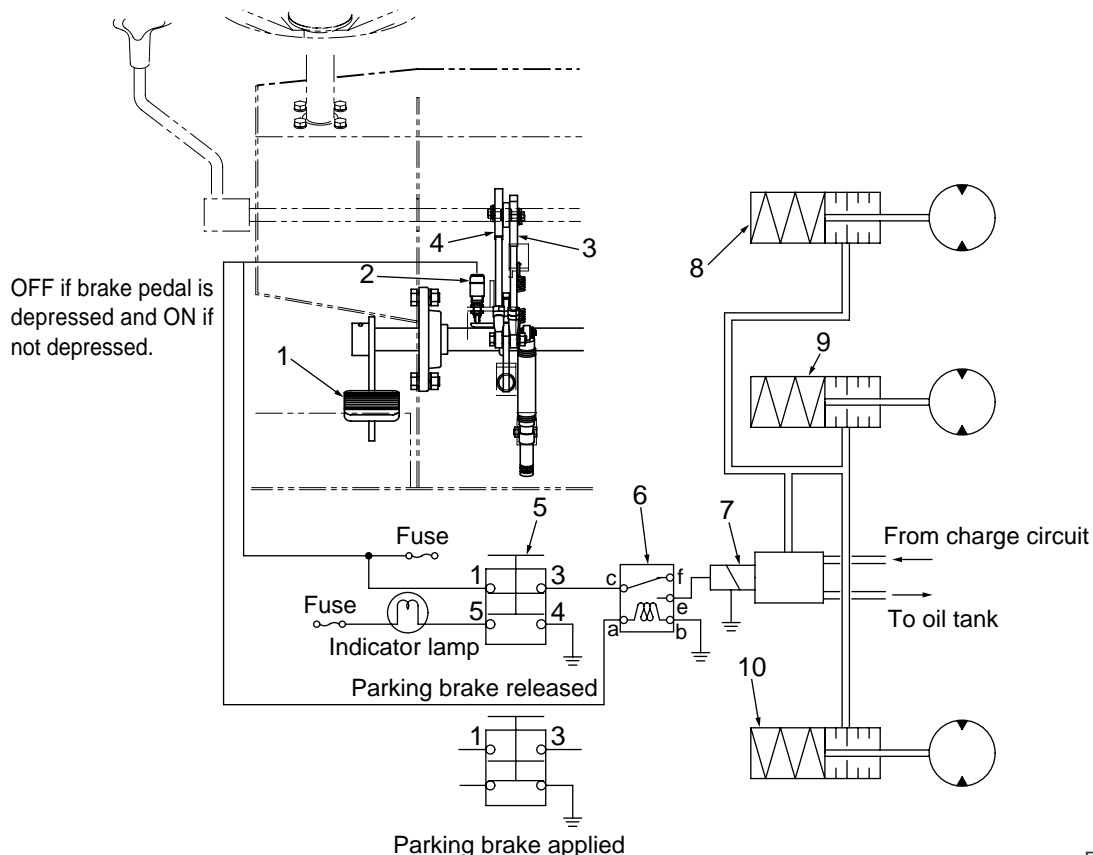
- In parking brake switch (5), contact 1-3 opens and contact 5-4 closes. This deenergizes solenoid (7) and energizes the brake indicator lamp circuit. Parking brakes (8), (9) and (10) are applied with the parking brake indicator lamp illuminated.

#### Parking brake switch set to RELEASE position (Brake pedal not depressed)

- Opposite to the case above in which the switch is in position PARKING, contact 1-3 closes with contact 5-4 opening. If, at this time, the brake pedal is not depressed, the winding of brake relay (6) stays energized and contact c-e remains closed. This energizes solenoid (7) which feeds oil to to brakes (7), (8) and (10) to disengage them. The indicator lamp goes off.

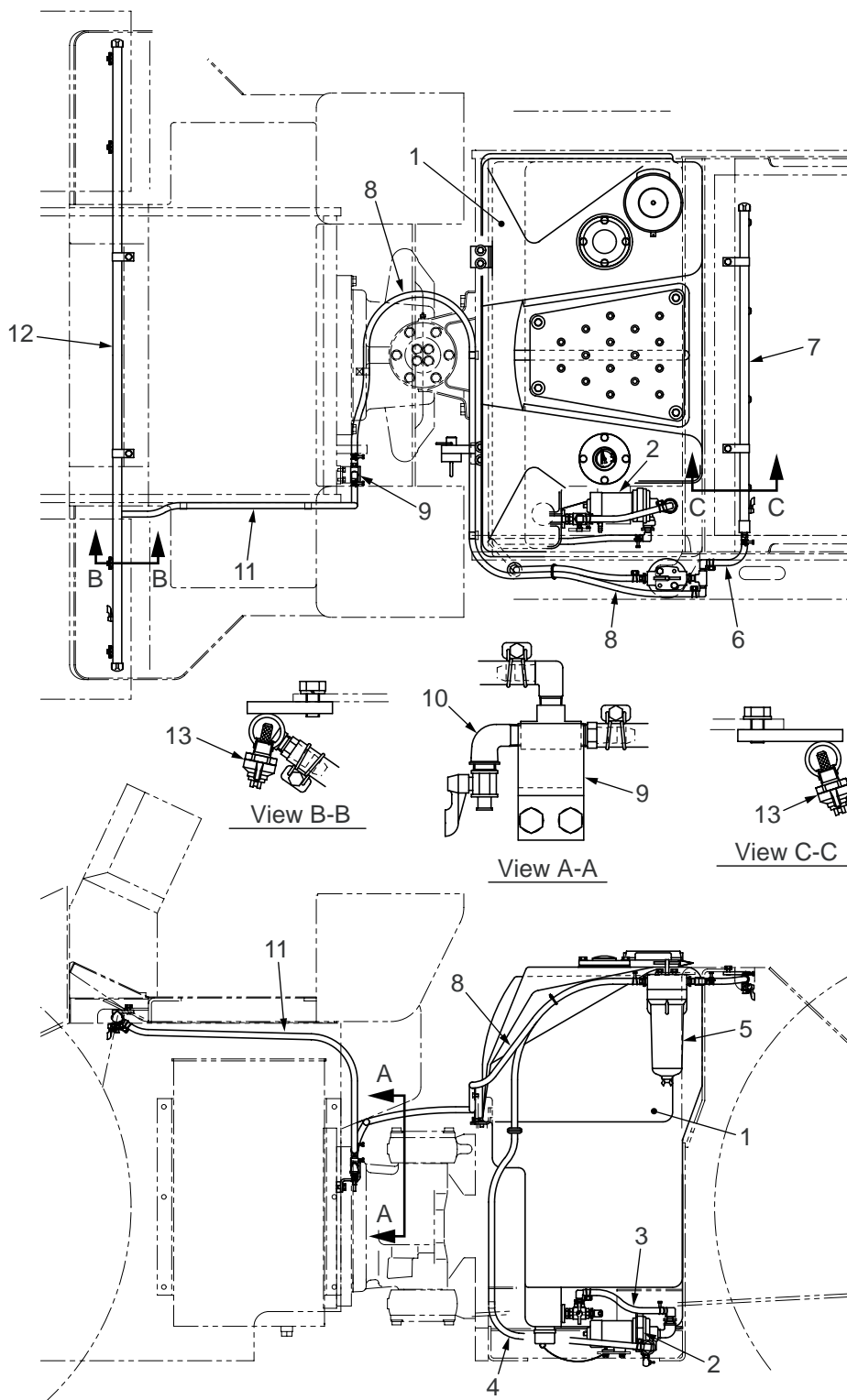
#### In an emergency

- Depressing the brake pedal switches off brake pedal switch (2) to deenergize the winding of brake relay (6). Contact c-e opens to deenergize solenoid (7). The pressure acting on the brake pistons is released and the springs in the brake cylinders provide braking. At the same time, F-R lever linkage brings the F-R lever to the neutral position to add dynamic braking.



## 5. Sprinkler & Scraper

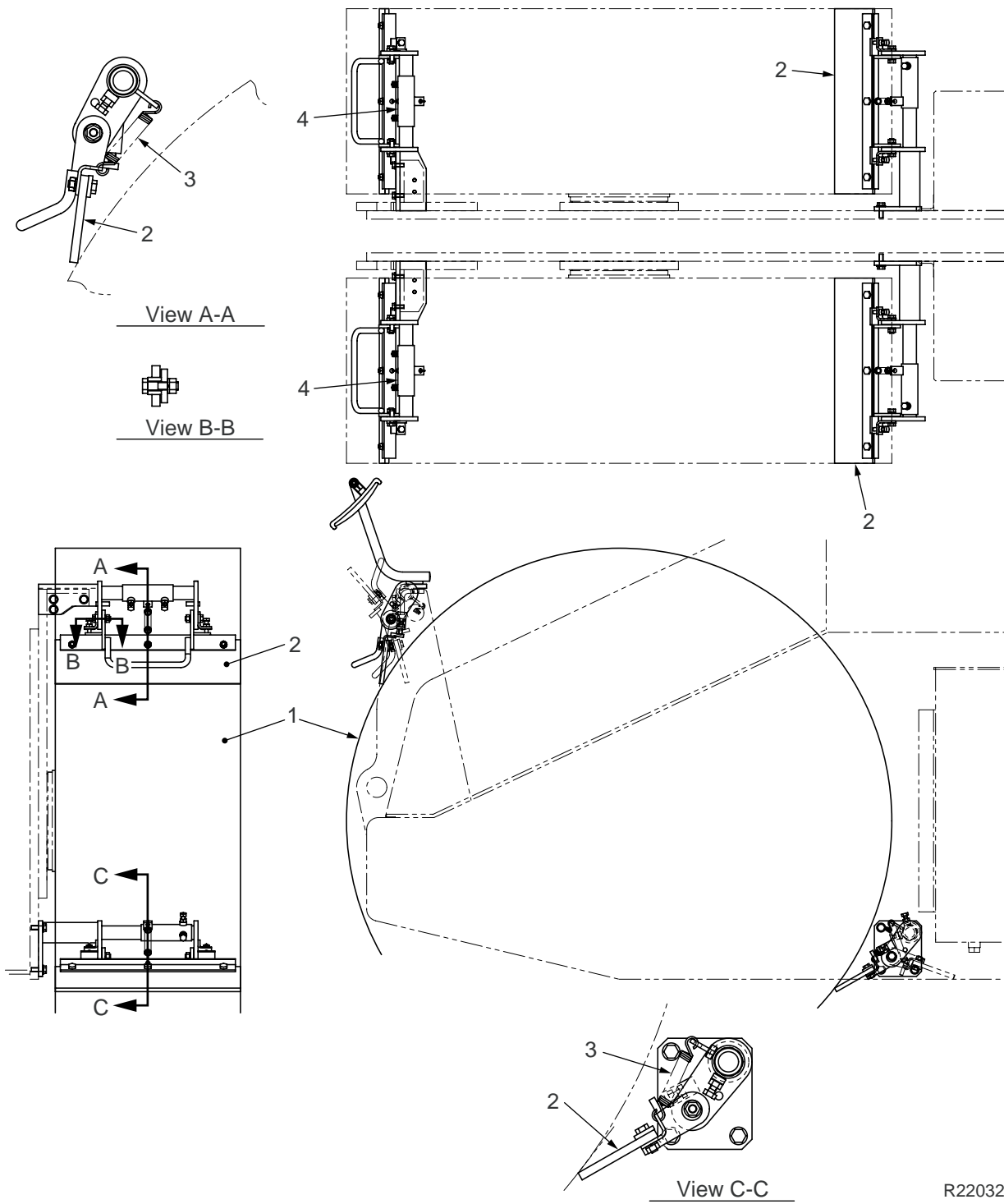
### 5-1. Sprinkler line



- |   |  |   |
|---|--|---|
| 1. Water tank                               | 6. Sprinkler hose<br>(filter to rear sprinkler pipe) | 11. Hose<br>(bracket to front sprinkler pipe) |
| 2. Sprinkler pump                           | 7. Rear sprinkler pipe                               | 12. Front sprinkler pipe                      |
| 3. Suction hose<br>(tank to sprinkler pump) | 8. Hose (filter to bracket)                          | 13. Nozzle                                    |
| 4. Hose (sprinkler pump to filter)          | 9. Bracket   |   |
| 5. Filter                                   | 10. Drain cock                                       |   |

R22031

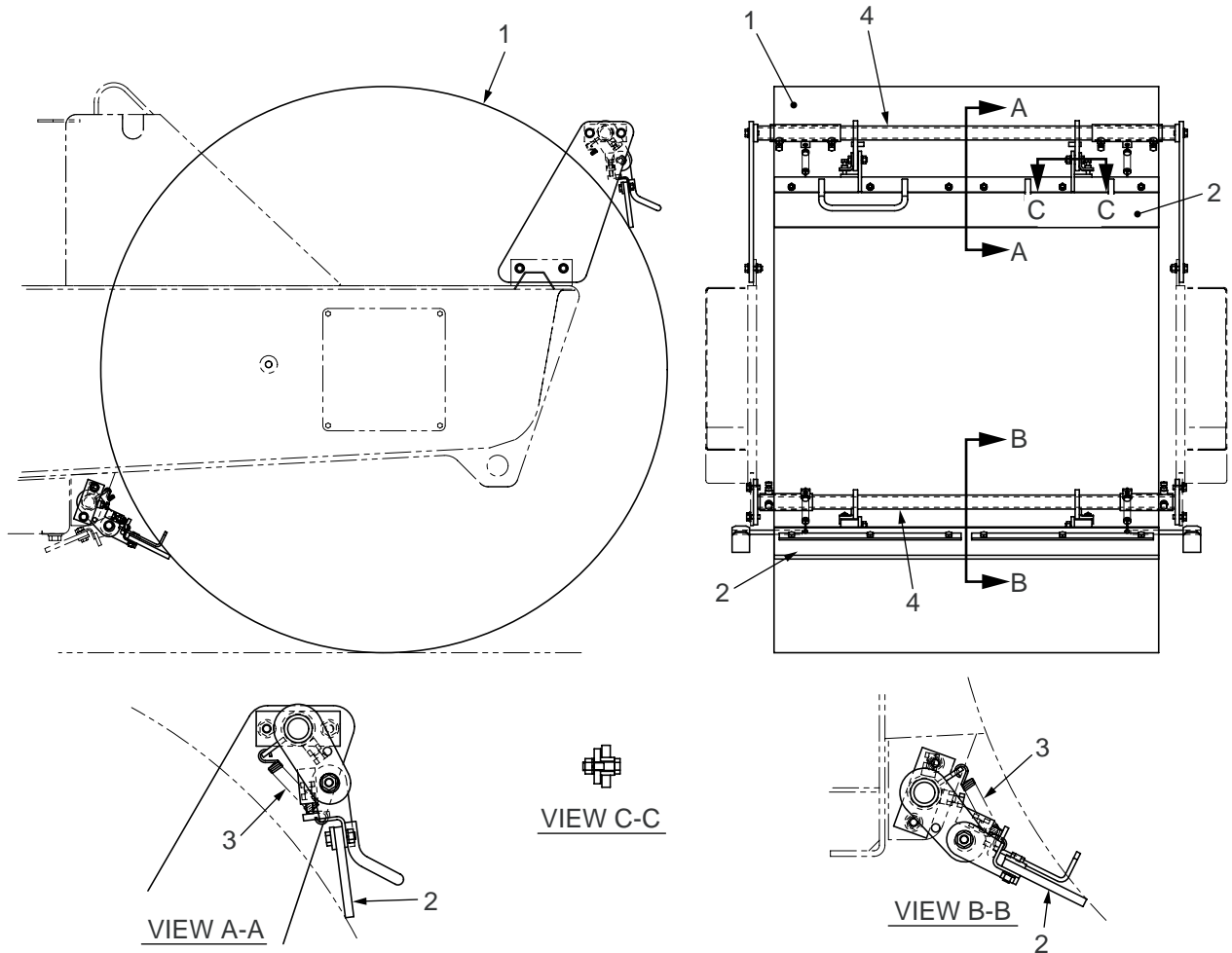
### 5-2. Scraper (Front drum)



- 1. Drum
- 2. Blade
- 3. Spring
- 4. Bracket



### 5-3. Scraper (Rear drum)

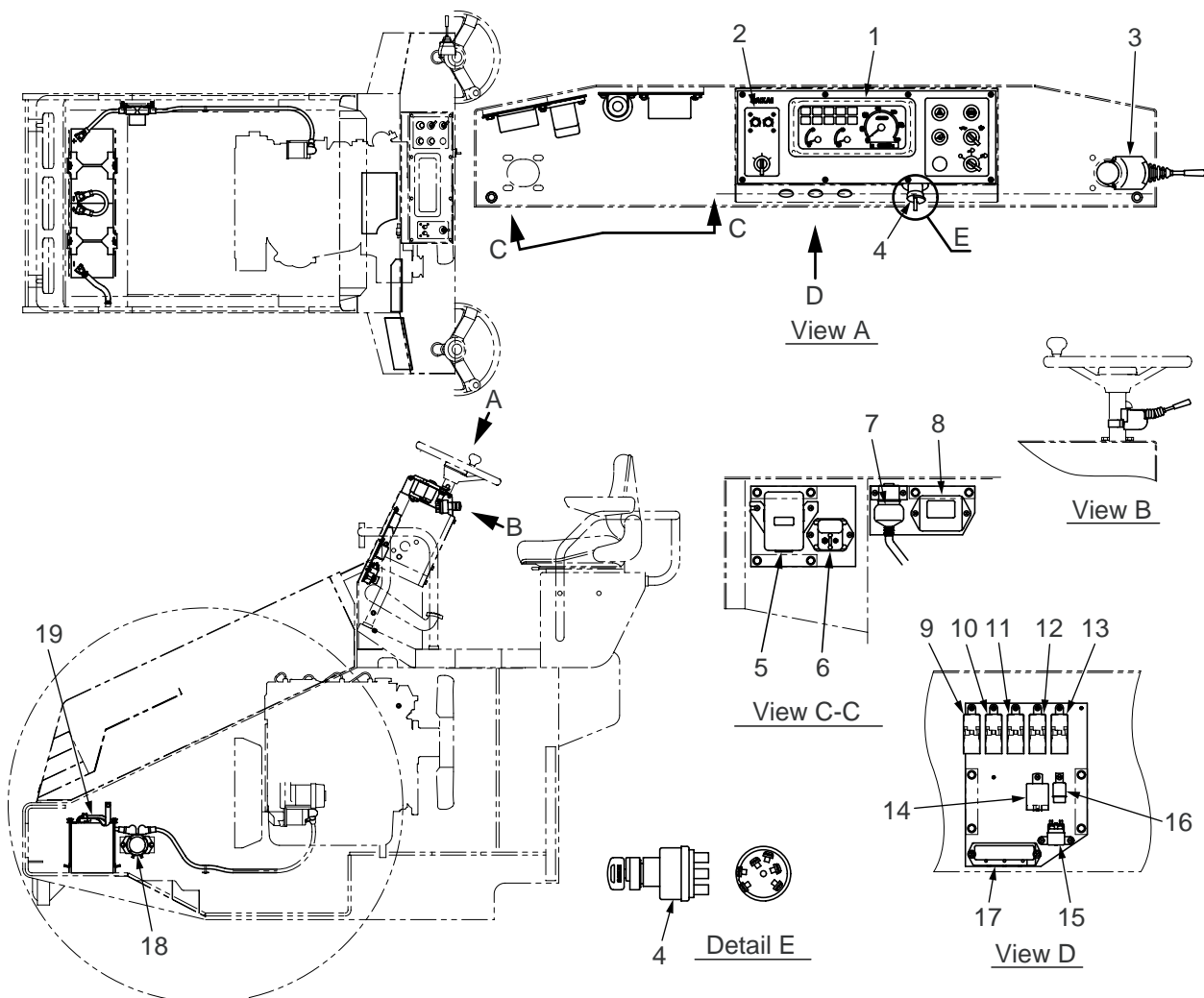


R22033

- 1. Drum
- 2. Blade
- 3. Spring
- 4. Bracket

## 6. Electric System

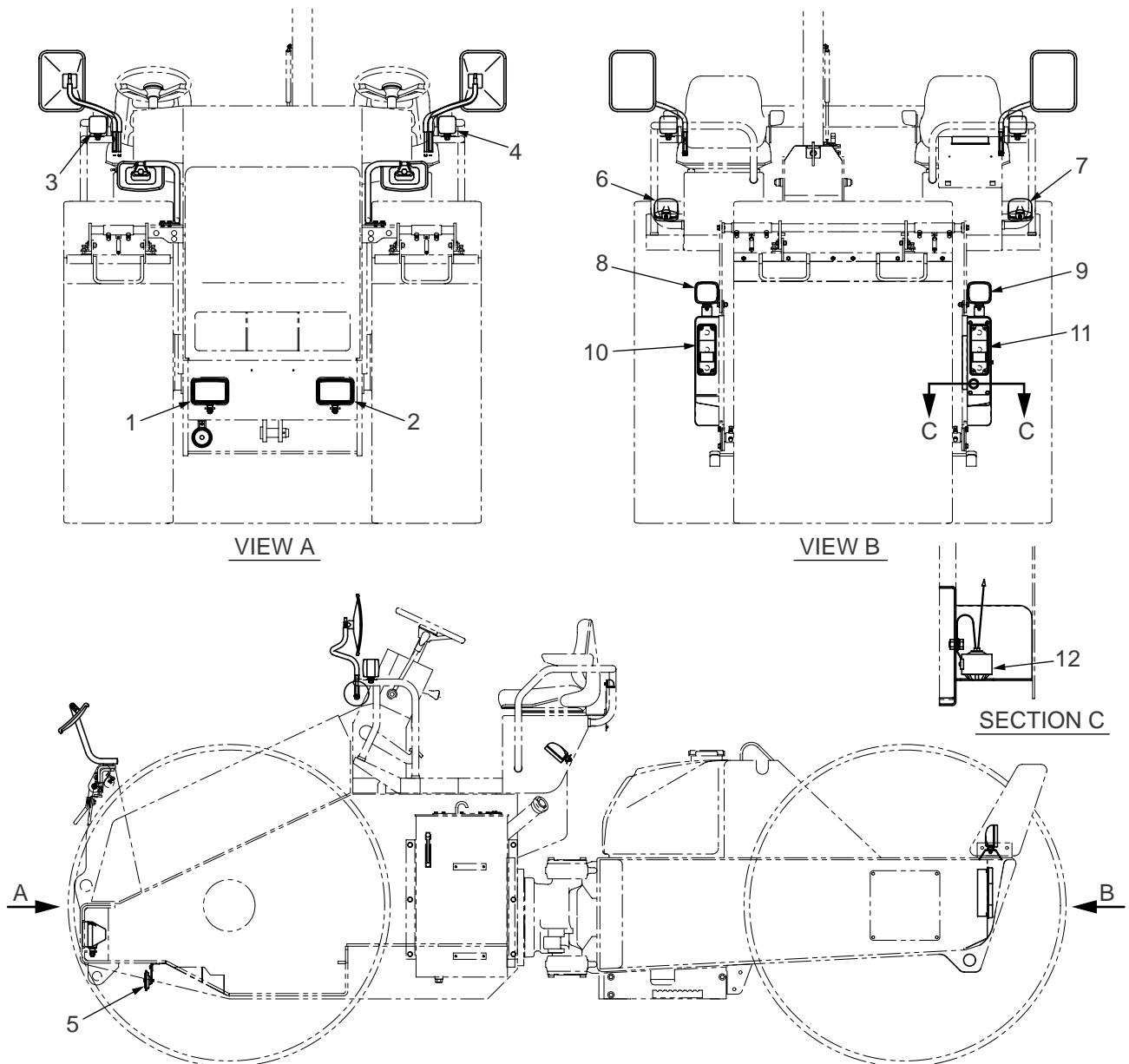
### 6-1. Location of electric components (Panel • Relays)



R22034

- |                            |                      |                     |
|----------------------------|----------------------|---------------------|
| 1. Combination meter panel | 8. Engine stop relay | 15. Sprinkler relay |
| 2. Sprinkler timer         | 9. Interlock relay   | 16. Horn relay      |
| 3. Turn signal switch      | 10. Glow relay       | 17. Fuse box        |
| 4. Starter switch          | 11. Stop lamp relay  | 18. Battery relay   |
| 5. Intake air heater timer | 12. Brake relay      | 19. Battery         |
| 6. Safety relay            | 13. Lamp check relay |                     |
| 7. Intake air heater relay | 14. Flasher unit     |                     |

## 6-2. Location of electric components (Lamps)

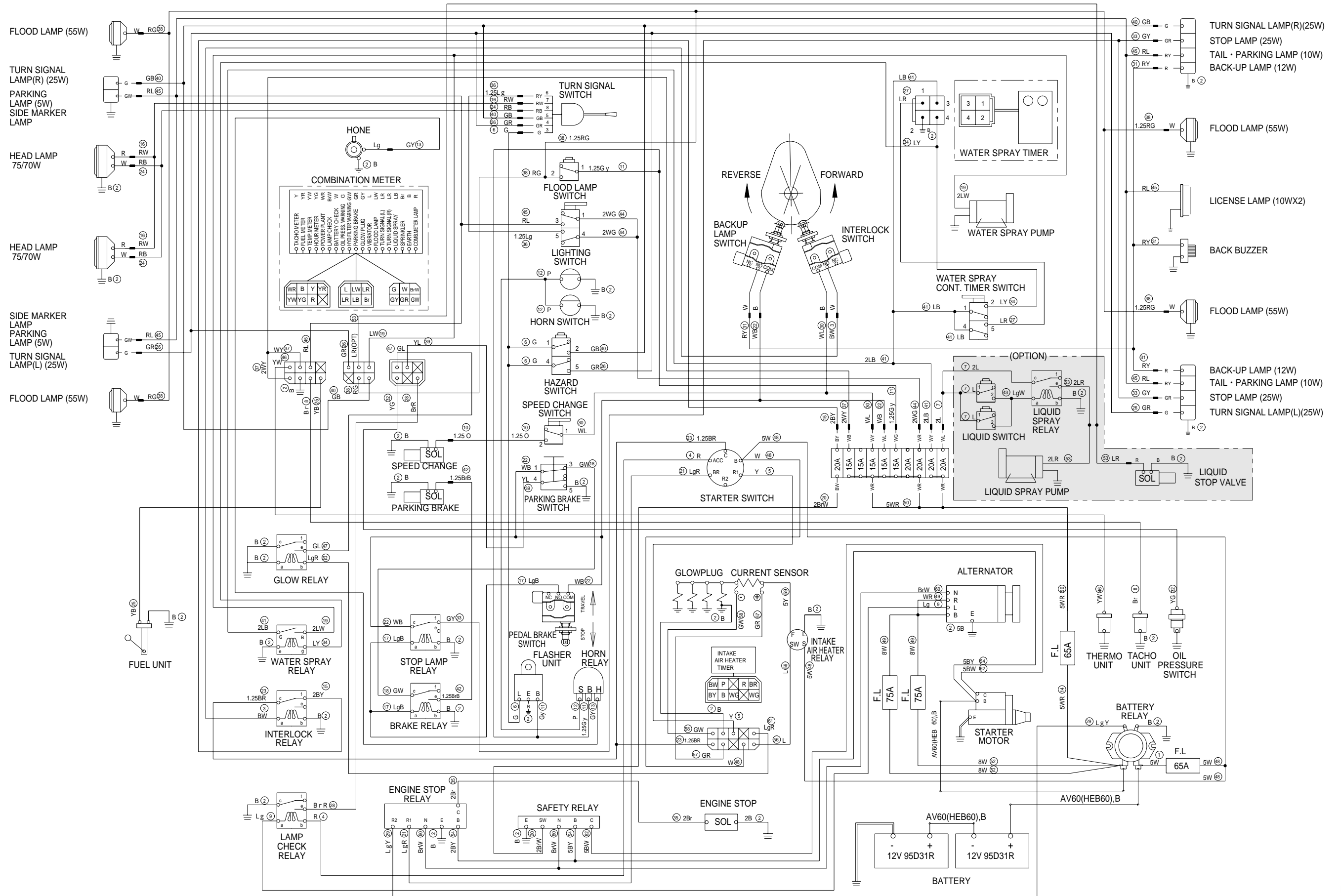


R22035

- |  |  |
|--|--|
| 1. Headlamp (right hand)               | 7. Flood lamp (right hand front)       |
| 2. Headlamp (left hand)                | 8. Flood lamp (left hand rear)         |
| 3. Combination lamp (right hand front) | 9. Flood lamp (right hand rear)        |
| 4. Combination lamp (left hand front)  | 10. Combination lamp (left hand rear)  |
| 5. Horn                                | 11. Combination lamp (right hand rear) |
| 6. Flood lamp (left hand front)        | 12. Backup buzzer                      |



6-3.Electric wiring diagram





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# ***INSPECTION & ADJUSTMENT***

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# INSPECTION & ADJUSTMENT

|                                      |       |
|--------------------------------------|-------|
| <b>1. Standard Value Chart</b> ..... | 3-002 |
|--------------------------------------|-------|

## **2. Inspection & Adjustment**

|  |       |
|--|-------|
| 2-1. Measurement and adjustment of pressure in propulsion main circuit .....   | 3-101 |
| 2-2. Measurement of propulsion charge pressure .....                           | 3-103 |
| 2-3. Measurement of pressure in propulsion motor speed selection circuit ..... | 3-104 |
| 2-4. Measurement of pressure in parking brake release circuit .....            | 3-105 |
| 2-5. Measurement and adjustment of pressure in steering circuit .....          | 3-106 |
| 2-6. Throttle linkage adjustment .....   | 3-107 |
| 2-7. F-R lever linkage adjustment .....  | 3-108 |

### **Precautions for Use of Standard Value Chart**

- 1) Values in the chart are based upon ones approved when the machine leaves the factory. They should be used for estimation of parts wear after extended operation and for guidance for repair.
- 2) Values in the chart are ones based on various test results etc. They should be used for a guide to fault finding practice in due consideration of the past repair frequency and operating record of the machine.
- 3) Values in the chart should not be used as the standard for claim application.

