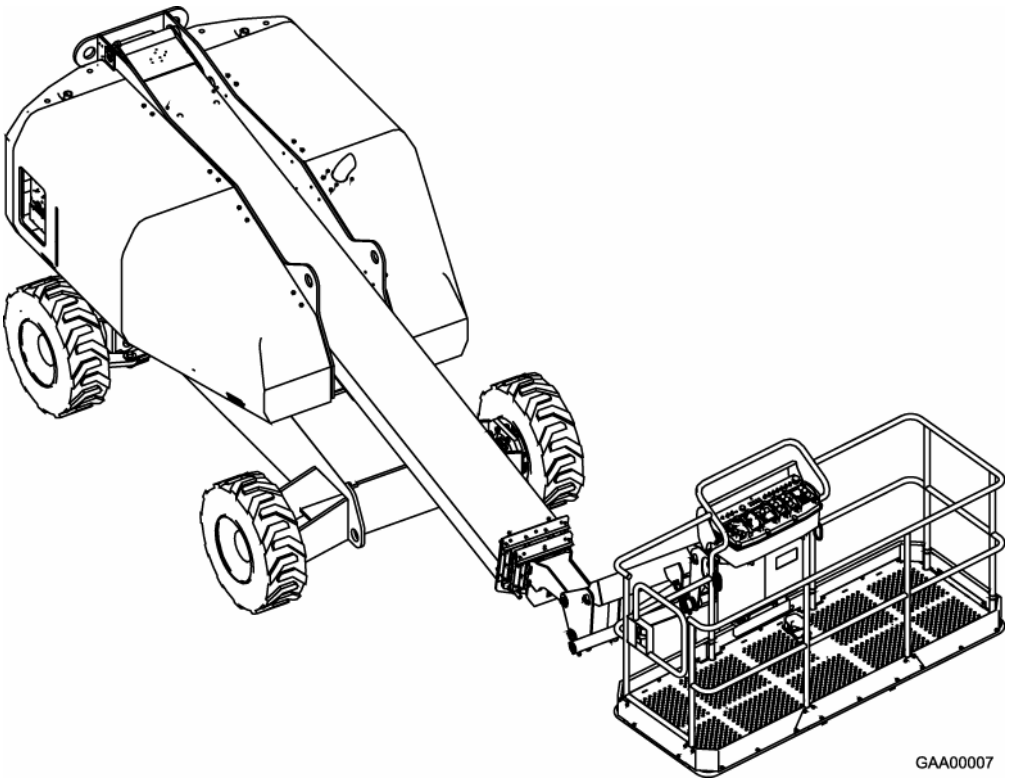
SERVICE MANUAL

SSJ00003 Rev 2

AICHI

SP12C / SP400C
SP14CJ / SP460CJ



AICHI CORPORATION
1152, RYOKE, AGEO, SAITAMA, JAPAN.

Introduction

This manual describes correct adjustment and servicing procedures for Boom type self- propelled Elevation work platform: SP12C / SP400C and SP14CJ / SP460CJ in order to ensure safe and reliable operation, the most effective use of superb performance and excellent features for your satisfaction.

Qualified personnel should read this manual carefully and understand the descriptions correctly before making any repair or maintenance works.

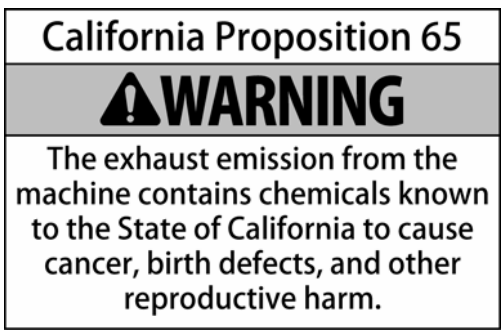
Always be sure of the following items when conducting repair or maintenance works.

Use only the spare parts approved by the manufacturer, particularly for load-supporting components (Structural components including chassis, turntable, boom section and platform) and safety related components (Scheduled replacement parts listed in the page 7-6).

Use proper tools, lifting equipment and suitable workshop.

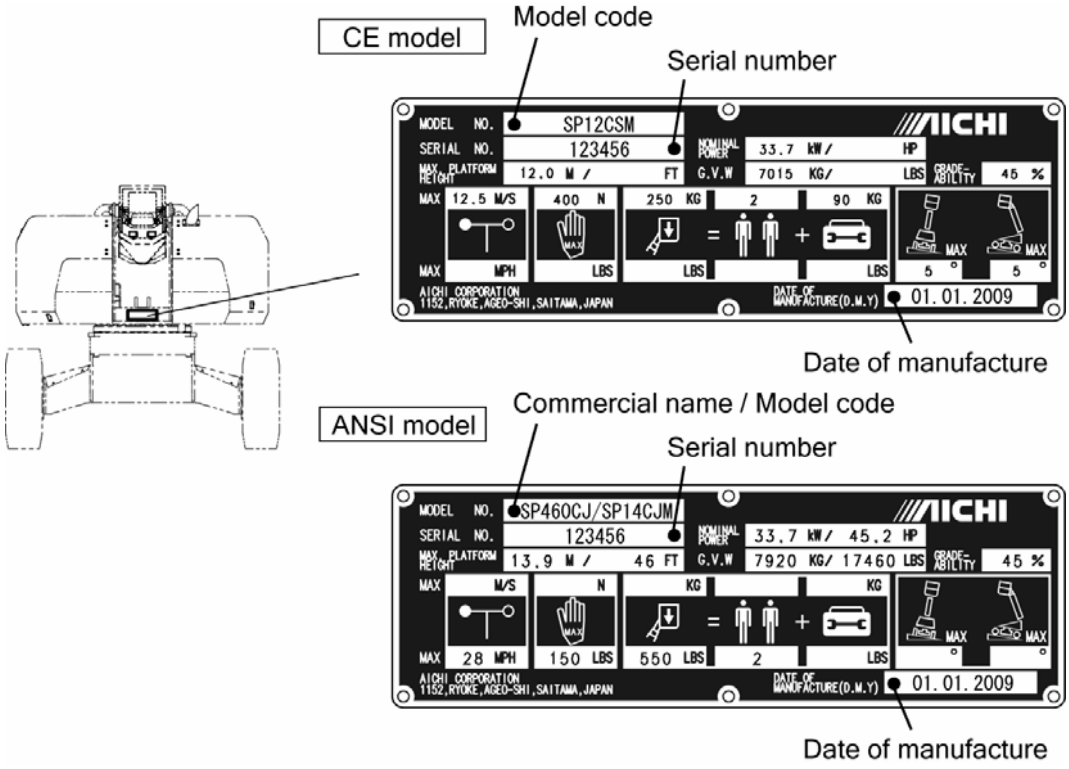
It is strictly forbidden to make modifications to the machine without obtaining AICHI's written approval.

Constant improvement of its products is AICHI's policy.
Therefore, specifications of the machine are subject to change without prior notice.





Location of Serial number plate



When you contact Aichi / Aichi dealer for Technical support, Parts order / inquiry or Warraty claim, Inform Commercial name / Model code, Serial number and Date of manufacture inscribed on the serial number plate.

Commercial name / Model code

	CE model		ANSI model	
Commercial name	SP12C	SP14CJ	SP400C	SP460CJ
Model code	SP12CSM	SP14CJM	SP12CSM	SP14CJM

Meaning of model code

S P 1 2 C S M
① ② ③ ④ ⑤

① Machine type: SP --- Boom type self propelled with wheel
② Maximum platform height in metric
③ Machine generation
④ Boom type: S --- without Fly jib, J --- with Fly jib
⑤ Machine size: M --- middle

Safety warnings and safety signal words

⚠DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor / moderate injury or property damage.

NOTICE

Information not related to personal injury or property damage.

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Chapter 1
General Information

Specifications (CE models)

Commercial name			SP12C	SP14CJ
Model code			SP12CSM	SP14CJM
Performance	Platform height maximum		12.0 m	13.9 m
	Horizontal outreach maximum		10.9 m	12.7 m
	Platform capacity (6ft)		250 kg (2 Persons + tools: 90 kg)	
	Platform capacity (8ft)		227 kg (2 Persons + tools: 67 kg)	
	Platform rotation		+/-90 deg	
	Turntable rotation		360 deg (Continuous)	
	Maximum allowable wind speed		12.5 m/s	
	Maximum allowable tilt angle		5 deg	
	Maximum allowable manual side force		400 N (41kg)	
	Gradeability (stowed)		45 % (24 deg)	
	Ground Clearance		330 mm	
	Minimum turning radius		5.0 m	
Measurements	Overall length-6ft		6.86 m	7.56 m
	Overall length-8ft		7.02 m	7.72 m
	Overall width-6ft		2.30 m	
	Overall width-8ft		2.45 m	
	Overall height		2.00 m	
	Inside diameter of Platform -6ft		1.76x0.72x1.1 m	
	Inside diameter of Platform -8ft		2.36x0.86x1.1 m	
	Wheel Base		2.34 m	
	Tread		2.00 m	
	Tires		12-16.5 Form-Filled	
Vehicle weight			7,015 kg	8,200 kg
Max. tire loading force			3,800 kg	4,130 kg
Max. tire ground contact pressure			518 kPa	526 kPa
Power source	Engine		YANMAR 4TNV88 (4 Cylinder Diesel 33kW)	
	Auxiliary Power unit		DC12V	
	Fuel Tank Capacity		120 L	
	Hydraulic Tank Capacity		190 L	
Function Speed	Elevation	Up	39 - 51 s	
		Down	39 - 51 s	
	Telescope	Out	24 - 36 s	
		In	19 - 31 s	
	Rotation		120 - 150 s / 360 deg	
	Jib Elevation	Up	-	20 - 30 s
		Down	-	15 - 25 s
	Platform Rotation		10 - 20 s / -90 ~ +90 deg	
	Travel speed (High)		6.4 - 8.0 km/h	
	Travel speed (Low)		1.0 - 1.4 km/h	

The CE model has been manufactured to conform to European Standard EN280.

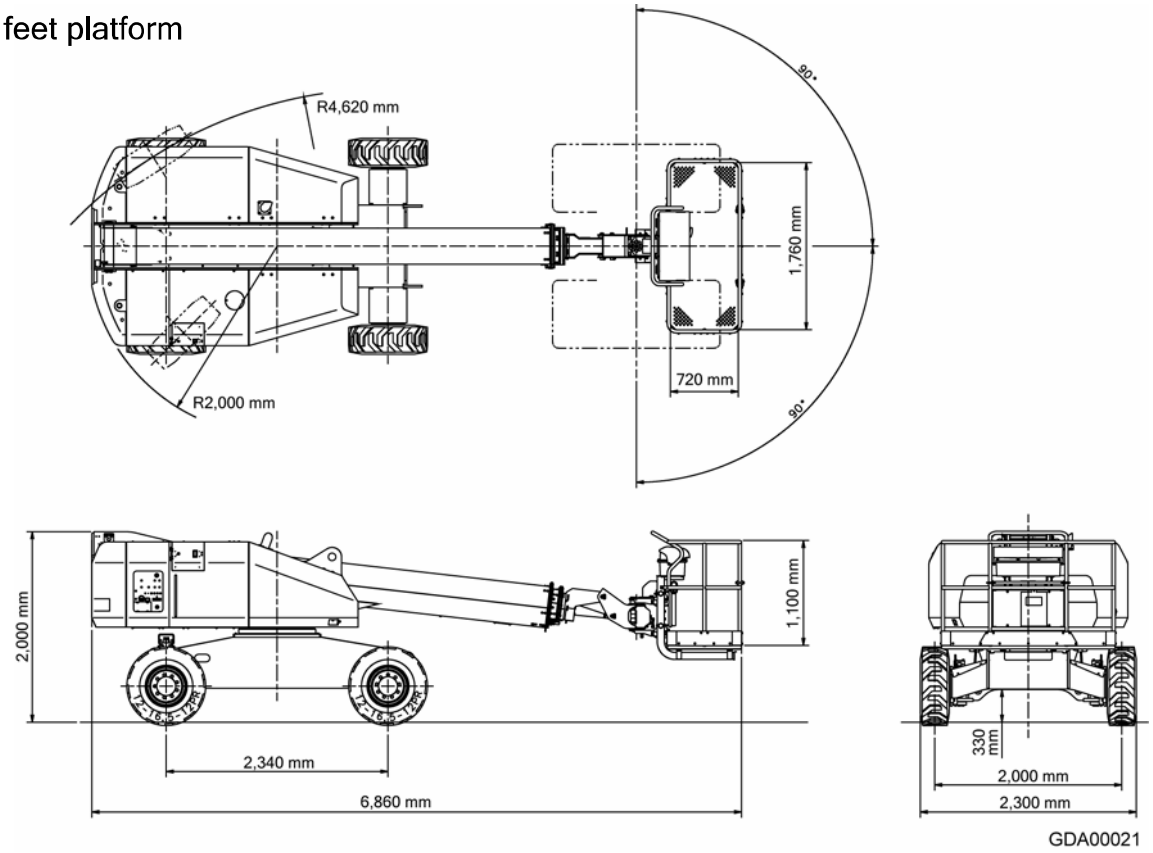
Specifications (ANSI models)

Commercial name			SP400C	SP460CJ
Model code			SP12CSM	SP14CJM
Performance	Platform height maximum		39 ft 4 in	45 ft 7 in
	Horizontal outreach maximum		35 ft 9 in	41 ft 8 in
	Platform capacity (6ft)		550 lbs (2 Persons)	
	Platform capacity (8ft)		500 lbs (2 Persons)	
	Platform rotation		+/-90 deg	
	Turntable rotation		360 deg (Continuous)	
	Maximum allowable wind speed		28 mph	
	Maximum allowable manual side force		150 lbs	
	Gradeability (stowed)		45 % (24 deg)	
	Ground Clearance		13 in	
	Minimum turning radius		16 ft 5 in	
Measurements	Overall length-6ft		22 ft 6 in	24 ft 9 in
	Overall length-8ft		23 ft	25 ft 4 in
	Overall width-6ft		7 ft 7 in	
	Overall width-8ft		8 ft	
	Overall height		6 ft 7 in	
	Inside diameter of Platform -6ft		5 ft 9 in x 2 ft 4 in x 3 ft 7 in	
	Inside diameter of Platform -8ft		7 ft 9 in x 2 ft 9 in x 3 ft 7 in	
	Wheel Base		7 ft 8 in	
	Tread		6 ft 7 in	
	Tires		12-16.5 Form-Filled	
Vehicle weight			15,470 lbs	18,080 lbs
Max. tire loading force			8,378 lbs	9,105 lbs
Max. tire ground contact pressure			75.1 PSI	76.3 PSI
Power source	Engine		YANMAR 4TNV88 (4 Cylinder Diesel 33kW)	
	Auxiliary Power unit		DC12V	
	Fuel Tank Capacity		31.7 gallons	
	Hydraulic Tank Capacity		50.2 gallons	
Function Speed	Elevation	Up	39 - 51 s	
		Down	39 - 51 s	
	Telescope	Out	24 - 36 s	
		In	19 - 31 s	
	Rotation		120 - 150 s / 360 deg	
	Jib Elevation	Up	-	20 - 30 s
		Down	-	15 - 25 s
	Platform Rotation		10 - 20 s / -90 ~ +90 deg	
	Travel speed (High)		4.0 - 5.0 mph	
	Travel speed (Low)		0.65 - 0.90 mph	

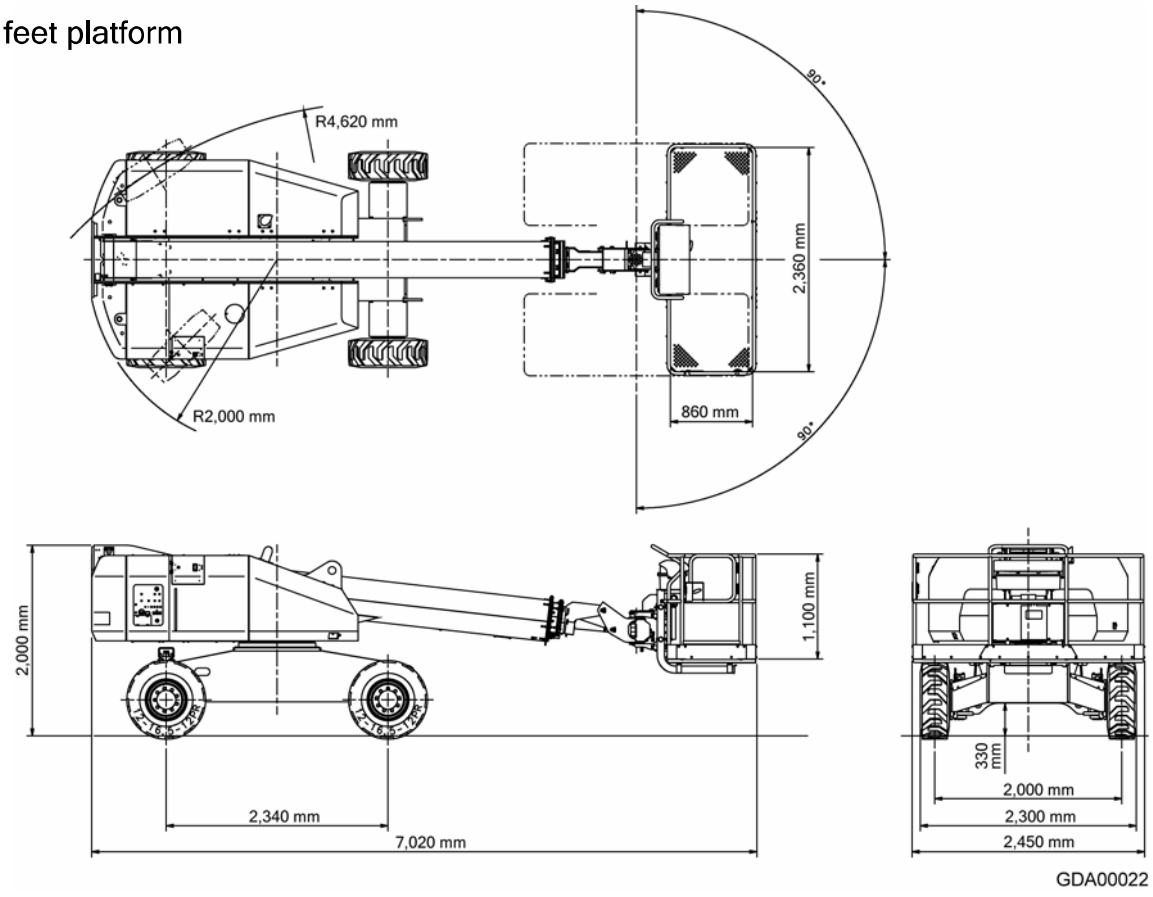
The ANSI model has been manufactured to conform to all applicable requirements of Occupational Safety and Health Administration (OSHA) and American National Standards Institute (ANSI)

Overall dimensions (SP12C / SP12CSM) CE model

6 feet platform

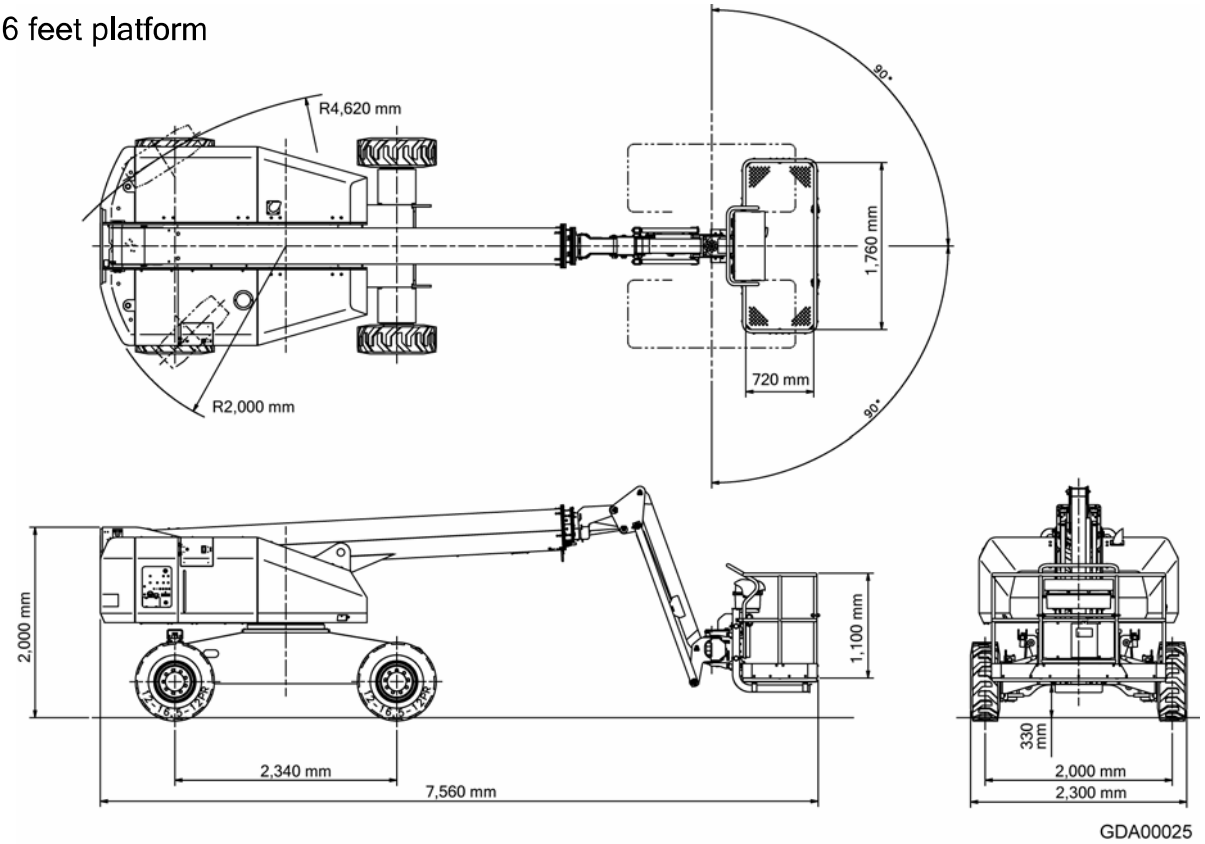


8 feet platform

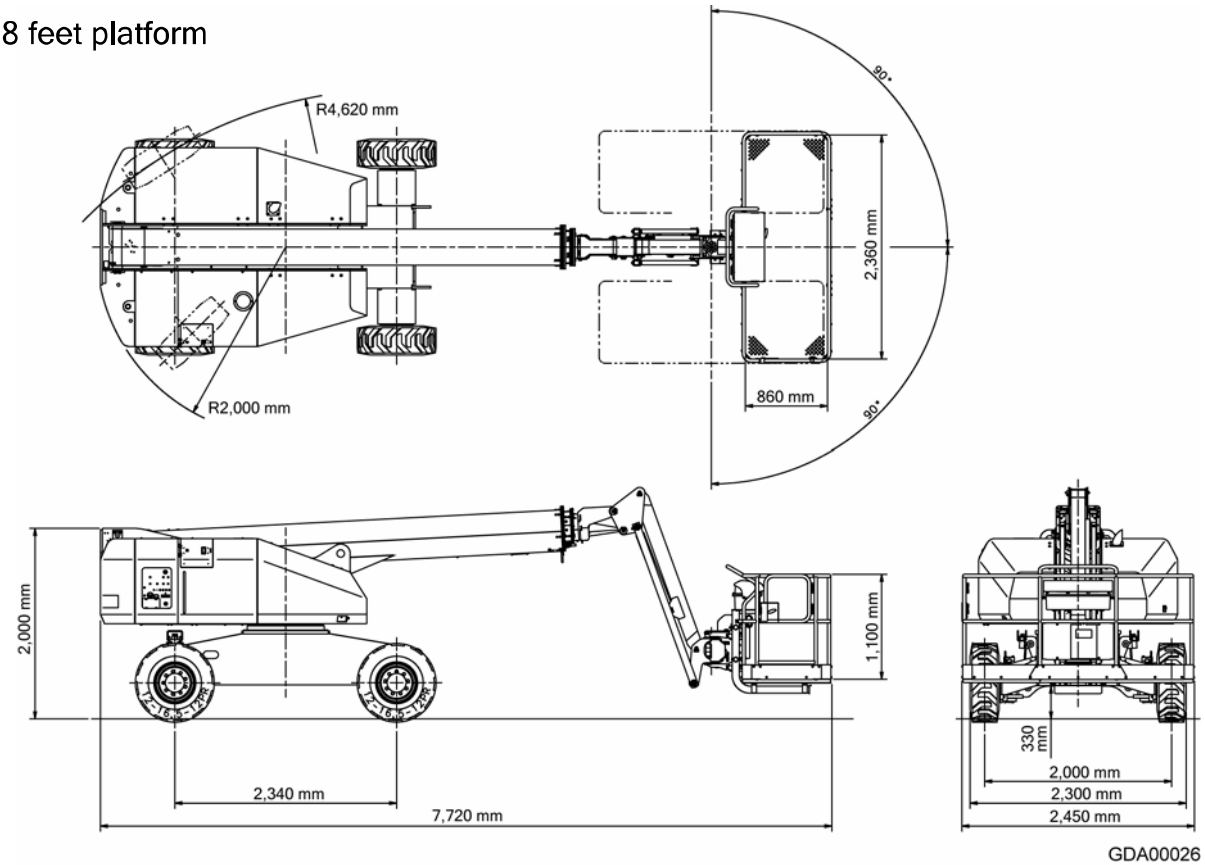


Overall dimensions (SP14CJ / SP14CJM) CE model

6 feet platform

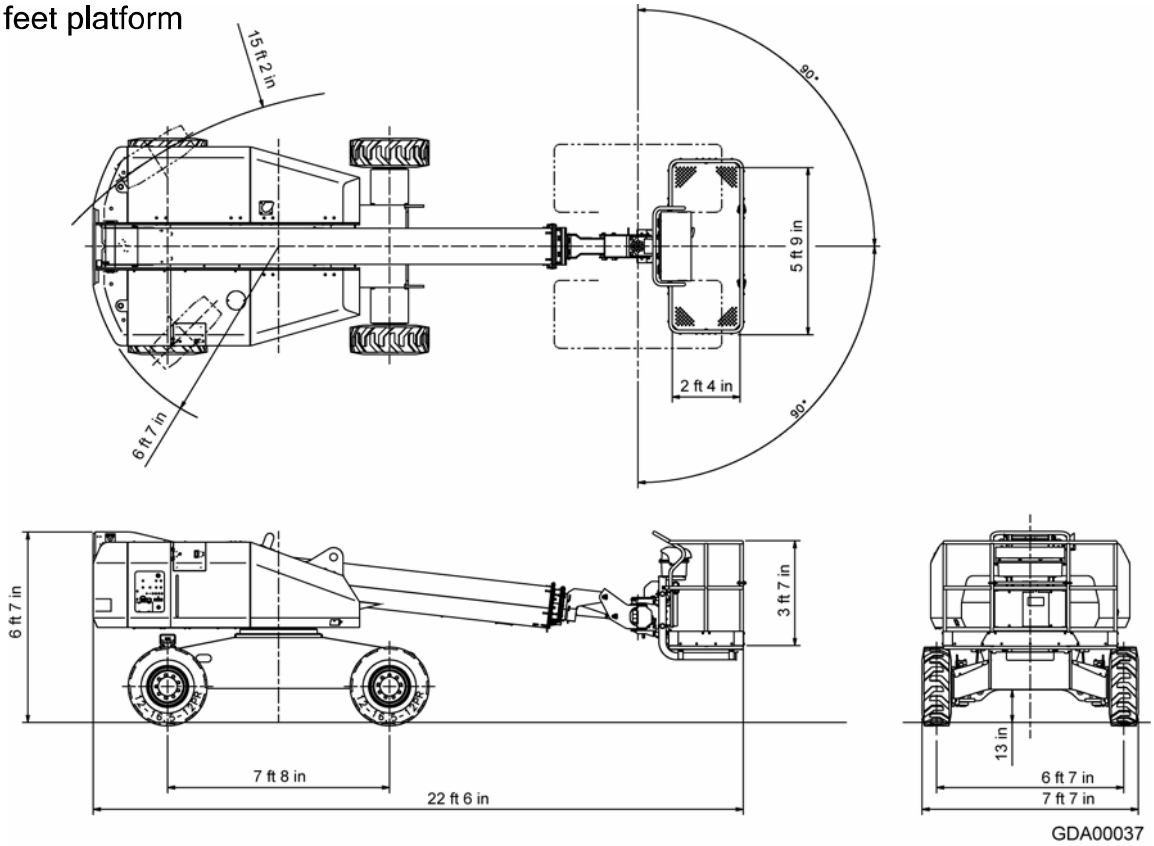


8 feet platform

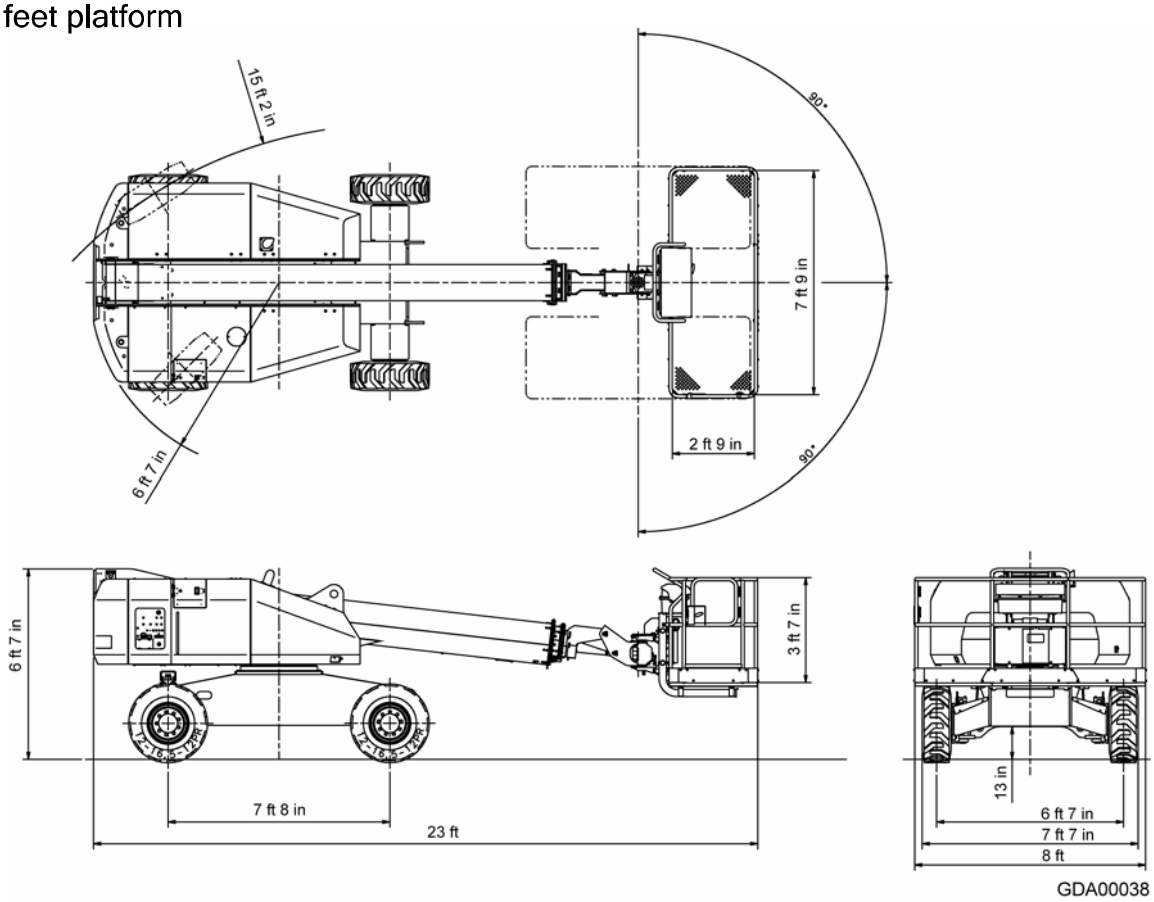


Overall dimensions (SP400C / SP12CSM) ANSI model

6 feet platform

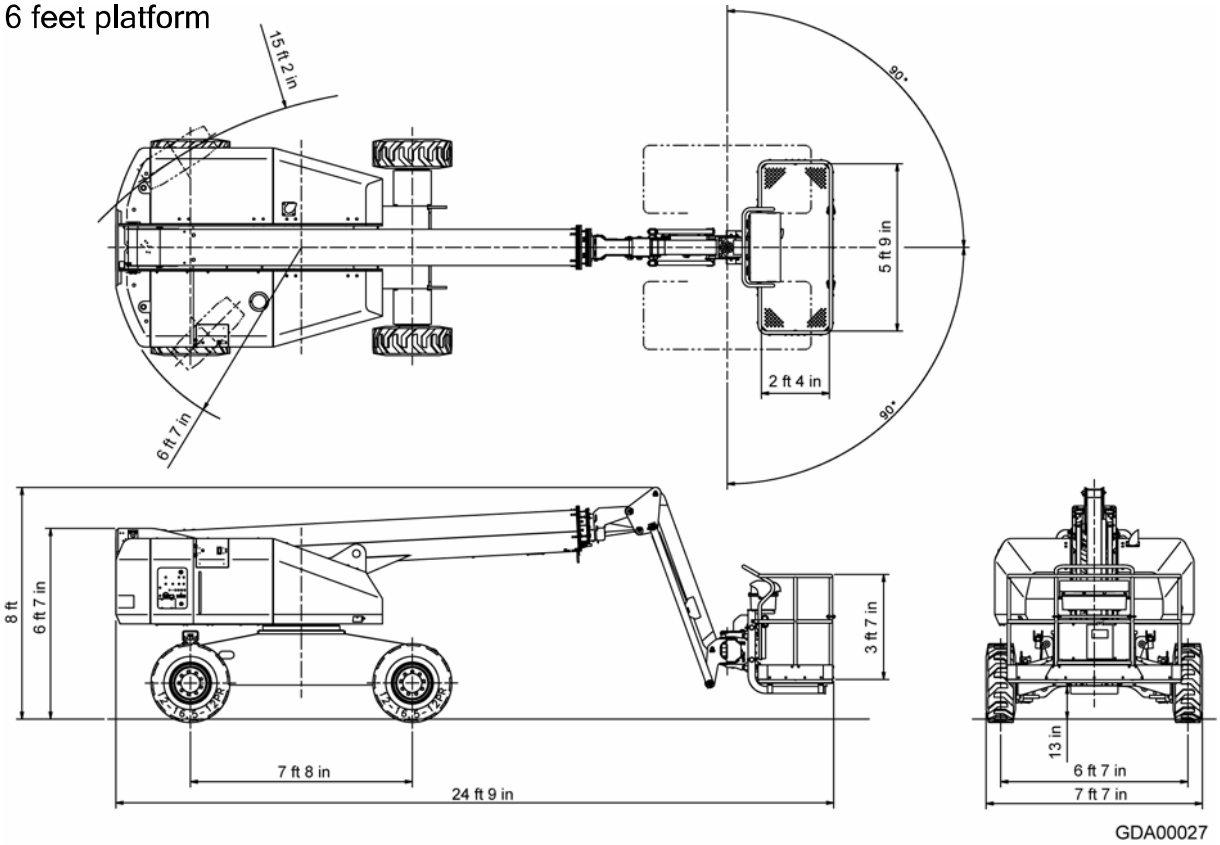


8 feet platform

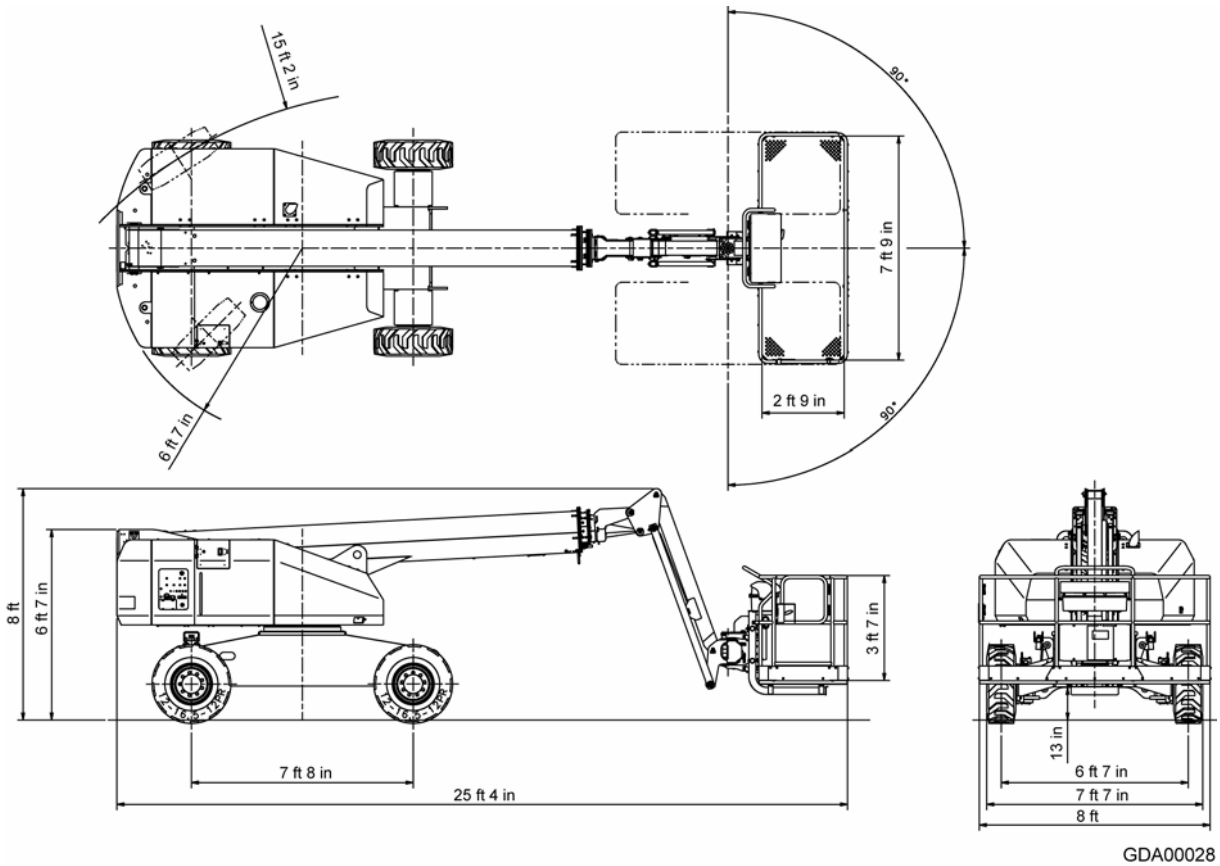


Overall dimensions (SP460CJ / SP14CJM) ANSI model

6 feet platform



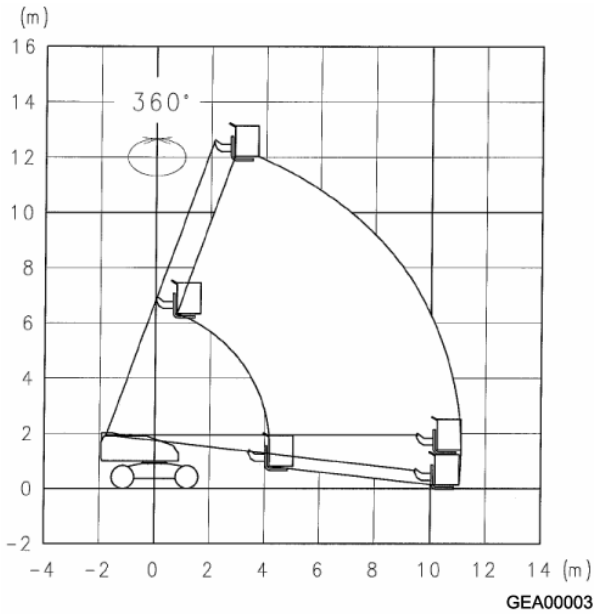
8 feet platform



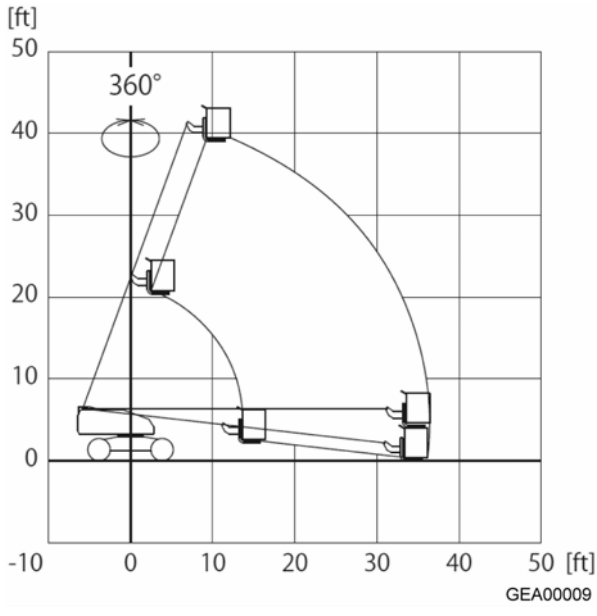
Work range diagram

Rated load 6 feet platform : 250 kg (550 lbs)
8 feet platform : 227 kg (500 lbs)

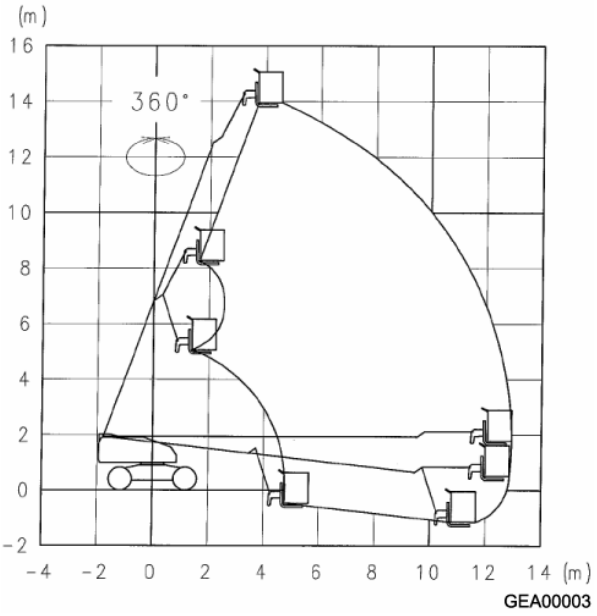
SP12C / SP12CSM



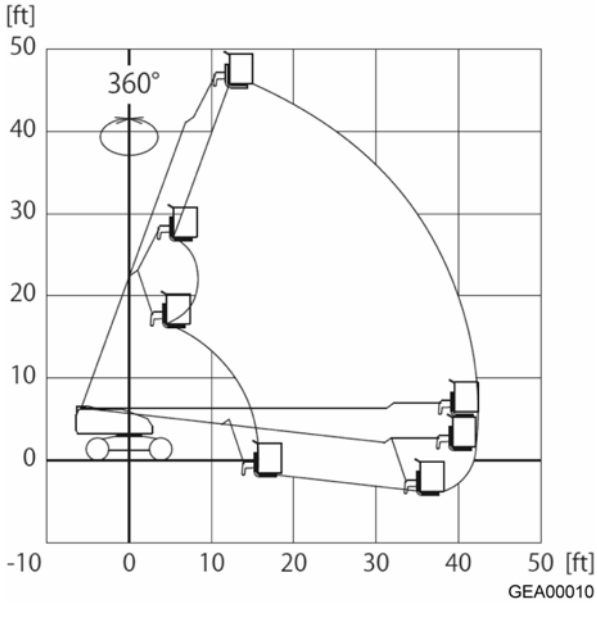
SP400C / SP12CSM



SP14CJ / SP14CJM



SP460CJ / SP14CJM



1) The boom deflection is not taken into account in the above working range diagram.
2) The working range shown in the diagram is obtained in any boom rotated directions.
3) It is assumed that the machine is on firm and level surface.

Safety devices

No	Name	Main function
1	Relief valve	Protect the hydraulic components by relieving abnormally high pressure in the hydraulic system.
2	Single holding valve on Boom elevation cylinder	Prevents the boom from natural descent in the event of hydraulic hose breakage.
3	Double holding valve on Boom telescope cylinder	Prevents the boom from natural descent in the event of hydraulic hose breakage.
4	Double holding valve on Upper leveling cylinder	Maintains the platform level in the event of hydraulic hose breakage.
5	Double holding valve on Fly- jib cylinder (SP14CJ / SP460CJ)	Prevents the fly- jib from natural descent in the event of hydraulic hose breakage.
6	Foot switch	The boom, fly-jib, platform and traveling functions are disabled unless the foot switch is depressed.
7	Foot switch cancel system	This system cancel the foot switch / enable switch if any of the boom, fly-jib, platform and traveling function is not operated more than 20 seconds. Release the switch once, then operate again to enable the functions.
8	Enable switch (Lower control)	The boom, fly-jib and platform functions from the lower control panel are disabled unless the enable switch is operated.
9	Motion alarm buzzer	The motion alarm buzzer sounds when the machine is in motion to warn the people nearby.
10	Emergency stop button	Stops all of the movements of the machine when this button is pressed.
11	Tilt alarm buzzer	The tilt alarm buzzer sounds, if the machine tilts more than 5 degrees.
12	Travel speed limit system	The high speed traveling is disabled, unless the boom is retracted, lowered under the horizontal and rotated to rear center of the machine.
13	Rotation lock pin	Fixes the turntable to the chassis to prevent the turntable from being rotated when transporting the machine.
14	Emergency pump	Auxiliary hydraulic pump driven by the battery. And used to lower the platform in the event of engine or main pump failure.
15	Alarm horn	Before moving the machine, sound the alarm horn to warn the people around the machine.
16	Boom wire rope failure detecting system (CE model)	This system disables the boom extending functions in the event of the boom extension wire rope failure.
17	Overload sensing system (CE model)	This system disables all of the functions, Overload warning light blinks and Overload buzzer sounds when the platform is overloaded.
18	Boom / Travel function interlock system (CE model)	This system stops all of the functions when the travel and boom operations are conducted simultaneously.
19	Oscillation axle locking system	The system locks the oscillation axle unless the boom is rotated to rear center of the chassis, or the boom is retracted and lowered under the horizontal.