### **Precautions for Checking, Adjustment and Trouble Diagnosis**

- ⚠ For checking, adjustment and trouble diagnosis, park the machine on level ground and engage the safety pins.**
- ⚠ When working with other workers, use hand signals positively and keep people not concerned away from the work area.**
- ⚠ Cool off the engine coolant or hydraulic fluid when removing the radiator cap or the hydraulic tank filler cap. Hot fluids can burn you.**
- ⚠ Do not put your hands close to parts in motion such as fan belts.**

## 1. Standard Value Chart

### 1-1. Standard value chart for machine body

|              |                          | Item                           | Measuring conditions  | Unit                          | Standard value of new machine                              | Permissible range |
|--------------|--------------------------|--------------------------------|---|-------------------------------|--|-------------------|
| Engine       | Revolution               | Low idle                       | <ul style="list-style-type: none"> <li>Coolant temp : Green zone on gauge</li> <li>Engine oil working temperature: <math>50 \pm 5^{\circ}\text{C}</math> (<math>122 \pm 41^{\circ}\text{F}</math>)</li> </ul>                                     | min <sup>-1</sup><br>(rpm)    | 800 ± 25   |                   |
|              |                          | High idle                      |   |                               | 2,200 ± 30   |                   |
|              |                          | Rated revolution               |   |                               | 2050   |                   |
| Travel speed | Forward                  | Lo                             | <ul style="list-style-type: none"> <li>Engine at full throttle</li> <li>Coolant temp : Green zone on gauge</li> <li>Hydraulic oil temperature : <math>50 \pm 5^{\circ}\text{C}</math></li> </ul>  | km/h                          | 0 ~ 8 ± 1.5  |                   |
|              |                          | Hi                             |   |                               | 0 ~ 16 ± 1.5   |                   |
|              | Reverse                  | Lo                             |   |                               | 0 ~ 8 ± 1.5  |                   |
|              |                          | Hi                             |   |                               | 0 ~ 16 ± 1.5   |                   |
| Oil pressure | Propulsion circuit       | High relief pressure           | <ul style="list-style-type: none"> <li>Hydraulic oil pressure : <math>50 \pm 5^{\circ}\text{C}</math> (<math>122 \pm 41^{\circ}\text{F}</math>)</li> <li>For measurement, refer to relevant items under "Inspection &amp; Adjustment".</li> </ul> | MPa<br>{kgf/cm <sup>2</sup> } | $41.8 \pm_{2.0}^0$<br>{427 ± <sub>20</sub> <sup>0</sup> }  | 38.4<br>{392}     |
|              |                          | Charge relief pressure         |   |                               | $2.4 \pm_{0.2}^0$<br>{24.0 ± <sub>0.2</sub> <sup>0</sup> } | 2.0<br>{20}       |
|              |                          | Speed selection pressure       |   |                               | $2.4 \pm_{0.2}^0$<br>{24.0 ± <sub>0.2</sub> <sup>0</sup> } | 2.0<br>{20}       |
|              |                          | Parking brake release pressure |   |                               | $2.4 \pm_{0.2}^0$<br>{24.0 ± <sub>0.2</sub> <sup>0</sup> } | 2.0<br>{20}       |
|              | Steering relief pressure | $15.7 \pm 1.0$<br>{160 ± 10}   |   |                               | 13.5<br>{136}  |                   |

## 2. Inspection & Adjustment

### 2-1. Measurement and adjustment of pressure in propulsion main circuit

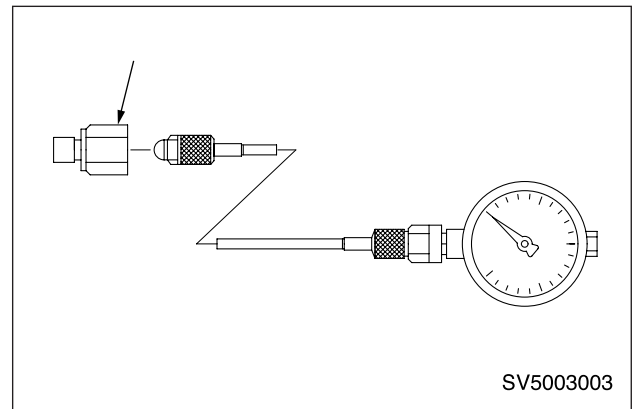
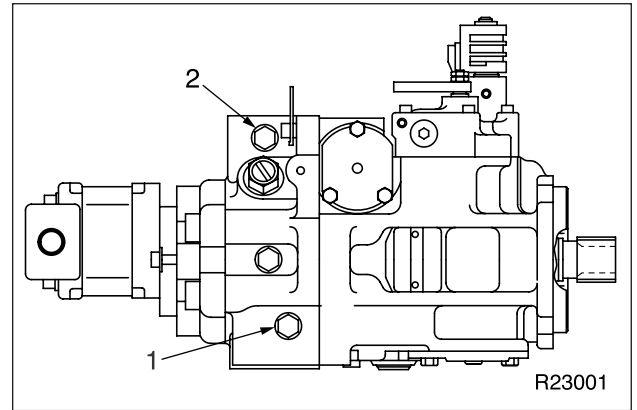
- ▲ Park on level ground. Stop the engine. Block the wheels.
- ▲ Make certain that the parking brake functions correctly.

#### 1. Measurement

Hydraulic oil temperature:

$50 \pm 5$  ( $122 \pm 41$  F)

- 1) Remove plugs at gauge points (1) and (2) in the propulsion pump and attach adapter . Fit a pressure gauge to the adapter.
  - Gauge : 0 ~ 60MPa (0 ~ 600 kgf/cm<sup>2</sup>)  
{0 ~ 8,530 lbf/in<sup>2</sup>}
  - Gauge port : 9/16-18UNF
  - Port (1) : Forward drive
  - Port (2) : Reversing
- 2) Set the speed selector switch to HIGH SPEED. Start the engine and move the throttle lever slowly to the full throttle position.
- 3) Ensuring that the parking brake stays applied, move the F-R lever slowly away from the neutral position and take the pressure reading.  
Take the reading quickly. When the reading has been taken, bring the F-R lever back to the neutral position immediately.



## 2. Adjustment

If the measured value does not fall within the permissible range, adjust as follows:

- 1) Loosen locknut (5) on either front drive multifunction valve (7) or rear drive multifunction valve (8) as necessary. To adjust, rotate adjusting screw (6).
  - Clockwise rotation raises the pressure. When turned counterclockwise, the pressure is lowered.
  - A quarter of a turn (90 degrees) of the screw increases or decreases the pressure by 2.1MPa (21 kgf/cm<sup>2</sup>) {299 lbf/in<sup>2</sup>}.
  - Tightening torque setting for locknut: 9.1Nm (92 kgf·cm) {79.9 lbf·in}

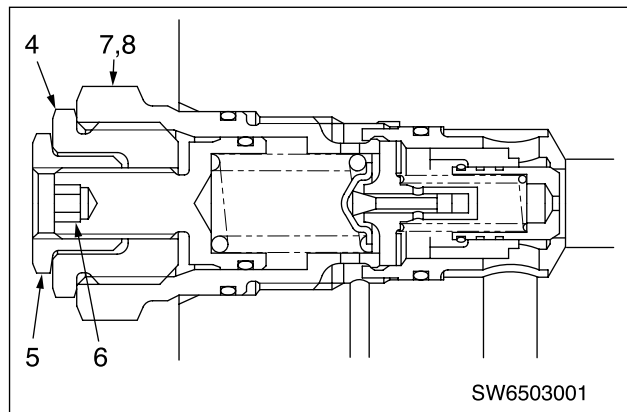
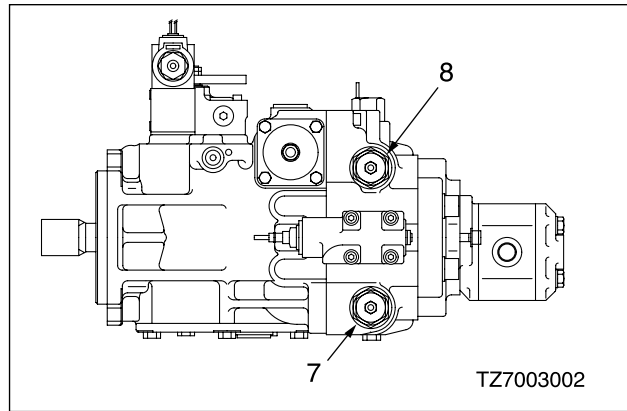
- 2) If the valve is beyond adjustment:

Disassemble and clean the multifunction valve assembly. Renew as necessary.

- To clean the popette portion, remove nut (4).
- The tightening torque of nut (4) is 41.2N·m (420 kgf·cm) {365 lbf·ft}.
- The tightening torque of multifunction valves is 79.4N·m (810 kgf·cm) {704 lbf·ft}.

Carefully perform disassembly and reassembly with necessary measures taken to prevent ingress of foreign matter.

For the measurement of pressure during the adjustment, follow steps 1-2) and 1-3) on page 3-101.



## 2-2. Measurement of propulsion charge pressure

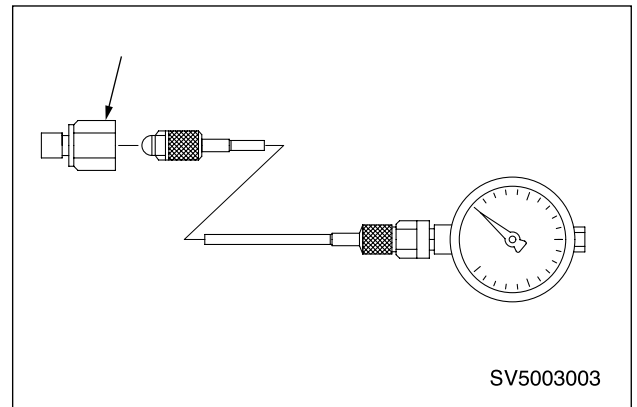
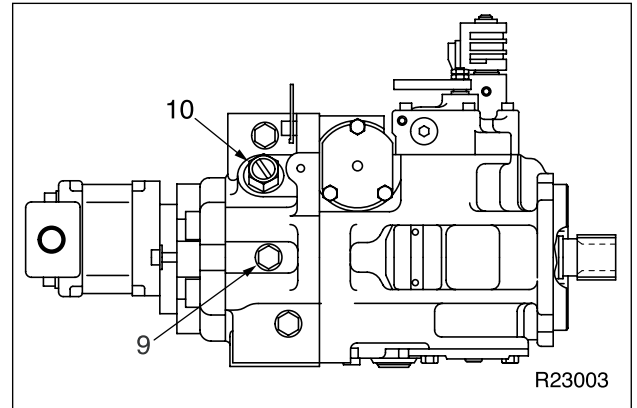
- ⚠ Park on level ground. Stop the engine. Block the wheels.
- ⚠ Make certain that the parking brake functions correctly.

### 1. Measurement

Hydraulic oil temperature :

$50 \pm 5$  (  $122 \pm 41$  F )

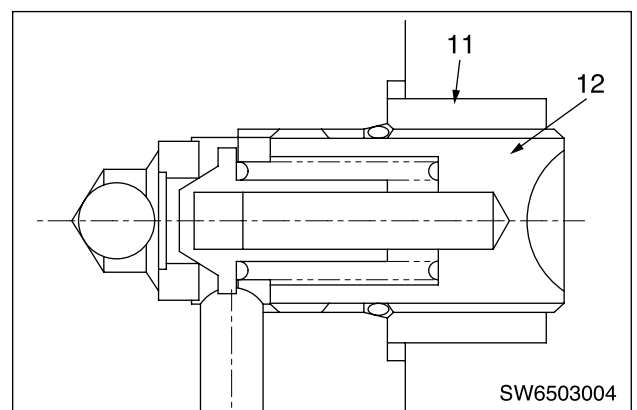
- 1) Remove the plug at propulsion pump gauge port (9) and fit adapter . Connect a pressure gauge to the adapter.
  - Gauge port: 9/16-18UNF
  - Gauge: 0 ~ 6.0MPa ( 0 ~ 60kgf/cm<sup>2</sup> ) { 853 lbf/in<sup>2</sup> }
- 2) Start the engine. Slowly operate the throttle lever to run the engine at maximum speed.
- 3) Ensuring that the F-R lever is in the neutral position, take the reading of the pressure gauge.



### 2. Adjustment

If the measured value is not within the permissible range, adjust as follows:

- 1) Loosen locknut (11) on charge relief valve (10). Adjust by rotating adjusting screw (12).
  - Clockwise rotation raises the pressure. When turned counterclockwise, the pressure decreases.
  - Tightening torque of the locknut is 51.4N·m (524kgf·cm) {46.9 lbf·in}. For measurement of pressure during adjustment, do steps 1-2) and 1-3) as described above.
- 2) If the charge valve is beyond adjustment, disassemble and clean the valve. Renew if necessary. Carefully perform disassembly and reassembly while taking necessary means to prevent entry of foreign matter.



### 2-3. Measurement of pressure in propulsion motor speed selection circuit

**▲ Park the machine on level ground. Stop the engine. Block the wheels.**

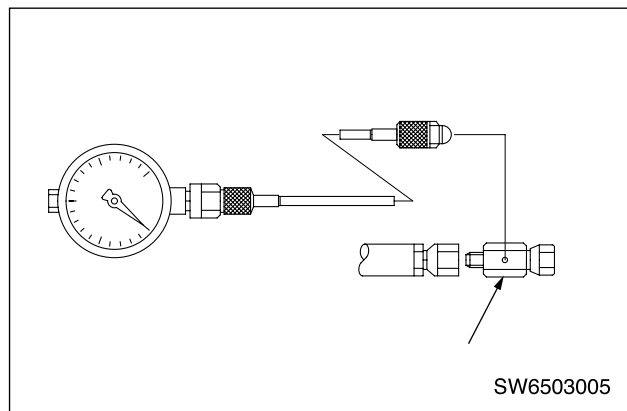
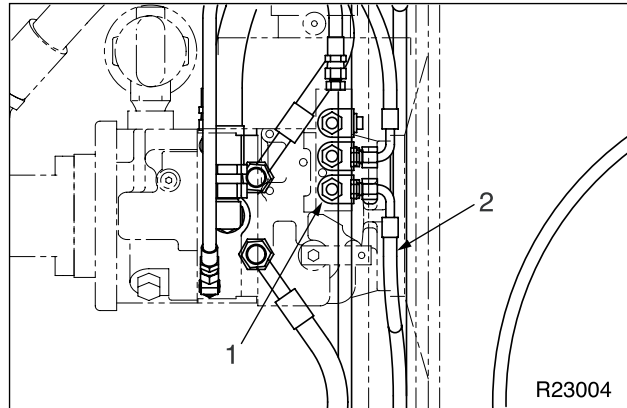
#### 1. Measurement

Hydraulic oil temperature :

$50 \pm 5$  (  $122 \pm 41$  F )

Because oil is fed from the steering circuit, check first to see if the steering functions correctly.

- 1) Disconnect hose (2) at speed selector solenoid valve (1) in the propulsion pump. Reconnect the hose after fitting adapter .
- 2) Attach a pressure gauge to adapter .
  - Gauge:  $0 \sim 6.0$ MPa (  $0 \sim 60$ kgf/cm<sup>2</sup> )  
{  $853$  lbf/in<sup>2</sup> }
- 3) Start the engine. Slowly operate the throttle lever to run the engine at maximum speed.
- 4) Select the speed selector switch to HIGH, and take the reading of the pressure gauge.



## 2-4. Measurement of pressure in parking brake release circuit

**▲ Park the machine on level ground. Stop the engine. Chock the wheels.**

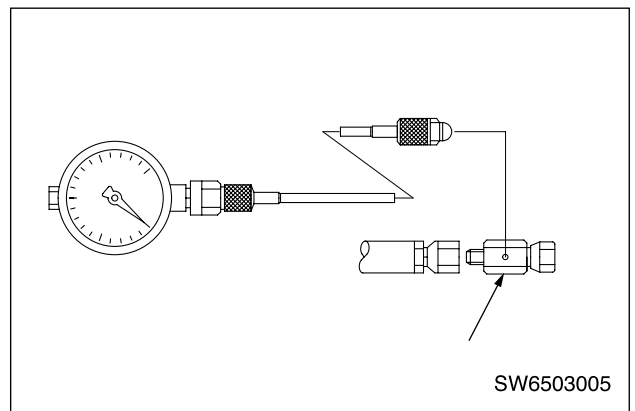
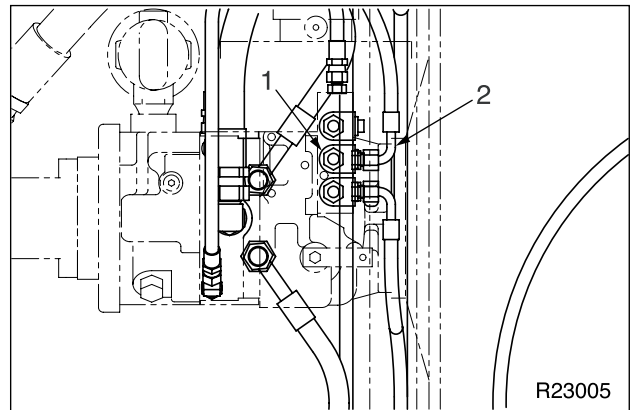
### 1. Measurement

Hydraulic oil temperature :

$$50 \pm 5 \quad (122 \pm 41 \text{ F})$$

Because the steering circuit feeds the oil to the brake release line, make sure, prior to the measurement, that the steering works correctly.

- 1) Disconnect hose (2) at brake solenoid valve (1) on the propulsion pump.  
Fit adapter . Reconnect the hose.
- 2) Attach a pressure gauge to adapter .  
Gauge : 0 ~ 6.0MPa (0 ~ 60kgf/cm<sup>2</sup>)  
{0 ~ 853 lbf/in<sup>2</sup>}
- 3) Make sure that the F-R lever stays in the neutral position. Start the engine. Slowly operate the throttle lever to run the engine at maximum speed.
- 4) Set the parking brake switch to the RELEASE position, and take the reading of the pressure gauge.



## 2-5. Measurement and adjustment of pressure in steering circuit

**▲ Park the machine on level ground. Stop the engine. Chock the wheels.**

### 1. Measurement

Hydraulic oil temperature :

$$50 \pm 5 \quad (122 \pm 41 \text{ F})$$

Because the return flow of the steering circuit feeds the propulsion charge line, check, in advance, that the charge pressure is normal.

1) Disconnect steering pump delivery hose (1) or (2) at the steering pump.  
Reconnect the hose after fitting adapter .

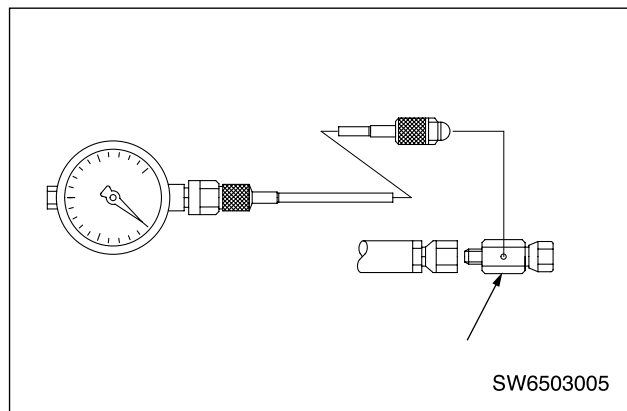
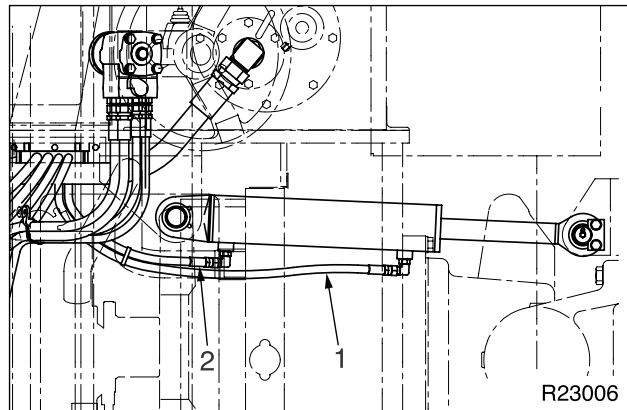
2) Install a pressure gauge to adapter .

Gauge : 0 ~ 24.8 MPa (0 ~ 250 kgf/cm<sup>2</sup>)  
{0 ~ 3,555 lbf/in<sup>2</sup>}

3) Start the engine. Ensuring that the F-R lever is in the neutral position, slowly move the throttle lever to the full throttle position.

4) Rotate the steering wheel clockwise to full lock and take the reading of the pressure gauge.

When rotating the steering wheel, keep people away from the pinch area of the articulated frame.



### 2. Adjustment

If the measured value is not within the permissible range, disassemble and clean the relief valve assembly built in Orbitrol. Renew as necessary.

The valve is not adjustable.

Carefully perform disassembly and reassembly with necessary means taken to avoid entry of foreign matter.



## 2-6. Throttle linkage adjustment

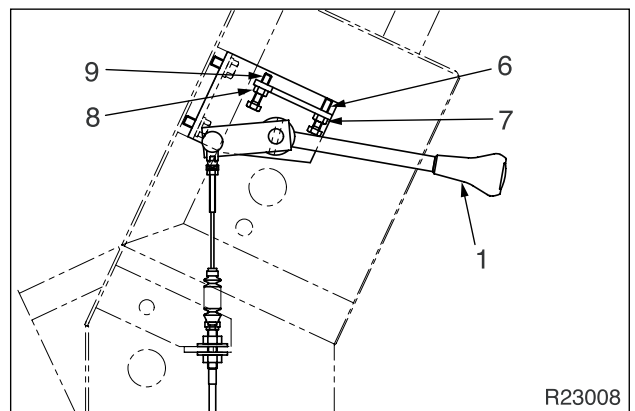
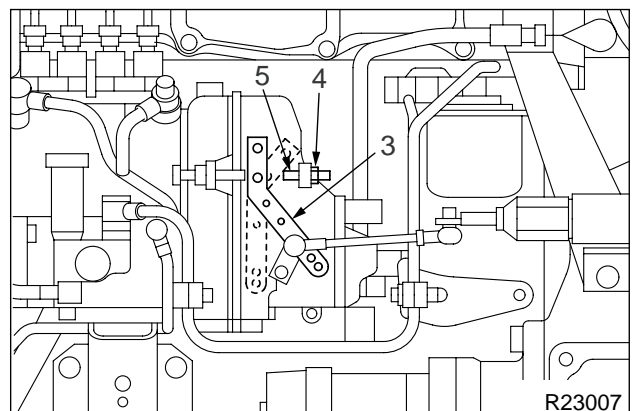
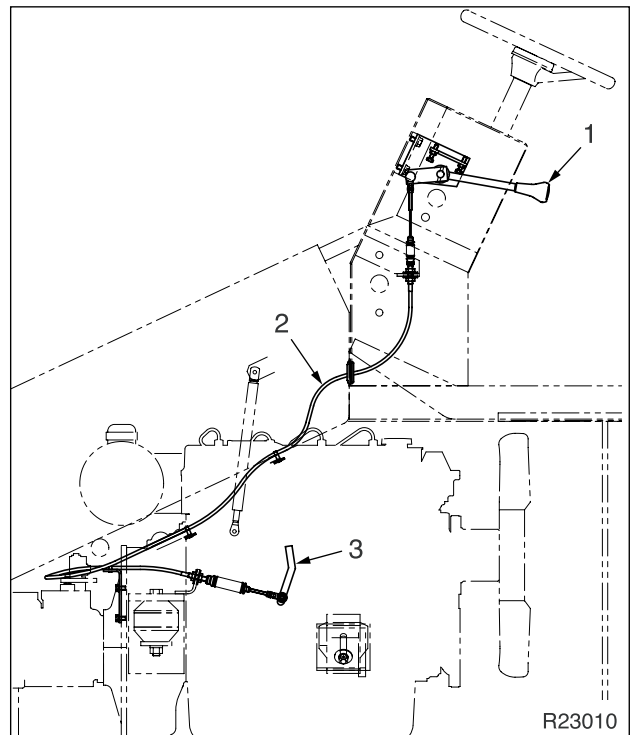
When the throttle linkage has been renewed (or reconnected) or if the high idle or low idle rpm is not to specification, adjust as follows:

- ▲ Park the machine on level ground. Stop the engine. Chock the wheels.**

### 1. Adjustment

Coolant temperature: Green area on gauge

- 1) Set throttle lever (1) to the low idle position.
- 2) Connect throttle cable (2) to throttle lever (1) and fuel injection pump governor lever (3).
- 3) Start the engine. Slacken lock nut (4) and adjust stop bolt (5) until correct low idle revolution is reached.  
Low idle :  $800 \pm 25 \text{min}^{-1}$  (rpm)
- 4) Screw in stop bolt (6) until it is against throttle lever (1), then screw out by 1/4 to 1/2 turns. Tighten lock nut (7).
- 5) With throttle lever (1) moved to the full throttle position, loosen locknut (8) and adjust stop bolt (9) so that high idle is to specification.  
High idle :  $2,200 \pm 30 \text{min}^{-1}$  (rpm)
- 6) Screw out stop bolt (9) by 1/4 to 1/2 turns and tighten locknut (8).



## 2-7.F-R lever linkage adjustment

When the F-R lever linkage has been renewed (or reconnected) or if the F-R lever fails to move smoothly, adjust as described below:

**▲ Park the machine on level ground. Stop the engine. Chock the wheels.**

### 1. Adjustment

Hydraulic oil temperature :

$50 \pm 50$  (122  $\pm$  41 F)

Inspect the pump control lever stroke. Because the maximum angle of F-R lever for forward drive and reversing is positively determined by a notch ball, set the F-R lever linkage correctly by adjusting the pump control lever stroke.

- 1) Set the F-R lever to the correct neutral position. Connect control cable (3) to F-R lever (1).

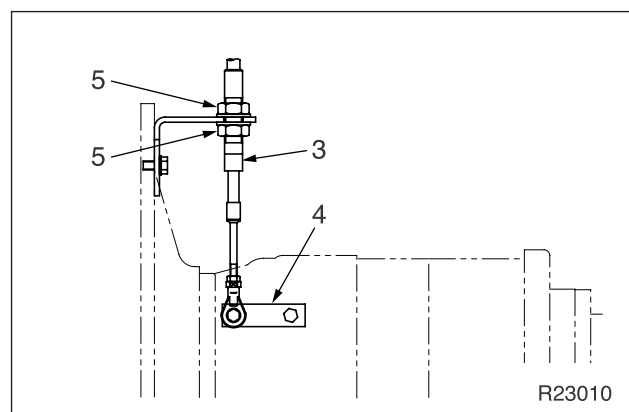
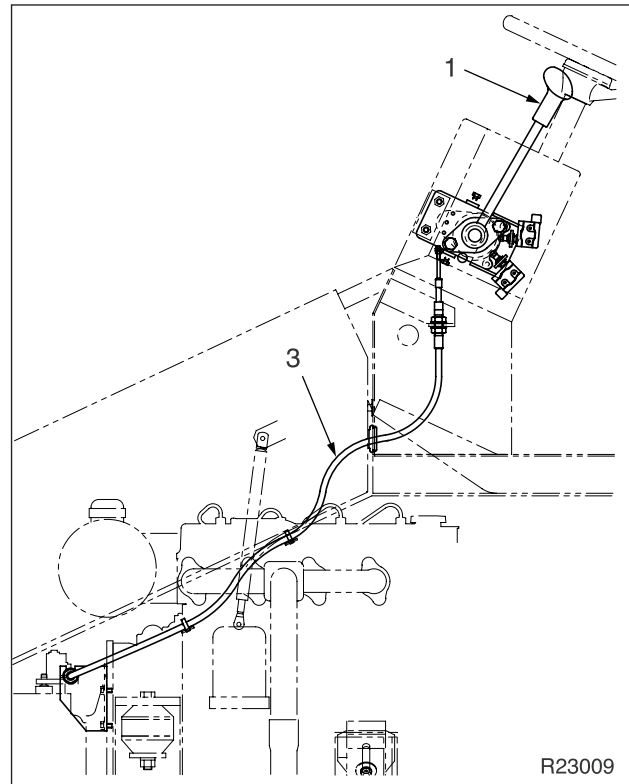
Make sure that F-R lever (1) moves smoothly.