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Chapter 2
Mechanical Components

Chassis

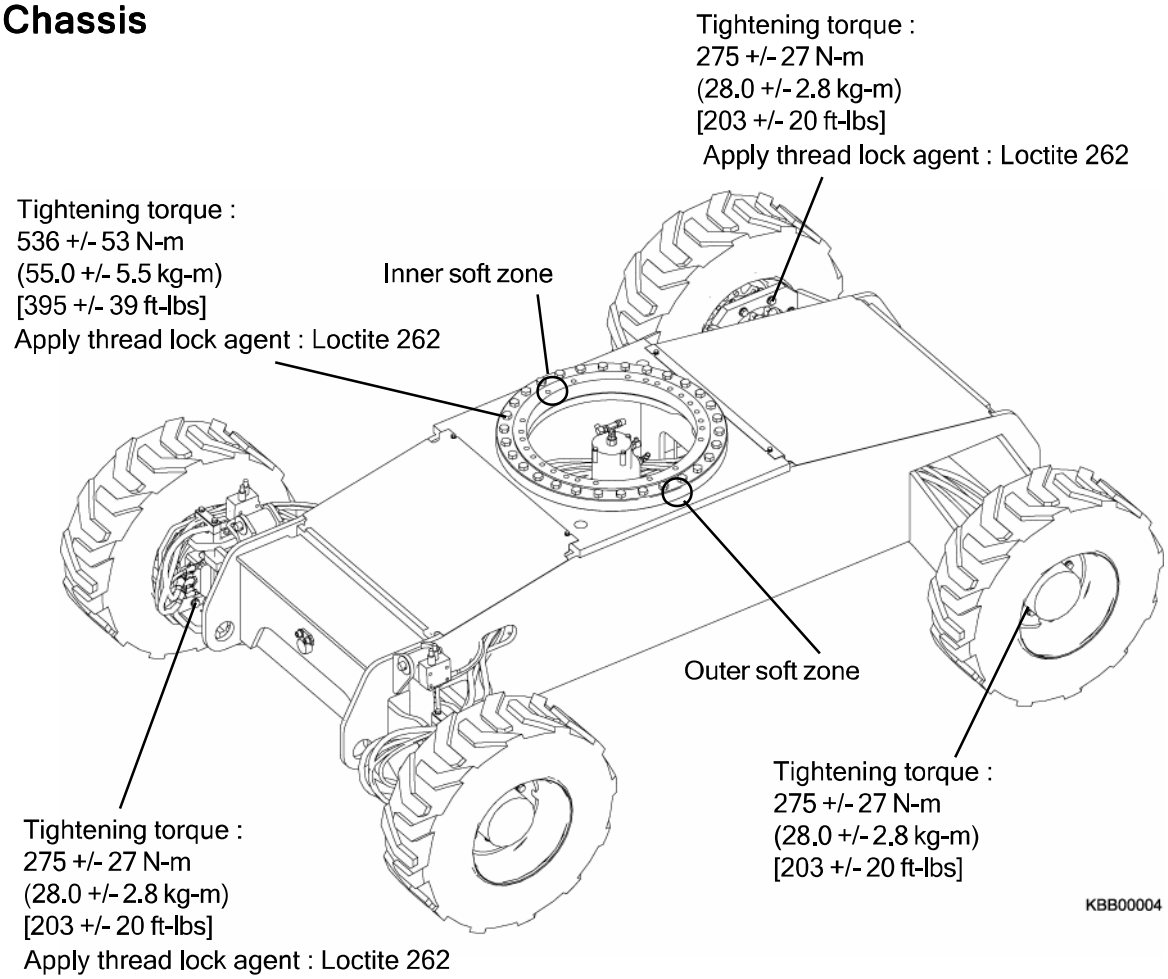
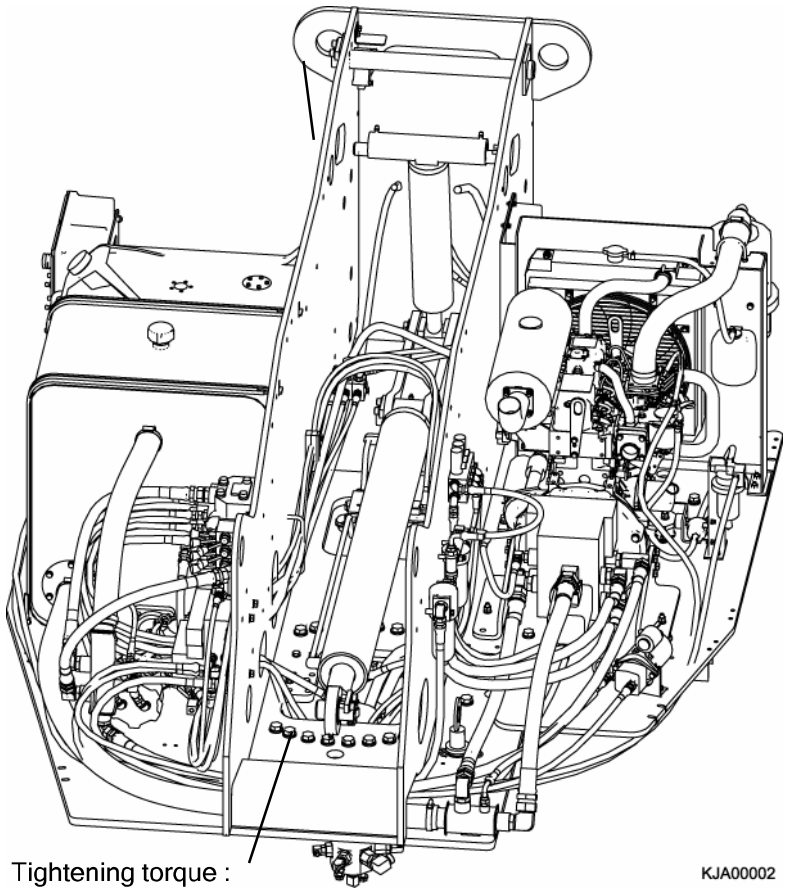


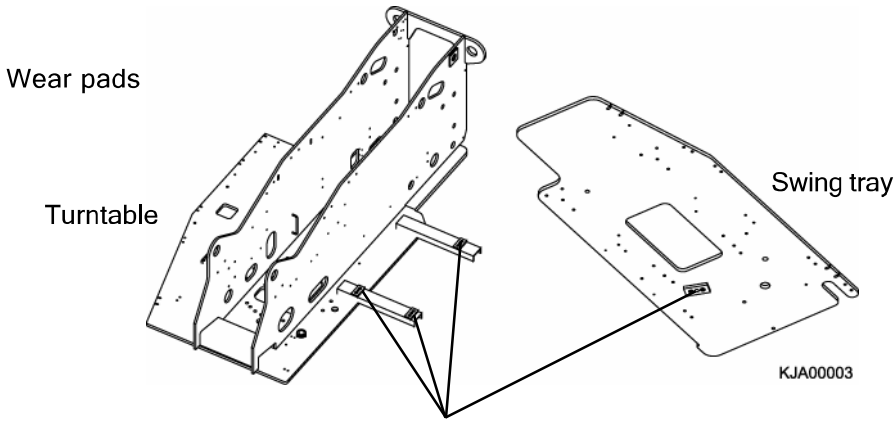
Fig. 2-1 Chassis

Turntable



Tightening torque :
384 +/- 38 N-m
(39.0 +/- 3.9 kg-m)
[283 +/- 28 ft-lbs]
Apply thread lock agent : Loctite 262

Fig. 2-2 Turntable



Wear pads [454-0000744] x4
Machine screw [036-30816] x 8
Apply thread lock agent : Loctite 262

Fig. 2-3 Wear pads for swing tray

Hydraulic pump installation

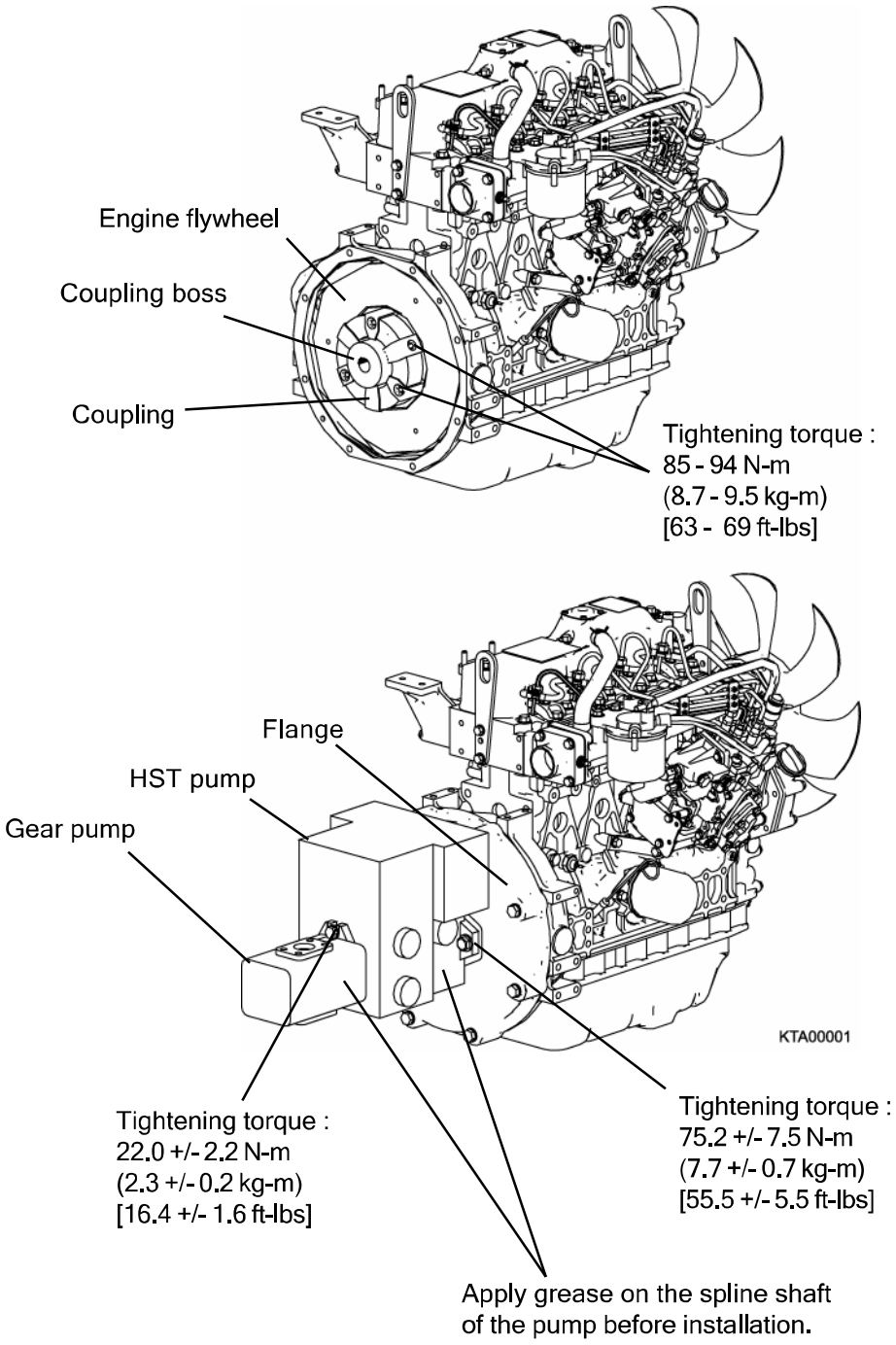


Fig. 2-4 Hydraulic pump installation

Turntable bearing (372-0000044)

This turntable bearing is mounted between the chassis and the turntable, and enables the turntable to rotate freely over the chassis.

Inspection

1. Check the anchor bolts and nuts for looseness, omission and any other damage.
   a. Loose bolts should be removed and checked for damaged threads and deformation.
   b. When re-installing anchor bolts or nuts, apply thread lock agent to the threads.
      * Recommended thread lock agent: Loctite 262.
   c. Tighten anchor bolts by the specific tightening torque.
      * Specified tightening torque
      Anchor bolt for Turntable : 384 +/- 38 N-m (39.0 +/- 3.9 kg-m) [283 +/- 28 ft-lbs]
      Anchor bolt for Chassis : 536 +/- 53 N-m (55.0 +/- 5.5 kg-m) [395 +/- 39 ft-lbs]

NOTICE

In case it is hard to loosen anchor bolts due to lock agent, heat them up by using a gas burner to melt the agent.
The heated or removed bolts and nuts should be replaced with new ones.

2. Check the ring gear for cracks and any other damage.
   To make the cracks obvious, use a liquid penetrant test such as a color check.
3. Check the backlash between the ring gear of the turntable bearing and the pinion gear of the rotation gearbox.
   * Standard backlash: 0.2 - 0.3 mm (0.008 - 0.012 in) or less.

NOTICE

To check the backlash, rotate the turntable and insert a lead wire between the ring gear and the pinion gear of the turntable gearbox to crush the wire, and then measure the thickness of the crushed lead wire.
If the backlash is inadequate, adjust it by moving the rotation gearbox.

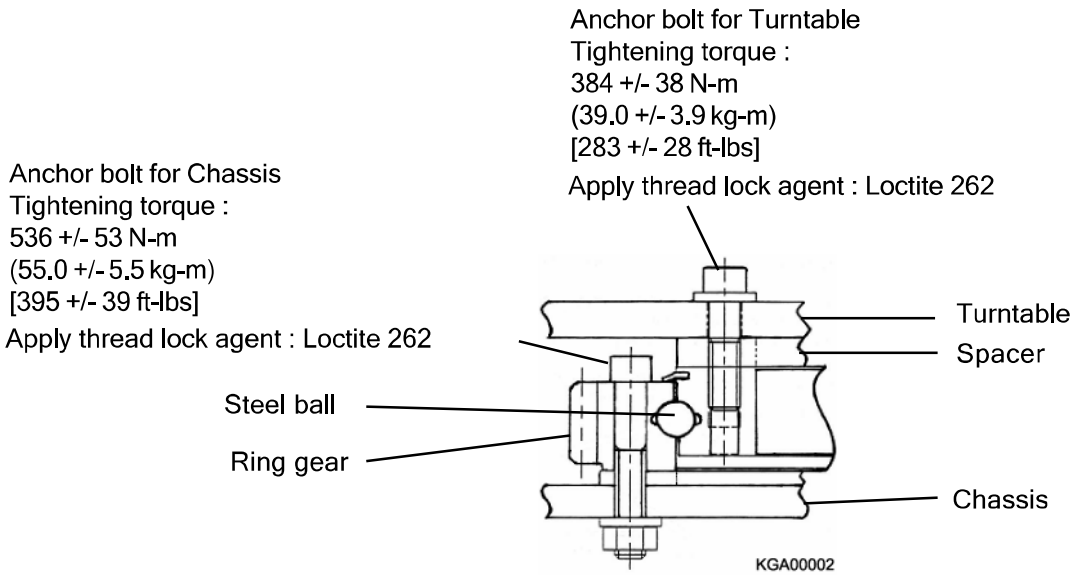


Fig. 2-5 Turntable bearing

4. Check the free-play between inner and outer races of the turntable bearing as follows.

a. Set a dial gauge between the turntable and the chassis as shown in the Fig. 2-6.

b. Retract and raise the boom fully, and set the pointer of the dial gauge at ZERO.

c. Lower the boom, set it horizontally, extend it fully to its maximum outreach and then read the dial gauge again.

The reading of the gauge is the numerical value of free-play.

* Standard free-play: 0.9 mm (0.035 in).
* Serviceable limit: 3.0 mm (0.118 in).

NOTICE

The turntable bearing should be replaced, if the free-play exceeds the serviceable limit.

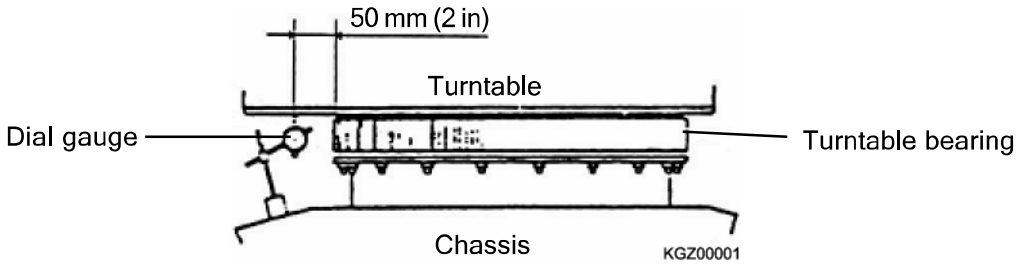


Fig. 2-6 Checking freeplay

Boom rotation gearbox (372-0000082A)

The boom rotation gearbox reduces the rotation speed of the hydraulic motor and increases the torque to rotate the turntable through the turntable bearing.

Specifications

* Type : Worm gear
* Reduction ratio : 1/50
* Gear oil : Shell Spirax EP-90
* Oil change interval : 1,200 hours or annually

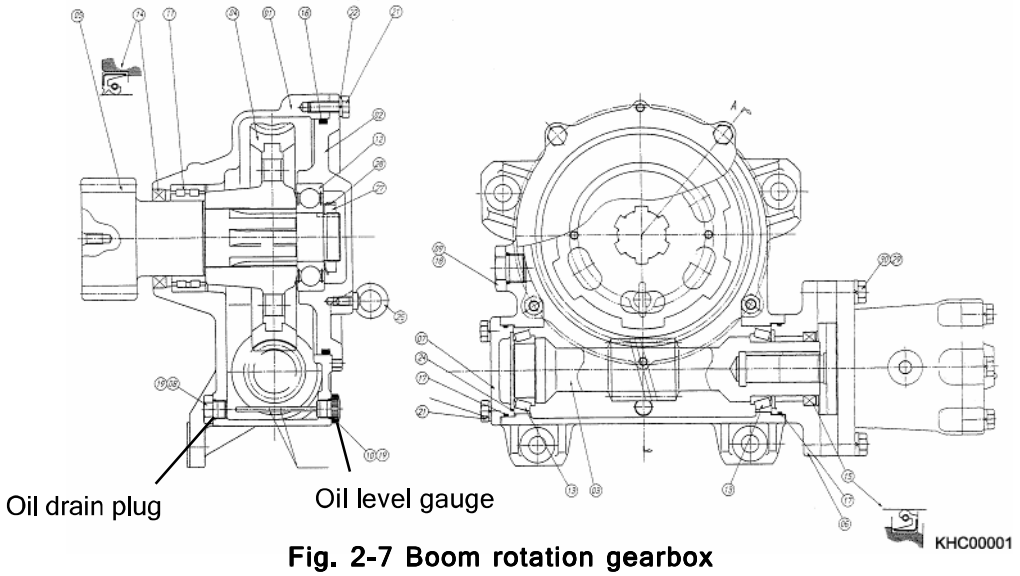


Fig. 2-7 Boom rotation gearbox

Inspection

1. Check the gear oil level and replenish the oil, if necessary.

Recommended gear oil --- Shell Spirax EP- 90

To check the oil level, screw in the oil level gauge (Dipstick) fully into the gearbox first, then remove the dipstick.
The proper oil level is between the two lines on the dipstick as shown in the Fig.2-8.

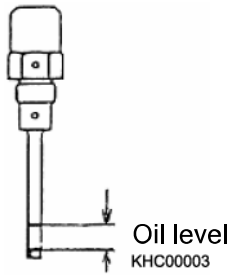


Fig. 2-8 Oil level gauge

Adjustment

1. Check the backlash following instruction in the page 2-5 and adjust if it is necessary.
1) Screw out the bolt (1)so that the rotation gearbox touches to the stopper.
2) Screw in the two bolts (2) alternately so that the backlash between Rotation gearbox and Turntable bearing become 02 -0.3 mm [0.008- 0.012 in]
3) Tighten the four bolts (3) to fix the rotation gearbox. Apply thread lock agent before tightening the bolts.

Recommended thread lock agent : Loctite 262

4) Tighten the bolt (1) and two bolts (2) and then tighten their lock nuts.

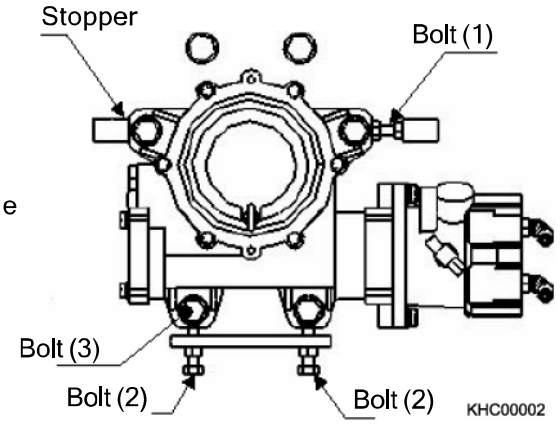


Fig. 2-9 Backlash adjustment

Boom

1. Structure

The boom consists of the 1st, 2nd, and 3rd boom sections, Boom telescope cylinder, the Extension/ Retraction wire ropes, Hydraulic hoses, Electric cables and Sheaves.

The 2nd boom section is extended or retracted directly by the Boom telescope cylinder.

However, the 3rd boom section is telescoped by the movement of the 2nd boom section through the extension and retraction wire ropes.

The 1st and 2nd boom sections are connected by the Boom telescope cylinder, which directly extends and retracts the 2nd boom section.

While, the 3rd boom section is connected to the 2nd boom section by the extension and retraction wire ropes as shown in the figure below.

The retraction wire ropes are connected to the tail of the 3rd boom section through the tail sheave installed on the tail of the 2nd boom section.

The extension wire ropes are also connected to the tail of the 3rd boom section through the head sheave that is installed on the head of the 2nd boom section.

The 2nd boom section is extended by the Boom telescope cylinder together with the head sheave coming along. As a result, the 3rd boom section is pulled by the extension wire rope and accordingly goes out of the 2nd boom section.

When retracting the boom, the 2nd boom section is retracted by the Boom telescope cylinder together with the tail sheave coming along. As a result, the 3rd boom section is pulled by the retraction wire rope and accordingly goes into the 2nd boom section.

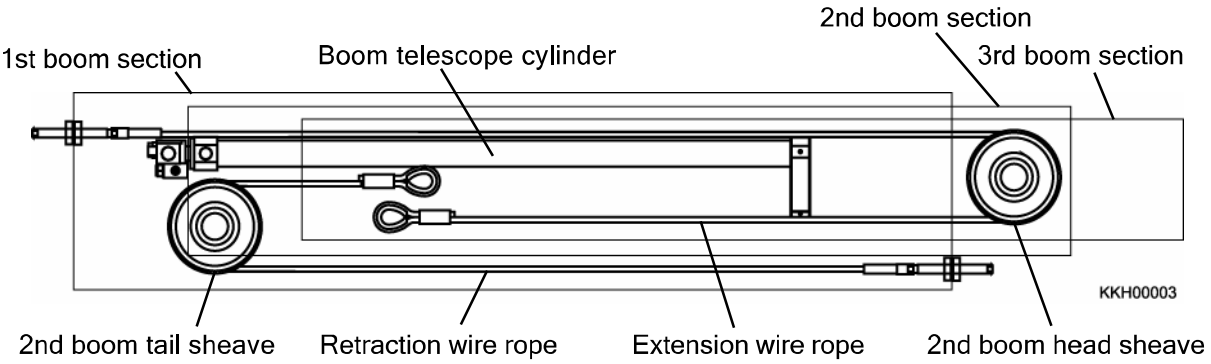


Fig. 2-10 Structure of the boom

2. Inspection proceduresе

The boom is to be disassembled for a detailed inspection every 5 years.

1. Clearance between each boom section.
 1) Check the clearance between each wear pad and boom section.

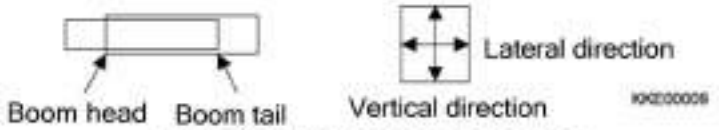


Fig. 2-11 Clearance inspection

		Vertical direction	Lateral direction, Sum of Right and Left
Clearance between 1st and 2nd boom sections	boom head	0.5 - 1.0 mm (0.020 - 0.039 in)	0.5 - 0.9 mm (0.020 - 0.035 in)
	boom tail	0.6 - 1.1 mm (0.024 - 0.043 in)	0.5 - 1.1 mm (0.020 - 0.043 in)
Clearance between 2nd and 3rd boom sections	boom head	0.5 - 1.0 mm (0.020 - 0.039 in)	0.5 - 0.9 mm (0.020 - 0.035 in)
	boom tail	0.5 - 0.9 mm (0.020 - 0.035 in)	0.5 - 0.9 mm (0.020 - 0.035 in)

 2) If the clearance is not adequate, adjust the clearance by adding or reducing the spacers installed under each wear pad.
 Check each wear pad for wear, and replace them if the thickness is thinner than serviceable limit.