- 2) Connect cable (3) to propulsion pump control lever (4).

- 3) Make sure that lever (4) follows surely to the movement of F-R lever (1) when moved to the forward and reverse drive detent positions.

- 4) To adjust the neutral position, rotate fixing nuts (5) on cable (3) while moving the F-R lever (neutral  $\rightleftarrows$  forward  $\rightleftarrows$  neutral  $\rightleftarrows$  backward), so that the F-R lever travel from the neutral position to the position in which the machine starts travelling is equal for both forward drive and backing.

Perform this adjustment on level and flat concrete pavement while varying the engine revolution in several steps ranging from low idle to high.



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# ***TROUBLE DIAGNOSIS***

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## **TROUBLE DIAGNOSIS**

|  |       |
|--|-------|
| <b>1. Precautions for Trouble Diagnosis</b> .....                              | 4-002 |
| <b>2. How to Make a Trouble Diagnosis</b> .....                                | 4-003 |
| <b>3. How to Use Trouble Diagnosis Flow Chart</b> .....                        | 4-004 |
| <b>4. Precautions for Trouble Diagnosis of Electric System</b> .....           | 4-006 |
| <b>5. Trouble Diagnosis of Electric System (Mode E)</b> .....                  | 4-201 |
| <b>6. Trouble Diagnosis of Hydraulic and Mechanical Systems (Mode H)</b> ..... | 4-401 |

## 1. Precautions for Trouble Diagnosis

- ▲ **Park the machine on level ground. Make sure that the safety pins are engaged, wheels chocked and parking brake applied.**
- ▲ **When working with other workers, use hand signals authorized, and keep people not concerned away from the work area.**
- ▲ **If the radiator cap is carelessly removed from a hot engine, hot coolant will gush out to cause a burn. Remove the cap only when the engine has been cooled off.**
- ▲ **Exercise care not to touch hot parts or not to get caught in rotating parts.**
- ▲ **When disconnecting electric wires, disconnect the battery negative (-) cable.**
- ▲ **When taking off plugs or caps from units which are under pressure such as hydraulic, water and air pressures, remove residual pressure first.**

- Trouble diagnosis is to determine the root cause of a trouble. Repair faulty parts as quickly as practicable, and prevent recurrence of the trouble.
- Important when making a trouble diagnosis is of course to well understand the structure and function of the machine at fault. For effective trouble diagnosis, however, it is of prime importance to have a clear picture of the trouble concerned by contacting the operator.

### 1. When a trouble has occurred, do not attempt to disassemble suspected parts blindly.

Disassembling in a hurry without careful considerations will invite disadvantageous situations as described below:

- Parts which need not to be disassembled may be disassembled.
- Tracing the cause of the trouble will become more difficult.

These will cause increased service costs because of wasteful service hours, spare parts or expendables like oil or grease. To make matters worse, such a careless practice will invite operator's (customer's) distrust. For these reasons, a full investigation and a prudent diagnosis in accordance with trouble diagnosis procedures recommended are essential for efficient fault finding practices.

### 2. Questions to be addressed to operator (customer)

- 1) Are there any troubles other than the trouble in question?
- 2) Had there been any unusual conditions with the machine before the trouble has occurred?
- 3) Has the trouble occurred suddenly without showing any signs of unusual conditions in advance?
- 4) In what occasion has the trouble occurred?
- 5) Had the machine been repaired before the trouble has occurred? If so, when had it been repaired?

- 6) Had similar trouble occurred before the trouble has developed?

### 3. Before-diagnosis inspection

- 1) Perform daily inspections.
- 2) Perform other inspections necessary for diagnosis.

### 4. Confirmation of trouble

Know the degree of the trouble. Determine whether the trouble is attributable to a structural defect etc. or caused by incorrect handling.

When making the trouble recur in an attempt to trace the source of the trouble by putting the machine in motion, use care not to cause more damages to the machine.

### 5. Trouble diagnosis

From the results obtained from items 2 to 4 above, narrow down the cause of the trouble, and pinpoint its source by utilizing the diagnosis flow chart.

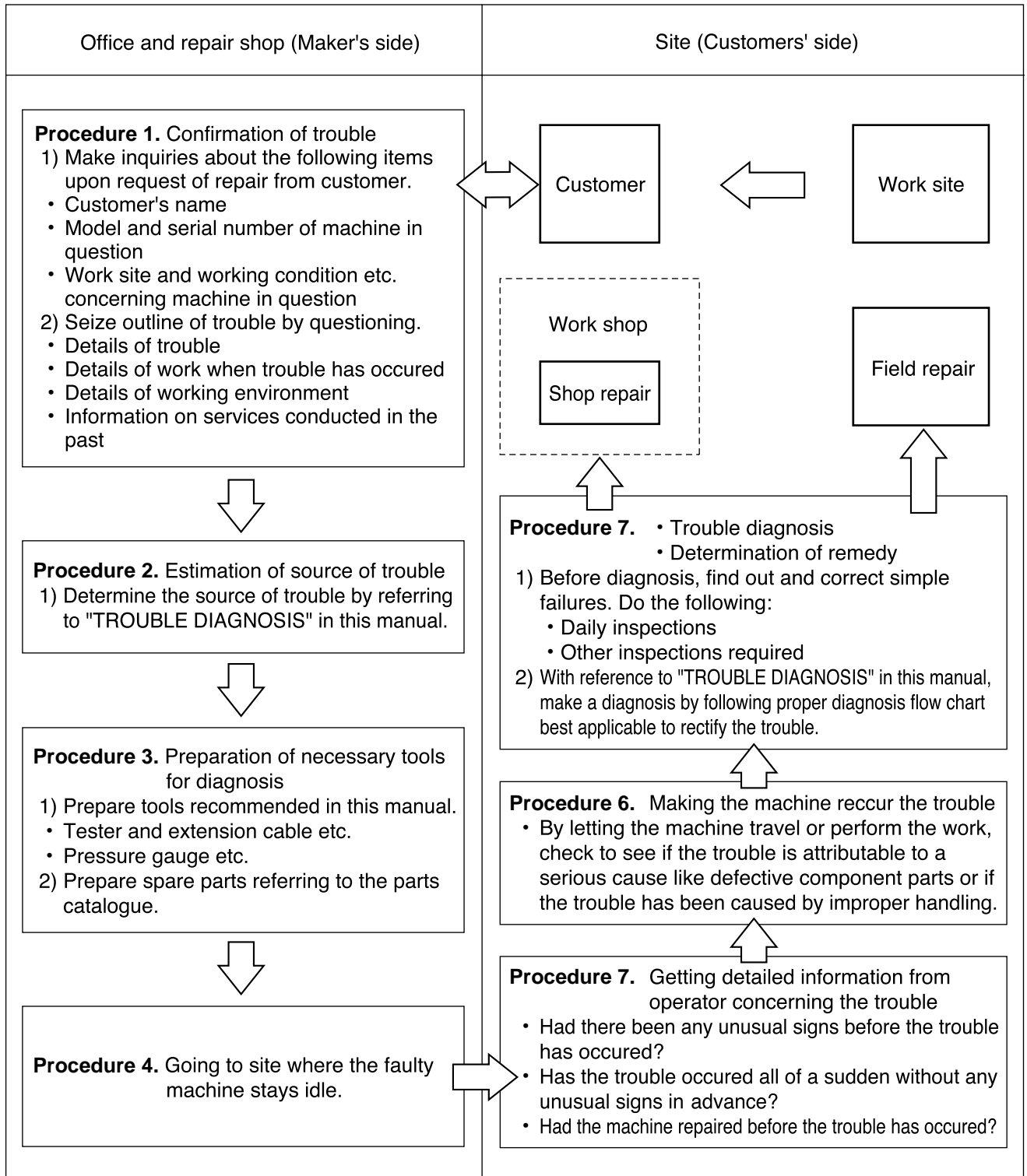
The basic points of diagnosis are:

- 1) Start from the simple portion.
- 2) Start from the portion having a high probability.
- 3) Investigate related matters.

### 6. Fundamental remedy for a trouble

Even if a trouble has been corrected, it will develop again if its cause is not determined. It is of prime importance to grasp the very cause of the trouble.

## 2. How to Make a Trouble diagnosis



### 3. How to Use Trouble Diagnosis Flow Chart

#### 1. Trouble diagnosis code numbers

- 1) Electric system: E-01 to E-18
- 2) Hydraulic and mechanical systems: H-01 to H-10

#### 2. How to use the trouble diagnosis flow chart

See example shown on page 4-005.

Trouble diagnosis code number and fault symptom

On top of the flow chart are code number and fault symptom.

General precautions

Under the code number and fault symptom are precautions with mark .

Take necessary measures as instructed by these precautions when making the inspection described in each checking instruction box .

Sub classification

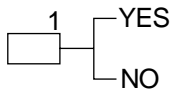
To make diagnosis easier or simplify the flow chart, fault symptom is subclassified.

Ex. a) Starter does not run.

How to make diagnosis

- Each box contains a diagnosis procedure. Depending upon the result of inspection or measurement, proceed to YES or NO line.
- Normally, if the result is YES then proceed to the upper line. If NO then go to the lower line.

NOTE : The number above each box is a reference number. It does not mean a sequence in which diagnosis procedure should proceed.



- As a result of a checking, if YES line or NO line directly goes to the description in the CAUSE column, take necessary action as instructed in the REMEDY column.
- Under each box are standard value and condition necessary for diagnosis procedure. If the result gives an affirmative answer to the question addressed in the box or agrees with the value indicated under the box, then go to YES line. Otherwise, go to NO line.
- The standard values were taken from the standard value list.
- For the location of component parts such as relays mentioned in the flow chart, see the drawing which shows the location of key units. The line colors mentioned in the flow chart are indicated in the electric wiring diagram shown under the flow chart. In the actual machine, each wire is also identified by color.

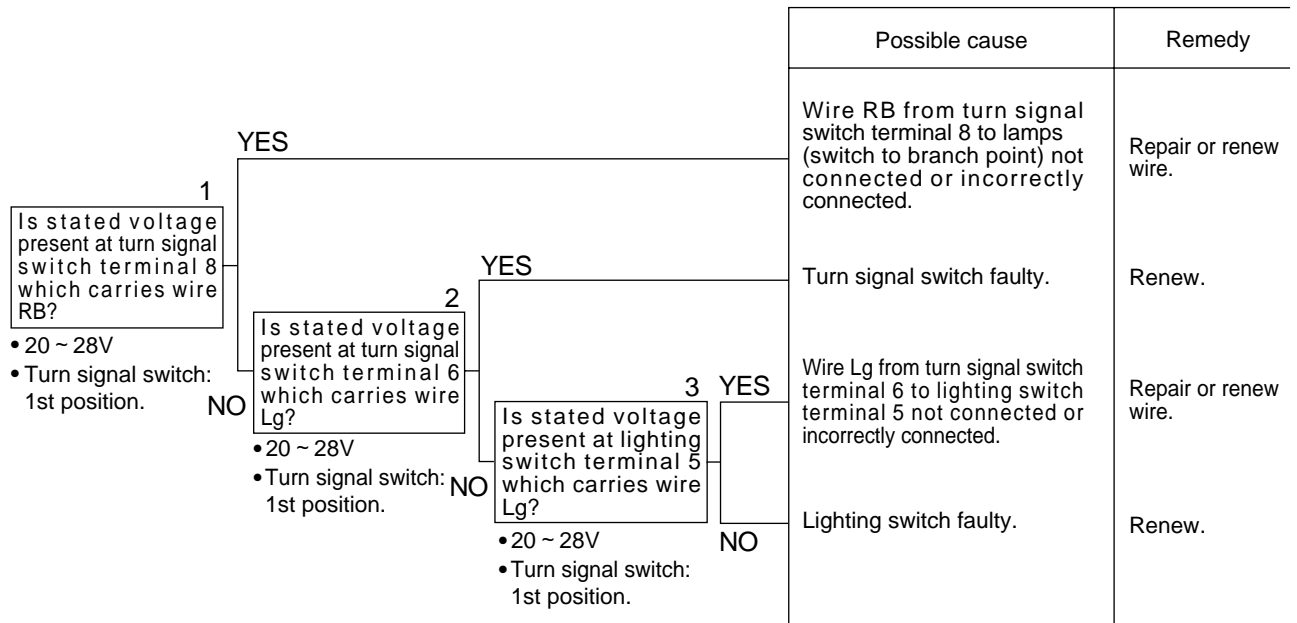


### E-08 Head lamps, side marker lamps and tail lamps do not light

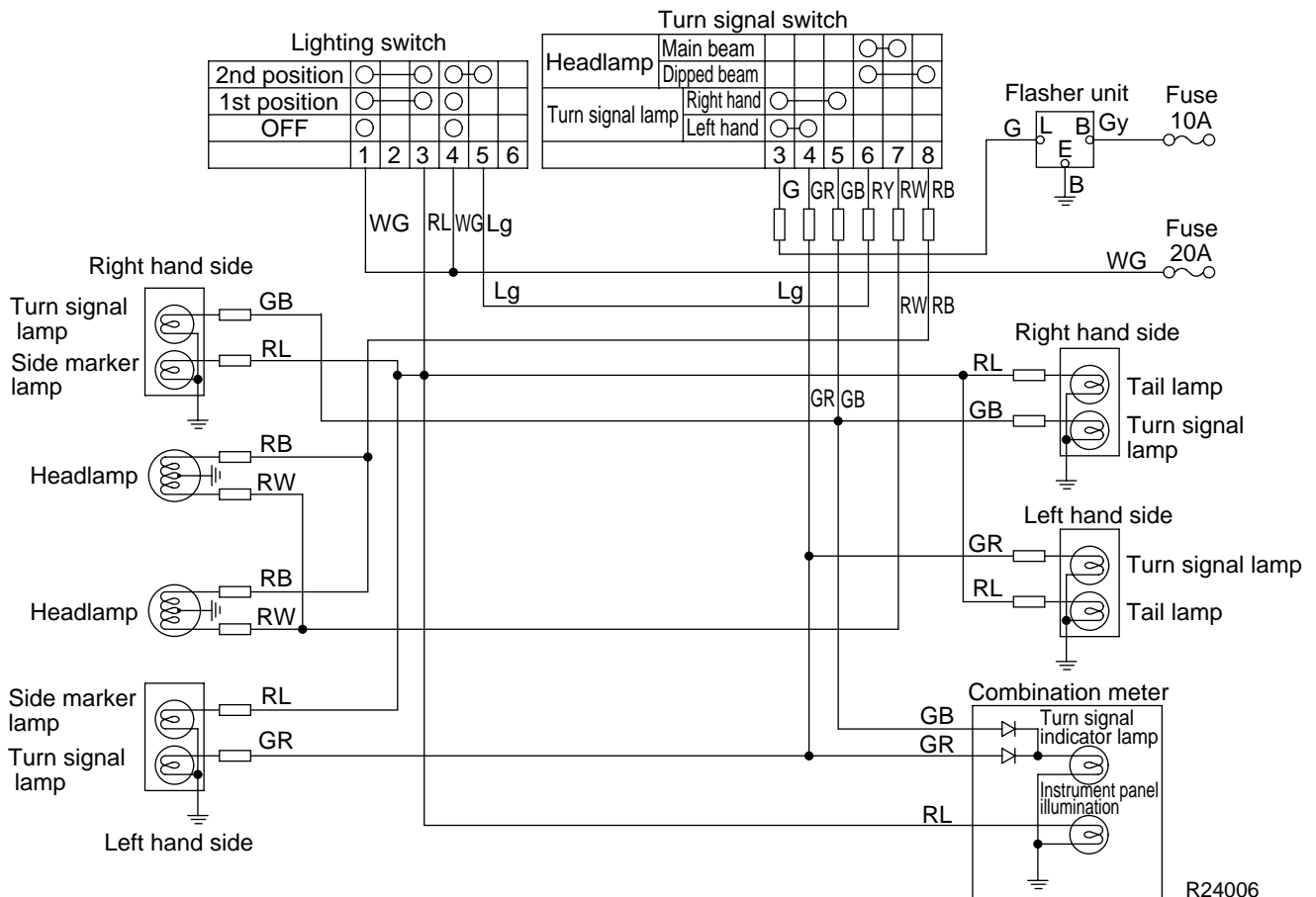
It is assumed that other electric circuits are normal.

Take the voltage measurement with the starter switch ON.

b) Dipped beam lights in neither left hand nor right hand headamps.



Electric wiring diagram for modes E-07 and E-08



#### **4. Precautions for Trouble Diagnosis of Electric System**

1. When disconnecting or connecting connectors or harnesses, cut the power supply.
2. Before making a diagnosis, check the connectors or harnesses for poor connection.  
Check connectors by repeating connection and disconnection practices several times.
3. Before proceeding to the subsequent step, reconnect removed connectors or harnesses in place.
4. When making diagnoses of circuit troubles (while performing measurement of voltage, resistance and current or continuity test, etc.), check to see if the tester readings vary by shaking connectors or harnesses.  
If readings vary, a possible cause is a poor connection of the circuit.
5. For voltage measurement, turn the starter switch ON. For resistance checking, set the switch to the OFF position.  
If necessary to take a measurement of resistance by energizing relays or other units with the starter switch ON, the instruction to do so is given under the checking instruction box in the flow chart.

## 5. Trouble Diagnosis of Electric System (Mode E)

|      |  |       |
|------|--|-------|
| E-01 | Engine does not start. ....  | 4-202 |
| E-02 | Engine is not shut down. ....  | 4-206 |
| E-03 | Glow plugs do not become red-hot (Engine is hard to start). ....   | 4-207 |
| E-04 | No charging (Charge indicator lamp stays bright). ....   | 4-210 |
| E-05 | Backup buzzer does not sound or backup lamps do not light. ....  | 4-211 |
| E-06 | Horn does not sound. ....  | 4-212 |
| E-07 | Turn signal lamps do not light. ....   | 4-213 |
| E-08 | Headlamps, side marker lamps and tail lamps do not light. ....   | 4-215 |
| E-09 | Stop lamps do not light. ....  | 4-217 |
| E-10 | Flood lamps do not light. ....   | 4-218 |
| E-11 | F-R lever neutral position retention valve is at fault. ....   | 4-219 |
| E-12 | Poor parking brake function. ....  | 4-220 |
| E-13 | Timer sprinkling not selected. ....  | 4-221 |
| E-14 | Low-High speed range not selected. ....  | 4-223 |
| E-15 | Fuel gauge reads wrong. ....   | 4-224 |
| E-16 | Coolant temperature gauge reads wrong. ....  | 4-225 |
| E-17 | Tachometer reads wrong. ....   | 4-226 |
| E-18 | Charge warning lamp, engine oil pressure warning lamp, hydraulic oil filter warning lamp and parking brake indicator lamp do not light with the starter switch ON. ... | 4-227 |

### Identification color of wire

**▲ NOTE:** Size of wire not indicated in the diagram is AV 0.85.

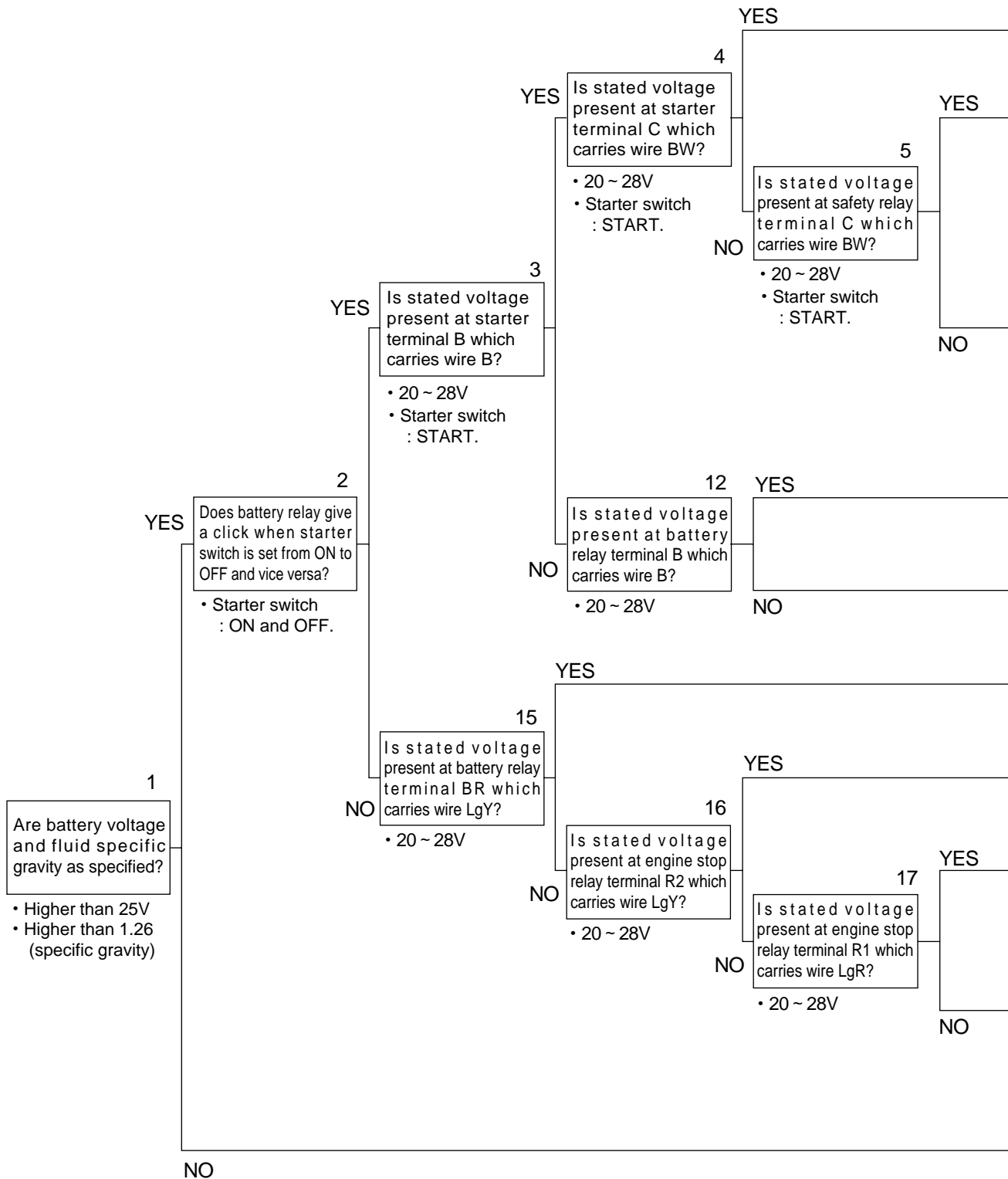
|     |                         |     |                         |     |                              |     |                               |    |                         |    |                         |
|-----|-------------------------|-----|-------------------------|-----|------------------------------|-----|-------------------------------|----|-------------------------|----|-------------------------|
| B   | Black                   | BrY | Brown/<br>Yellow stripe | L   | Blue                         | LgW | Light green/<br>White stripe  | W  | White                   | YG | Yellow/<br>Green stripe |
| BR  | Black/<br>Red stripe    | G   | Green                   | LB  | Blue/<br>Black stripe        | LgY | Light green/<br>Yellow stripe | WB | White/<br>Black stripe  | YL | Yellow/<br>Blue stripe  |
| BW  | Black/<br>White stripe  | GB  | Green/<br>Black stripe  | LR  | Blue/<br>Red stripe          | R   | Red                           | WG | White/<br>Green stripe  | YR | Yellow/<br>Red stripe   |
| BY  | Black/<br>Yellow stripe | GL  | Green/<br>Blue stripe   | LW  | Blue/<br>White stripe        | RB  | Red/<br>Black stripe          | WL | White/<br>Blue stripe   | YW | Yellow/<br>White stripe |
| Br  | Brown                   | GR  | Green/<br>Red stripe    | LY  | Blue/<br>Yellow stripe       | RG  | Red/<br>Green stripe          | WR | White/<br>Red stripe    | Gy | Gray                    |
| BrB | Brown/<br>Black stripe  | GW  | Green/<br>White stripe  | Lg  | Light green                  | RL  | Red/<br>Blue stripe           | WY | White/<br>Yellow stripe | O  | Orange                  |
| BrR | Brown/<br>Red stripe    | GY  | Green/<br>Yellow stripe | LgB | Light green/<br>Black stripe | RW  | Red/<br>White stripe          | Y  | Yellow                  | Sb | Sky blue                |
| BrW | Brown/<br>White stripe  |     |                         | LgR | Light green/<br>Red stripe   | RY  | Red/<br>Yellow stripe         | YB | Yellow/<br>Black stripe | P  | Pink                    |

## E-01 Engine does not start

Set the F-R lever to the neutral position.

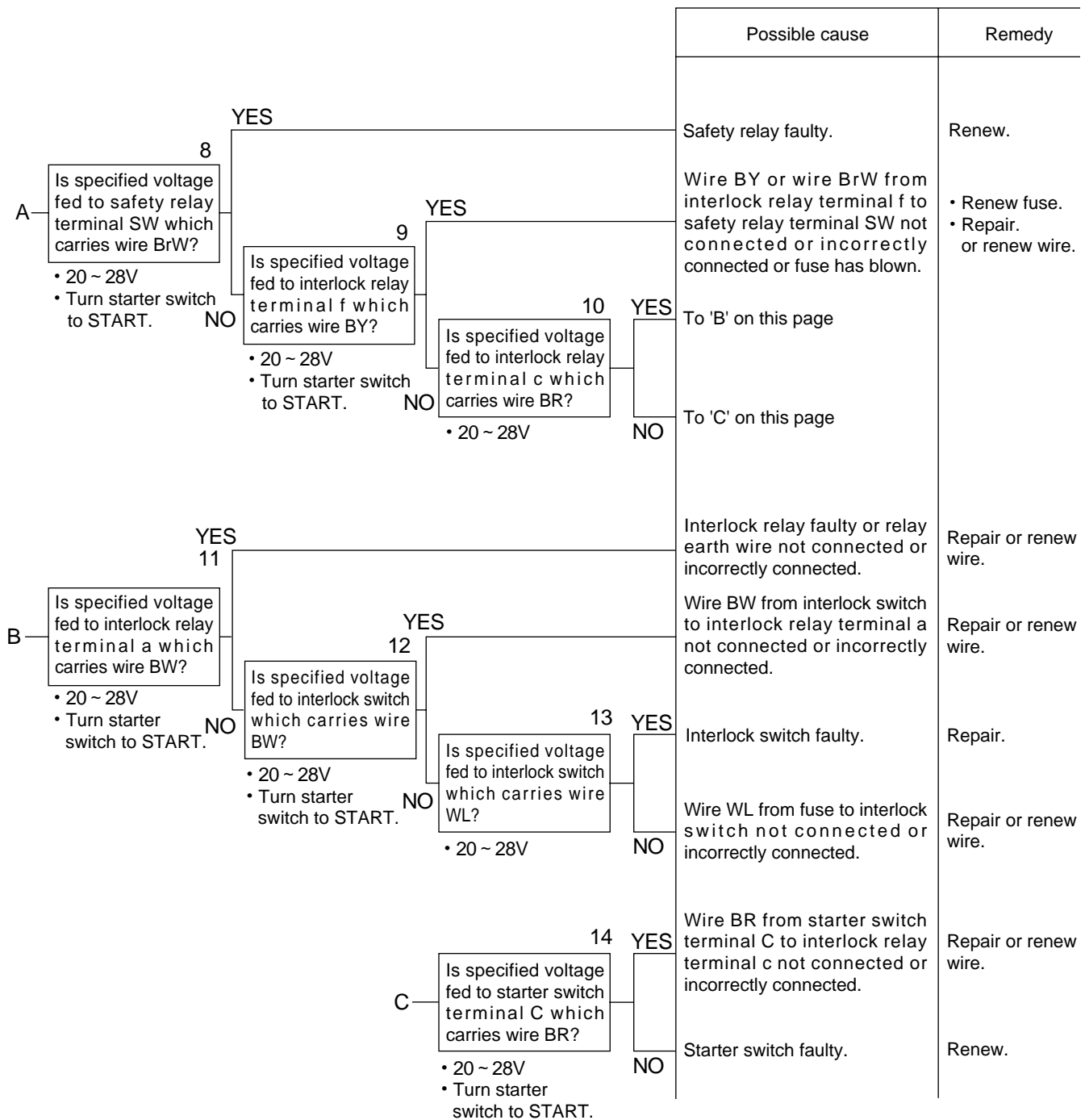
For voltage measurement, turn the starter switch ON.

a) Starter motor does not operate. (1/3)



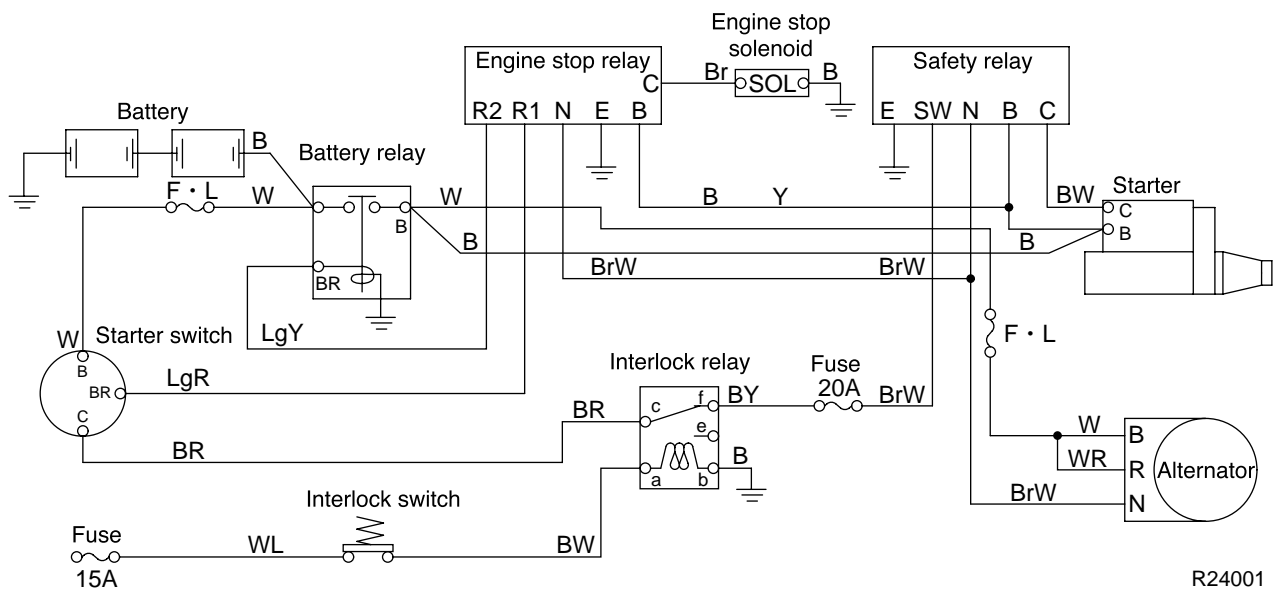
|   | Possible cause   | Remedy                |
|---|--|-----------------------|
|   | Starter faulty.  | Renew.                |
|   | Wire BW from safety relay terminal C to starter terminal C not connected or incorrectly connected.               | Repair or renew wire. |
| <p style="text-align: center;">7</p> <p style="text-align: center;">YES</p> | To 'A' on page 4-204   |                       |
| <p style="text-align: center;">6</p> <p style="text-align: center;">YES</p> | Wire BY from safety relay terminal B to starter terminal B not connected or incorrectly connected.               | Repair or renew wire. |
| <p style="text-align: center;">6</p> <p style="text-align: center;">NO</p>  | Alternator faulty (including regulator).   | Renew.                |
| <p style="text-align: center;">7</p> <p style="text-align: center;">NO</p>  | Wire B from battery relay to starter terminal B not connected or incorrectly connected.                          | Repair or renew wire. |
|   | Battery relay contact faulty.  | Renew.                |
|   | Battery relay winding faulty.  | Renew.                |
|   | Wire LgY from engine stop relay terminal R2 to battery relay terminal BR not connected or incorrectly connected. | Repair or renew wire. |
|   | To 'D' on page 4-205   |                       |
|   | To 'E' on page 4-205   |                       |
|   | Battery capacity lowered.  | Charge or renew.      |

a) Starter motor does not operate. (2/3)



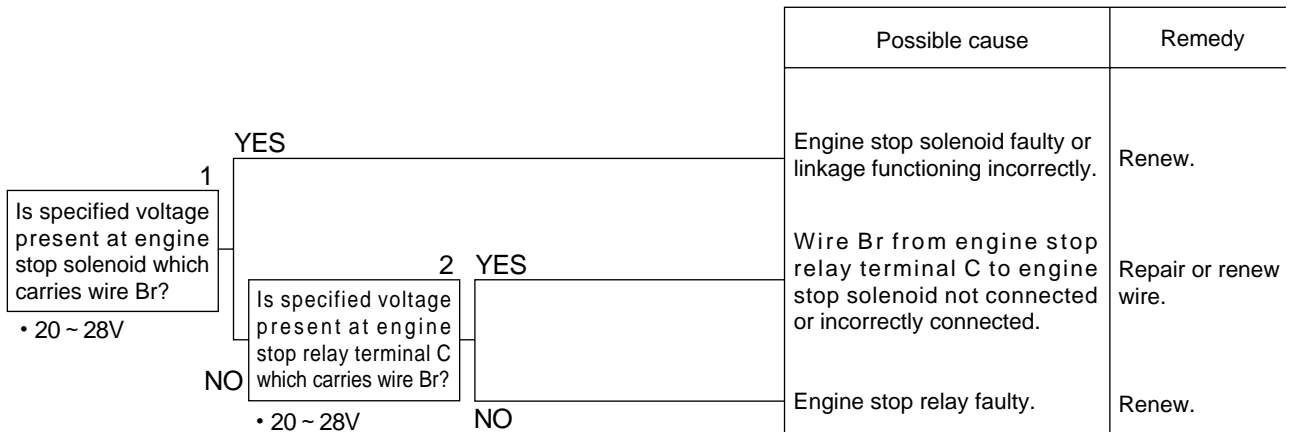
a) Starter motor does not operate. (3/3)

|   |   | Possible cause  | Remedy   |                       |
|---|---|---|--|-----------------------|
| D | 18 YES<br>Is specified voltage fed to engine stop relay terminal B which carries wire BY?<br>• 20 ~ 28V | Engine stop relay faulty.   | Renew.   |                       |
|   | NO  | Wire BY from engine stop relay terminal B to starter terminal B not connected or incorrectly connected.           | Repair or renew wire.  |                       |
| E | 19 YES<br>Is specified voltage fed to starter switch terminal BR which carries wire LgR?<br>• 20 ~ 28V  | Wire LgR from starter switch terminal BR to engine stop relay terminal R1 not connected or incorrectly connected. | Repair or renew wire.  |                       |
|   | NO  | 20 YES<br>Is specified voltage fed to starter switch terminal B which carries wire W?<br>• 20 ~ 28V               | Starter switch faulty (between B and BR).  | Renew.                |
|   |   | 21 YES<br>Is specified voltage fed to battery relay which carries wire B?<br>• 20 ~ 28V                           | Wire W from battery relay to starter switch terminal B not connected or incorrectly connected. | Repair or renew wire. |
|   |   | NO  | Wire B from battery to battery relay not connected or incorrectly connected.                   | Repair or renew wire. |



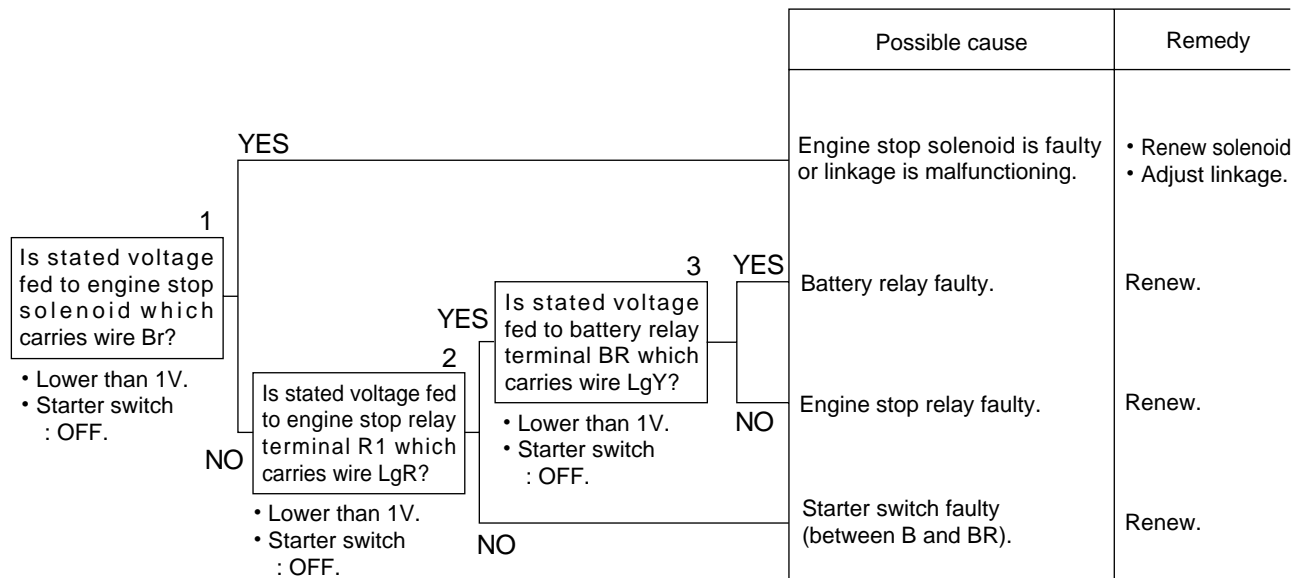
R24001

- b) Engine stop solenoid does not operate.  
 Set the F-R lever to the neutral position.  
 For voltage measurement, turn the starter switch ON.



### E-02 Engine is not shut down.

Measure the voltage with the starter switch OFF.



For electric wiring diagram, see page 4-205.

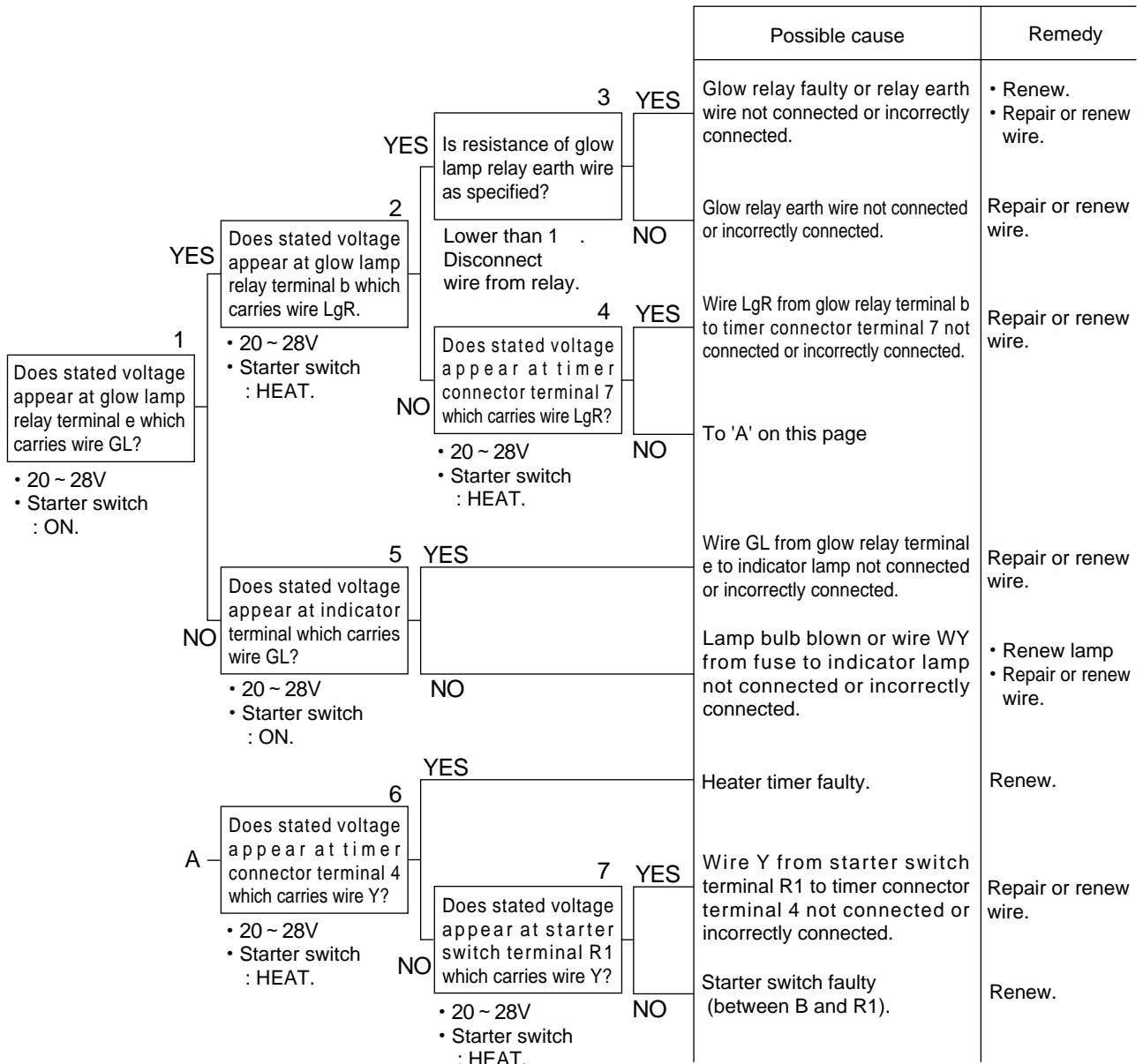


### E-03 Glow plugs do not become red-hot (Engine is hard to start).

It is assumed that the starter operation is normal.  
Measure the voltage with the starter switch ON.  
Check to see first if the fuse has burnt.

a) Glow indicator lamp does not become bright.

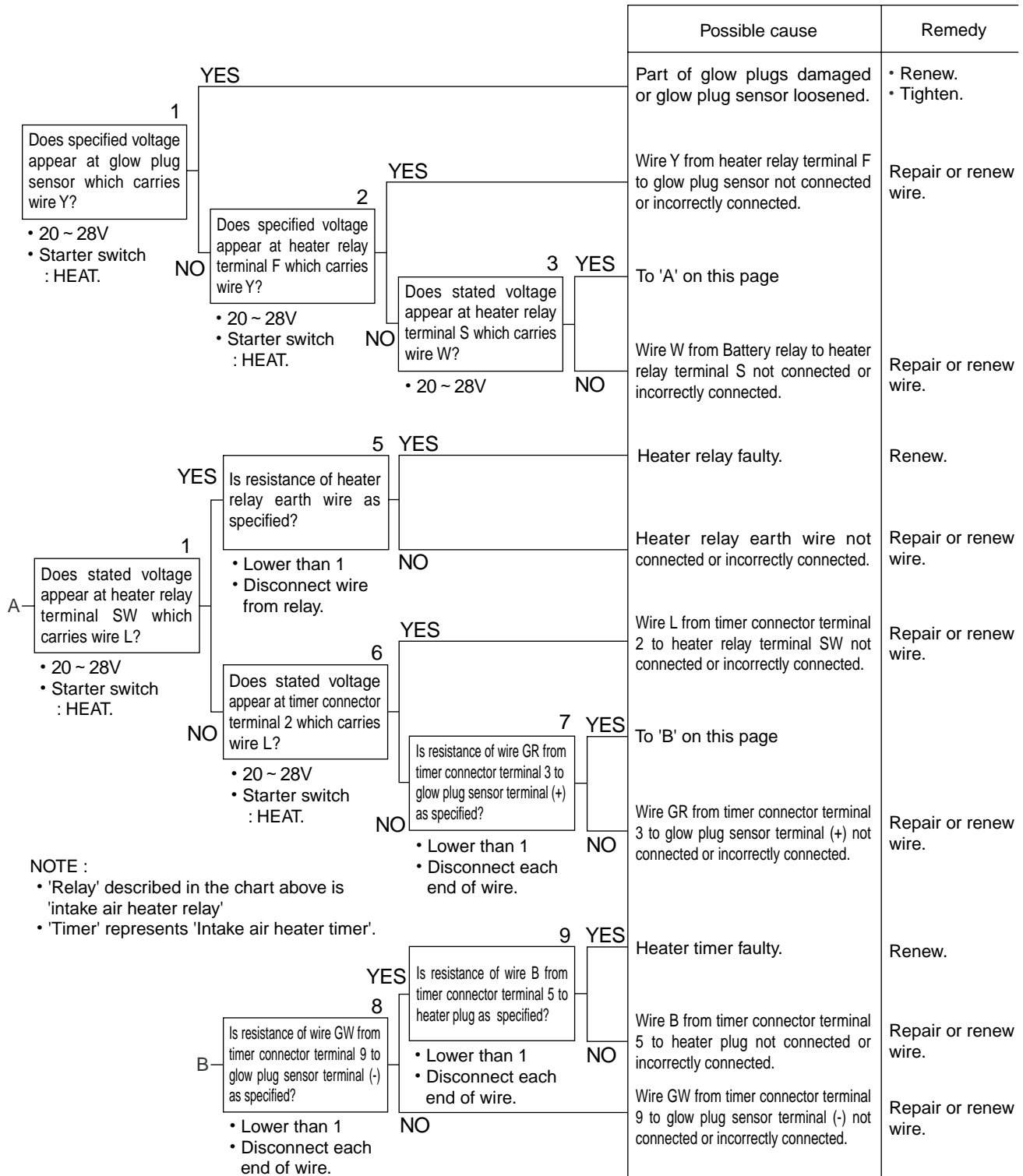
The glow indicator lamp should light when the starter switch is turned to the HEAT position, and come off when preheating is complete.



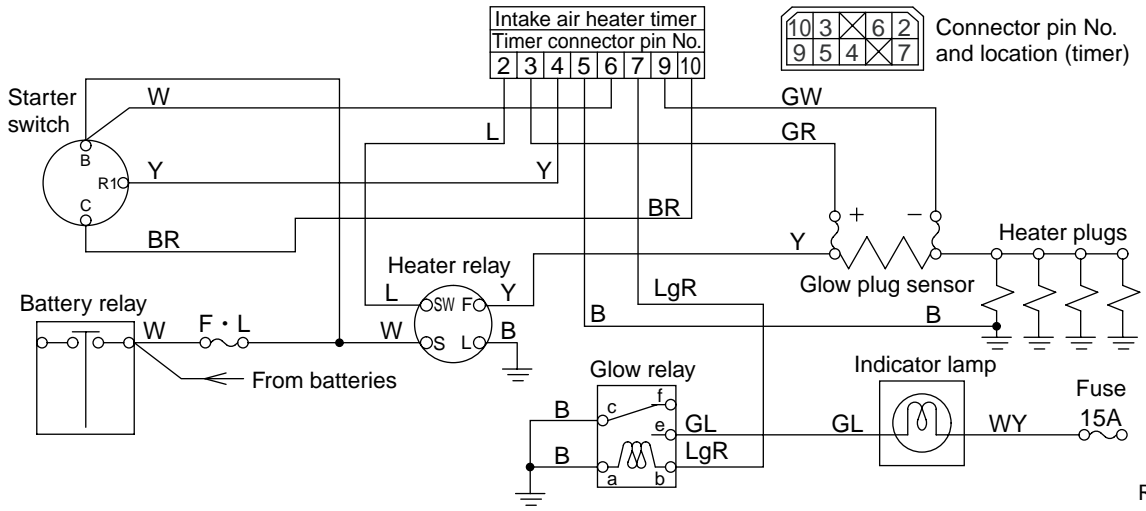
NOTE :

- 'Heater relay' described in the chart above is 'Intake air heater relay'.
- 'Timer' represents 'intake air heater timer'.

b) Glow plugs do not become red-hot.  
Glow lamp becomes bright.



Electric wiring diagram for mode E-03

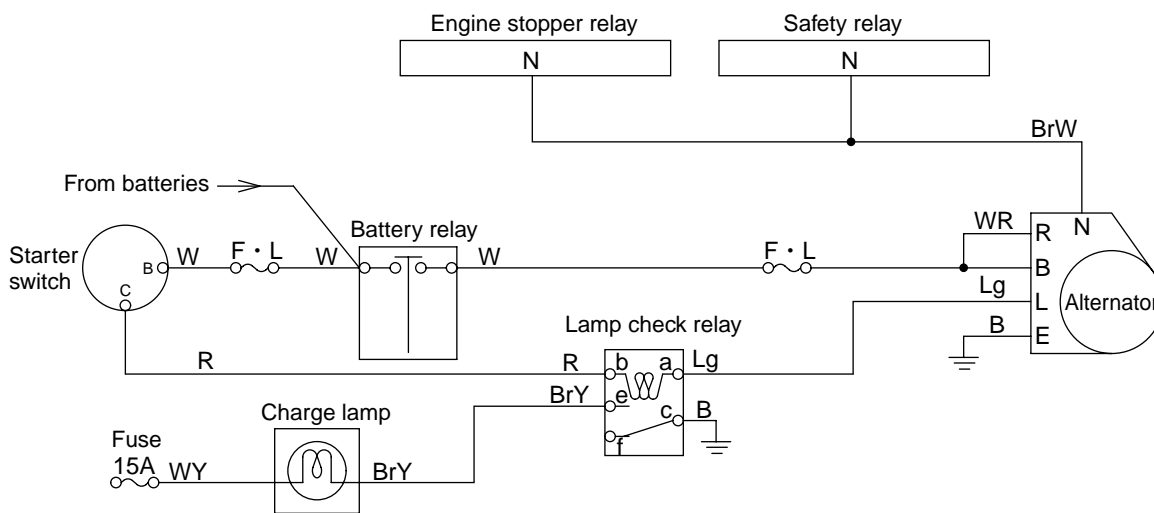


### E-04 No charging (Charge indicator lamp stays bright)

Check first that the fuse has burnt.

|  |     | Possible cause  | Remedy   |   |
|--|-----|---|--|---|
| <p><b>1</b></p> <p>Does specified voltage appear at alternator terminal L which carries wire Lg?</p> <ul style="list-style-type: none"> <li>• 27.5 ~ 29.5V</li> <li>• Run engine at higher than medium speed.</li> </ul> | YES | Lamp check relay faulty.  | Renew.   |   |
|  | NO  | <p><b>2</b></p> <p>Does specified voltage appear at alternator terminal B which carries wire W?</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> <li>• Starter switch : ON</li> </ul> | <p>YES</p> <p><b>3</b></p> <p>Is resistance of alternator earth wire as specified?</p> <ul style="list-style-type: none"> <li>• Lower than 1 Ω</li> <li>• Disconnect wires from alternator.</li> </ul> | <p>YES</p> <p>Alternator faulty.</p> <p>Renew.</p>        |
|  |     | NO  | <p>NO</p> <p>Alternator earth wire not connected or incorrectly connected.</p> <p>Wire W from battery relay to alternator terminal B not connected or incorrectly connected.</p>                       | <p>Repair or renew wire.</p> <p>Repair or renew wire.</p> |

Electric wiring diagram for mode E-04



R24003

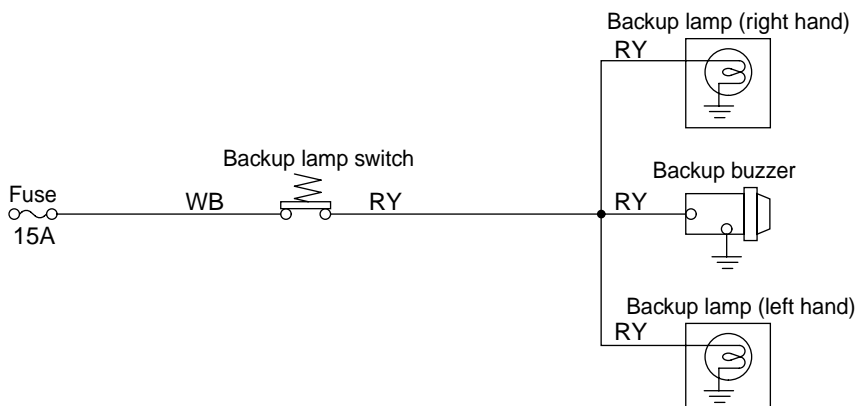
### E-05 Backup buzzer does not sound or backup lamps do not come on.

Check first that the fuse has blown.

Take the voltage measurement with the starter switch ON.

|                            |   | Possible cause   | Remedy  |
|----------------------------|---|--|---|
| 1<br>Which is inoperative? | Backup buzzer is inoperative.   | 2 YES<br>Does specified voltage appear at backup buzzer which carries wire RY?<br>• 20 ~ 28V<br>• F-R lever : BACKWARD.              | Backup buzzer faulty or backup buzzer earth wire not connected or incorrectly connected.<br>• Renew buzzer.<br>• Repair or renew wire.      |
|                            |   | NO   | Wire RY from backup buzzer to backup lamp switch (buzzer to branch point) not connected or incorrectly connected.<br>Repair or renew wire.  |
|                            | Either right hand backup lamp or left hand one is faulty.   | 3 YES<br>Does specified voltage appear at backup lamp which carries wire RY?<br>• 20 ~ 28V<br>• F-R lever : BACKWARD.                | Backup lamp faulty or backup lamp earth wire not connected or incorrectly connected.<br>• Renew buzzer.<br>• Repair or renew wire.          |
|                            |   | NO   | Wire RY from backup lamp to backup lamp switch (lamp to branch point) not connected or incorrectly connected.<br>Repair or renew wire.      |
|                            | Both lamps are inoperative.   | 4 YES<br>Is specified voltage present at backup lamp switch terminal which carries wire RY?<br>• 20 ~ 28V<br>• F-R lever : BACKWARD. | Wire RY from backup lamp switch to backup lamp (from lamp to branch point) not connected or incorrectly connected.<br>Repair or renew wire. |
| NO                         |   | To 'A' on this page  |   |
| A                          | 5 YES<br>Is specified voltage present at backup lamp switch terminal which carries wire WB?<br>20 ~ 28V | Backup lamp switch faulty.<br>Renew.   |   |
|                            | NO  | Wire WB from backup lamp switch to fuse not connected or incorrectly connected (including fuse).<br>Repair or renew wire.            |   |

#### Electric wiring diagram for mode E-05



R24004

### E-06 Horn does not sound.

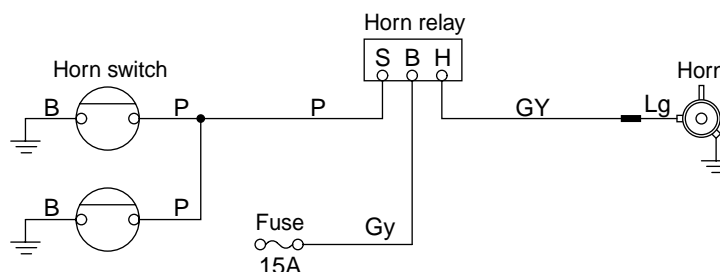
Check to see first if fuse has blown.

Take the voltage measurement with the starter switch ON.