Serviceable limit of ware pad

1st boom section Lower
 Nominal thickness : 12 mm (0.47 in)
 Serviceable limit : 10 mm (0.39 in)

1st boom section Side
 Nominal dimension : 15 mm (0.59 in)
 Serviceable limit : 13 mm (0.51 in)

2nd boom section Lower
 Nominal thickness : 15 mm (0.59 in)
 Serviceable limit : 13 mm (0.51 in)

2nd boom section Side
 Nominal dimension : 40 mm (1.58 in)
 Serviceable limit : 38 mm (1.50 in)

Apply a thread lock agent to the thread of each setscrew for wear pad before setting.
 Recommended thread lock agent: Loctite 262

2. Bend of boom section.
 1) Set the boom horizontally and extend it fully.
 2) Visually check the bend of each boom section and disassemble the boom to measure the bend, if the excessive bend is observed.

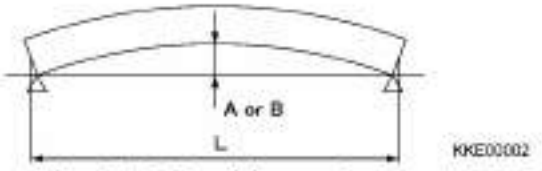


Fig. 2-12 Bend inspection

* Serviceable limit

			1st boom section	2nd boom section	3rd boom section
Length		L	4,700 mm (15 ft 5.0 in)	4,523 mm (14 ft 10.1 in)	4,748 mm (15 ft 6.9 in)
Serviceable limit	Vertical direction	A	7.1 mm (0.28 in)	6.8 mm (0.27 in)	7.1 mm (0.28 in)
	Lateral direction	B	4.7 mm (0.19 in)	4.5 mm (0.18 in)	4.7 mm (0.19 in)

3. Dents, scratches

Check the each boom section for both dents and scratches thoroughly. If any dent or scratch that exceeds the serviceable limit is observed, replace the boom section.

* Serviceable limit:

Length = 50 mm [1.97 in], and/or Depth = 2 mm [0.08 in].

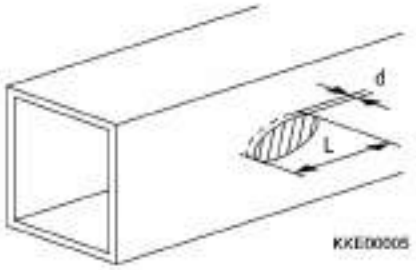


Fig. 2-13 Dent inspection

4. Dents on bottom plate of the 2nd and 3rd boom sections

Check the bottom plate of the 2nd and 3rd boom section for dents caused by contact with wear pads. If any dent that exceeds the serviceable limit is observed, replace the boom section.

* Serviceable limit: 1.6 mm

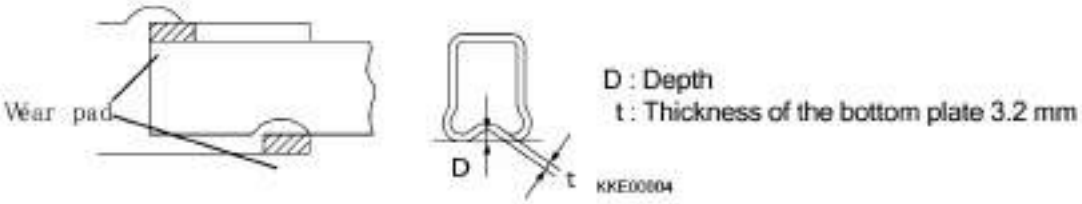


Fig. 2-14 Dent on the bottom plate of the boom section

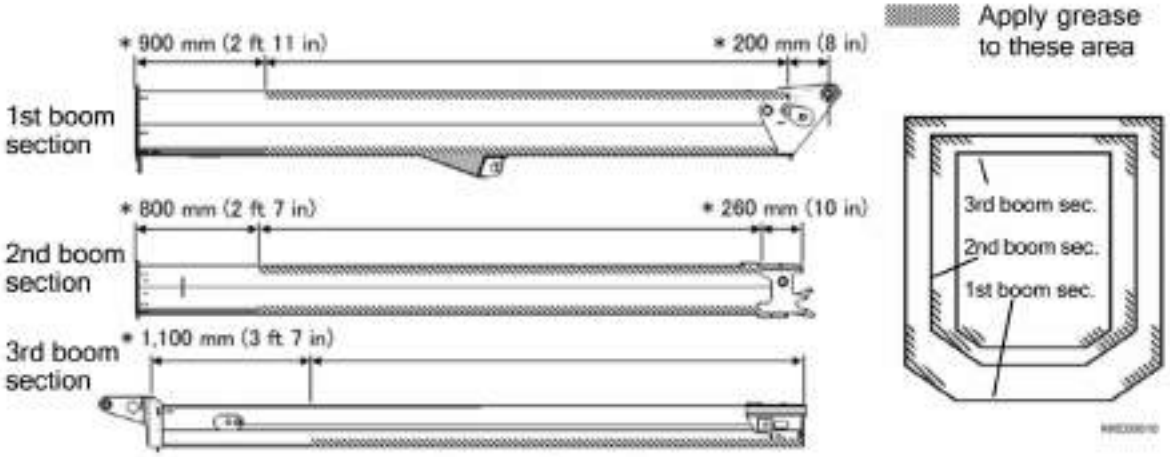
5. Cracks.

Check each boom section thoroughly for cracks. For fine cracks, use **COLOR CHECK** or penetrant check.

Pay special attention, when checking each pin boss and welded section.

6. Lubrications

Check the grease on the inner surface of each boom section and apply molybdenum grease.



* Do not apply grease to the end of each boom section.

Fig. 2-15 Lubrication of the boom section

3. Extension / Retraction wire rope

After disassembling the boom, inspect the extension and retraction wire ropes as follows.

1) Measure the diameter of both the extension and retraction wire ropes, using a slide calipers.
Replace the wire rope, if the decrease of the diameter is more than 3 % of the nominal diameter.

	Nominal diameter	Serviceable limit
Retarction wire rope	12.0 mm (0.47 in)	11.7 mm (0.46 in)
Extension wire rope	12.0 mm (0.47 in)	11.7 mm (0.46 in)

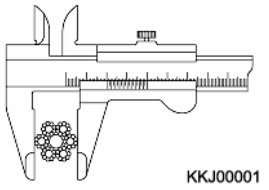


Fig. 2-16 Wire diameter

2) Check for broken wires.
If you find 3 or more single wires cut in one twist stroke, replace the wire rope.



Fig. 2-17 Broken wires

3) Check wire ropes for rust formation.
If the rust is penetrated into the rope, replace the wire rope.



Fig. 2-18 Rust formation

4) If any kinks are observed, replace the wire rope.
Also, a deformed wire rope requires replacement.



Fig. 2-19 Kink, Deformation

5) Check carefully the end sections of the wire rope, especially sections A and B.
Replace the wire rope, if any defects are found.

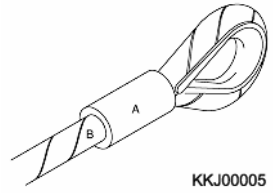


Fig. 2-20 Wire rope end

4. Adjustment of Extension / Retraction wire rope

Adjust the tension of the Extension/Retraction wire ropes as follows.

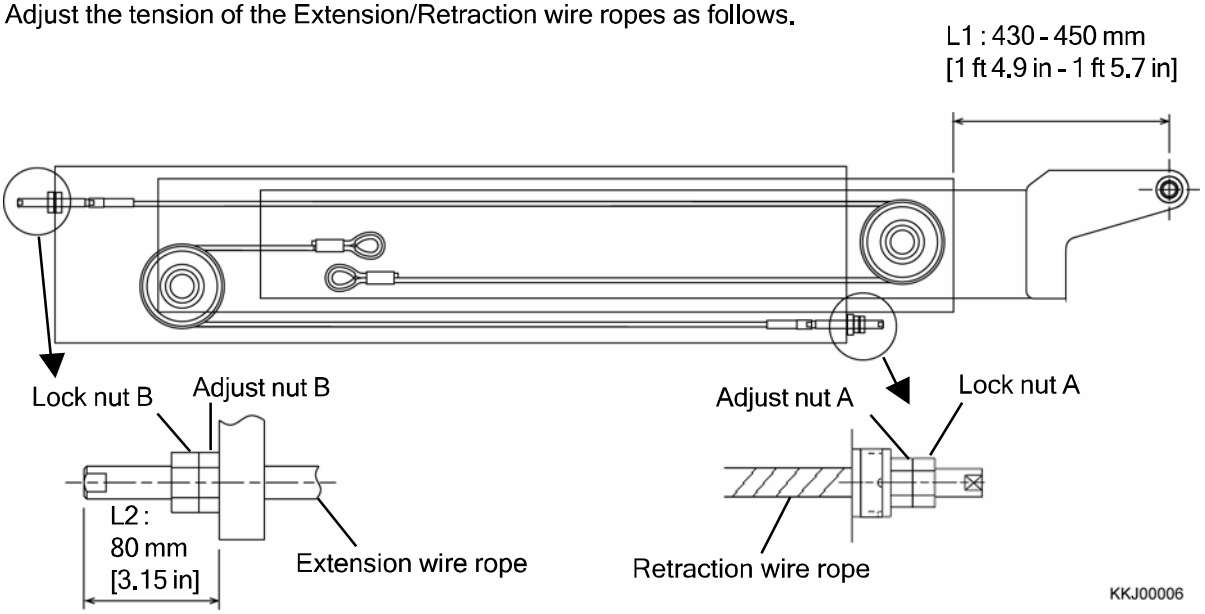


Fig. 2-21 Wire rope adjustment

1) Set the boom horizontally and retract it fully.

2) Unlock the Lock nuts B, turn the Adjust nuts B and adjust the Dimension L2 to 80 mm [3.15 in].

NOTICE

Do not twist the wire ropes when turning the adjust and lock nuts.

3) Loosen the Lock nuts A and the Adjust nuts A at the terminal end of the retraction wire ropes, and then make sure that the 6 plate springs, shims, 2 washers and 1 collar are assemble at the end of the retraction wire rope as shown in the Fig. 2-21.

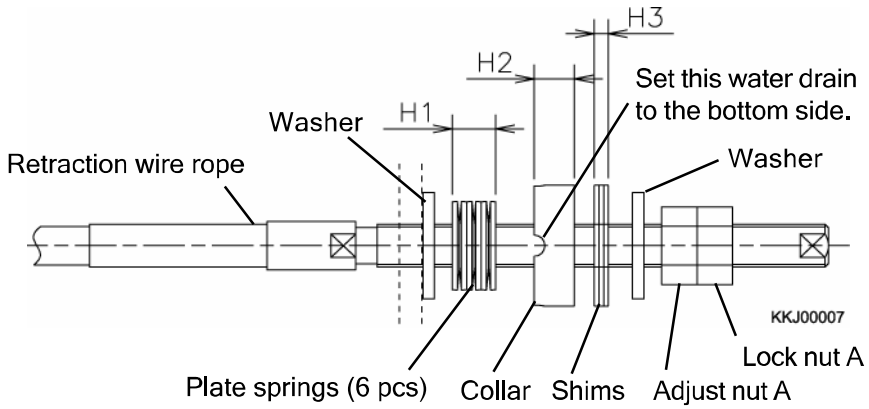


Fig. 2-22 Retraction wire end

4) Tighten the Adjust nut A until the washers touch the collar as shown in the fig. 2-22.

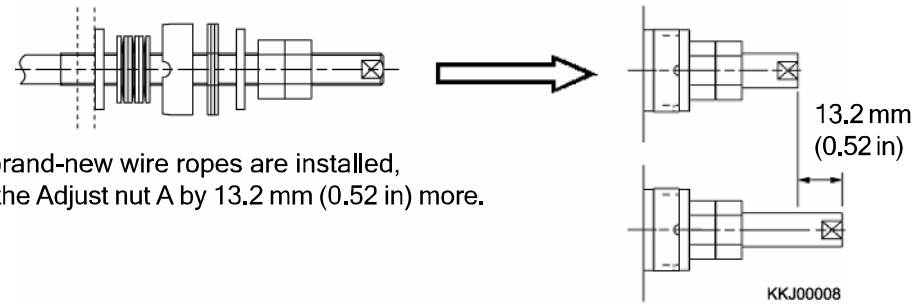


Fig. 2-23 Tighten the adjust nut

5) Measure the Dimension L1 and make sure that it is 430 - 450 mm [1 ft 4.9 in - 1 ft 5.7 in].

6) Adjust the Dimension L1 as follows, if the Dimension L1 is not 430 - 450 mm [1 ft 4.9 in - 1 ft 5.7 in].

* In case the Dimension L1 is shorter than 430 mm [1 ft 4.9 in].
Screw out the Adjust nuts A and screw in the Adjust nuts B to adjust the Dimension L1 to 430 - 450 mm [1 ft 4.9 in - 1 ft 5.7 in].

* In case the Dimension L1 is longer than 450 mm [1 ft 5.7 in].
Screw out the Adjust nuts B and screw in the Adjust nuts A to adjust the Dimension L1 to 430 - 450 mm [1 ft 4.9 in - 1 ft 5.7 in].

7) Repeat the steps 5 and 6, and then tighten the Lock nuts A and B.

8) Telescope the boom several times, retract the boom fully, and then make sure that Dimension L1 is 430 - 450 mm [1 ft 4.9 in - 1 ft 5.7 ft].

When replacing the Plate springs with the new ones, make sure to insert the correct Shims by following the next instructions.

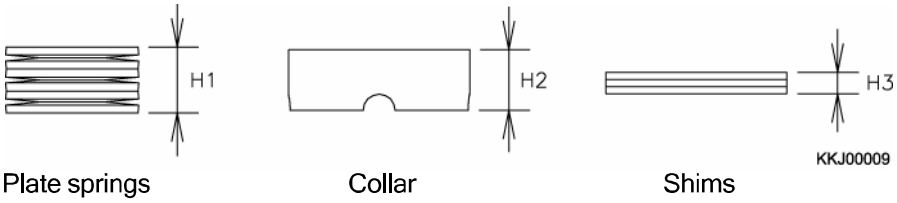


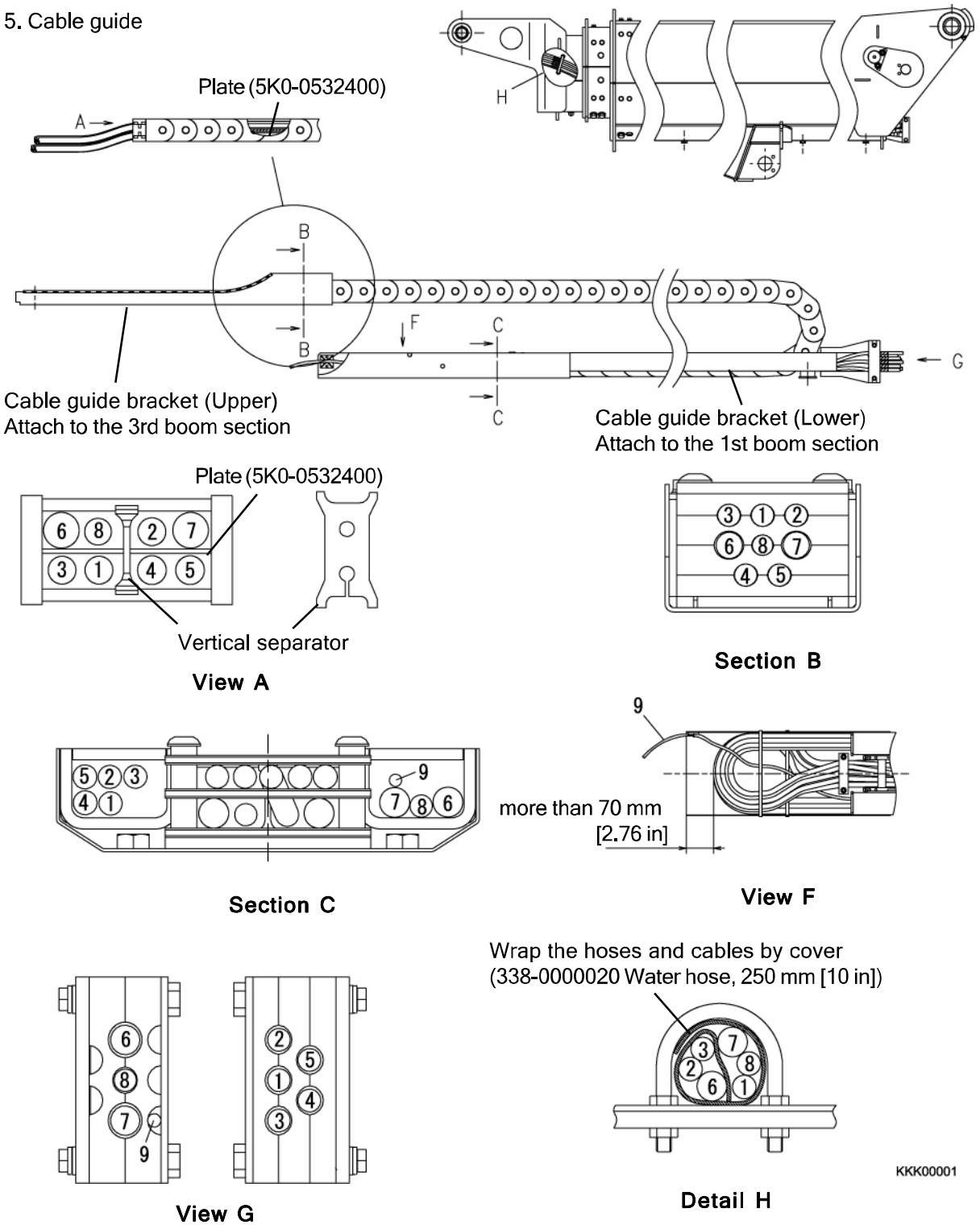
Fig. 2-24 Plate springs, Collar and Shims

1) Stack the new 6 Plate springs on level surface, and then measure the Overall height (H1) of the plate springs.
2) Measure the Height (H2) of the Collar.
3) Determine the Thickness (H3) of the Shims using the following formula.
H3 = H1 - H2 - 3.6 mm (0.142 in)

The following shims are provided as service parts.

Part number	Thickness of Shim
443-0000197	0.5 mm (0.02 in)
443-0000198	0.1 mm (0.004 in)

5. Cable guide



No.	Hoses	No.	Cables, Wire
1	Hose (P)	6	14 core cable
2	Hose (T1)	7	16 core cable with shield wires
3	Hose (T2)	8	4 core cable for AC outlet (CE model and ANSI model)
4	Hose (Platform leveling, Up)		
5	Hose (Platform leveling, Down)	9	Wire for Boom length limit switch

Fig. 2-25 Cable guide

6. Removal and installation of Cable guide

SP12C (SP400C) Removal

1) Set the machine on firm and level surface.

2) Set the boom horizontal, extend the boom about 100 mm [4 in]and then turn off the main key switch.

3) Support the platform by crane or forklift.

4) Take the cover on the platform off. (Fig. 2-26)

5) Disconnect the boom cables (14 cores: Connector 126Gy, 127Gy) and (16 cores: Connector 122Gy, 128Gy, 129Gy). (Fig. 2-27)
[Connector 129Gy is for CE and ANSI model only]

6) Disconnect the cable (4 cores) for AC outlet from the receptacle if it is equipped.

7) Tag, Disconnect the T1 hose, P hose and T2 hose from the platform rotation solenoid valve (Fig. 2-28), and then plug the fittings on the valve and hose ends.

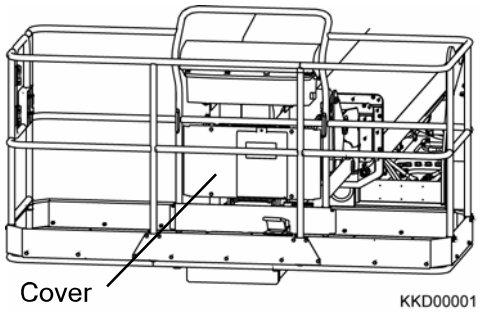


Fig. 2-26

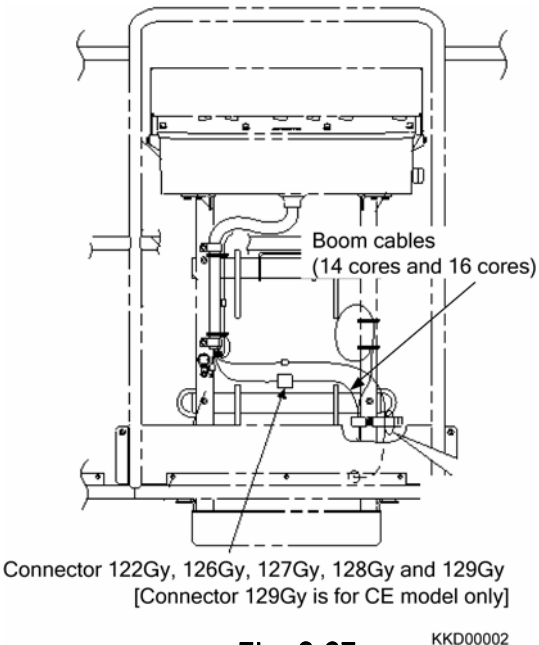


Fig. 2-27

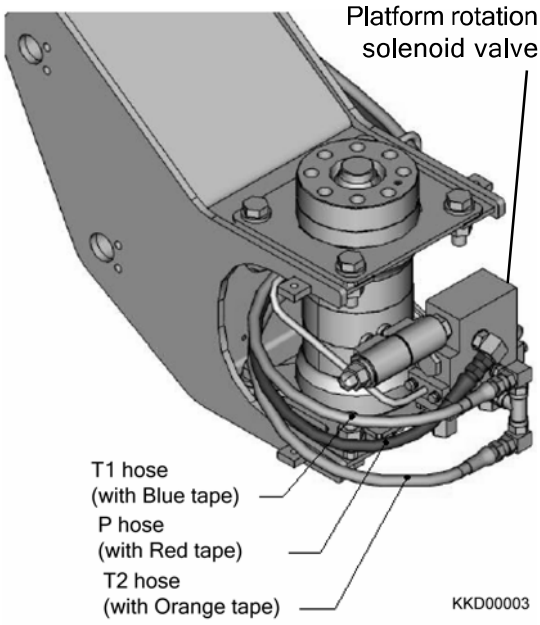


Fig. 2-28

8) Take the 3rd boom front cover and cylinder boot off. (Fig. 2-29)

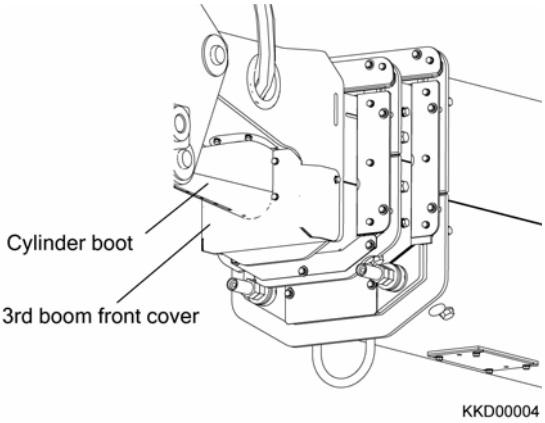


Fig. 2-29

9) Tag, disconnect the hoses for upper leveling cylinder and then plug the fittings on the hose ends. (Fig. 2-30)

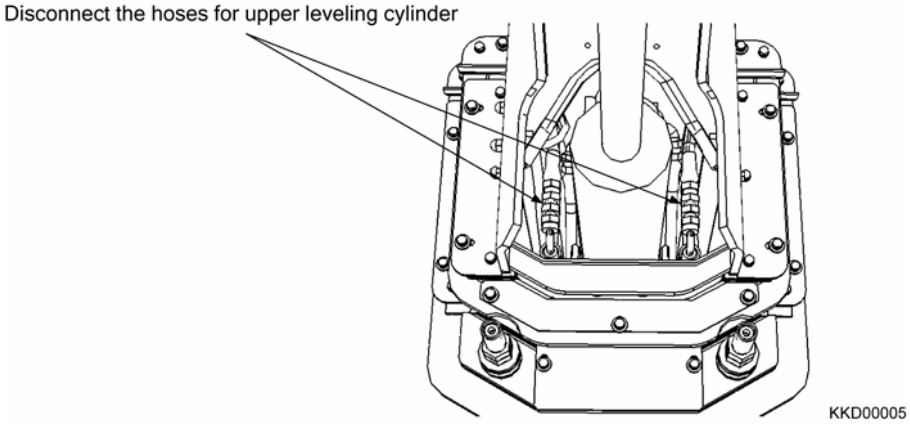


Fig. 2-30

10) Take the U bolt fixing the boom cable and hoses off. (Fig. 2-31)

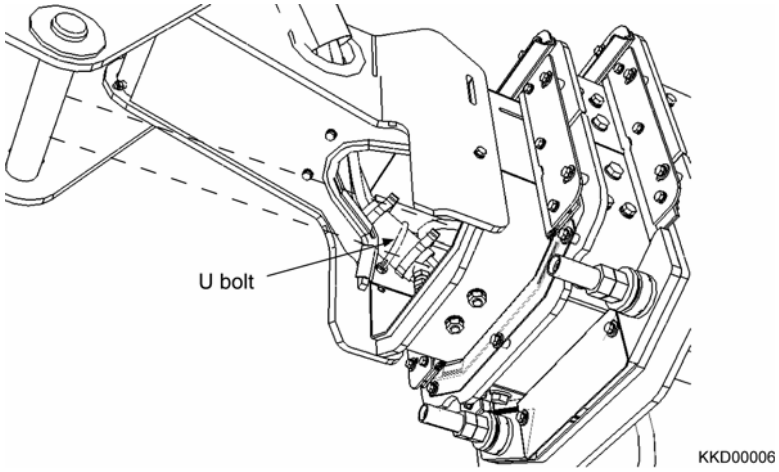


Fig. 2-31

11) Cut cable ties fixing the boom cables and then pull out the hoses and boom cables from the guard and hole at the top of the 3rd boom section. (Fig. 2-32)

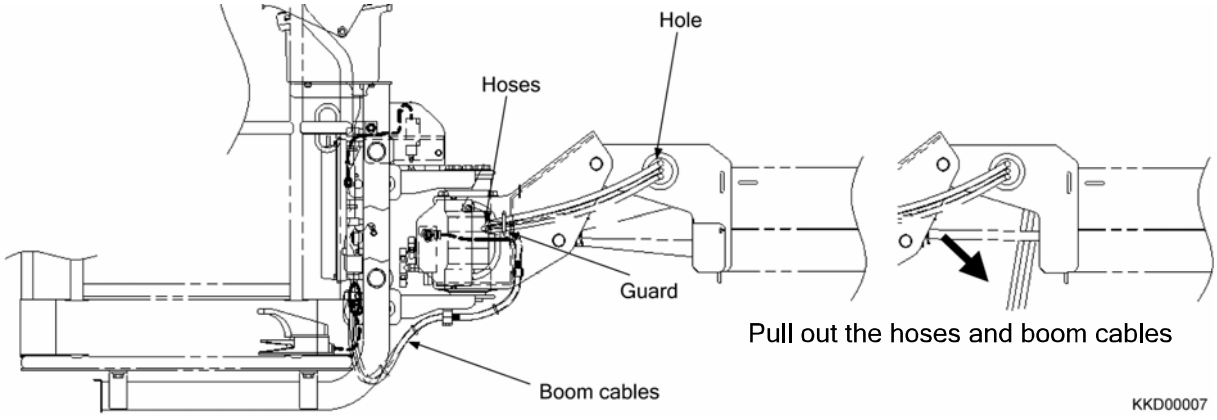


Fig. 2-32

12) Bundle the boom cables and hoses up, and then tie the leading rope to the 4 cores cable for AC outlet (Fig. 2-33)

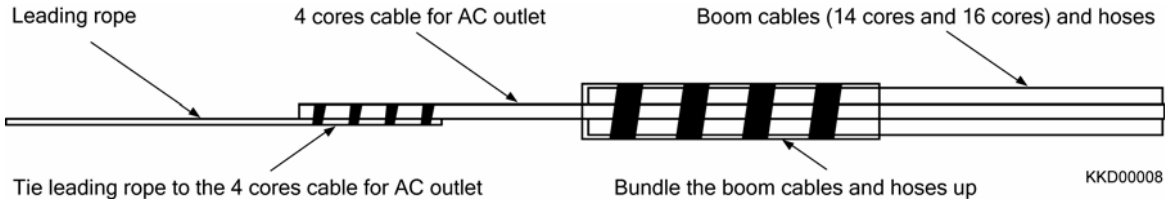


Fig. 2-33

NOTICE

Use leading rope longer than 8 meters [26 ft] to pass through the boom section.

13) Open the boom length limit switch cover located under the 1st boom section, and then disconnect the cable for the boom length limit switch (Connector 572Br) (Fig. 2-34).

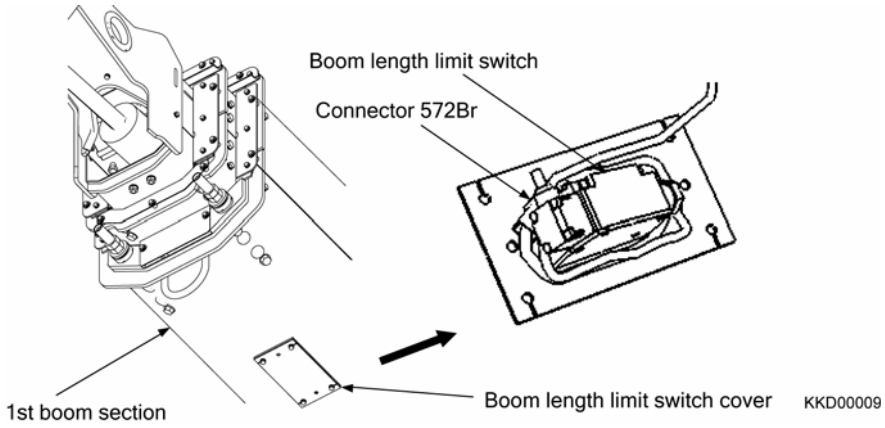


Fig. 2-34

14) Wind the disconnected cable and then put it on the cable guide bracket (Lower). (Fig. 2-35)

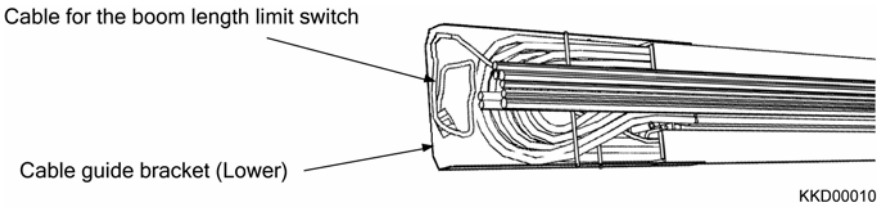


Fig. 2-35

15) Remove the cable guide fixing bolts. (Fig. 2-36)

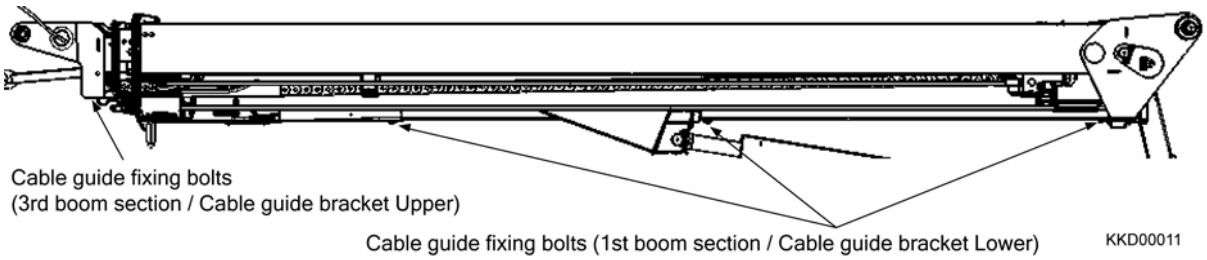


Fig. 2-36

16) Take the turntable rear cover off. (Fig. 2-37)

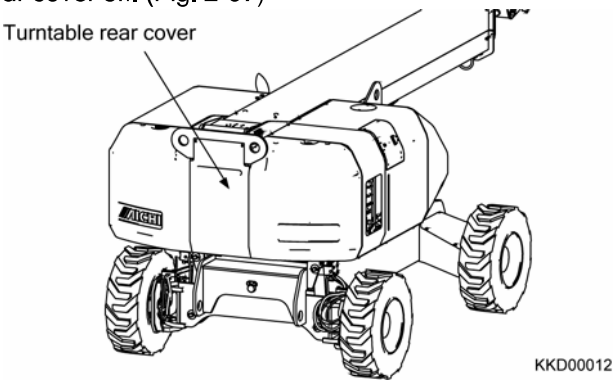


Fig. 2-37

17) Open the engine cover, take the key plate and then pull the lower leveling cylinder upper pivot pin out using slide hummer (Fig. 2-38).

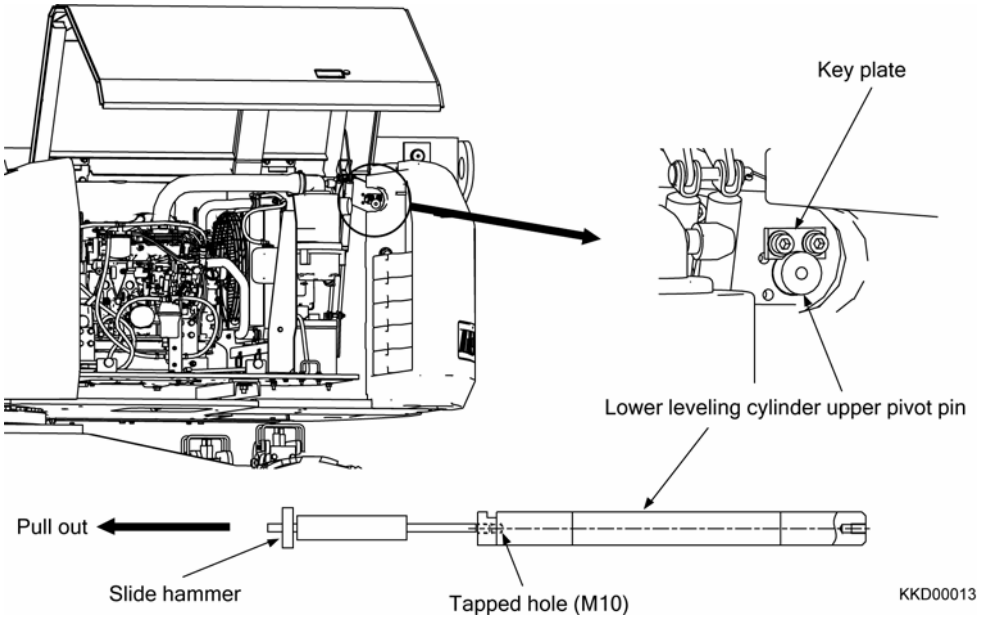


Fig. 2-38

18) Lay down the lower leveling cylinder. (Fig. 2-39)

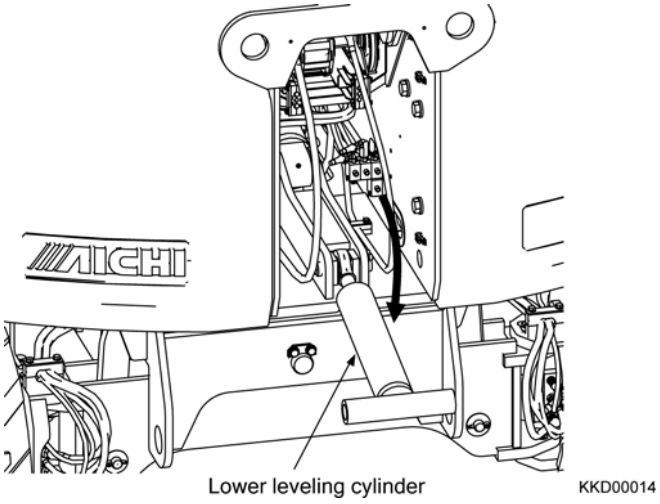


Fig. 2-39

19) Disconnect the cable for the boom wire rope failure limit switches (Connector 530Br, 531Br) and then cut cable ties fixing the cables (Fig. 2-40) [CE model only]

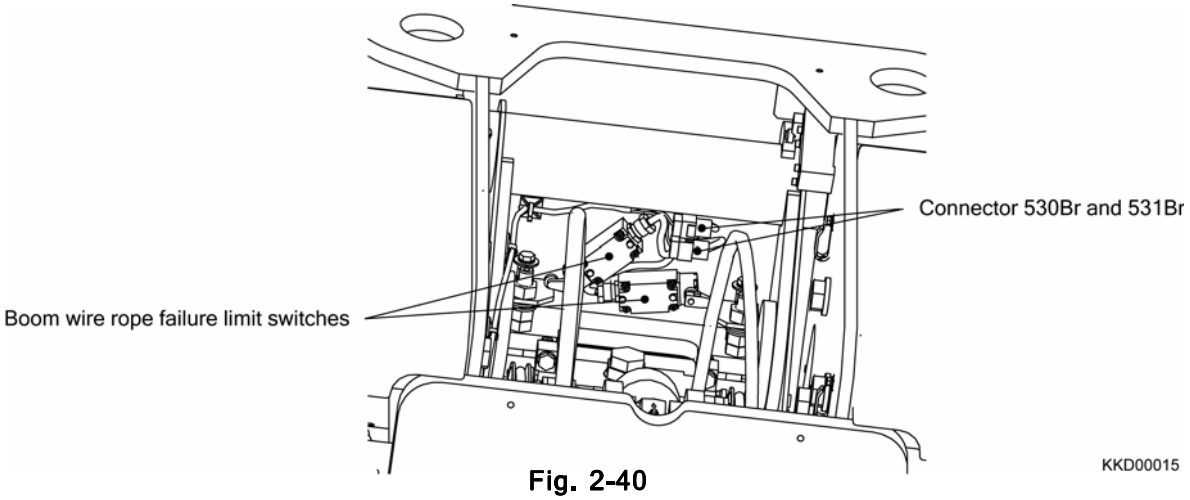
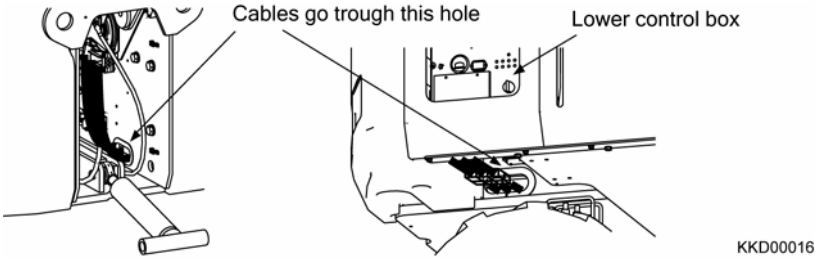


Fig. 2-40

20) Disconnect the cables listed below. Connectors are located behind the lower control box. (Fig. 2-41)

* Boom cable (14 cores: Connector 518Gy and 546Br)
* Boom cable (16 cores: Connector 516Gy, 517Gy and 521Gy)
  [Connector 521Gy is for CE and ANSI model only]
* Cable for Boom length limit switch (Connector 534Gy)
* Cable for Boom wire rope failure limit switches (Connector 503Gy) [CE model only]
* Boom cable (4 cores) for AC outlet (Disconnect from the receptacle if it is equipped)



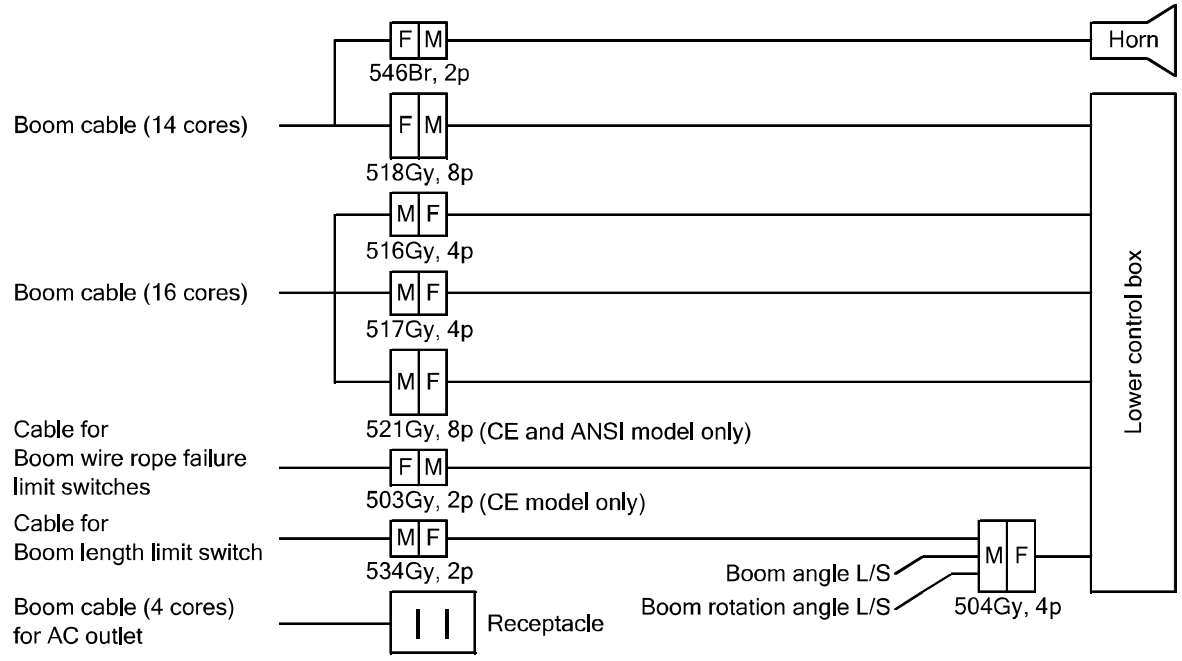


Fig. 2-41

21) Tag, Disconnect the T1 hose, T2 hose, P hose, Platform leveling Up hose and Down hose from the adaptor block (Fig. 2-42), and then plug the fittings on the adaptor block and hose ends.

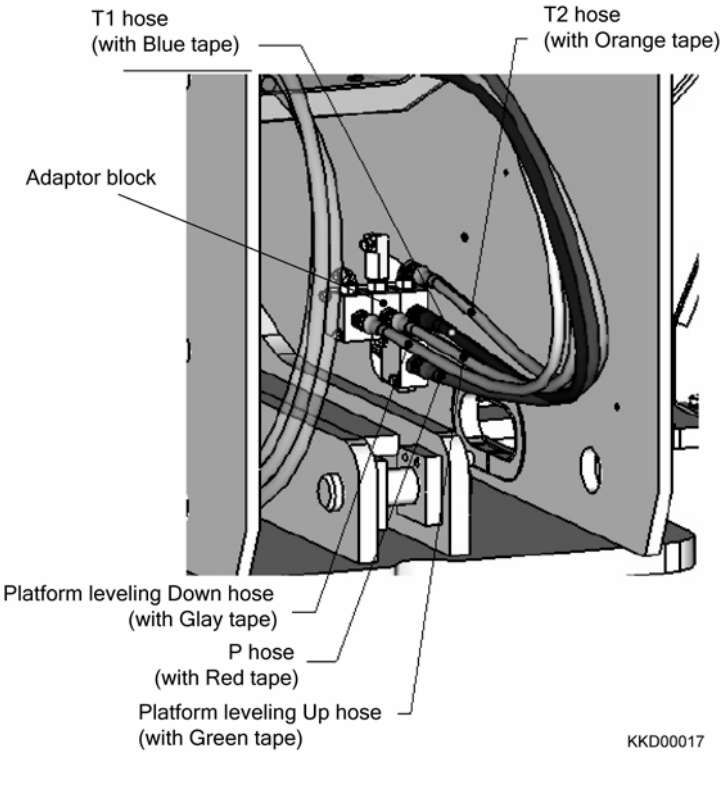


Fig. 2-42

22) Take the guide fixed to the tail end of 3rd boom section off. (Fig. 2-43)

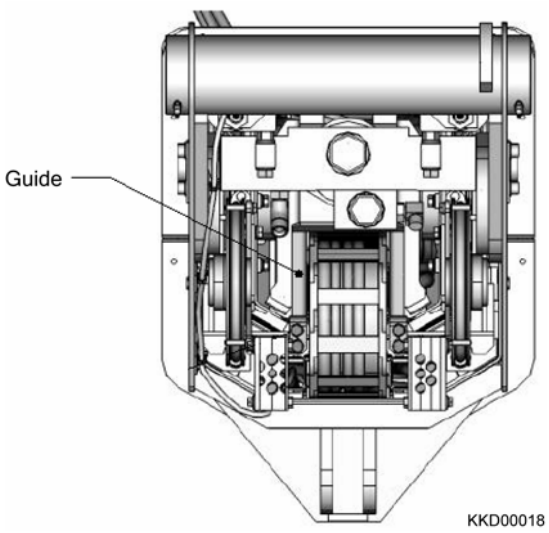


Fig. 2-43

23) Remove the cable guide, and then lay it on the stable place. (Fig. 2-44)

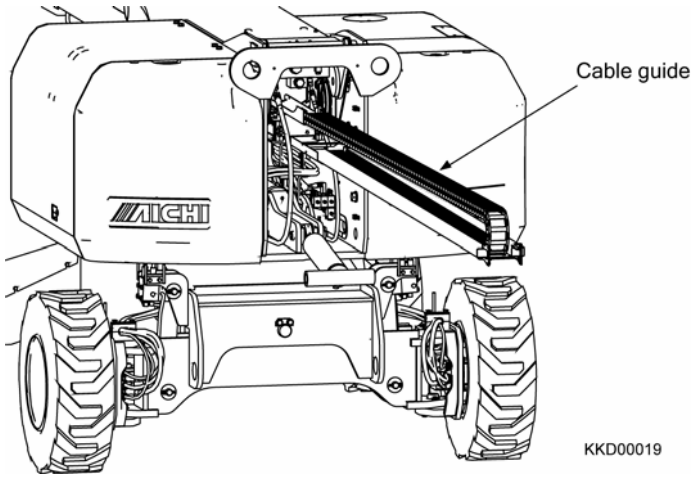


Fig. 2-44

24) Remove clamps, and then pull out the cables and hoses from the cable guide bracket (Lower). (Fig. 2-45)

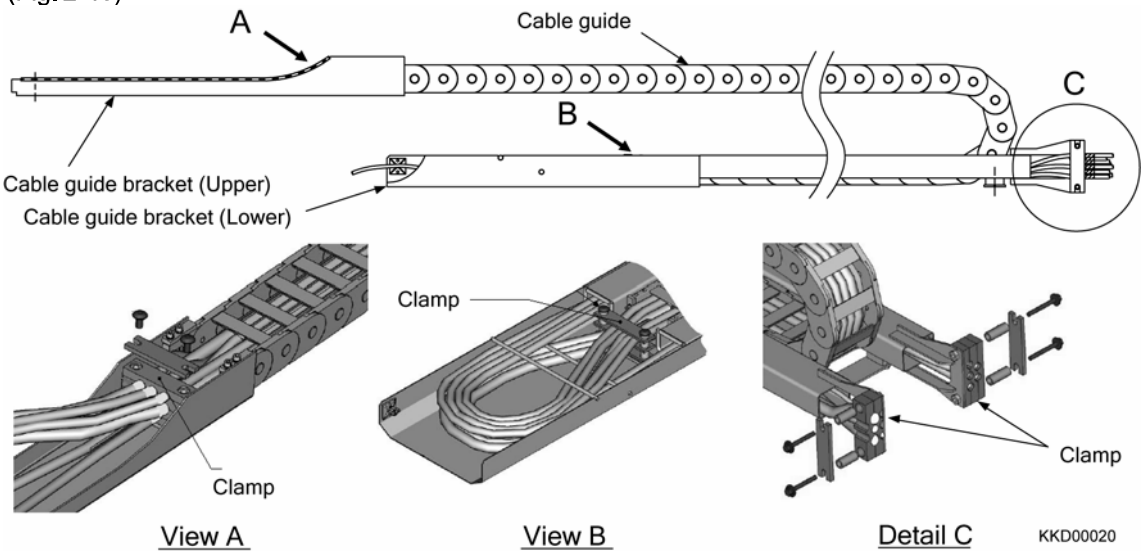


Fig. 2-45

25) Remove the cable guide from the cable guide bracket (Lower). (Fig. 2-46)

26) Open the cable guide by using screw driver (Flat), and then remove the cables and hoses (Fig. 2-47)

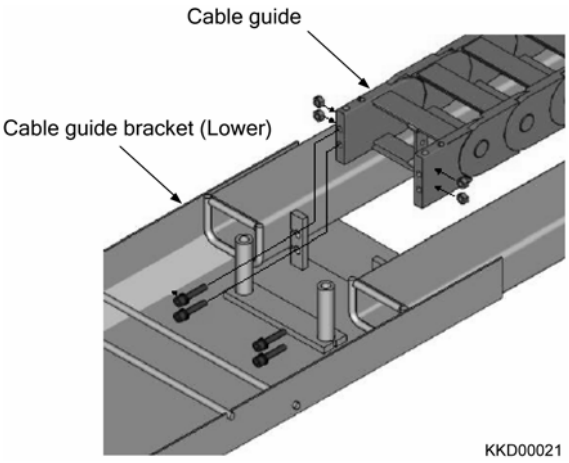


Fig. 2-46

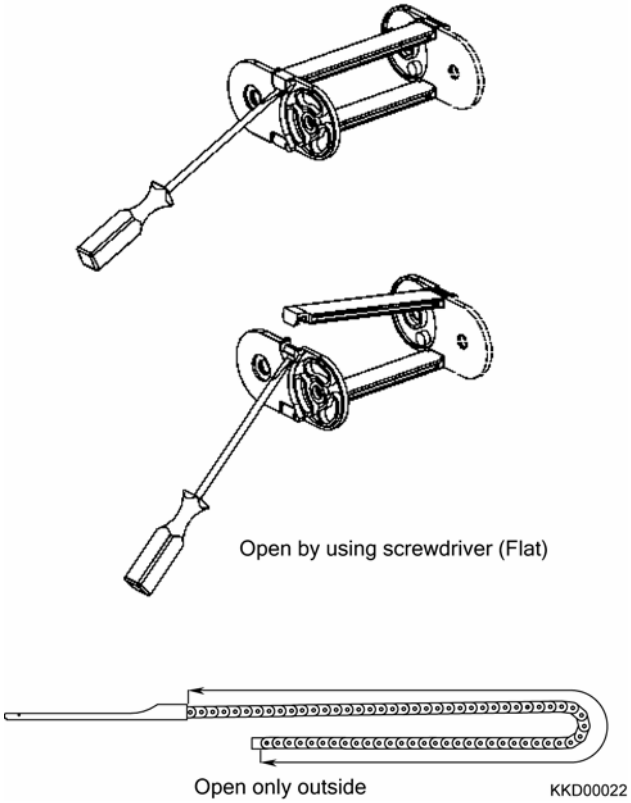


Fig. 2-47

SP14CJ (SP460CJ) Removal

1) Set the machine on firm and level surface.