If the horn does not sound with one of the two horn switches actuated, possible cause is defective switch or the wire from the switch to horn relay (switch to branch point) not connected or incorrectly connected.

|  |  | Possible cause   | Remedy                |
|--|--|--|-----------------------|
| <p>1</p> <p>Is stated voltage present at horn terminal which carries wire GY?</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> <li>• Horn switch : ON</li> </ul>                   | <p>2 YES</p> <p>Is resistance of horn earth wire as specified?</p>   | Horn faulty.   | Renew.                |
|  | <p>NO</p> <ul style="list-style-type: none"> <li>• Lower than 1</li> <li>• Disconnect wire from horn.</li> </ul>                           | Horn earth wire not connected or incorrectly connected.  | Repair or renew wire. |
| <p>NO</p> <p>3</p> <p>Is stated voltage present at horn relay terminal H which carries wire GY?</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> <li>• Horn switch : ON</li> </ul> | <p>YES</p> <p>4 YES</p> <p>Is stated voltage present at horn relay terminal B which carries wire Gy?</p>                                   | Wire GY from horn to horn relay terminal H not connected or incorrectly connected.                     | Repair or renew wire. |
|  | <p>NO</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> </ul>   | <p>NO</p> <p>4 NO</p> <p>Is stated voltage present at horn relay terminal B which carries wire Gy?</p> | To 'A' on this page   |
| <p>NO</p> <p>5</p> <p>Is stated voltage present at horn switch terminal which carries wire P?</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> <li>• Horn switch : OFF</li> </ul>  | <p>YES</p> <p>6</p> <p>Is resistance between horn switch terminals as specified?</p>   | Wire Gy from horn relay terminal B to fuse not connected or incorrectly connected.                     | Repair or renew wire. |
|  | <p>NO</p> <ul style="list-style-type: none"> <li>• Lower than 1 when switched ON.</li> <li>• Disconnect wires from horn switch.</li> </ul> | <p>YES</p> <p>7 YES</p> <p>Is resistance of horn switch earth wire as specified?</p>                   | Horn relay faulty.    |
| <p>NO</p> <p>8</p> <p>Is stated voltage present at horn relay terminal S which carries wire P?</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> <li>• Horn switch : OFF</li> </ul> | <p>NO</p> <p>6 NO</p> <ul style="list-style-type: none"> <li>• Lower than 1</li> <li>• Disconnect wire from horn switch.</li> </ul>        | Horn switch earth wire not connected or incorrectly connected.   | Repair or renew wire. |
|  | <p>YES</p> <p>8 YES</p> <p>Is stated voltage present at horn relay terminal S which carries wire P?</p>                                    | Horn switch faulty.  | Renew.                |
|  | <p>NO</p> <p>8 NO</p> <p>Is stated voltage present at horn relay terminal S which carries wire P?</p>                                      | Wire P from horn relay terminal S to horn switch not connected or incorrectly connected.               | Repair or renew wire. |
|  |  | Horn relay faulty.   | Renew.                |

Electric wiring diagram for mode E-06

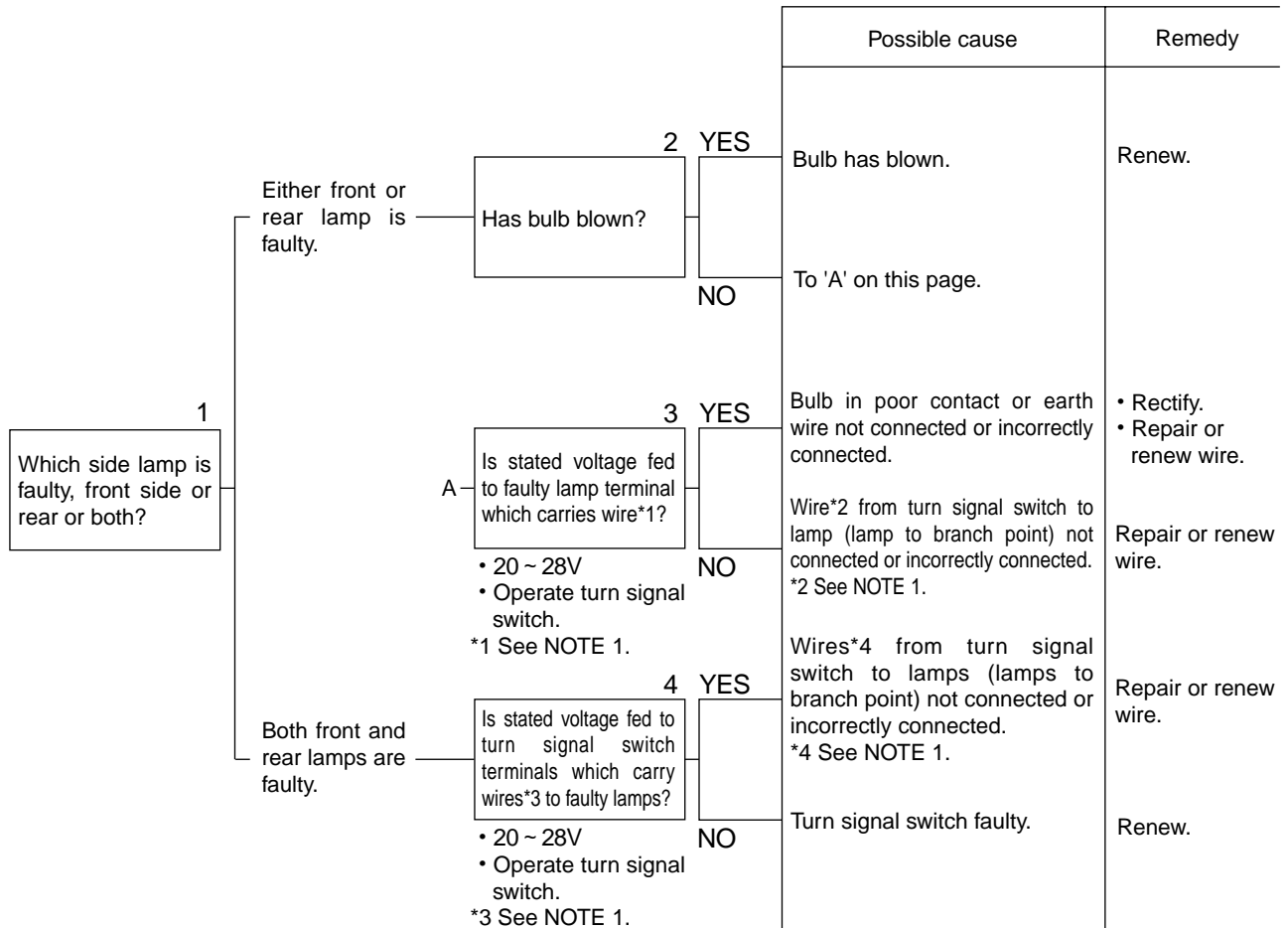


R24005

### E-07 Turn signal lamps do not come on.

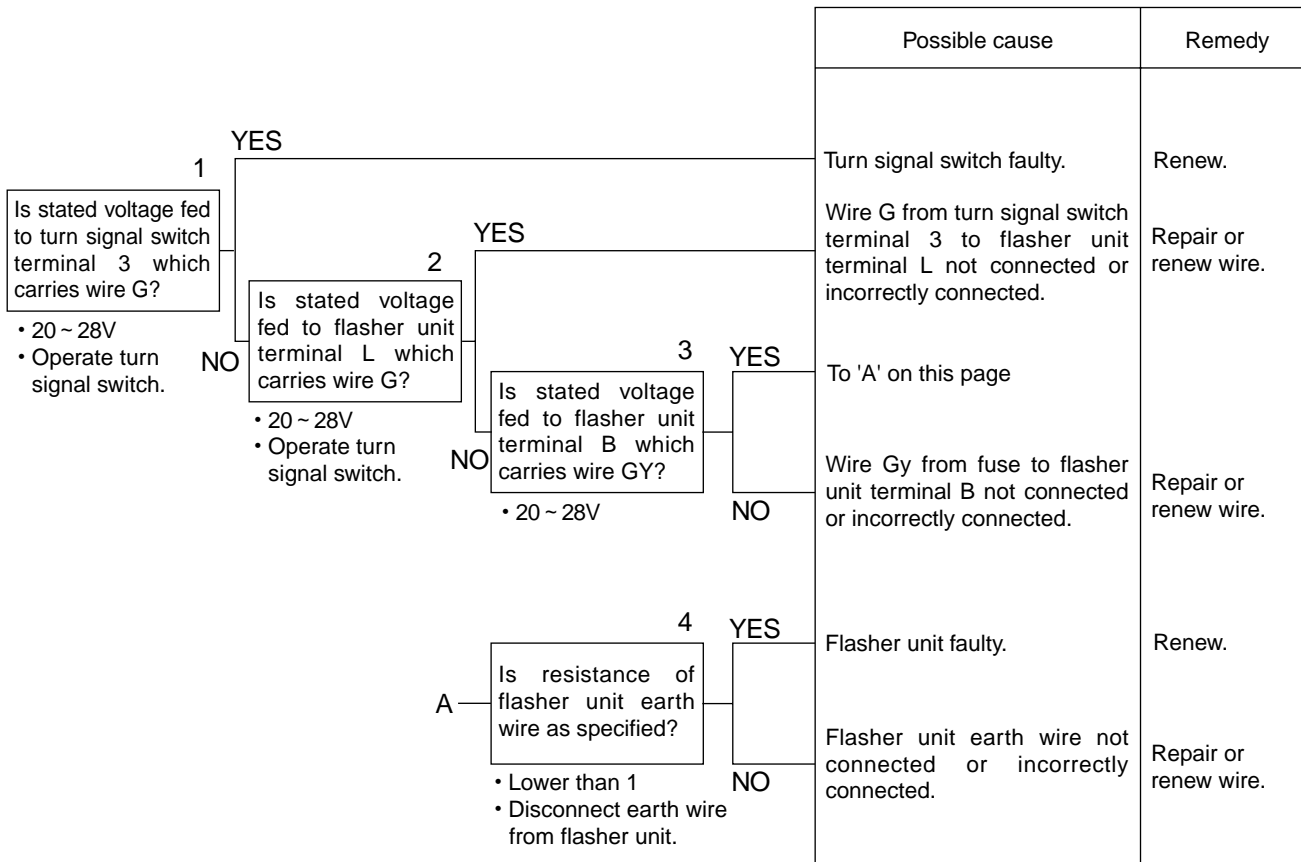
Ensure first that fuse has not blown.  
 Measure the voltage with the starter switch ON.

a) Either right hand or left hand lamp does not come on.

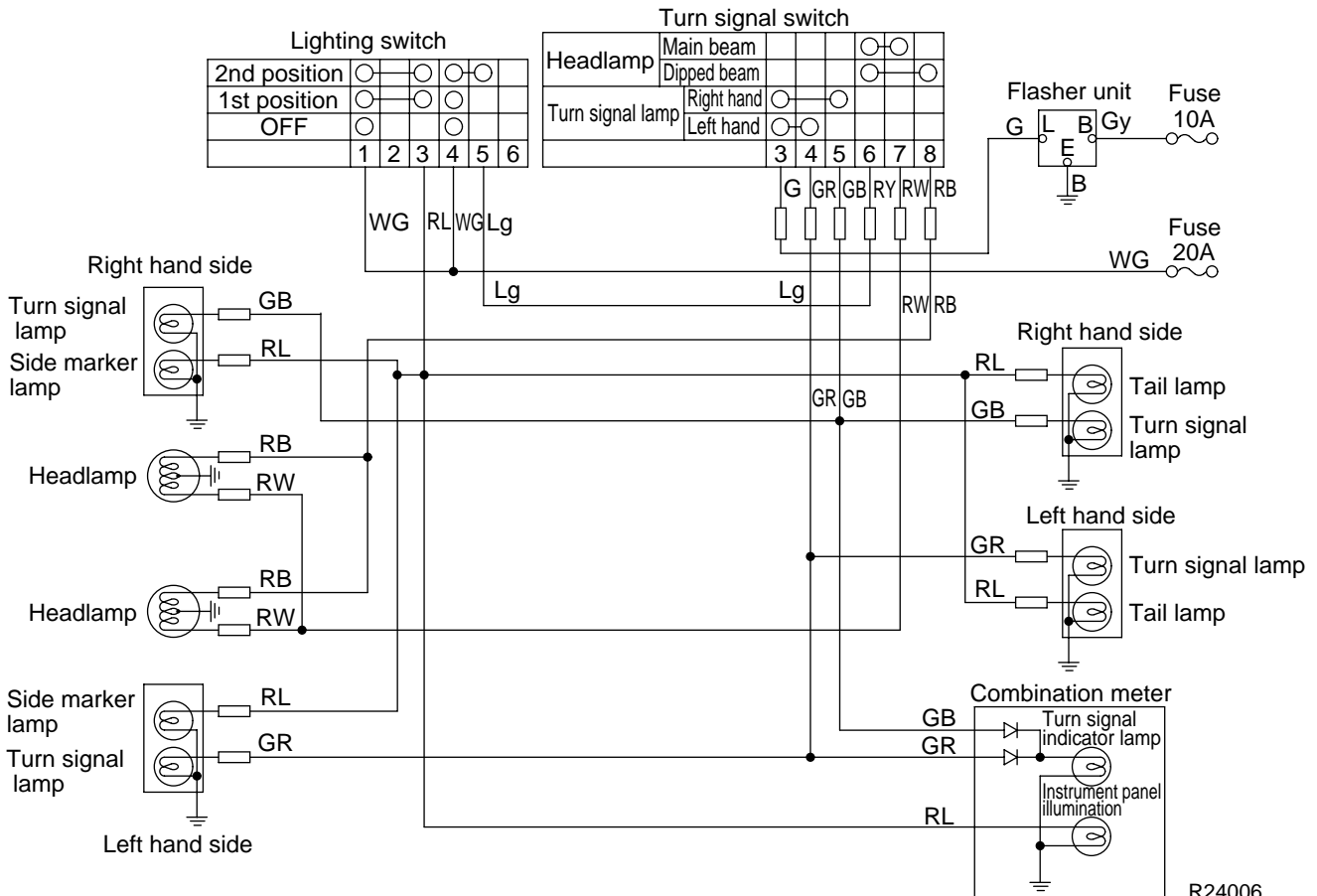


NOTE 1 :  
 Left hand :  
 GR (front and rear)  
 Right hand :  
 GB (front and rear)

b) Neither right hand nor left hand turn signal lamp flash.



Electric wiring diagram for modes E-07 and E-08

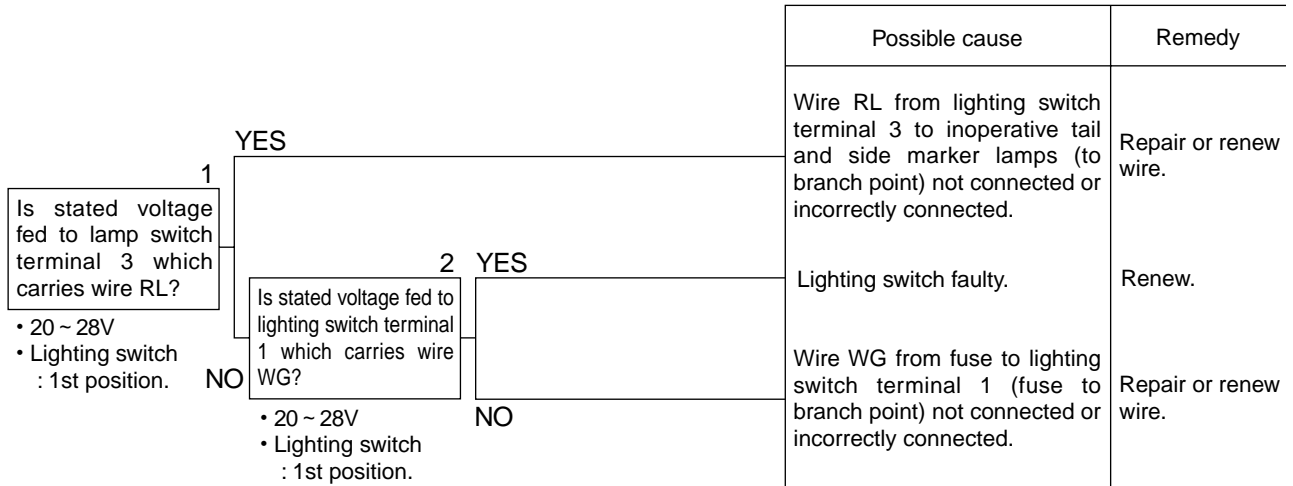




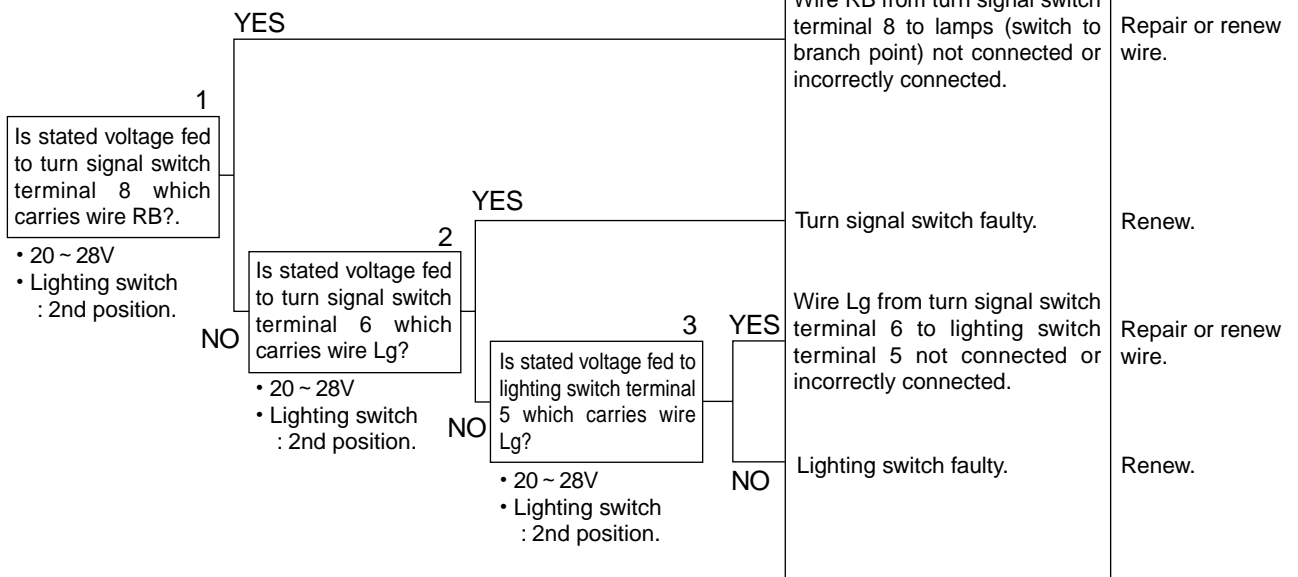
### E-08 Headlamps, side marker lamps and tale lamps do not light.

Ensure first that the fuse has not blown.  
 Measure the voltage with the starter switch ON.

a) Side marker lamps and tail lamps do not come on.



b) Dipped beam in right hand and left hand lamps does not light.  
 The side marker lamps come on.



c) Dipped beam only lights in either right hand or left hand lamp.

|   |   | Possible cause  | Remedy                              |
|---|---|---|-------------------------------------|
| 1 | YES<br>Has filament of bulb burnt?  | Bulb filament has burnt.  | Renew.                              |
|   | NO  |   |                                     |
|   | 2 YES<br>Is stated voltage fed to inoperative lamp terminal which carries wire RB?<br>• 20 ~ 28V<br>• Lighting switch : 2nd position. | Bulb in poor contact or its earth wire not connected or incorrectly connected.                                      | • Renew.<br>• Repair or renew wire. |
|   | NO  | Wire RB from turn signal switch terminal 8 to lamps (lamps to branch point) not connected or incorrectly connected. | Repair or renew wire.               |

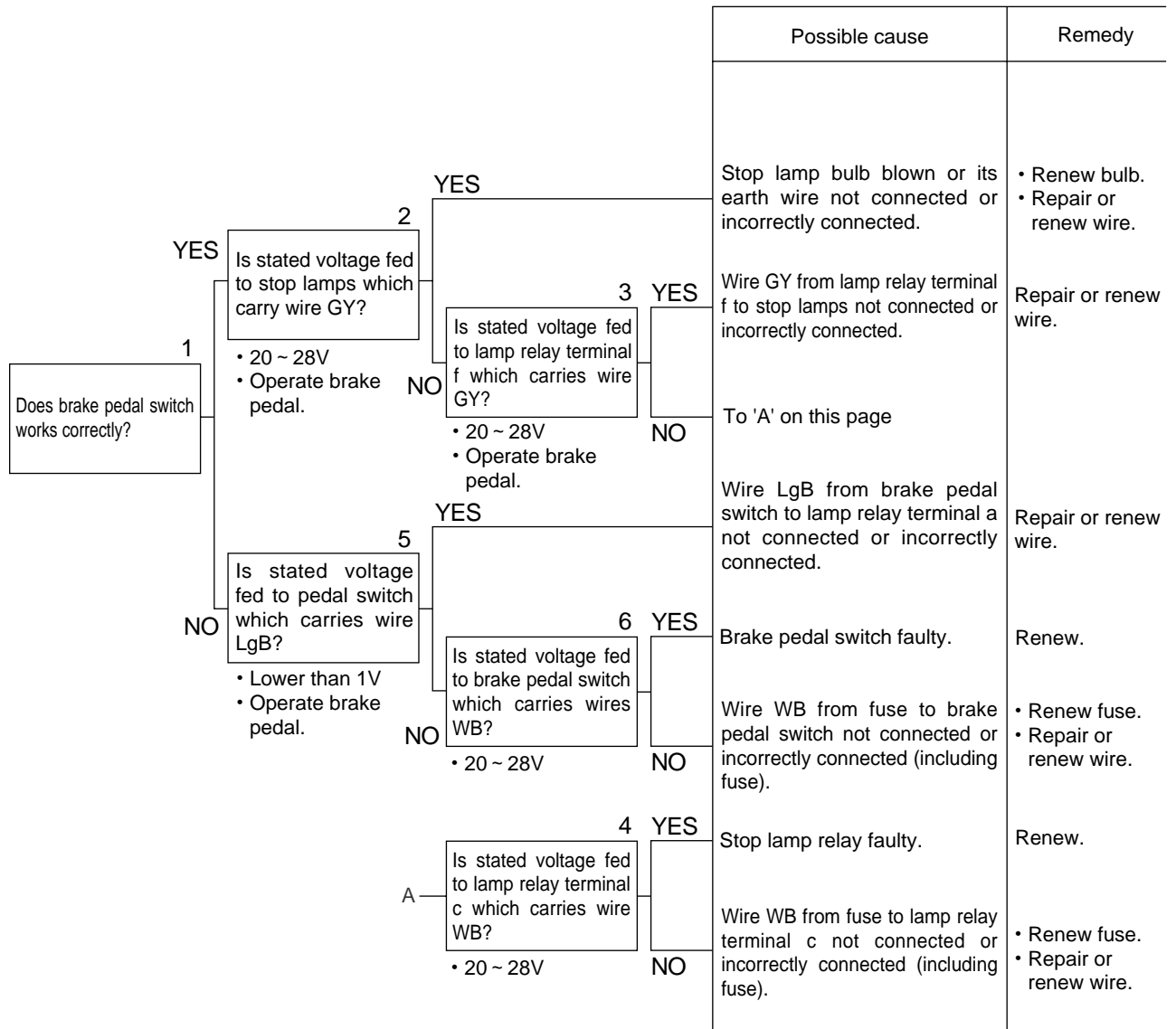
d) Main beam not selected.

|   |  |   |   |                                     |
|---|--|---|---|-------------------------------------|
| 1 | Either right hand or left hand lamp is at fault .  | 2 YES<br>Has bulb filament burnt?   | Bulb filament has burnt.  | Renew.                              |
|   |  | NO  | To 'A' on this page   |                                     |
| A | 3 YES<br>Is stated voltage fed to faulty lamp terminal which carries wire RW?<br>• 20 ~ 28V<br>• Operate turn signal switch. |   | Bulb in poor contact or its earth wire not connected or incorrectly connected.                                      | • Renew.<br>• Repair or renew wire. |
|   |  | NO  | Wire RW from lamp to turn signal switch terminal 7 (lamp to branch point) not connected or incorrectly connected.   | Repair or renew wire.               |
|   | Both right hand and left hand lamps are at fault.  | 4 YES<br>Is stated voltage fed to turn signal switch terminal 7 which carries wire RW?<br>• 20 ~ 28V<br>• Operate turn signal switch. | Wire RW from turn signal switch terminal 7 to lamps (switch to branch pint) not connected or incorrectly connected. | Repair or renew wire.               |
|   |  | NO  | Turn signal switch faulty.  | Renew.                              |

See page 4-214 for electric wiring diagram of mode E-07.

### E-09 Stop lamps do not light

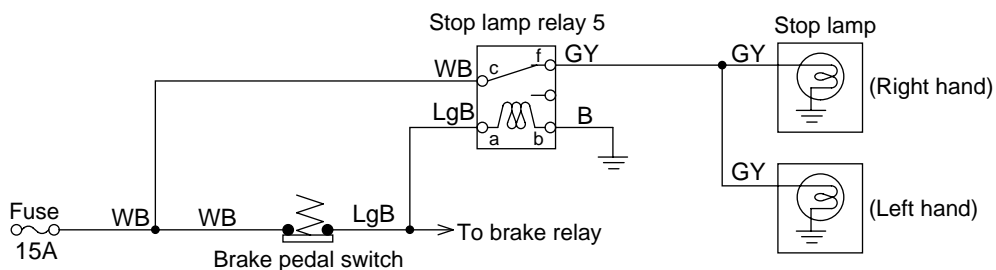
Ensure first that the fuse has not blown.  
Measure the voltage with the starter switch ON.



Relationship between brake pedal switch and stop lamp relay

|                            | Brake pedal switch | Stop lamp relay |
|----------------------------|--------------------|-----------------|
| Brake pedal: Depressed     | Contact: Opens     | Contact: Closes |
| Brake pedal: Not depressed | Contact: Closes    | Contact: Opens  |

### Electric wiring diagram for mode E-09



R24007

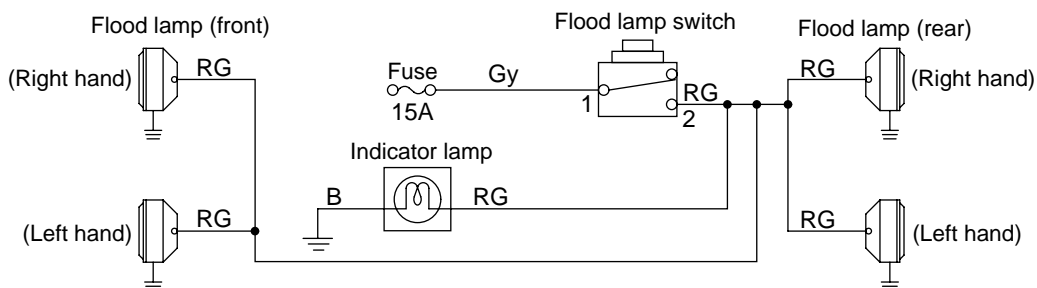
### E-10 Flood lamps do not light.

Check first to see if the fuse has blown.  
 Measure the voltage with the starter switch ON.

a) Neither left hand lamp nor right hand lamp come on.

|                                     |  | Possible cause   | Remedy                                   |
|-------------------------------------|--|--|--|
| 1<br>Which lamp is inoperative?     | Both front and rear lamps.   | 2 YES<br>Is stated voltage fed to flood lamp switch terminal 2 which carries wires RG?<br>• 20 ~ 30V<br>• Actuate flood lamp switch. | Repair or renew wire.                    |
|                                     |  | NO<br>To 'A' on this page  |  |
|                                     | A  | 3 YES<br>Is stated voltage fed to flood lamp switch terminal 1 which carries wires Gy?<br>20 ~ 30V                                   | Renew.                                   |
|                                     |  | NO<br>Wire Gy from fuse to flood lamp switch terminal 1 not connected or incorrectly connected.                                      | • Renew fuse.<br>• Repair or renew wire. |
|                                     | Either front or rear lamp  | Wire RG from lamps to flood lamp switch terminal 2 (lamps to branch point) not connected or incorrectly connected.                   | Repair or renew wire.                    |
| Either left hand or right hand lamp | 4 YES<br>Have flood lamps burnt?   | Flood lamps have burnt.  | Renew.                                   |
|                                     | NO<br>To 'B' on this page  |  |  |
|                                     | B  | 5 YES<br>Is stated voltage fed to flood lamps which carry wires RG?<br>• 20 ~ 30V<br>• Actuate flood lamp switch.                    | Repair or renew wire.                    |
|                                     | NO<br>Wire RG from flood lamps to flood lamp switch terminal 2 (lamps to branch point) not connected or incorrectly connected. | Repair or renew wire.  |  |

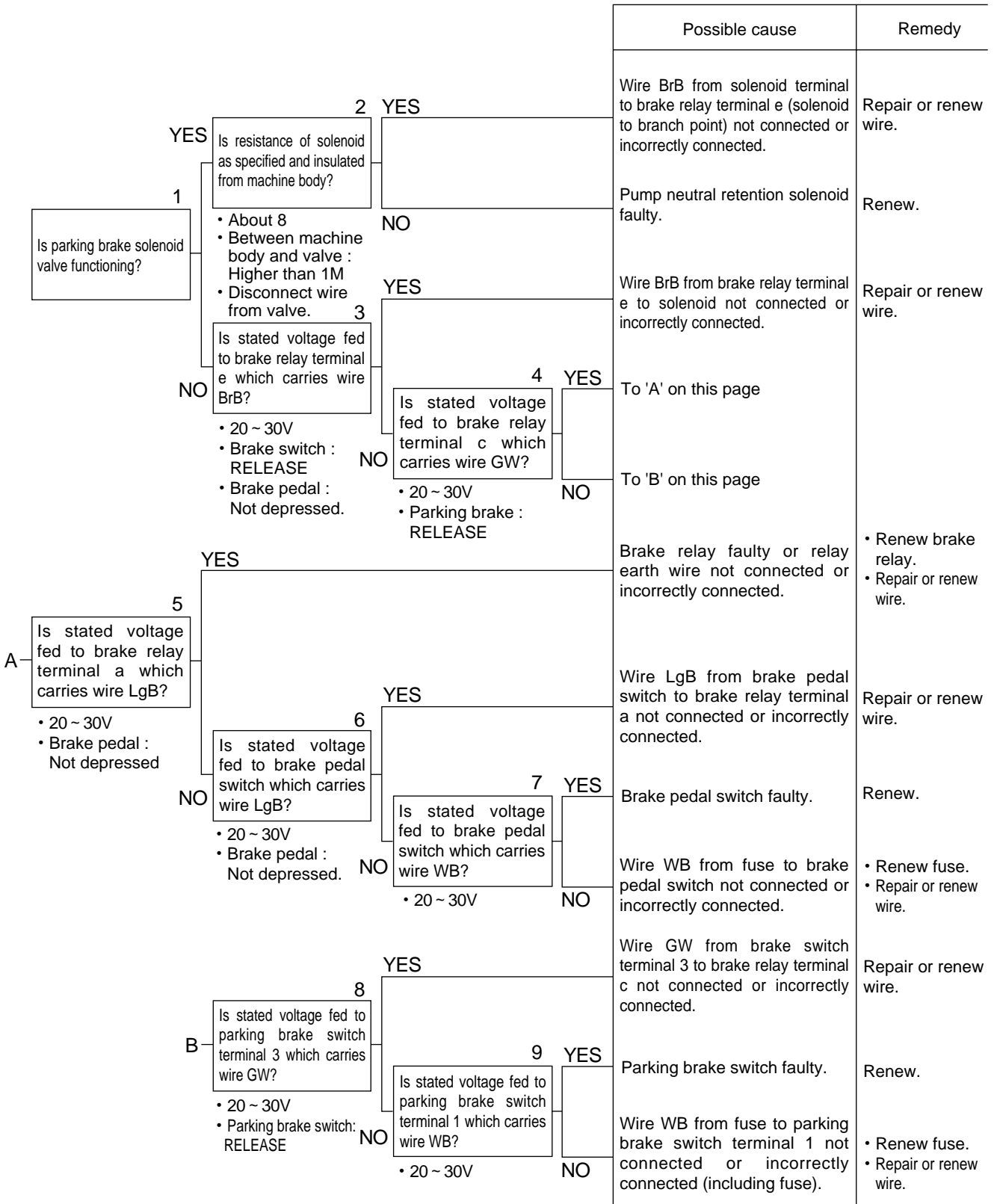
Electric wiring diagram for mode E-10



R24008

### E-11 Propulsion pump neutral retention valve is at fault.

Check to see first if the fuse has blown.  
 Measure the voltage with the starter switch ON.