2) Set the boom horizontal, Lower the fly-jib to put the platform on the wooden block and then turn off the main key switch.

3) Take the cover on the right side of the fly-jib off. (Fig. 2-48)

4) Disconnect the boom cables (14 cores: Connector 126Gy, 127Gy) and (16 cores: Connector 122Gy, 128Gy, 129Gy). (Fig. 2-49)
[Connector 129Gy is for CE and ANSI model only]

5) Disconnect the cable (4 cores) for AC outlet from the receptacle if it is equipped.

6) Tag, Disconnect the T1 hose, P hose and T2 hose and then plug the fittings on the hose ends. (Fig. 2-50)

7) Follow the SP12C (SP400C) removal instructions step 8 (Page 15) to step 26 (Page 22) to remove the cable guide.

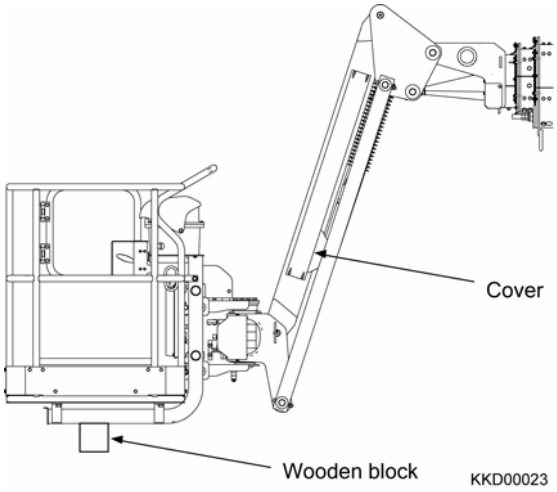


Fig. 2-48

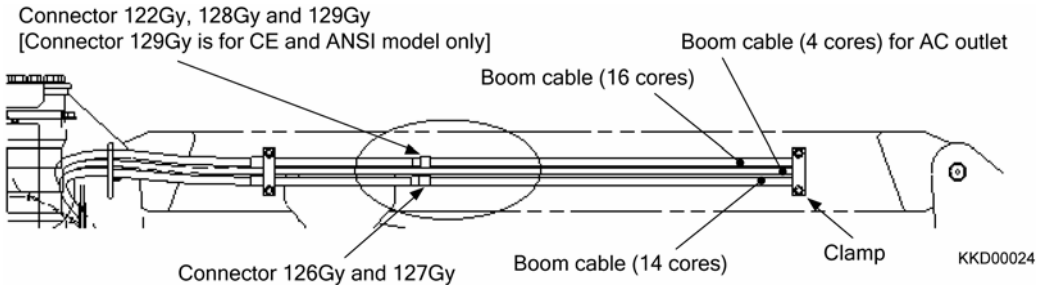


Fig. 2-49

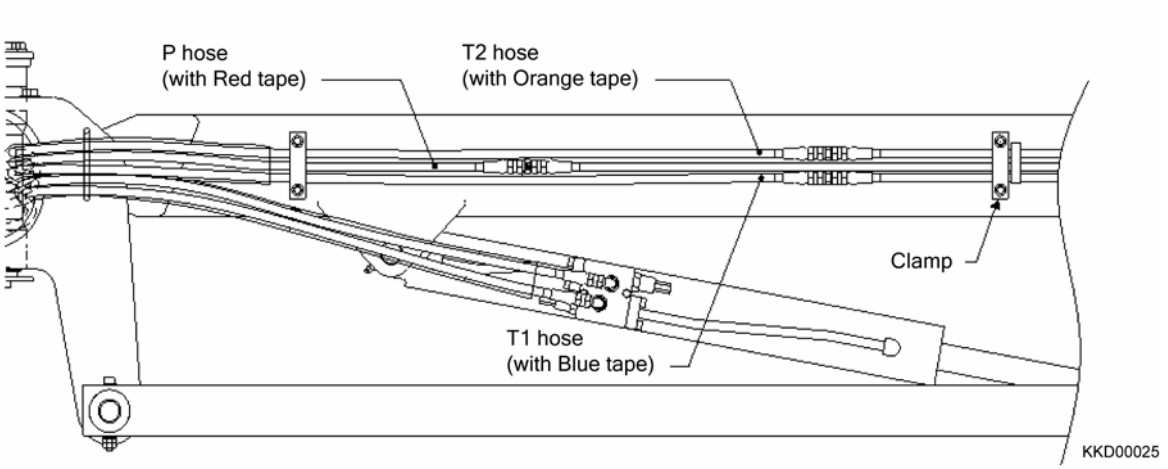


Fig. 2-50

SP12C (SP400C) Installation

1) When replacing the boom cables and/or hydraulic hoses with new one, put the designated colored vinyl tape on them to identify each cable/hose and their specific position as shown in Fig. 2-51 and Fig. 2-52.

Designated color and detail of Hydraulic hoses

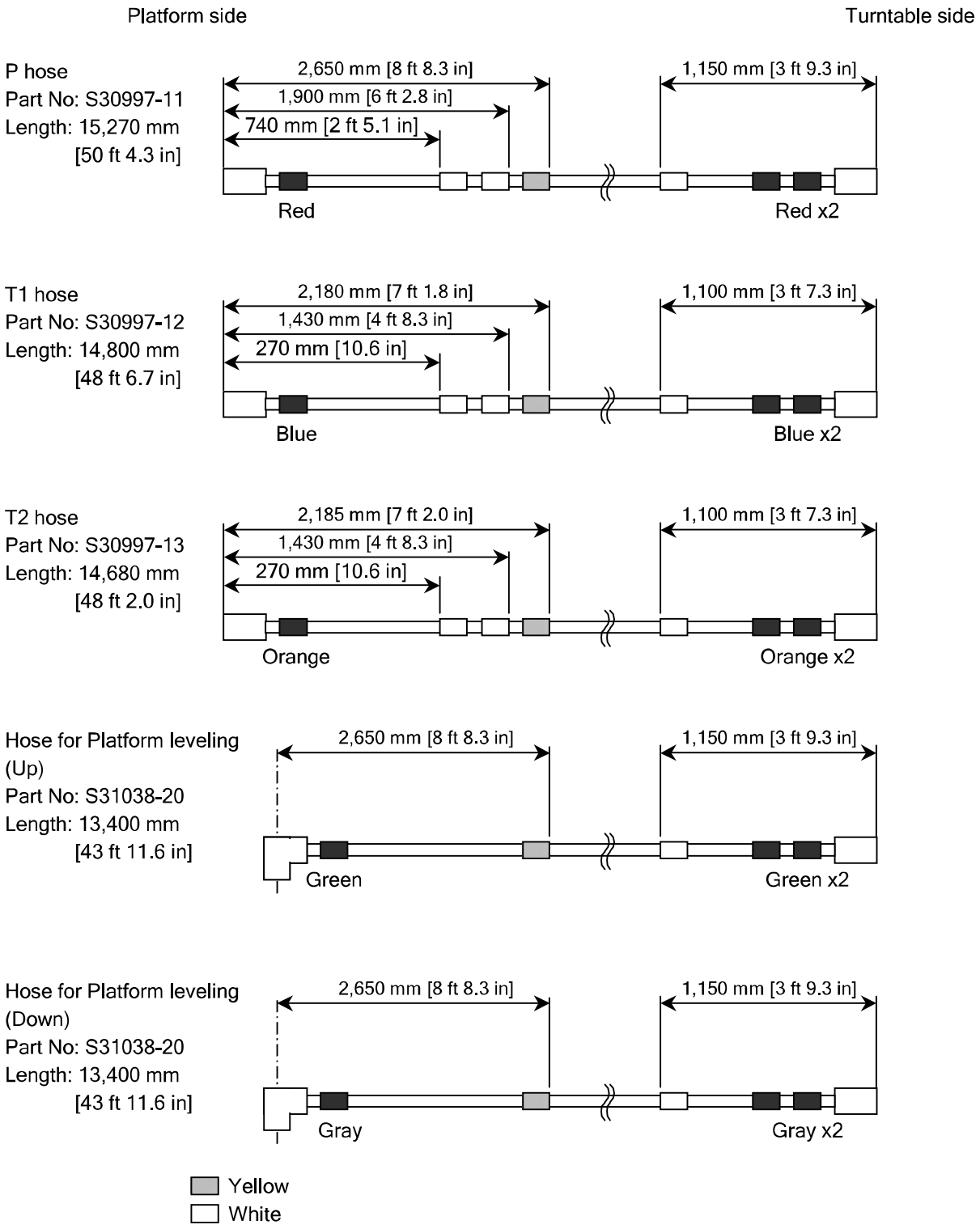


Fig. 2-51

Designated color and detail of Boom cables

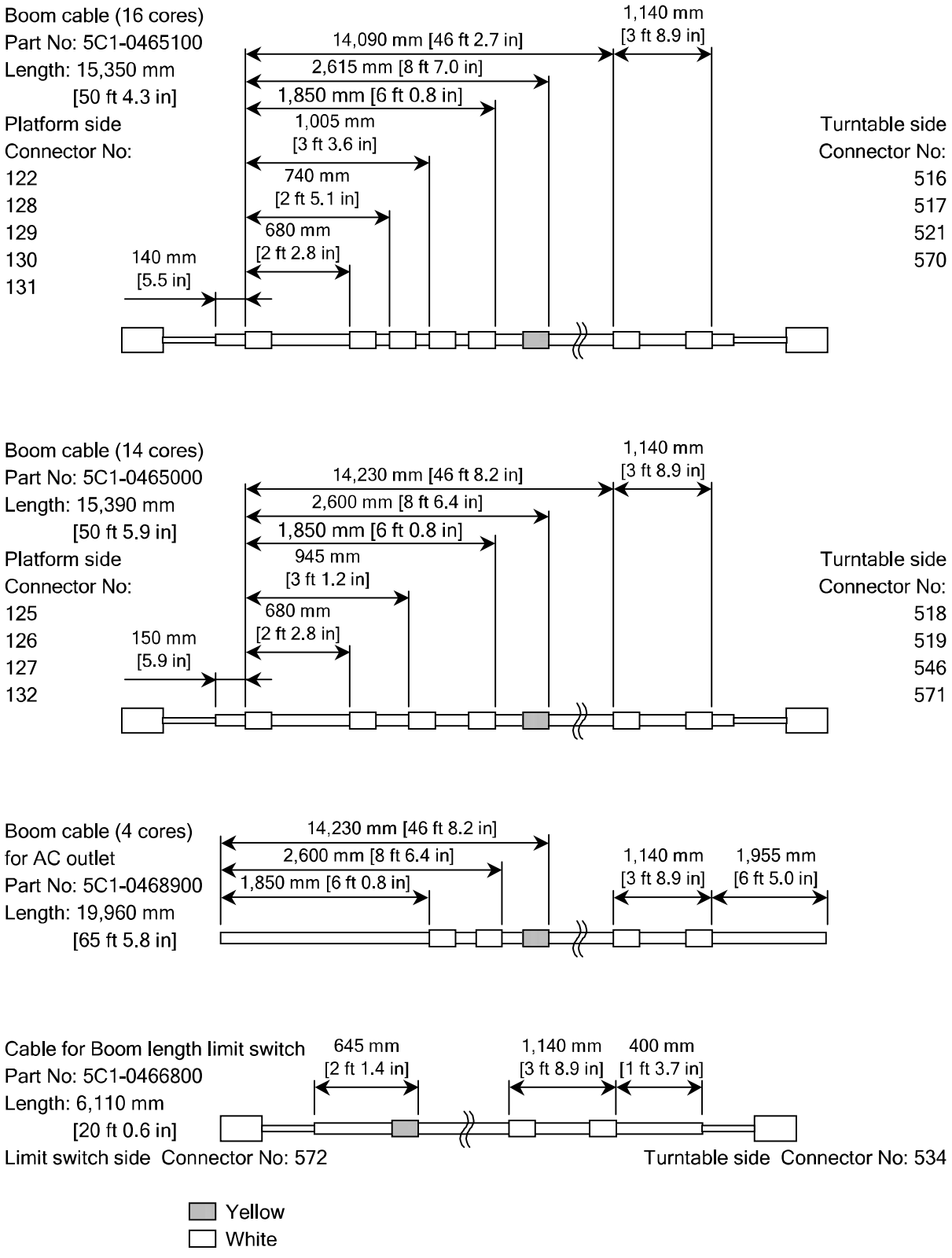


Fig. 2-52

2) Set the boom cables and hoses in the cable guide as shown in Fig. 2-53

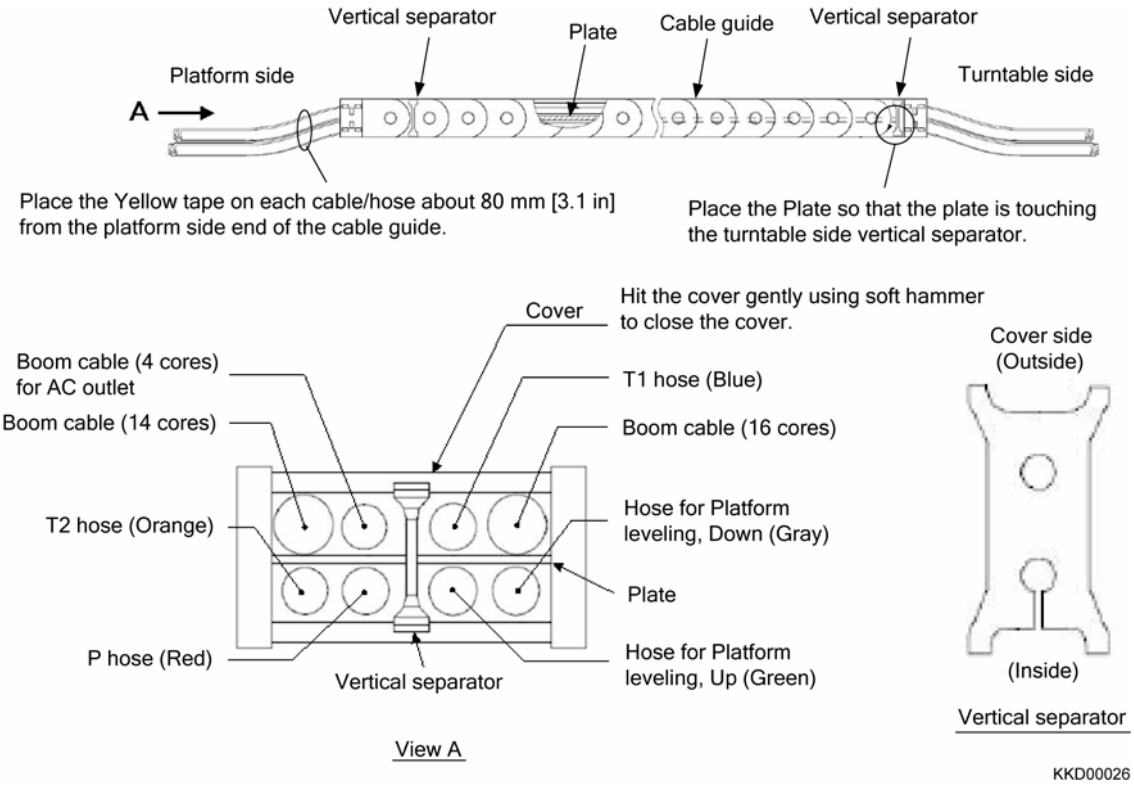


Fig. 2-53

NOTICE

Make sure that all covers are securely closed, or the cable guide may be damaged while extending / retracting the boom.

3) Fix the boom cables and hoses to the cable guide bracket (Upper) by clamp. (Fig. 2-54)

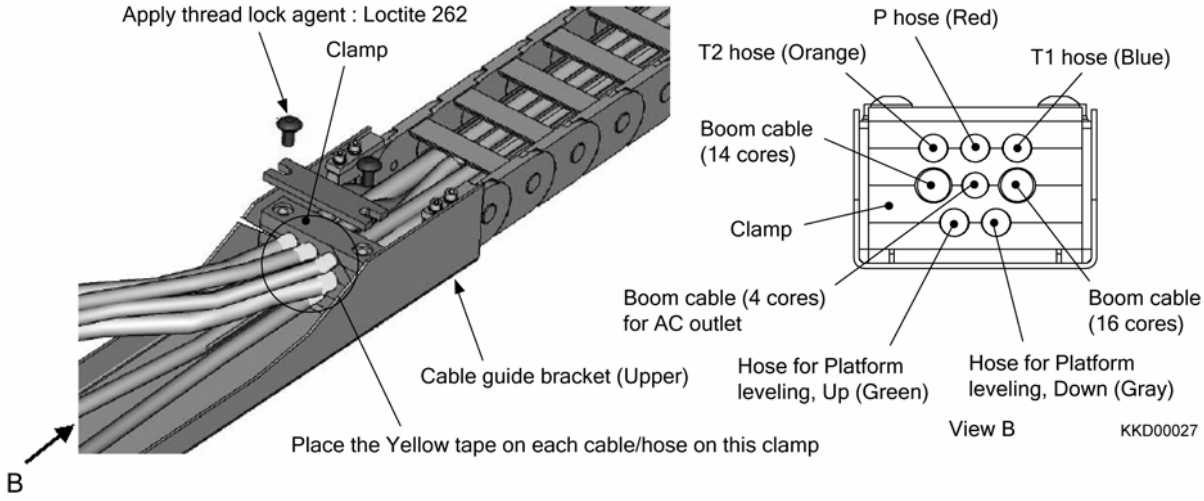


Fig. 2-54

4) Wrap the hoses and cables by cover. (Fig. 2-55)

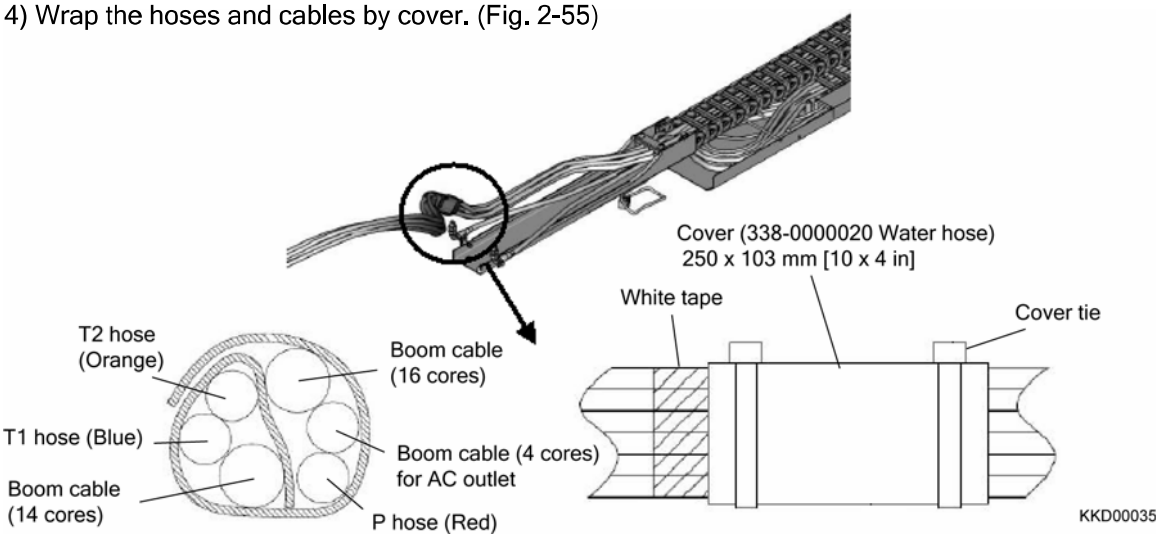


Fig. 2-55

5) Fix the hoses for platform leveling to the top of the cable guide bracket (Upper). (Fig. 2-56

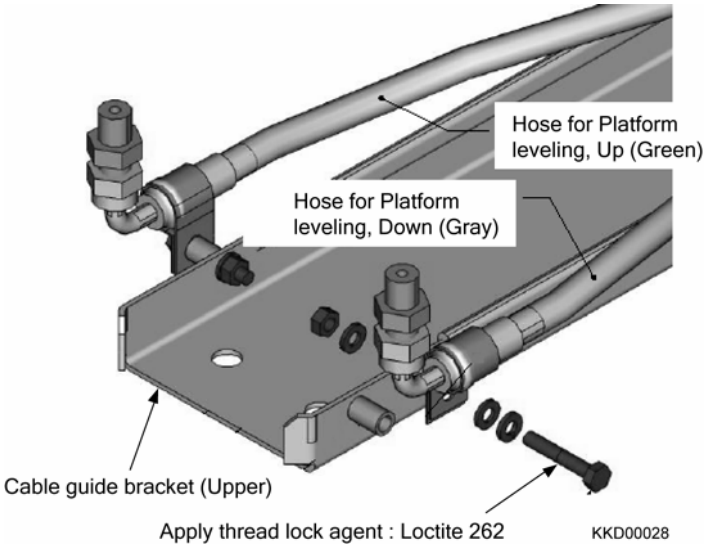


Fig. 2-56

6) Install the cable guide to the cable guide bracket (Lower). (Fig. 2-57)

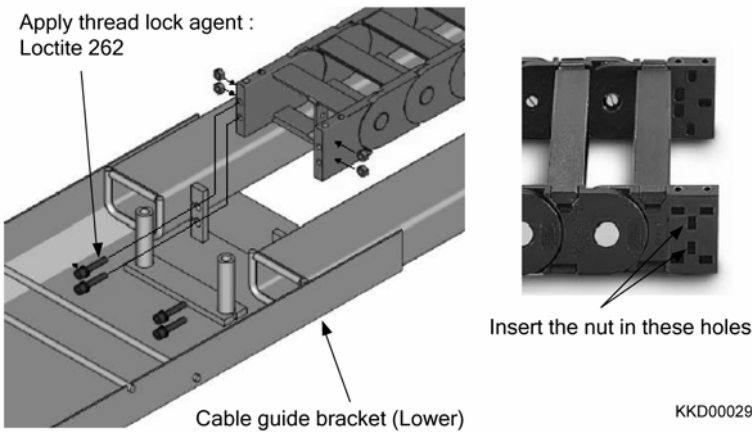


Fig. 2-57

7) Set the boom cables and hoses in the cable guide bracket (Lower) as shown in Fig. 2-58

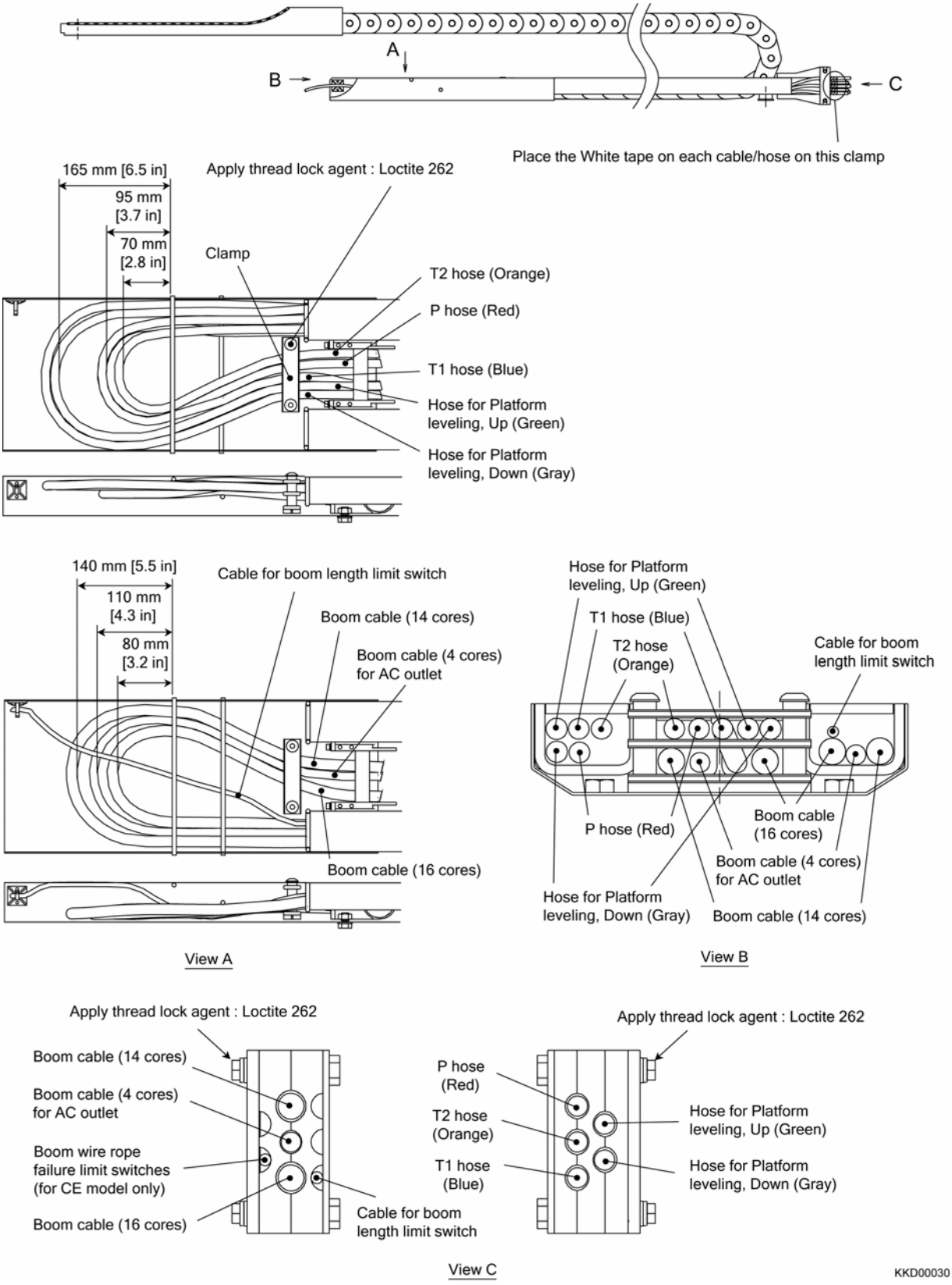


Fig. 2-58

8) Wind the cable for the boom length limit switch and then put it on the cable guide bracket (Lower). (Fig. 2-59)

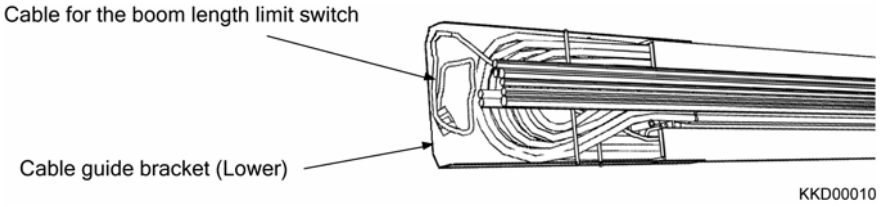


Fig. 2-59

9) Bundle the boom cables and hoses up, and then tie the leading rope to the 4 cores cable for AC outlet (Fig. 2-60)

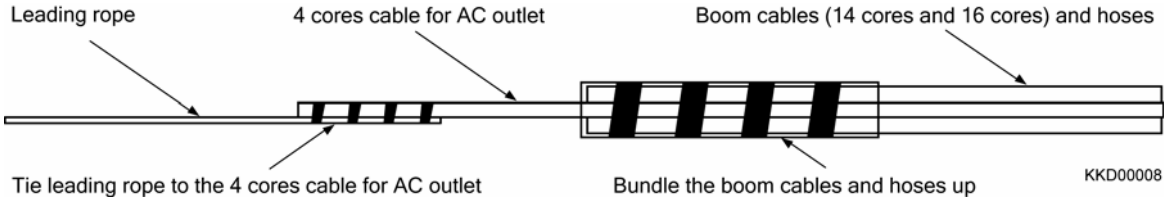


Fig. 2-60

10) Insert the cable guide into the boom section. (Fig. 2-61)

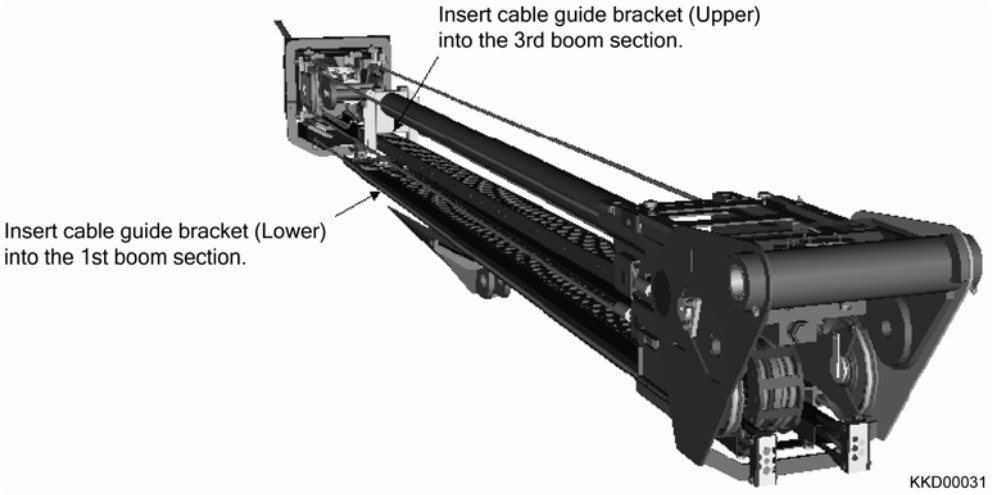


Fig. 2-61

11) Fix the cable guide bracket (Lower) to the 1st boom section and cable guide bracket (Upper) to the 3rd boom section. (Fig. 2-62)

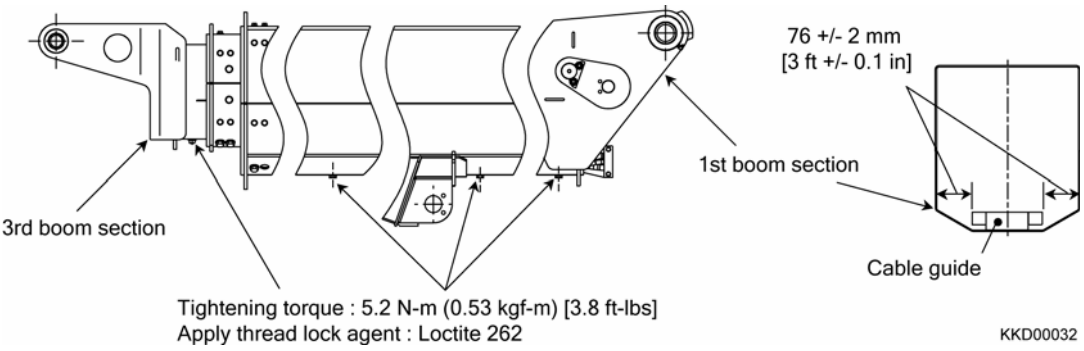


Fig. 2-62

12) Install the guide. (Fig. 2-63)

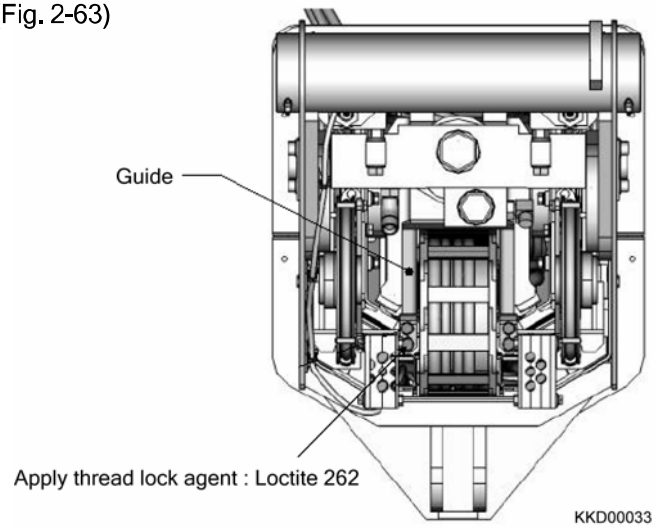


Fig. 2-63

13) Connect the cable for Boom length limit switch (Connector 572Br) ,Set the cable as shown in Fig. 2-64 to prevent the cable from interference with bottom of 2nd boom section and then install the boom length limit switch cover

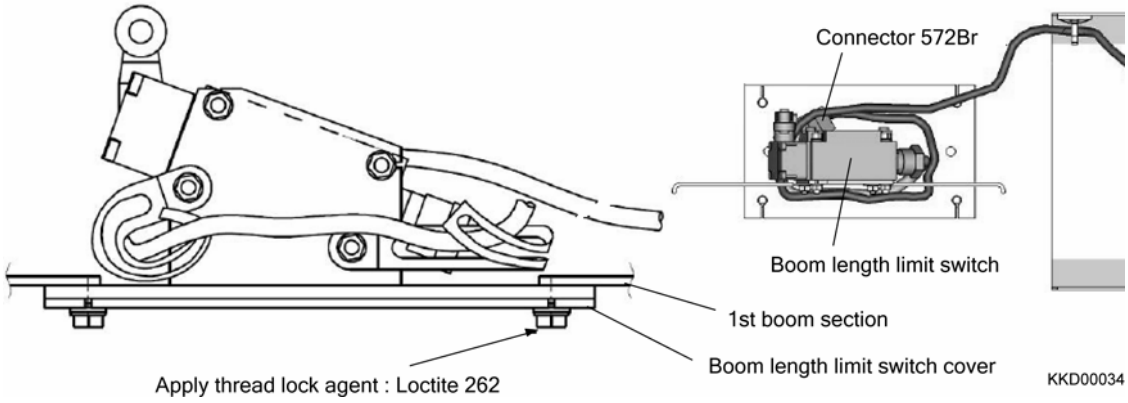


Fig. 2-64

14) Insert the T1 hose, T2 hose, P hose, Platform leveling Up hose and Down hose to the cover (Fig. 2-65), and then connect them to the adaptor block. (Page. 2-20, Fig. 2-42)

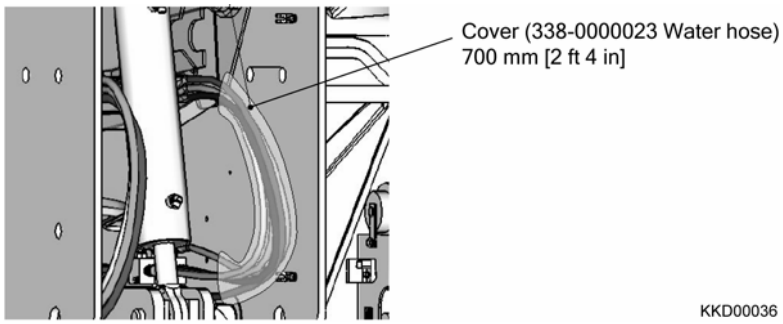


Fig. 2-65

15) Connect the cables listed below. (Page. 2-19, Fig. 2-41)

* Boom cable (14 cores: Connector 518Gy and 546Br)
* Boom cable (16 cores: Connector 516Gy, 517Gy and 521Gy)
  [Connector 521Gy is for CE and ANSI model only]
* Cable for Boom length limit switch (Connector 534Gy)
* Cable for Boom wire rope failure limit switches (Connector 503Gy) [CE model only]
* Boom cable (4 cores) for AC outlet (Disconnect from the receptacle if it is equipped)

16) Connect the cable for the boom wire rope failure limit switches (Connector 530Br, 531Br) and then fix them by cable tie. (Page. 2-19, Fig. 2-40) [CE model only]

17) Fix the lower leveling cylinder to the boom. (Fig. 2-66)

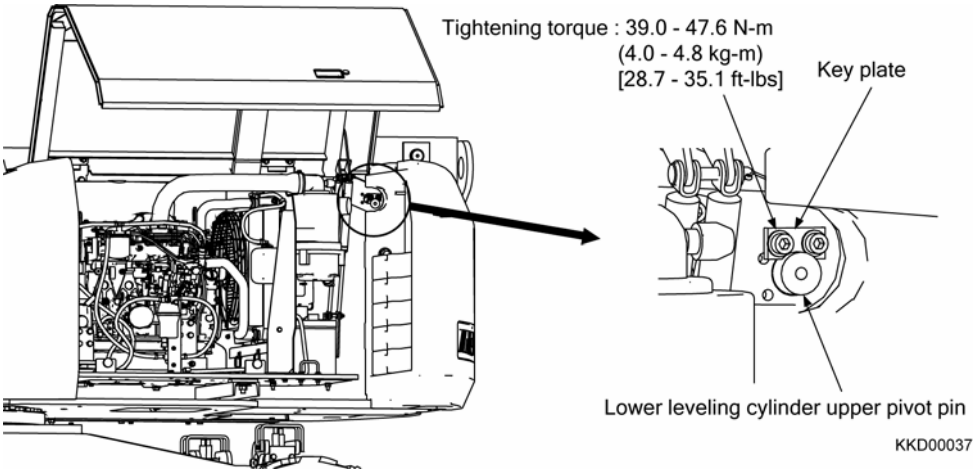


Fig. 2-66

18) Install the turntable rear cover. (Page. 2-18, Fig. 2-37)

19) Fix the cables and hoses with cover to the left side of the 3rd boom section by U-bolt. Apply thread lock agent (Loctite 262) to the U-bolt before tightening (Page. 2-16, Fig. 2-31)

20) Connect the hoses for upper leveling cylinder. (Page. 2-16, Fig. 2-30)

21) Install the 3rd boom front cover. Apply thread lock agent (Loctite 262) to the fixing bolts before tightening. (Page. 2-15, Fig. 2-29)

22) Arrange the hoses and cables as shown in the Fig. 2-67.

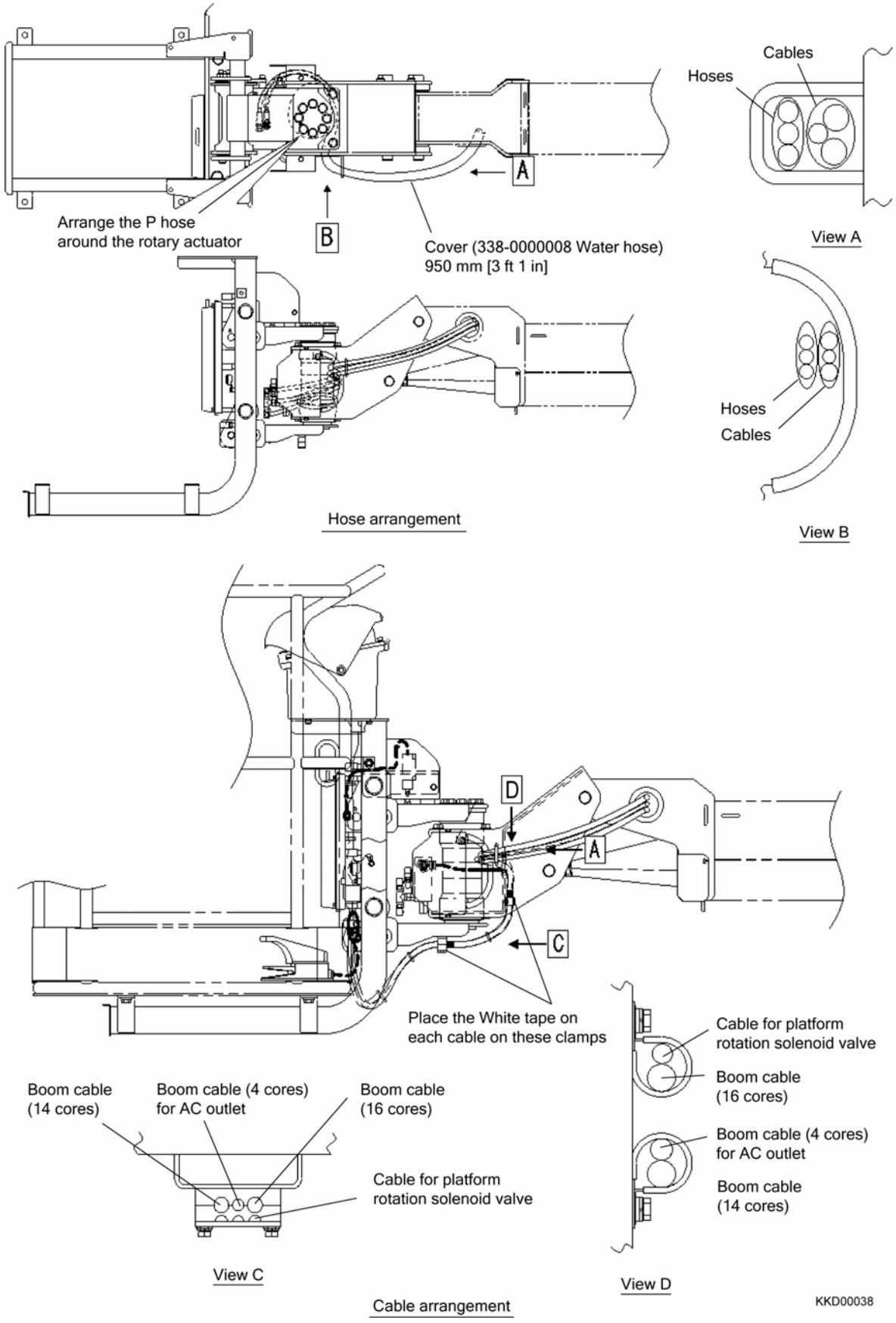


Fig. 2-67

23) Connect the T1 hose, P hose and T2 hose to the platform rotation solenoid valve. (Page. 2-15, Fig. 2-28)

24) Connect the boom cables (14 cores: Connector 126Gy, 127Gy) and (16 cores: Connector 122Gy, 128Gy, 129Gy). (Page. 2-15, Fig. 2-27)
[Connector 129Gy is for CE and ANSI model only]

25) Connect the cable (4 cores) for AC outlet from the receptacle if it is equipped.

26) Install the cover on the platform. (Page. 2-15, Fig. 2-26)

SP14CJ (SP460CJ) Installation

1) Follow the SP12C (SP400C) Installation instructions step 1 (Page 24) to step 21 (Page 31) to install the cable guide.

2) Arrange the hoses and cables as shown in the Fig. 2-68.