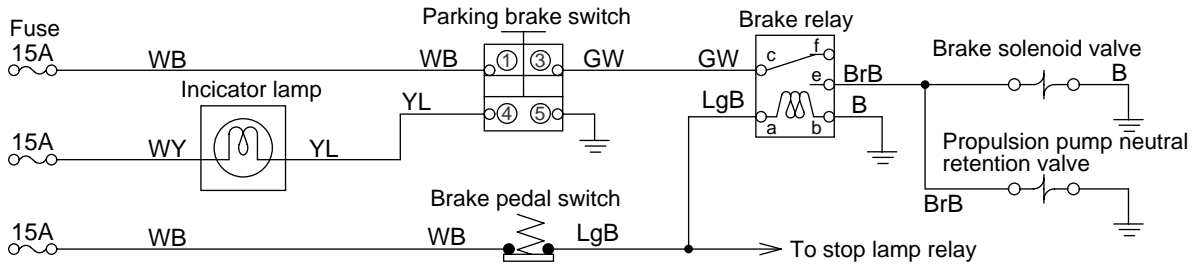


### E-12 Poor parking brake function

Check first to see if the fuse has blown.  
 Measure the voltage with the starter switch ON.

|  |     |  |   |
|--|-----|--|---|
| 1 YES<br>Is propulsion pump neutral retention valve functioning correctly?<br>NO | YES |  |   |
|  | NO  |  | Possible cause<br>Wire BrB from solenoid to brake relay terminal e (valve to branch point) not connected or incorrectly connected.<br>Diagnose starting from item 2 in mode E-11. |

### Electric wiring diagram for modes E-11 and E-12



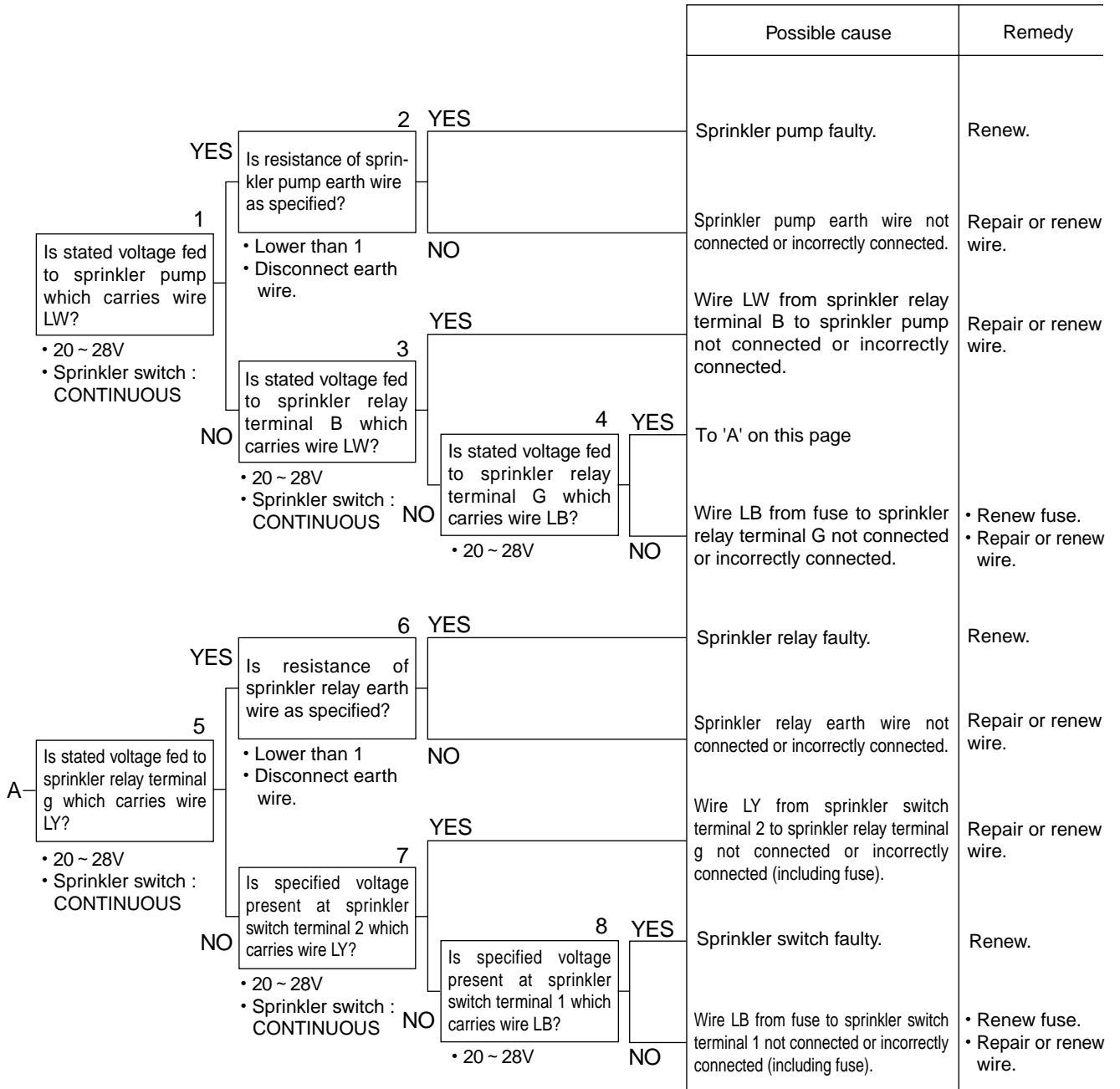
R24009

### E-13 Timer sprinkling not selected.

Ensure first that the fuse has not burnt.  
Measure the voltage with the starter switch ON.

a) Mode CONTINUOUS not selected

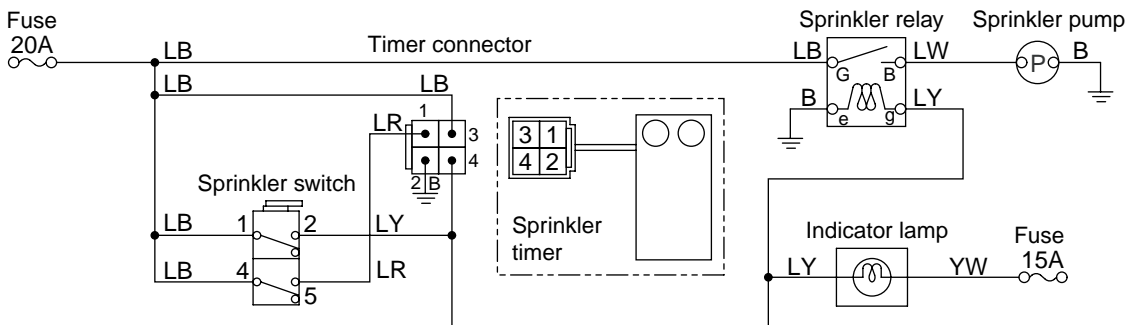
Set the sprinkler selector switch to the CONTINUOUS position.



b) Mode TIMER not selected.

|   |   | Possible cause  | Remedy   |                       |
|---|---|---|--|-----------------------|
| <p>1</p> <p>Is specified voltage present at timer connector 4 which carries wire LY?</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> <li>• Sprinkler switch : TIMER</li> </ul>           | YES   | Wire LY from timer connector 4 to sprinkler relay terminal g not connected or incorrectly connected.  | Repair or renew wire.  |                       |
|   | <p>2</p> <p>Is specified voltage present at timer connector 3 which carries wire LB?</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> </ul>                                     | YES   | To 'A' on this page  |                       |
|   |   | NO  | To 'B' on this page  |                       |
|   | <p>3</p> <p>Is specified voltage present at timer connector 1 which carries wire LR?</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> <li>• Sprinkler switch : TIMER</li> </ul> | YES   | Wire LB from fuse to timer connector 3 not connected or incorrectly connected. | Repair or renew wire. |
|   |   | NO  | Timer faulty.  | Renew.                |
|   | <p>4</p> <p>Is resistance of timer earth wire as specified?</p> <ul style="list-style-type: none"> <li>• Lower than 1 Ω</li> <li>• Disconnect earth wire.</li> </ul>                      | YES   | Timer earth wire not connected or incorrectly connected.                       | Repair or renew wire. |
| NO  |   | Wire LR from sprinkler switch terminal 5 to timer connector 1 not connected or incorrectly connected. | Repair or renew wire.  |                       |
| <p>5</p> <p>Is specified voltage present at sprinkler switch terminal 5 which carries wire LR?</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> <li>• Sprinkler switch : TIMER</li> </ul> | YES   | Sprinkler switch faulty.  | Renew.   |                       |
|   | NO  | Wire LB from fuse to sprinkler switch terminal 4 not connected or incorrectly connected.              | Repair or renew wire.  |                       |
| <p>6</p> <p>Is specified voltage present at sprinkler switch terminal 4 which carries wire LB?</p> <ul style="list-style-type: none"> <li>• 20 ~ 28V</li> </ul>                                     | YES   |   |  |                       |
|   | NO  |   |  |                       |

Electric wiring diagram for mode E-13

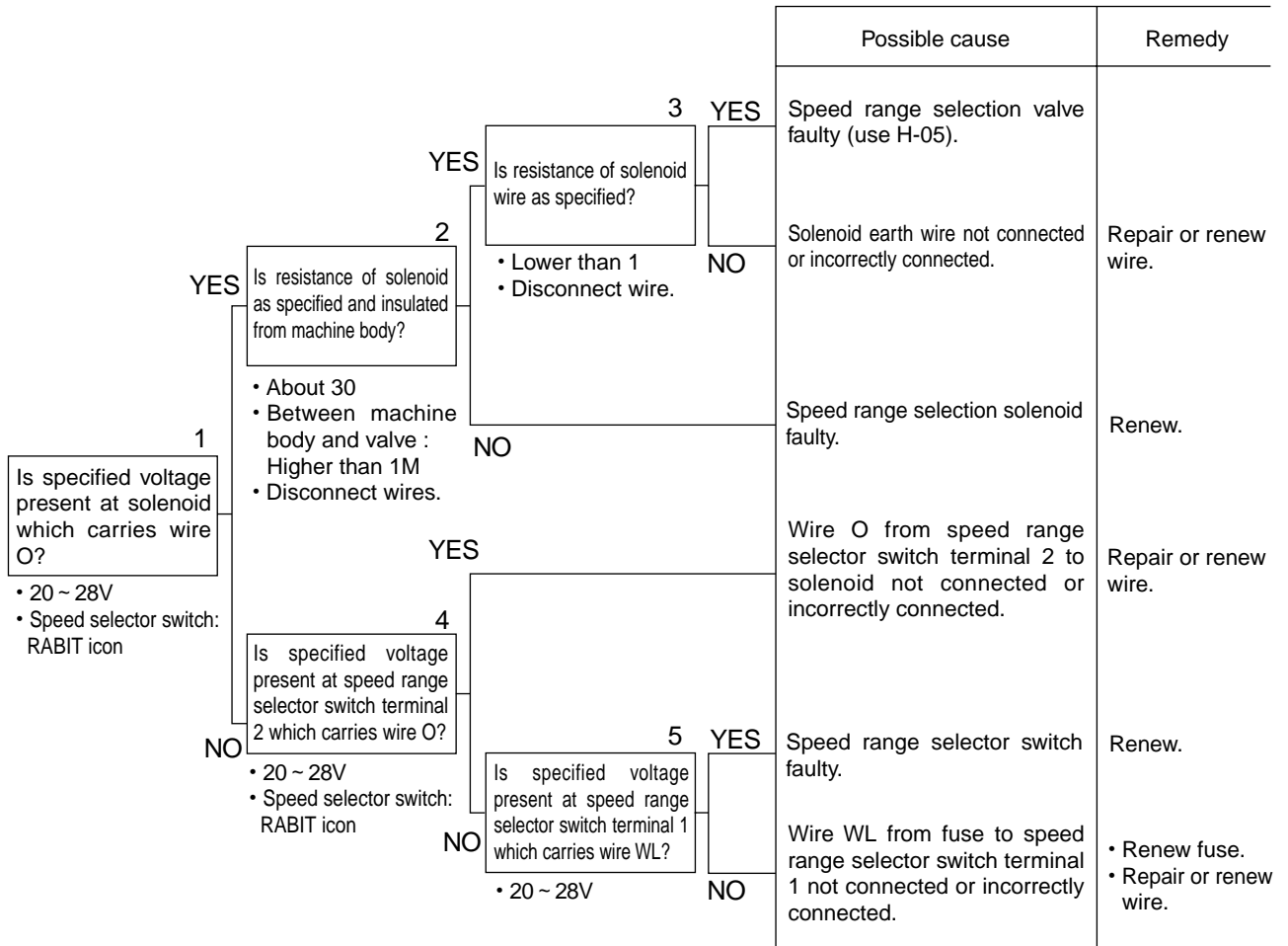


R24010

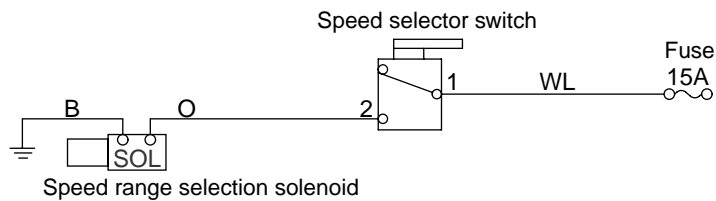


### E-14 Low-High speed range not selected

Ensure first that the fuse has not burnt.  
 Measure the voltage with the starter switch ON.



Electric wiring diagram for mode E-14



R24011

### E-15 Fuel gauge reads wrong.

Other gauges and lamps are normal.  
 Measure the voltage with the starter switch ON.

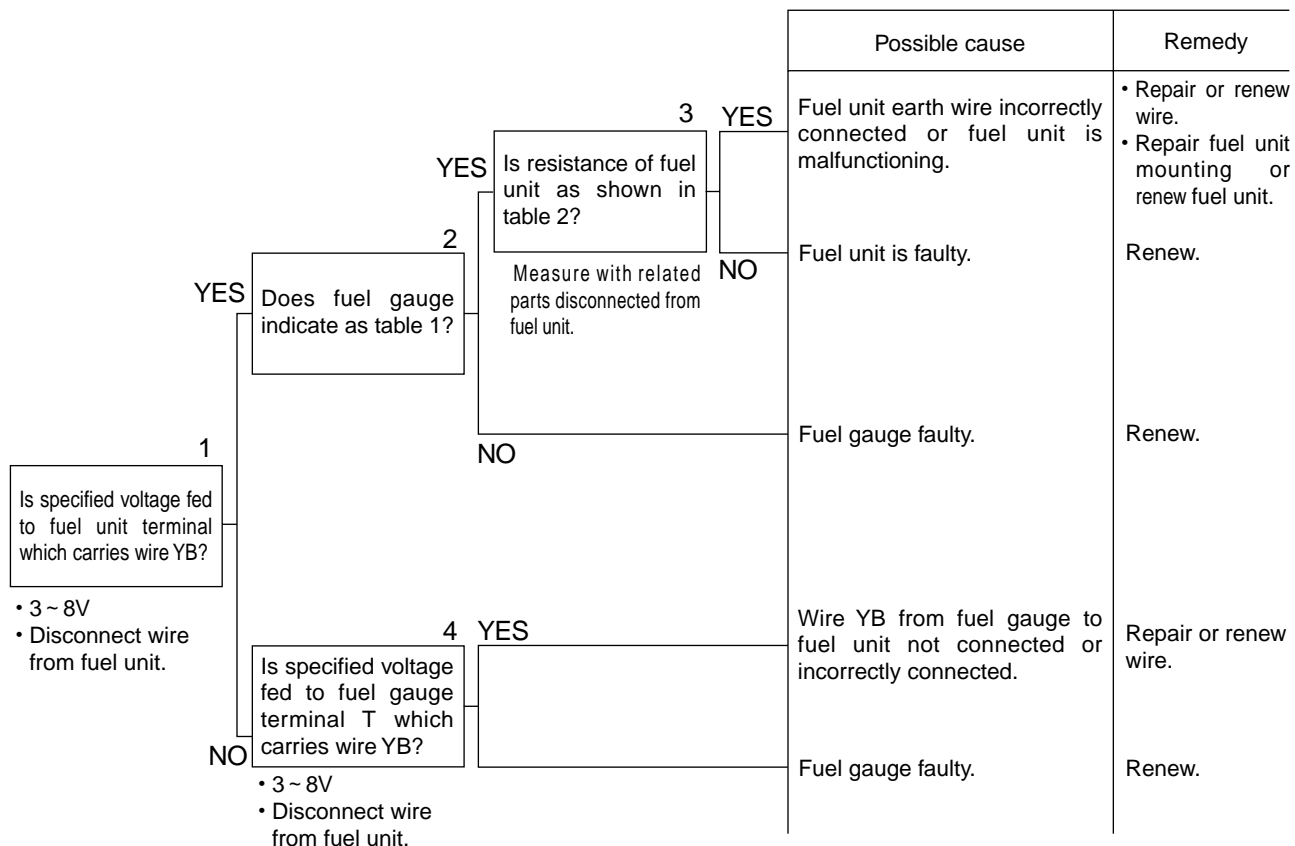


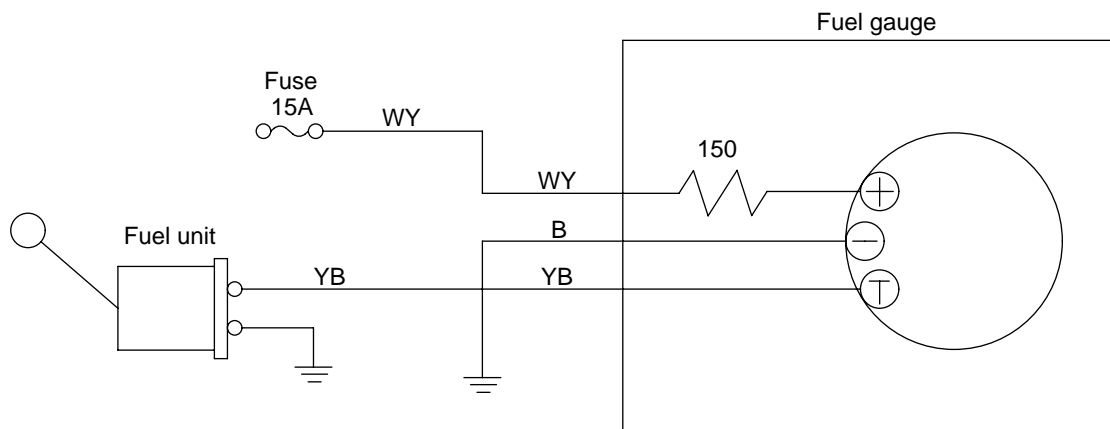
Table 1

| Fuel unit wire YB | Gauge reading |
|-------------------|---------------|
| Disconnected      | Empty         |
| Grounded          | Full          |

Table 2

| Fuel unit float | Resistance ( Ω ) |
|-----------------|------------------|
| Full            | 10 ~ 17.5        |
| Empty           | 82.5 ~ 90        |

### Electric wiring diagram for mode E-13



R24012

### E-16 Coolant temperature gauge reads wrong.

Other gauges and lamps are normal.  
 Measure the voltage with the starter switch ON.

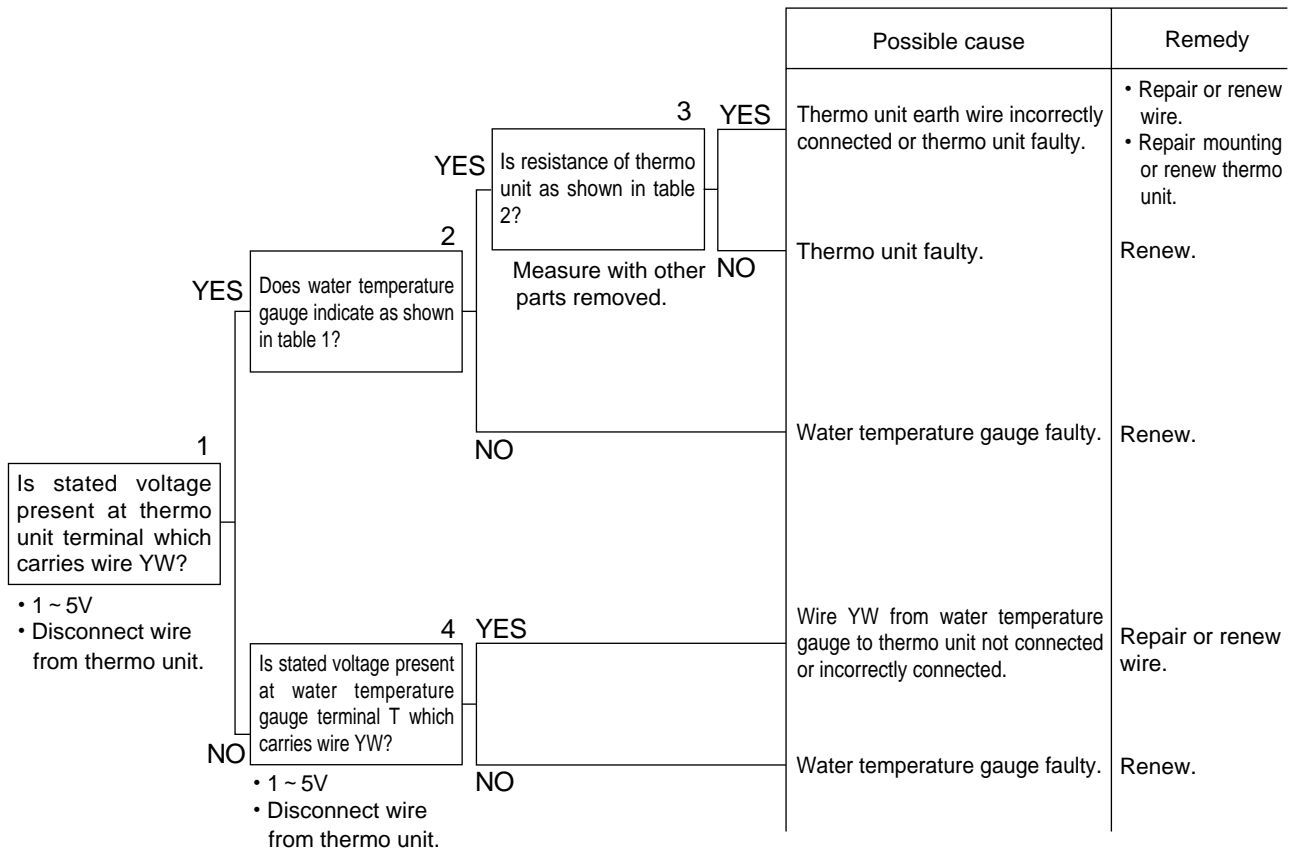


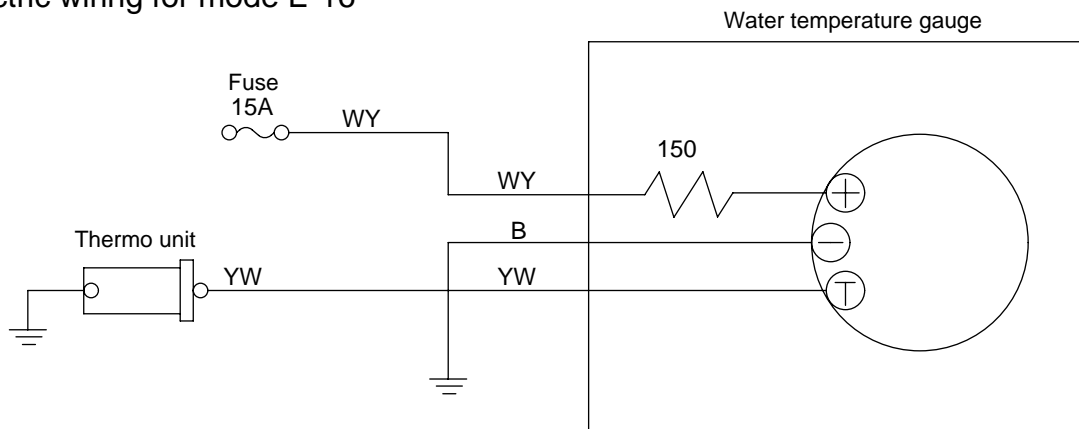
Table 1

| Thermo unit terminal wire YW | Gauge reading |
|------------------------------|---------------|
| Disconnected                 | Low range     |
| Grounded                     | High range    |

Table 2

| Thermo unit temperature | Resistance ( Ω ) |
|-------------------------|------------------|
| 50                      | 150 ~ 158        |
| 100                     | Approx. 27.4     |

### Electric wiring for mode E-16



R24013

### E-17 Tachometer reads wrong.

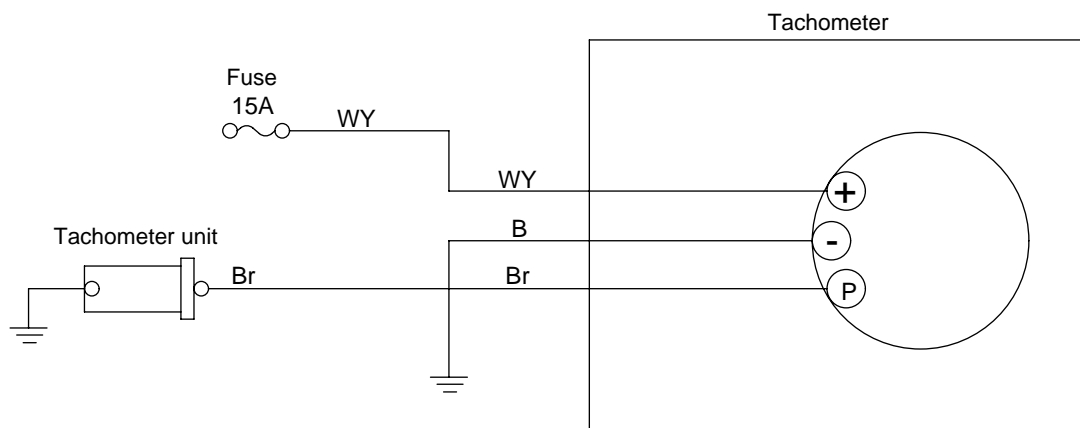
Other gauges and lamps are normal.  
 Measure the voltage with the starter switch ON.

|   |     | Possible cause   | Remedy                |
|---|-----|--|-----------------------|
| 1 | YES | To 'A' on this page  | Repair or renew wire. |
|   | NO  | To 'B' on this page  |                       |
| 2 | YES | Wire Br from tachometer sensor to tachometer not connected or incorrectly connected. | Renew.                |
|   | NO  | Tachometer unit faulty.  |                       |
| 3 | YES | Tachometer is malfunctioning.  | Renew.                |
|   | NO  | Wiring inside combination meter is faulty.   |                       |
| 4 | YES | Tachometer unit incorrectly fitted.  | Refit correctly.      |
|   | NO  | Tachometer sensor faulty.  |                       |

|   |  |   |
|---|--|---|
| 1 | Is resistance of tachometer sensor as specified?                           | <ul style="list-style-type: none"> <li>• About 500</li> <li>• Disconnect connector from tachometer sensor</li> </ul>                                      |
| 2 | Is resistance of tachometer sensor wire Br as specified?                   | <ul style="list-style-type: none"> <li>• About 500</li> <li>• Disconnect 8-pin connector from combination meter.</li> </ul>                               |
| 3 | Is specified voltage fed to tachometer sensor which carries wire Br?       | <ul style="list-style-type: none"> <li>• 1.6 ~ 4.0V</li> <li>• Start engine.</li> <li>• Measure in the same position in ac range as in item 2.</li> </ul> |
| 4 | Is specified voltage fed to tachometer terminal (+) which carries wire WY? | 20 ~ 28V  |
| 5 | Is fault corrected if tachometer unit is refitted?                         |   |

Electric wiring diagram for mode E-17



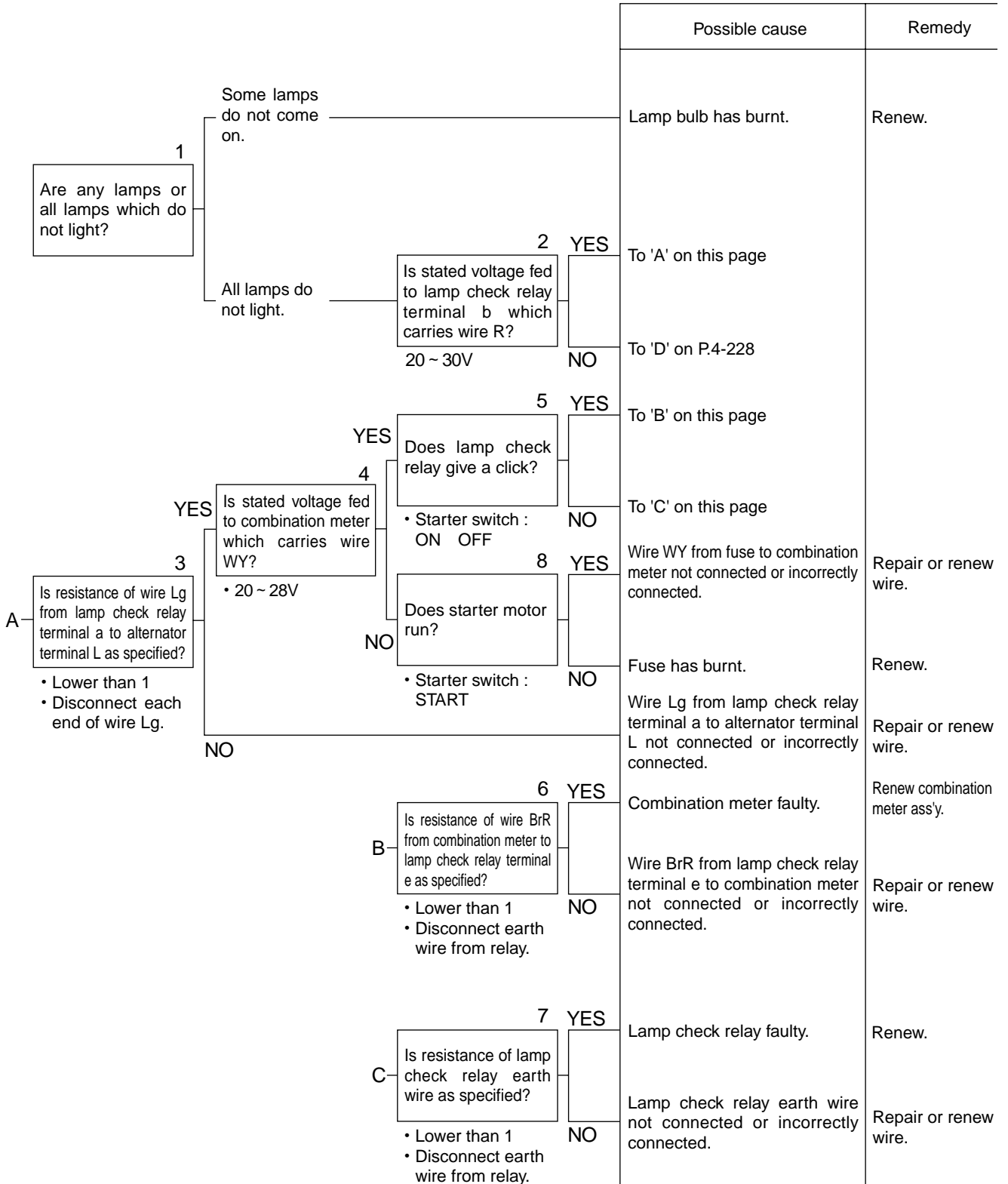
R24014

### E-18 Charge lamp, engine oil pressure warning lamp, hydraulic oil filter warning lamp and parking brake indicator lamp do not come on with starter switch ON.

These lamps should light only when the starter switch is turned to the ON position (for bulb failure check) and unusual conditions occur in the relevant systems.

Measure the voltage with the starter switch ON.

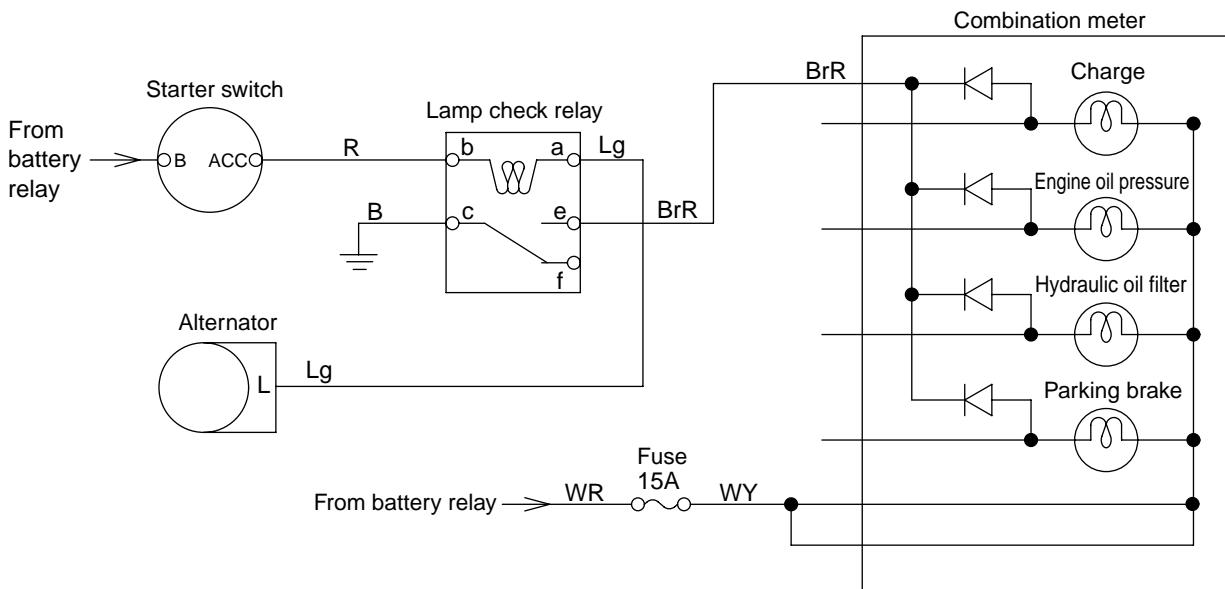
(1/2)



(2/2)

|   |   | Possible cause   | Remedy                |
|---|---|--|-----------------------|
| D | 9 YES<br>Is stated voltage fed to starter switch terminal ACC which carries wire R?<br>20 ~ 28V | Wire R from starter switch terminal ACC to lamp check relay terminal b not connected or incorrectly connected. | Repair or renew wire. |
|   | NO  | Starter switch faulty (between B and ACC).   | Renew.                |

Electric wiring diagram for mode E-18



R24015

## 6. Trouble Diagnosis of Hydraulic and Mechanical Systems (Mode H)

Troubles in hydraulic and mechanical systems and units with possible source of trouble ... 4-402

|   |       |
|---|-------|
| H-01 Unusual sounds .....                   | 4-402 |
| H-02 Hot hydraulic oil .....                | 4-402 |
| H-03 Not propelled .....                    | 4-402 |
| H-04 Speed not gained or low traction ..... | 4-402 |
| H-05 Speed range not selected .....         | 4-402 |
| H-06 Steering not achieved .....            | 4-402 |
| H-07 Heavy or slow steering .....           | 4-402 |
| H-08 Poor parking brake function .....      | 4-402 |
| H-09 Parking brake not released .....       | 4-402 |
| H-10 Timer sprinkling not selected .....    | 4-402 |

### Mechanical system diagnosis mode and units with possible source of trouble

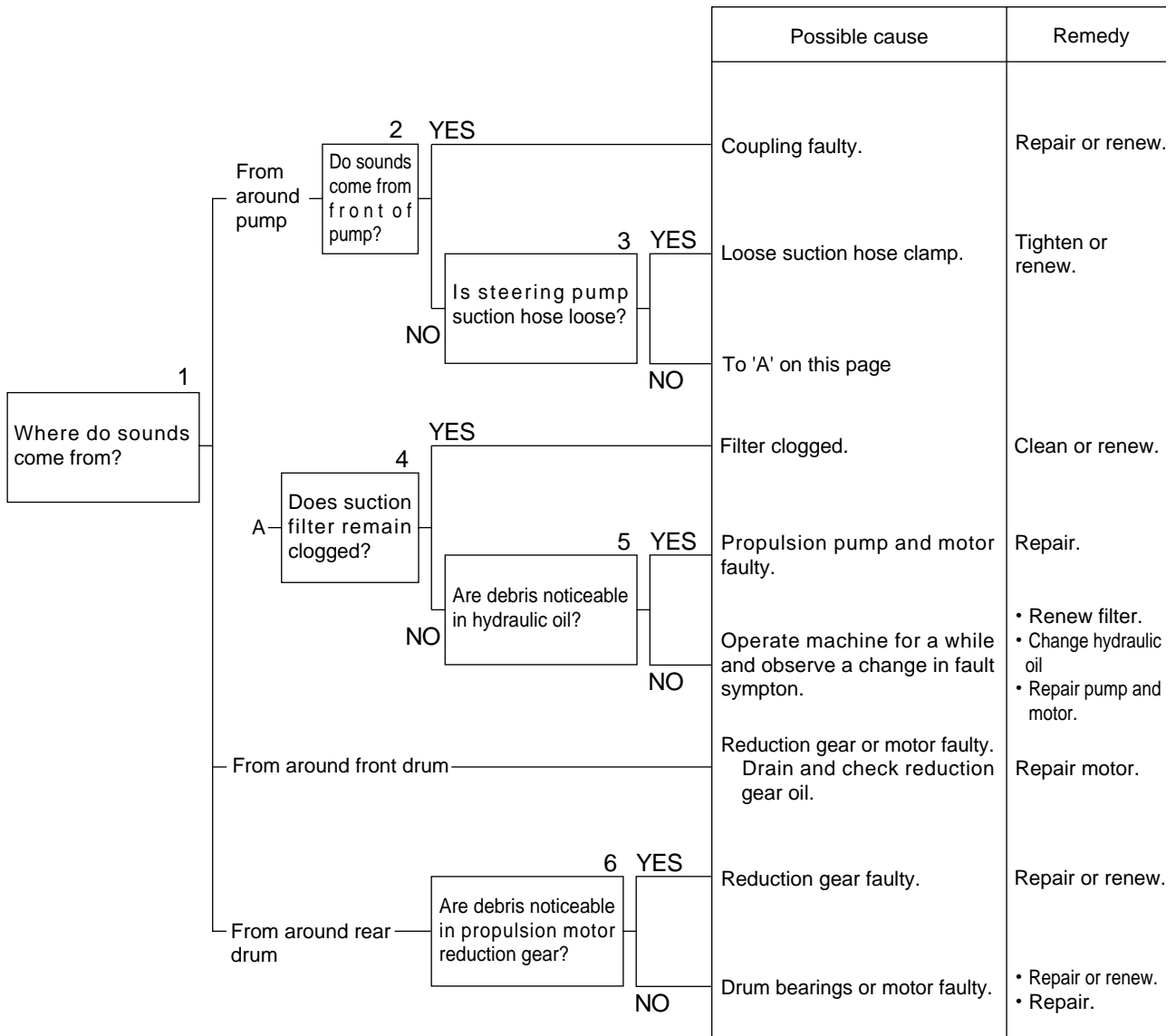
| Trouble mode                  |                                  | Propulsion                    |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
|-------------------------------|----------------------------------|-------------------------------|---------------------------------------|---------------------|---------------------|---|-----------------|----------------|---------------|---------------------------------|-----------------|----------------|---------------|---------------------------------|
|                               |                                  | Propulsion pump               |                                       |                     |                     |   | Front drive     |                |               |                                 |                 |                |               |                                 |
|                               |                                  | Pump (including servo system) | Control valve (forward-reverse shift) | Multifunction valve | Charge relief valve | Propulsion pump neutral retention valve | Left hand       |                |               |                                 | Right hand      |                |               |                                 |
|                               |                                  |                               |                                       |                     |                     |   | Inside of motor | Reduction gear | Parking brake | Speed range selection mechanism | Inside of motor | Reduction gear | Parking brake | Speed range selection mechanism |
| Unusual sounds                |                                  |                               |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
| Hot hydraulic oil             |                                  |                               |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
| Propulsion                    | Not propelled                    | a) Forward and reverse        |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
|                               |                                  | b) Either forward or reverse  |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
|                               | Speed not gained or low traction | a) Forward and reverse        |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
|                               |                                  | b) Either forward or reverse  |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
| Speed range not selected      |                                  |                               |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
| Steering                      | Not performed                    |                               |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
|                               | Heavy or slow                    |                               |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
| Parking brake                 | Poor braking                     |                               |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
|                               | Brake not released               |                               |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |
| Timer sprinkling not selected |                                  |                               |                                       |                     |                     |   |                 |                |               |                                 |                 |                |               |                                 |



| Propulsion      |                |               |                                 | Steering                     |                       |               |                                   | Sprinkling        |                               | Others          |                                | Diagnosis code |                                  |          |                   |       |
|-----------------|----------------|---------------|---------------------------------|------------------------------|-----------------------|---------------|-----------------------------------|-------------------|-------------------------------|-----------------|--------------------------------|----------------|----------------------------------|----------|-------------------|-------|
| Rear drive      |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   |       |
| Inside of motor | Reduction gear | Parking brake | Speed range selection mechanism | Parking brake solenoid valve | Speed selection valve | Steering pump | Orbitrol (including relief valve) | Steering cylinder | Steering mechanism in chassis | Steering column | Suction filter and line filter | Sprinkler pump | Filter, sprinkler bar and nozzle | Coupling | F-R lever linkage |       |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-01  |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-02  |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-03a |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-03b |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-04a |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-04b |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-05  |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-06  |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-07  |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-08  |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-09  |
|                 |                |               |                                 |                              |                       |               |                                   |                   |                               |                 |                                |                |                                  |          |                   | H-10  |

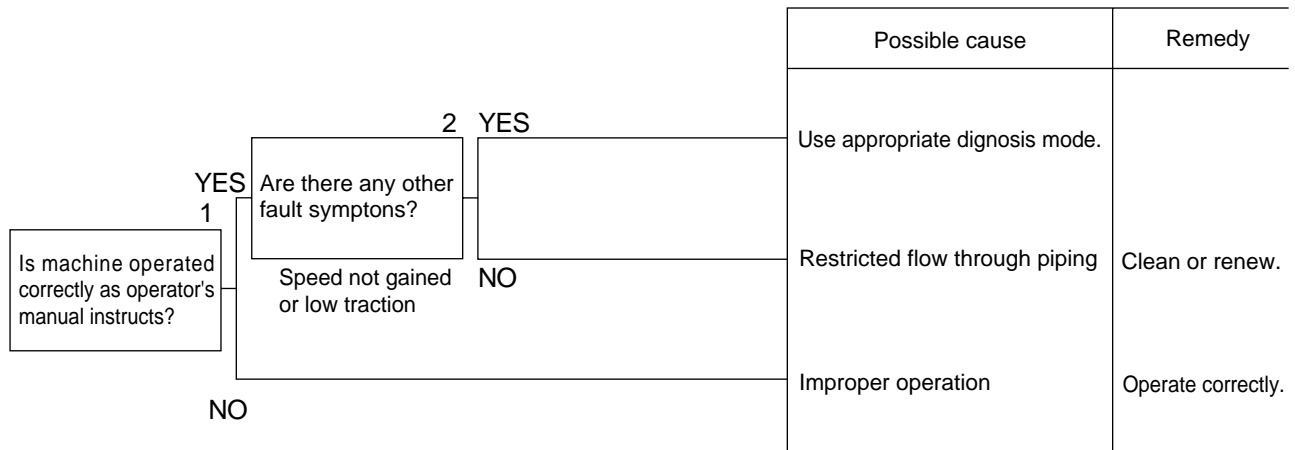
## H-01 Unusual sounds

Check the oil level in the hydraulic tank first.



## H-02 Hot hydraulic oil

Check the oil level in the hydraulic tank first.

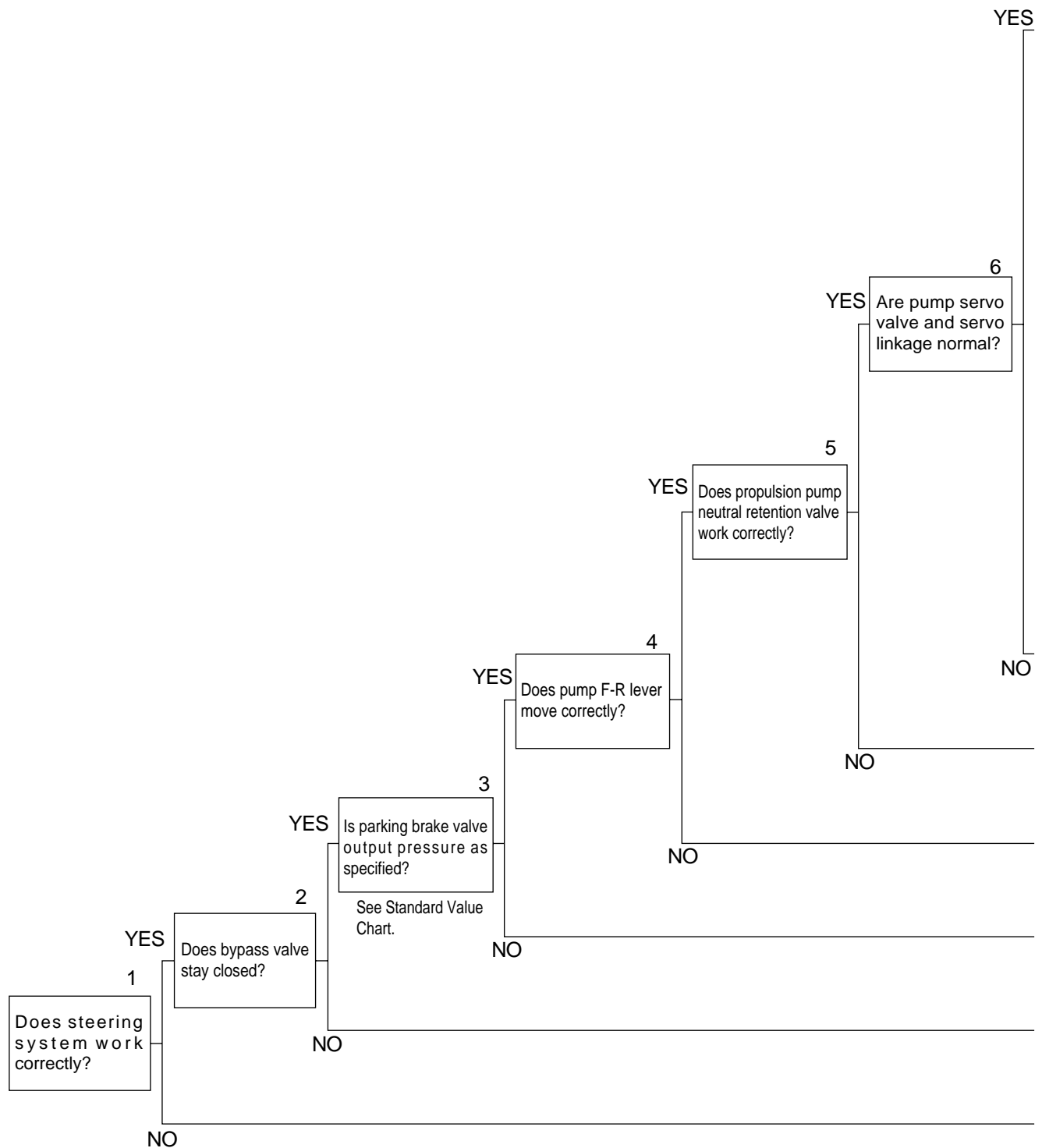


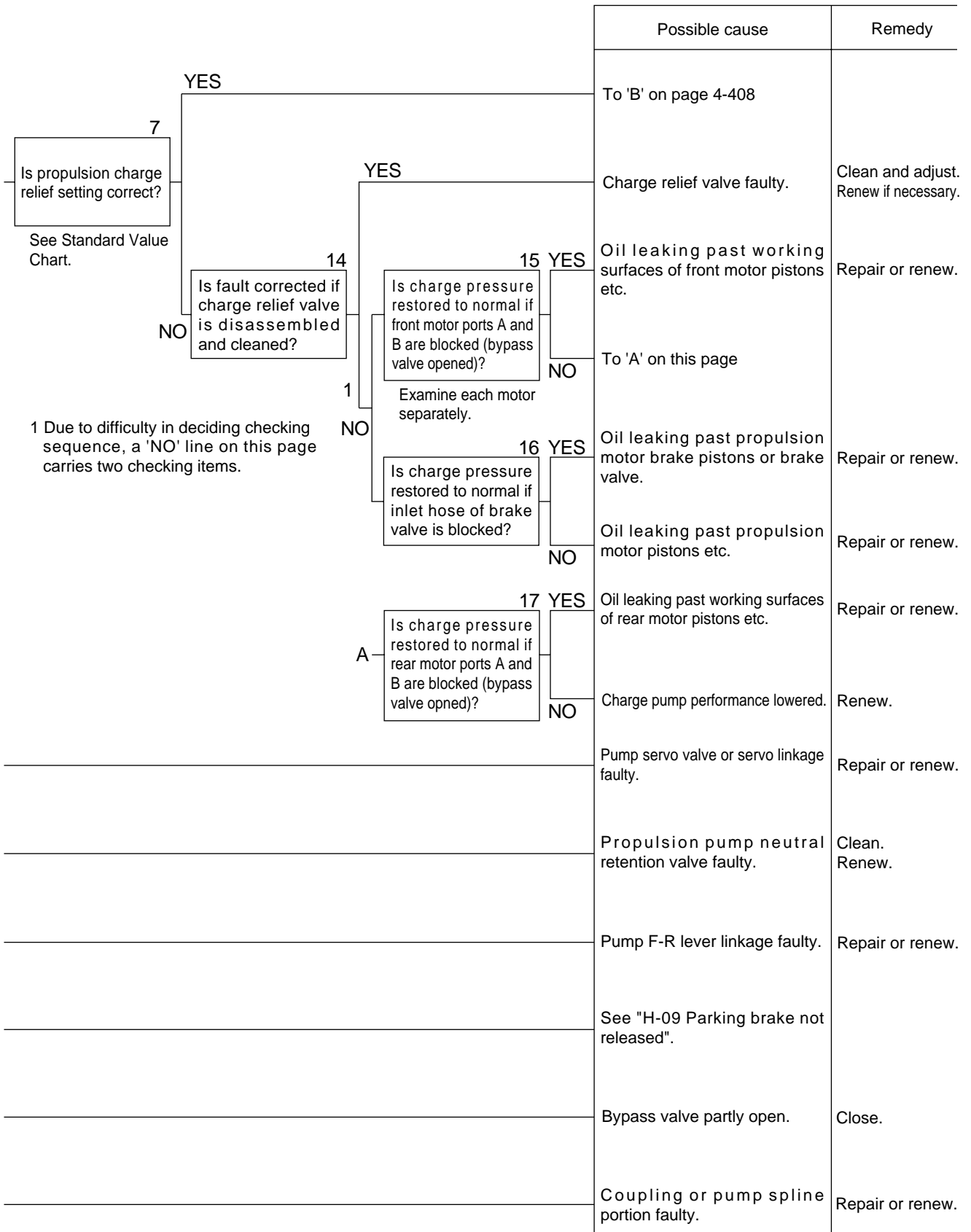
### H-03 Not propelled.

Make a diagnosis of the electric systems first. If they are normal, then use the flow charts on the pages that follow :

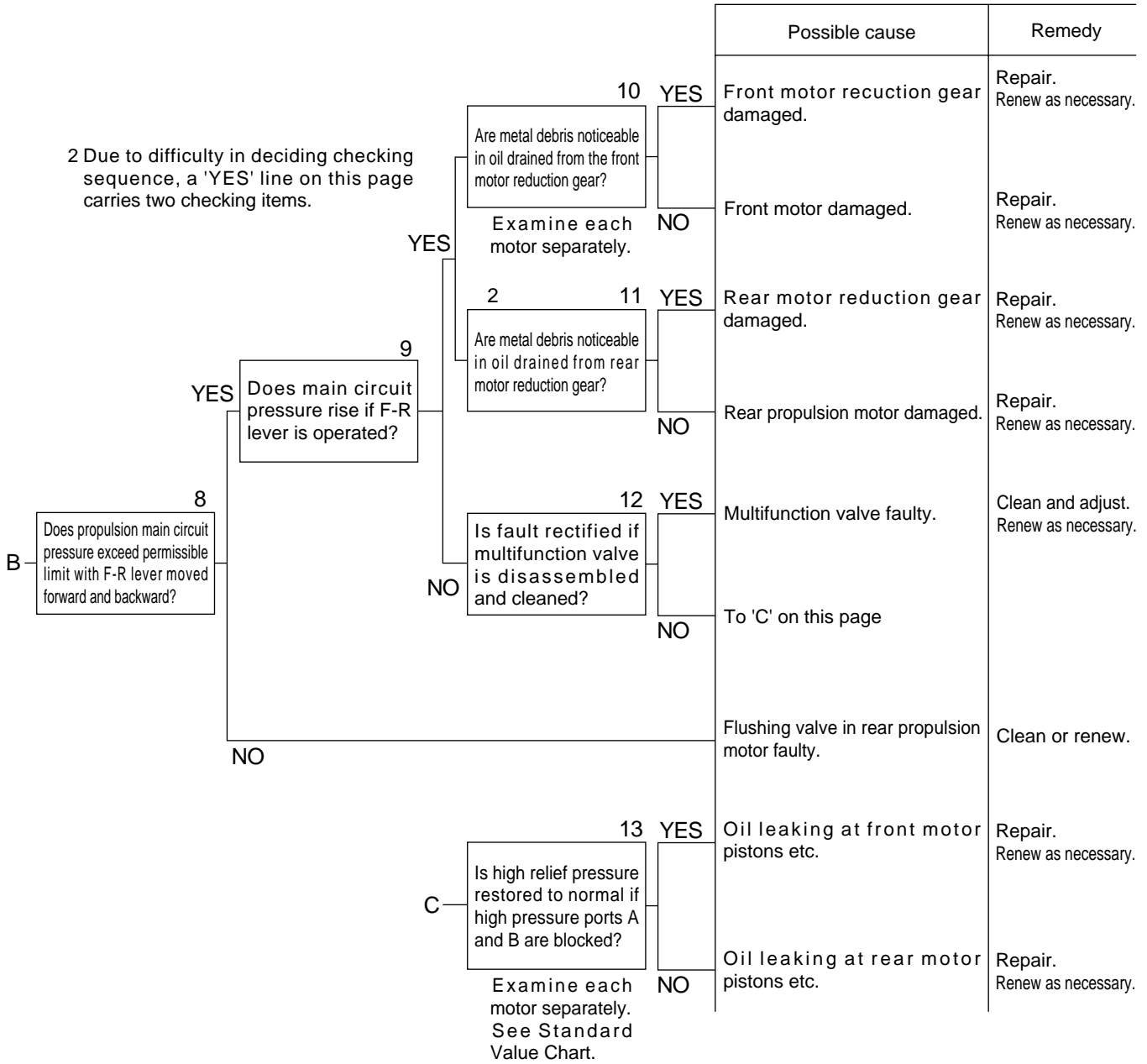
Check the oil level in the hydraulic tank first.

a) Propelled in neither direction. (1/2)

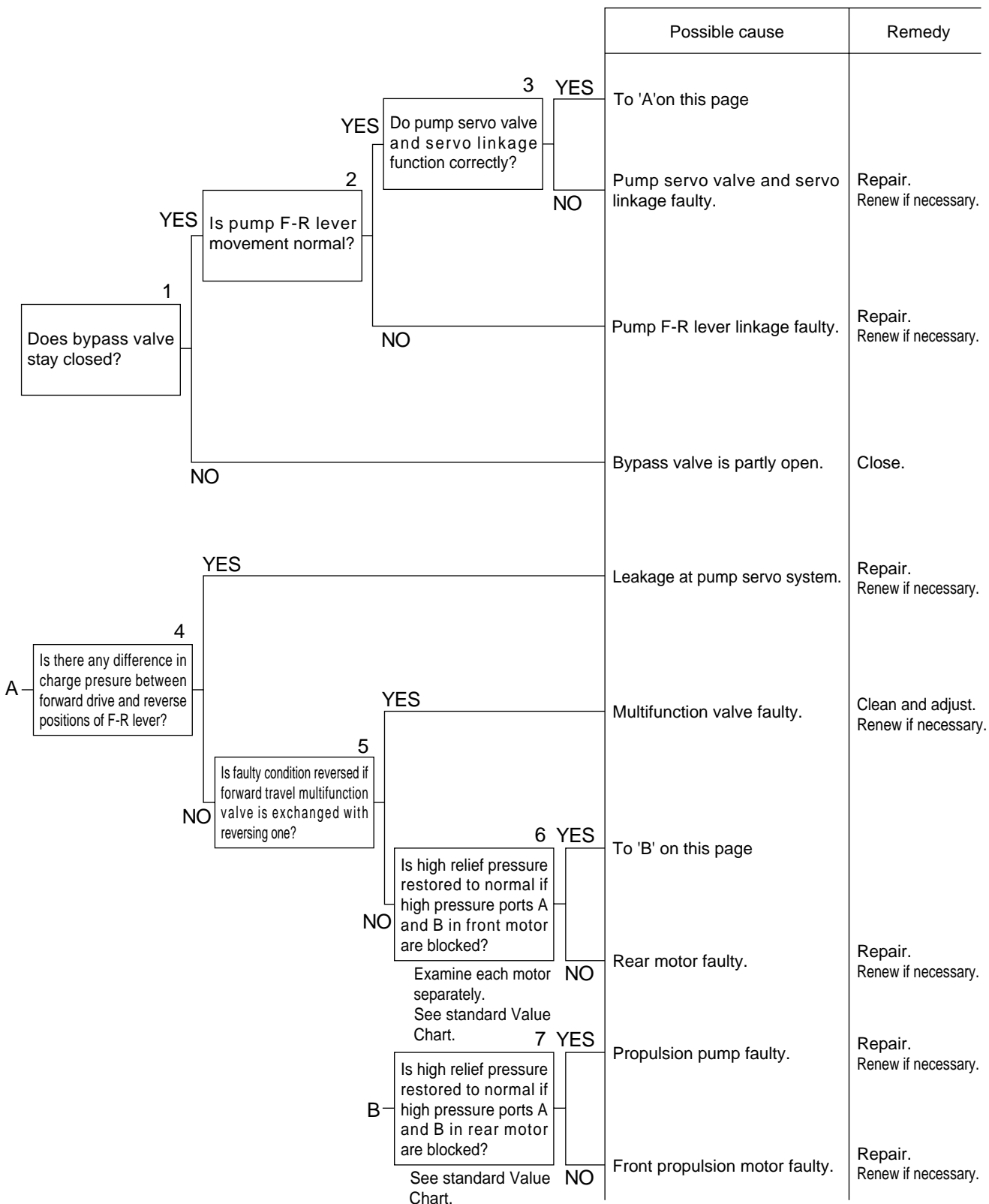




b) Propelled in one direction only. (2/2)



b) Propelled in one direction only.

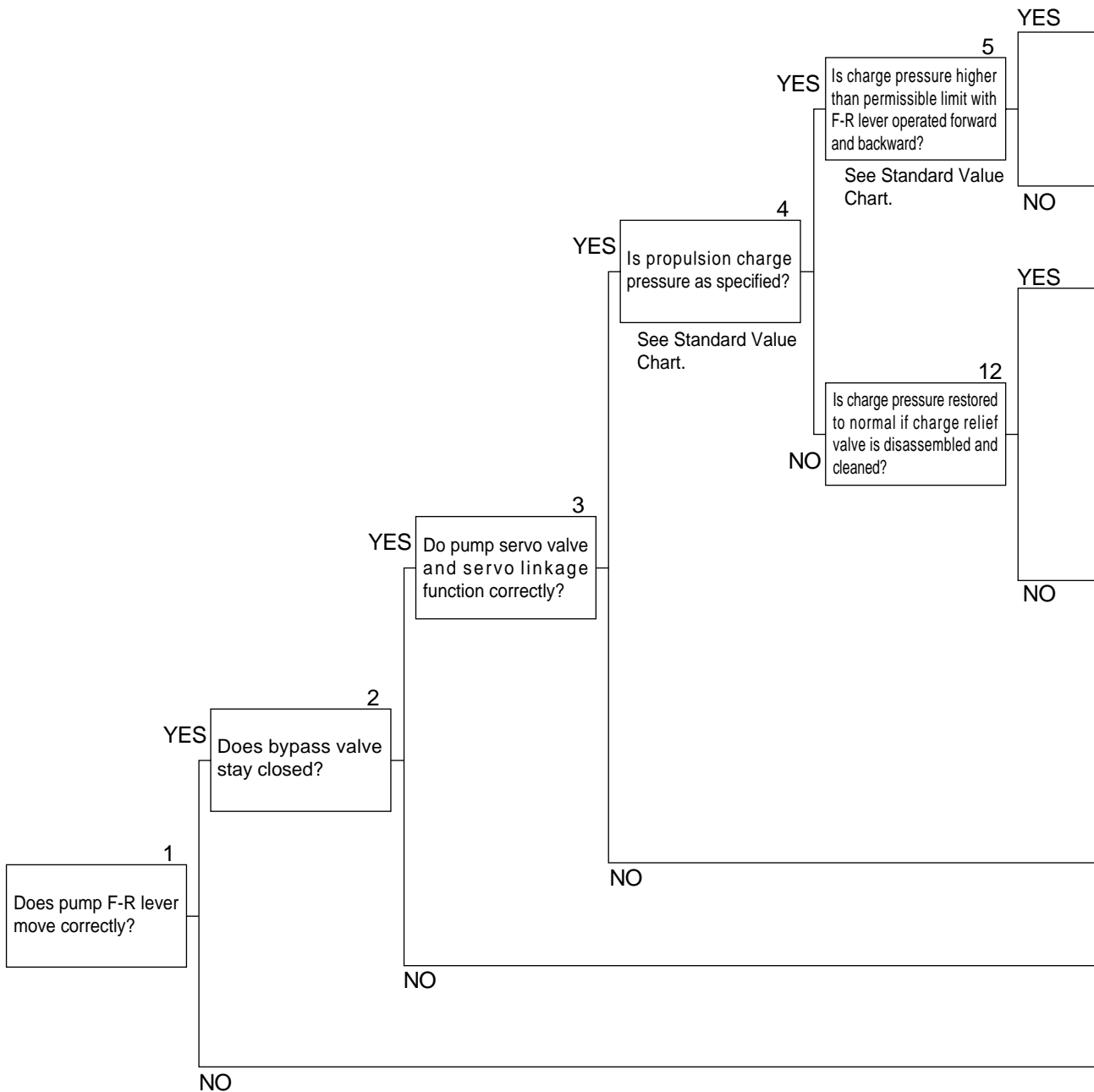


### H-04 Travel speed not gained or low traction.

Make a diagnosis of the electric systems first. If they are normal, then use the procedures described below :

Check the oil level in the hydraulic tank first.

a) Speed gained in neither travel direction. (1/2)





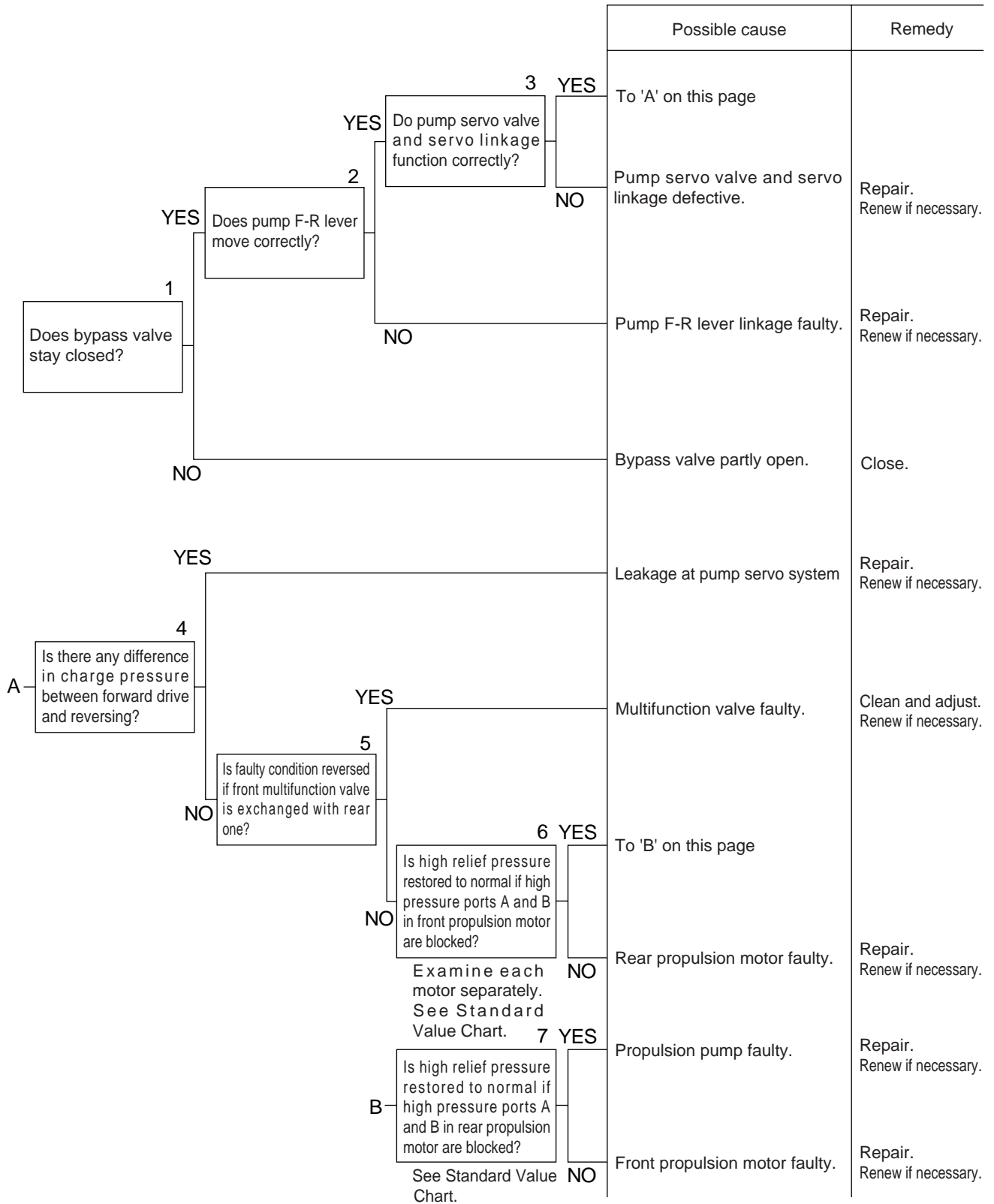
|   |  | Possible cause   | Remedy   |   |                                |
|---|--|--|--|---|--------------------------------|
| <p><b>6</b> YES</p> <p>Does propulsion main circuit pressure (relief pressure) stand as specified?</p> <p>See Standard Value Chart.</p>   | YES  | To 'A' on page 4-412   |  |   |                                |
|   | NO   | To 'B' on page 4-412   |  |   |                                |
|   |  | Rear motor flushing valve faulty.  | Clean.<br>Renew as necessary.  |   |                                |
|   |  | Charge relief valve faulty.  | Clean and adjust.<br>Renew if necessary.                                       |   |                                |
| <p><b>1</b></p> <p><b>13</b> YES</p> <p>Is charge pressure restored to normal with front motor ports A and B blocked (bypass valve opened)?</p> <p>Examine each motor separately.</p> | YES  | Leakage past sliding surfaces of front motor pistons etc   | Repair.<br>Renew as necessary.   |   |                                |
|   | NO   | <p><b>14</b> YES</p> <p>Is charge pressure restored to normal with rear motor ports A and B blocked (bypass valve opened)?</p> | YES  | Leakage past sliding surfaces of rear motor pistons etc | Repair.<br>Renew as necessary. |
|   |  | NO   | Steering pump performance lowered.   | Renew.  |                                |
|   | <p><b>15</b> YES</p> <p>Is charge pressure restored to normal if brake valve outlet hose is blocked?</p> <p>See "Inspection &amp; Adjustment".</p> | YES  | Oil leaking at motor brake cylinder seal or working surfaces of motor pistons. | Repair.<br>Renew as necessary.                          |                                |
| NO  |  | Oil leaking past working surfaces of propulsion pump pistons etc.  | Repair.<br>Renew as necessary.   |   |                                |
|   |  | Pump servo valve or servo linkage faulty.  | Clean.<br>Renew as necessary.  |   |                                |
|   |  | Bypass valve partly open.  | Repair.<br>Renew as necessary.   |   |                                |
| <p><b>1</b> Due to difficulty in deciding checking sequence, a 'NO' line on this page carries two checking items.</p>   |  | Pump F-R lever linkage faulty.   | Repair.<br>Renew as necessary.   |   |                                |

a) Speed gained in neither travel direction. (2/2)

|   |  | Possible cause   | Remedy  |
|---|--|--|---|
| 2 | A  | 7 YES<br>Drain oil from front motor reduction gear. Are metal particles noticeable in oil?                 | Front motor reduction gear damaged.<br>Repair.<br>Renew as necessary. |
|   |  | NO<br>Examine each reduction gear separately.  | Front motor damaged.<br>Repair.<br>Renew as necessary.                |
|   | 8 YES<br>Drain oil from rear motor reduction gear. Are metal particles noticeable in oil?  | Rear motor reduction gear damaged.<br>Repair.<br>Renew as necessary.                                       |   |
|   |  | NO<br>Rear motor damaged.<br>Repair.<br>Renew as necessary.  |   |
|   | 9 YES<br>Is amount of drain in front and rear motors normal?   | Propulsion pump performance lowered.<br>Repair.<br>Renew as necessary.                                     |   |
|   |  | NO<br>Propulsion motor performance lowered.<br>Repair.<br>Renew as necessary.                              |   |
| B | 10 YES<br>Is fault corrected if multifunction valve is disassembled and cleaned?   | Multifunction valve faulty.<br>Clean and adjust.<br>Renew if necessary.                                    |   |
|   | NO<br>11 YES<br>Is charge pressure restored to normal if front motor ports A and B are blocked (Bypass valve opened)?<br>See Standard Value Chart.<br>Examine each motor separately. | Oil leaking past sliding surfaces of front propulsion motor pistons etc.<br>Repair.<br>Renew as necessary. |   |
|   |  | NO<br>Oil leaking past sliding surfaces of rear motor pistons etc.<br>Repair.<br>Renew as necessary.       |   |

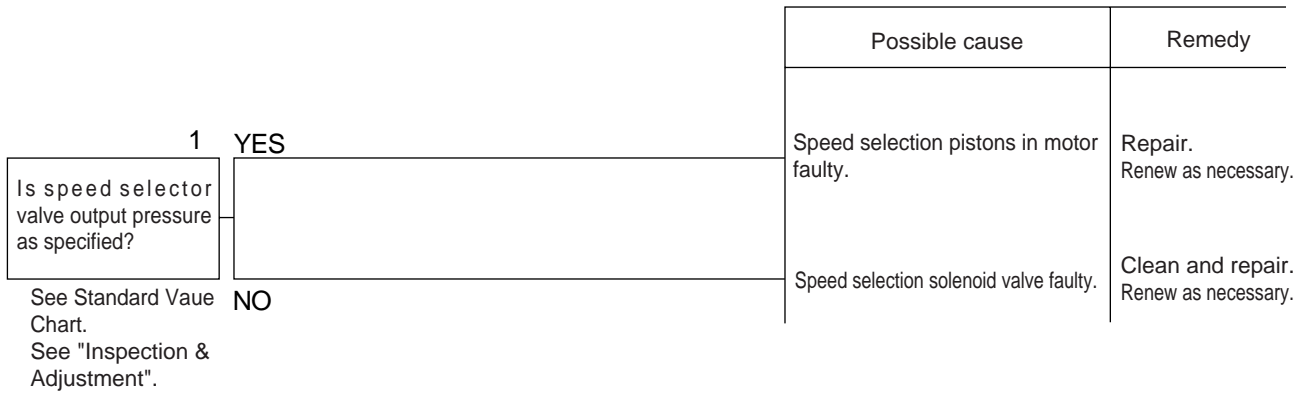
2 Due to difficulty in deciding checking sequence, a 'YES' line on this page carries three checking items.

b) Speed fails to gain or traction is low in either forward or reverse drive direction.



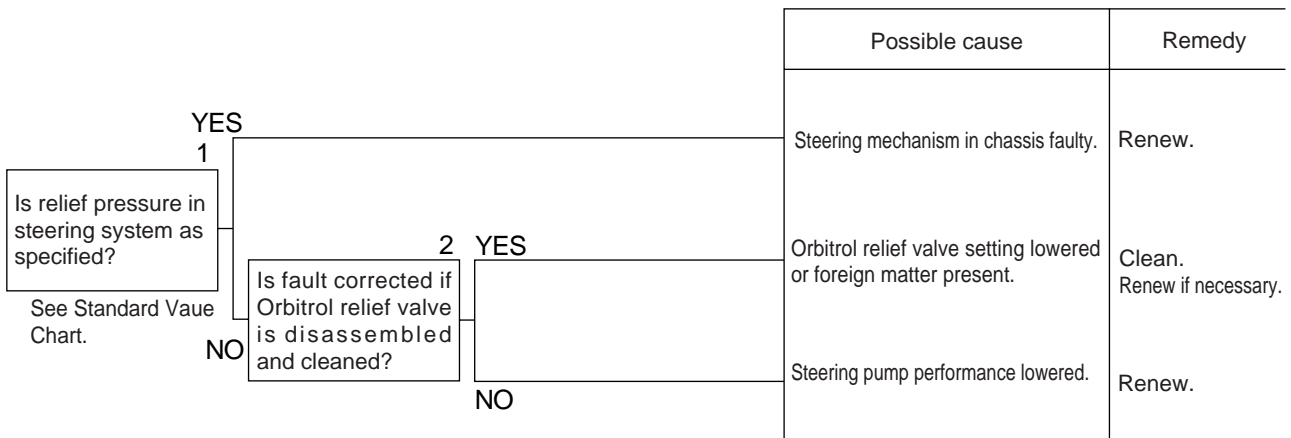
### H-05 Speed range not selected.

Make diagnoses of the electric systems first. If they are normal, then use the procedures stated below :



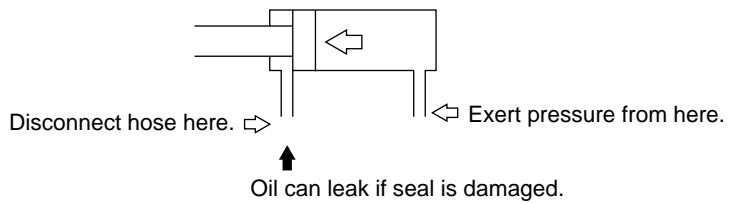
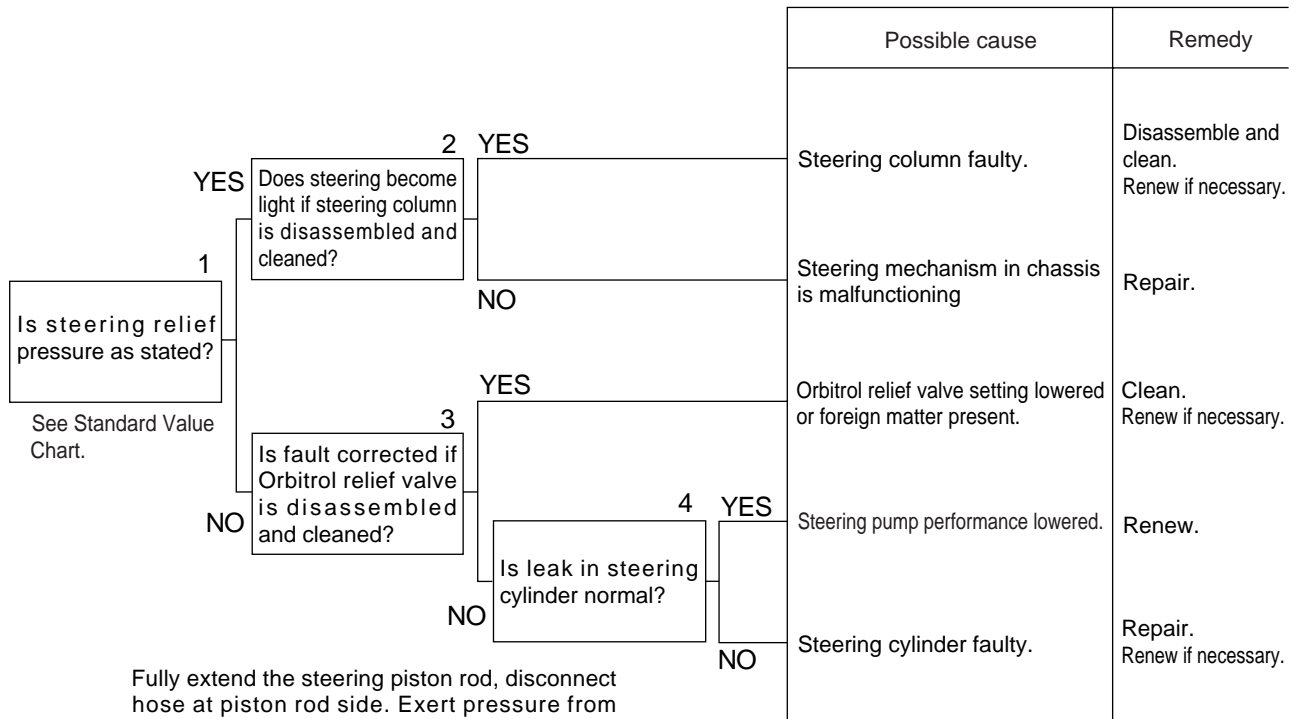
### H-06 Steering not achieved.

Check the oil level in the hydraulic tank first.



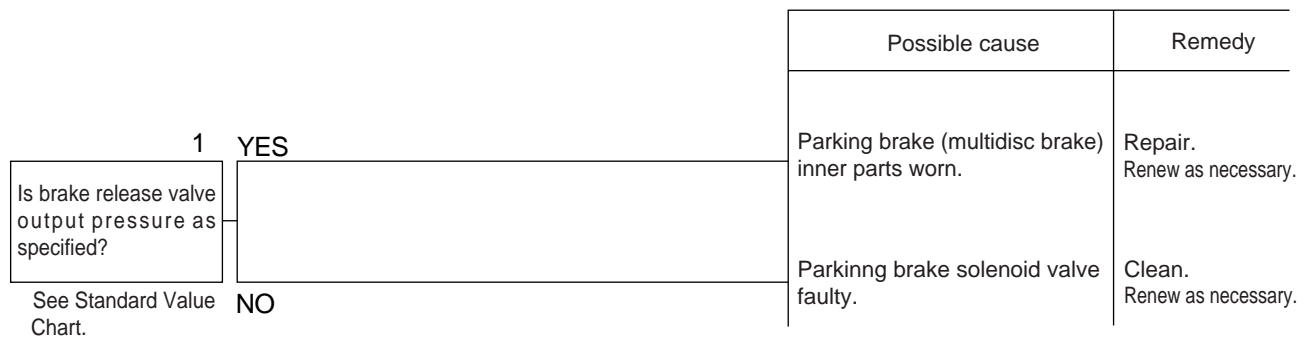
### H-07 Heavy or slow steering.

Check the oil level in the hydraulic tank first.



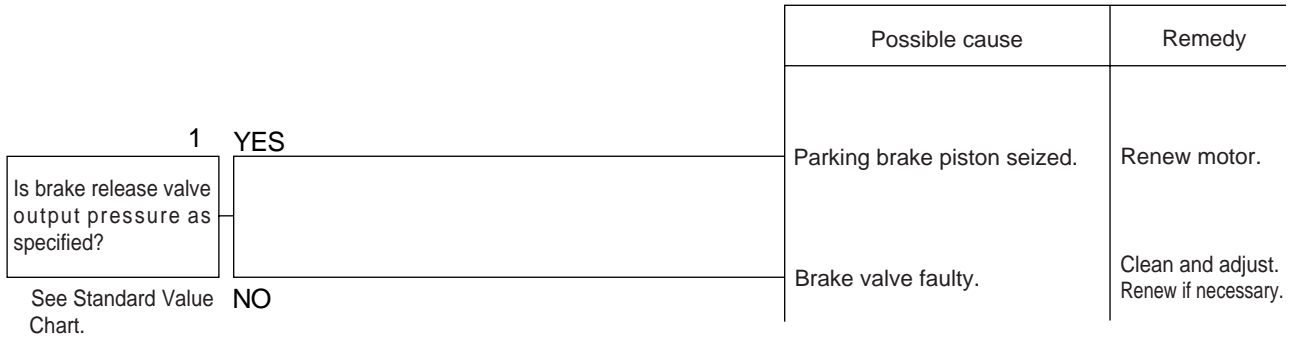
### H-08 Poor parking brake function.

Make a diagnosis of the electric systems first. If they are normal, then use the procedures stated as below :



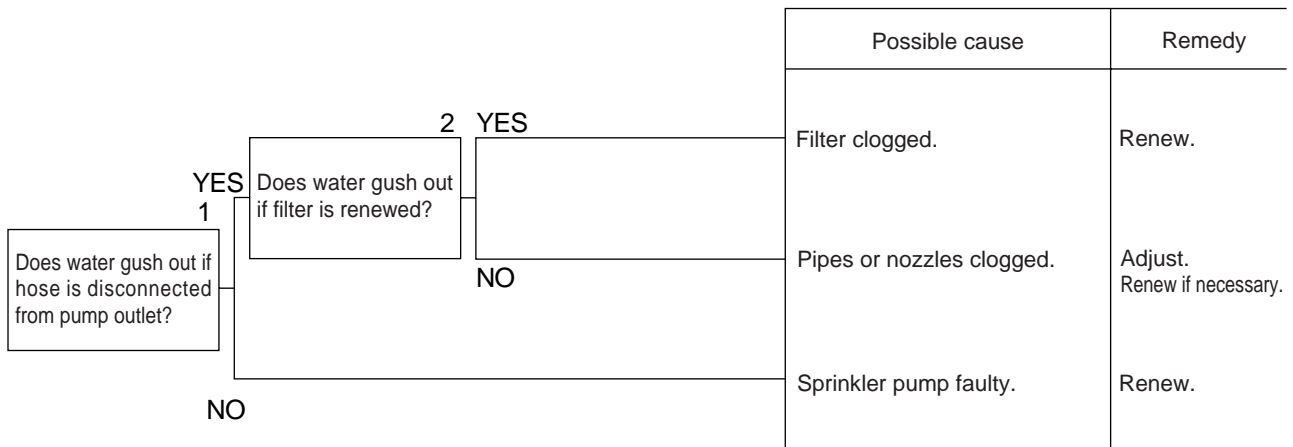
### H-09 Parking brake not released.

Make a diagnosis of the electric systems first. If they are normal, then use the procedures stated as below :



### H-10 Timer sprinkling not selected.

Make a diagnosis of the electric systems first. If they are normal, then use the procedures described below :





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