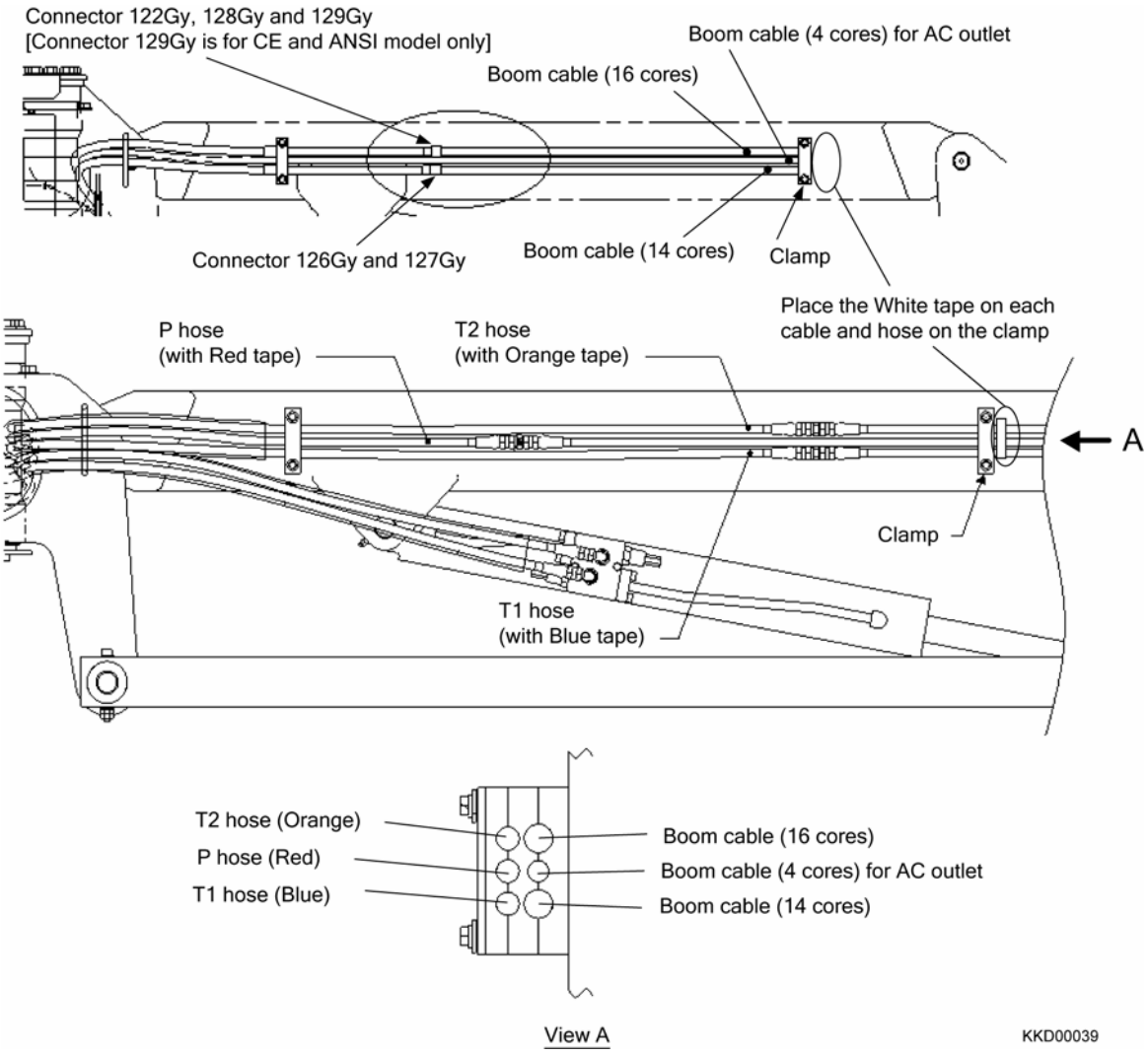


Fig. 2-68

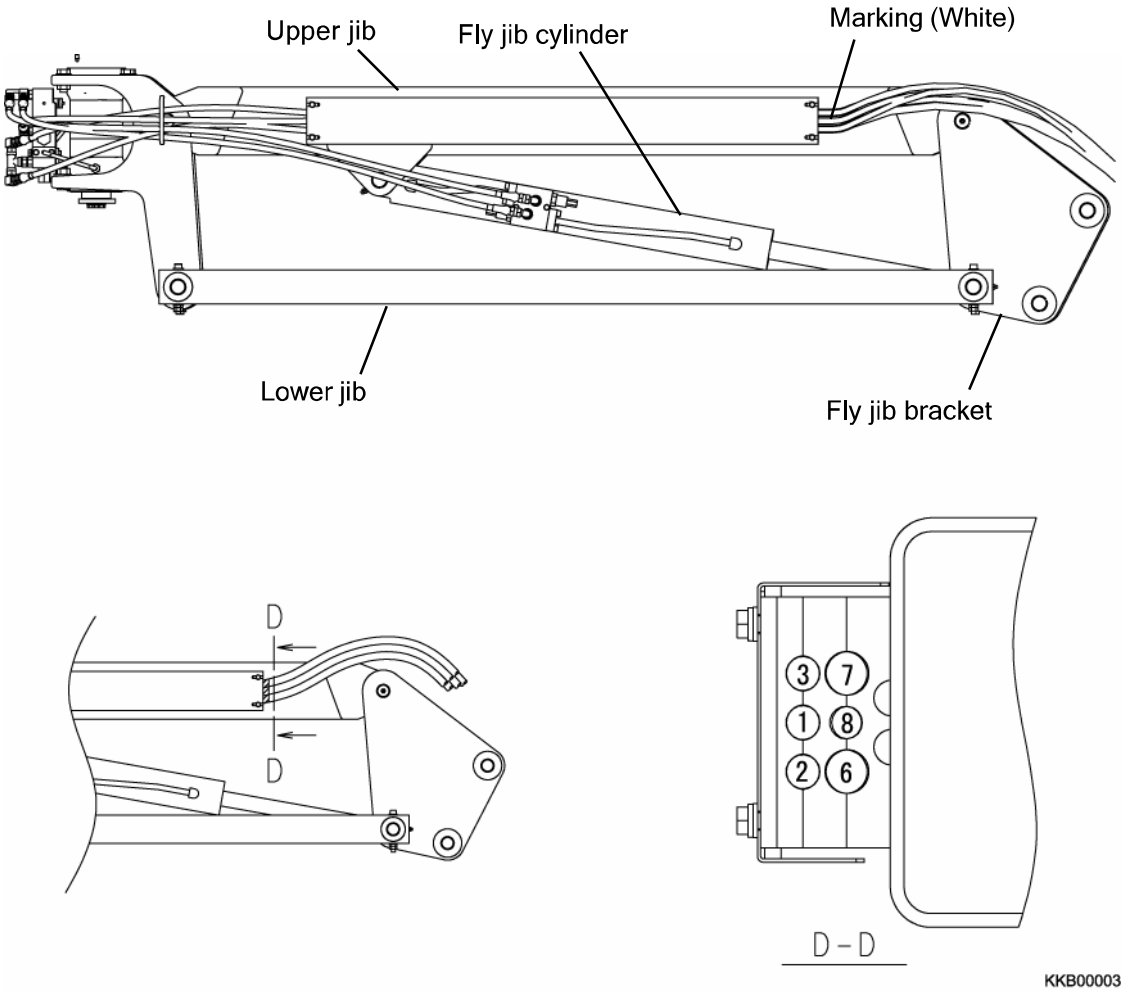
3) Connect the T1 hose, P hose and T2 hose.

4) Connect the boom cables (14 cores: Connector 126Gy, 127Gy) and (16 cores: Connector 122Gy, 128Gy, 129Gy).
[Connector 129Gy is for CE and ANSI model only]

5) Connect the cable (4 cores) for AC outlet from the receptacle if it is equipped.

6) Install the cover on the right side of the fly jib. (Page. 2-23, Fig. 2-48).

Fly jib (for SP14CJ/SP460CJ)



No.	Hoses	No.	Cables, Wire
1	Hose (P)	6	14 core cable
2	Hose (T1)	7	16 core cable with shield wires
3	Hose (T2)	8	4 core cable for AC outlet (CE model and ANSI model)

Fig. 2-69 Fly jib

Platform (Adjustment of Overload limit switch) (CE model)

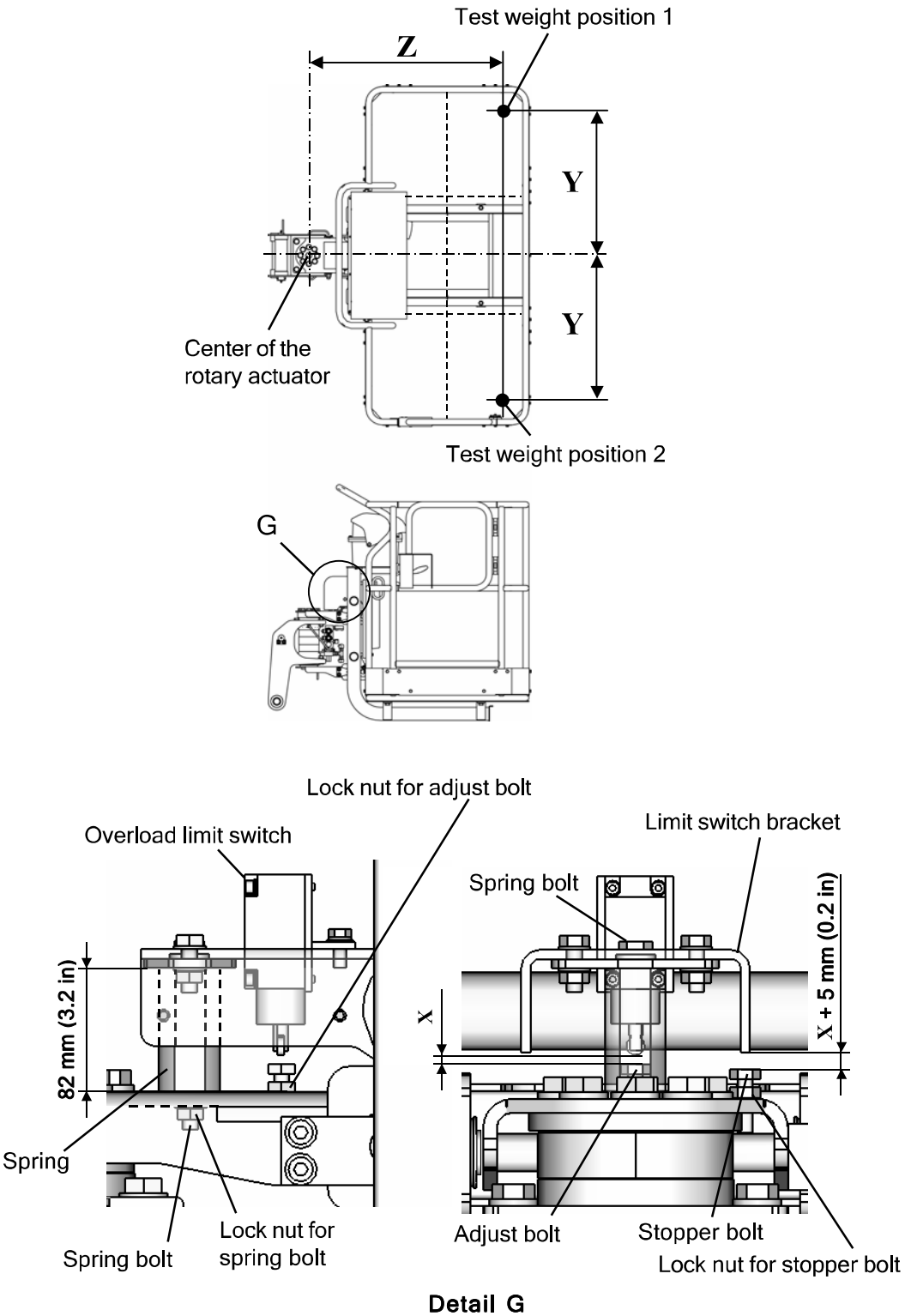


Fig. 2-70 Platform (Overload limit switch)

Adjustment procedures of Overload limit switch

1. Adjust the spring length to 82 mm (3.2 in) by tightening the spring bolt, and then lock the lock nut.
2. Load the platform with the test weight shown in the table below at the Test weight position **1**, and then shake the platform several times.
3. Move the weight to the Test weight position **2**, and then shake the platform several times.
4. Perform the above steps 2 and 3 five times to settle the spring and the linkages.
5. Load the platform with the test weight at the Test weight position **1**, and then turn the Adjust bolt so that the limit switch is switched on.
6. Move the weight to the Test weight position **2**, and then make sure that the limit switch switches on.

   If the limit switch does not switch on, perform the followings.
   1) Turn the Adjust bolt again until the limit switch switches on.
   2) Move the test weight to the Test weight position **1** again, and then make sure that the limit switch switches on.
   3) If the limit switch does not switch on, repeat the steps 2 to 6.
7. Lock the lock nut.
8. Measure the clearance "**X**" between the Roller of the overload limit switch and the Adjust bolt.

   Adjust the clearance between the limit switch bracket and the stopper bolts to X + 5 mm (X + 0.2 in) and then lock the lock nut to prevent the limit switch from breakage that is caused by overloading.

Platform size	Platform capacity	Dimension Y	Dimension Z	Test waight
6 feet	250 kg [550 lbs]	590 mm [1 ft 11 in]	890 mm [3 ft 11 in]	285 kg [630 lbs]
8 feet	227 kg [500 lbs]	870 mm [2 ft 10 in]	1,040 mm [3 ft 5 in]	260 kg [570 lbs]

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Chapter 3
Hydraulic Components

Locations of Hydraulic components

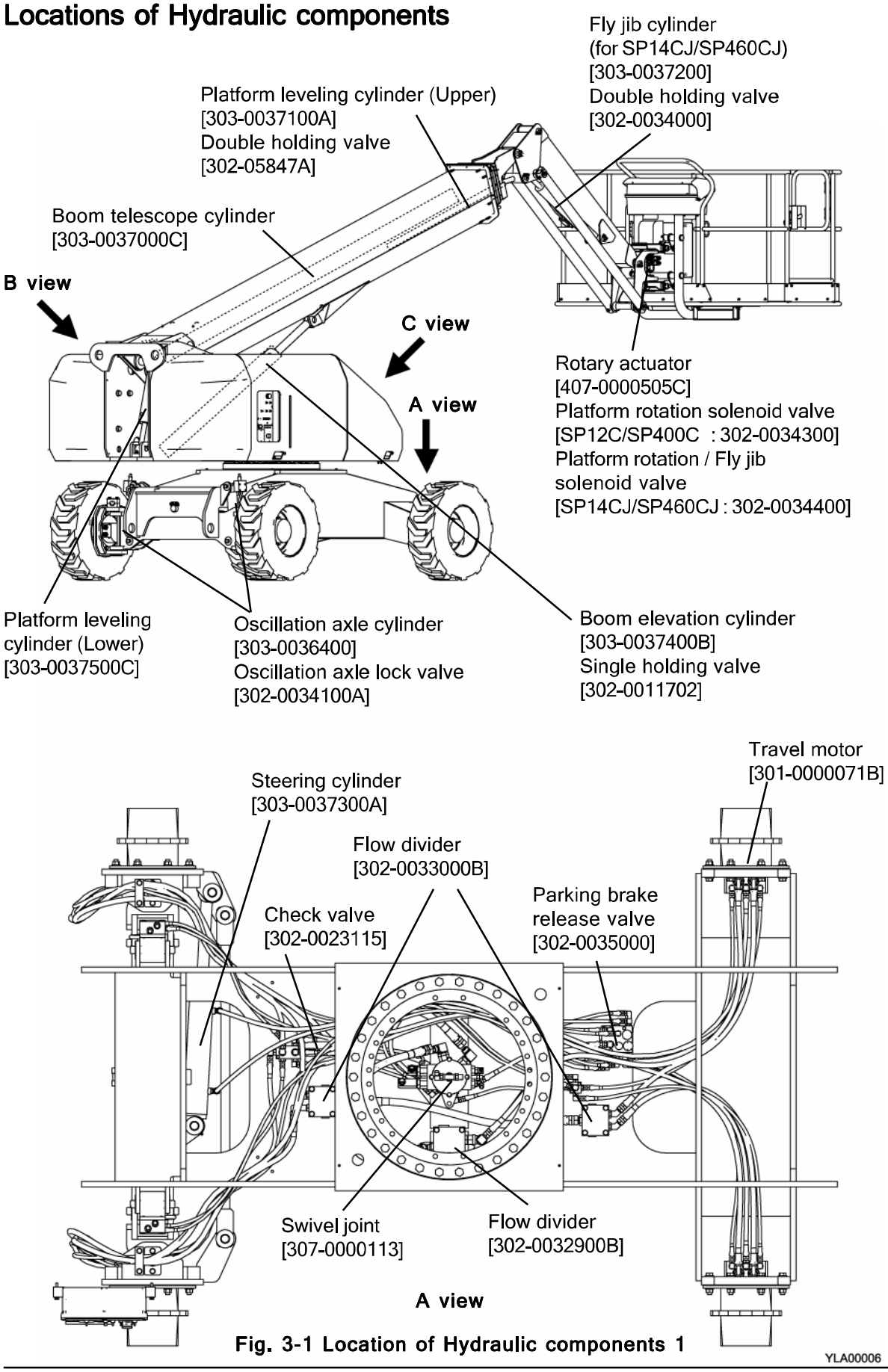


Fig. 3-1 Location of Hydraulic components 1

YLA00006

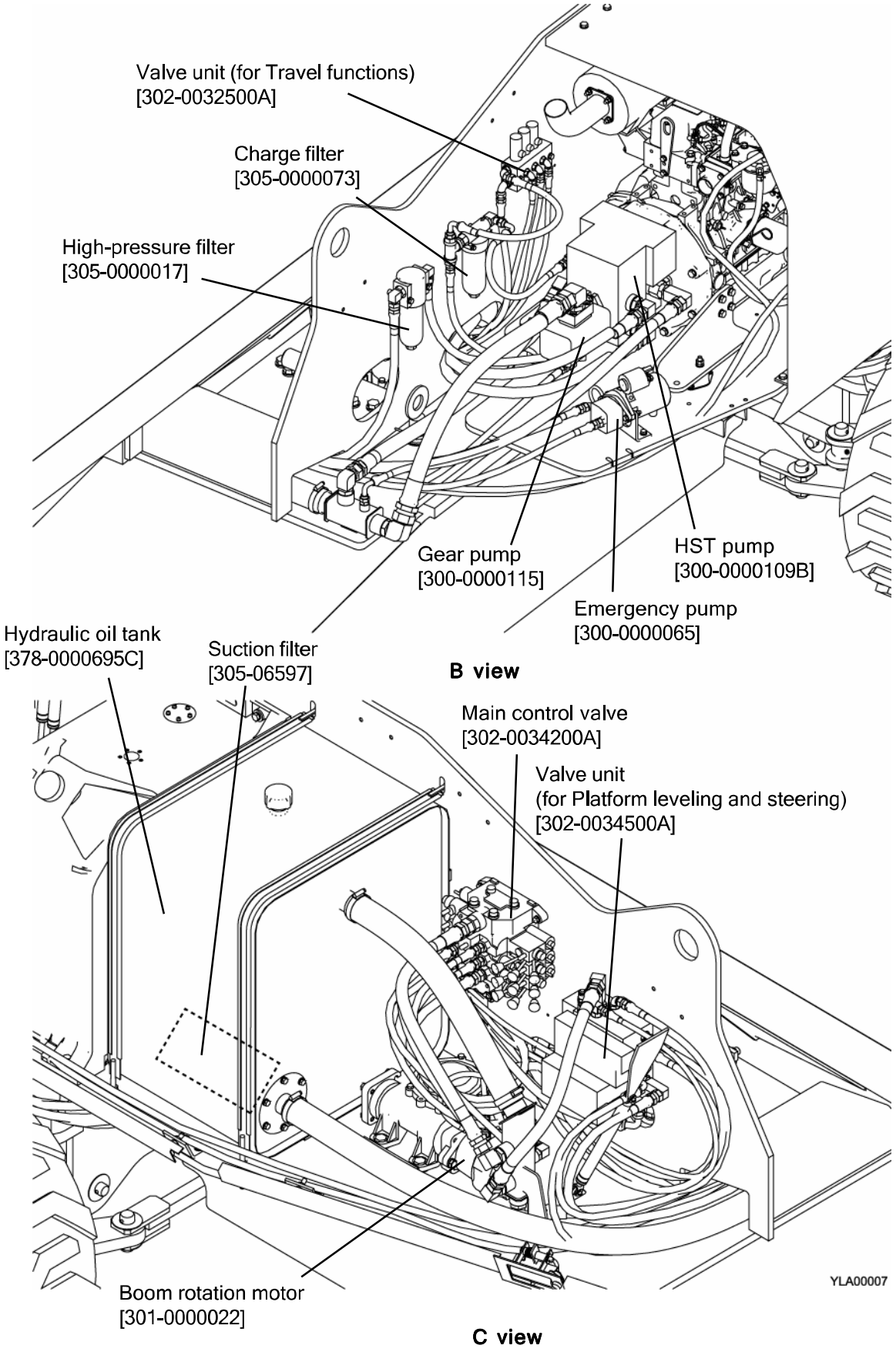


Fig. 3-2 Location of Hydraulic components 2

HST pump (300-0000109B)

Plunger pump (for Travel HST system)	Displacement	0 - 51 cm3/rev [0 - 3.1 in3/rev]
	Rated pressure	34.3 MPa (350 kgf/cm2) [5,000 PSI]
Charge pump	Displacement	15.6 cm3/rev [0.95 in3/rev]
	Rated pressure	2.4 +/- 0.07 MPa (24 +/- 0.7 kgf/cm2) [350 +/- 10 PSI]
Solenoid	Rated voltage	DC12V
	Rated current	1.6 A
	Coil resistance	5.3 ohms (at 20 degrees C)

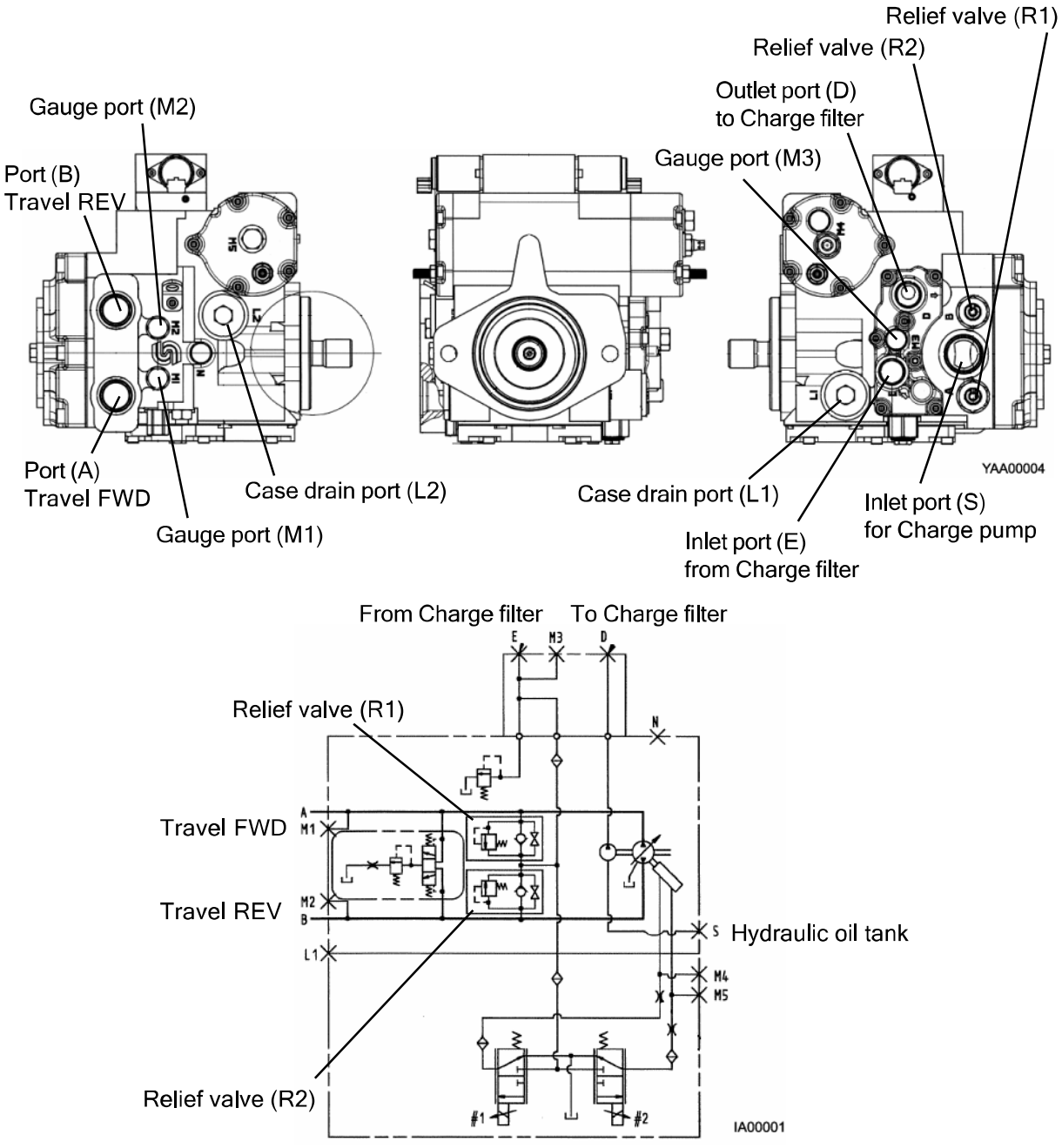


Fig. 3-3 HST pump

Gear pump (300-0000115)

	Displacement	Rated pressure
Gear pump 1 for Boom function	16.2 cm3/rev [0.99 in3/rev]	20.6 MPa (210 kgf/cm2) [3,000 PSI]
Gear pump 2 for Platform, Fly jib and Steering function	11.6 cm3/rev [0.71 in3/rev]	20.6 MPa (210 kgf/cm2) [3,000 PSI]

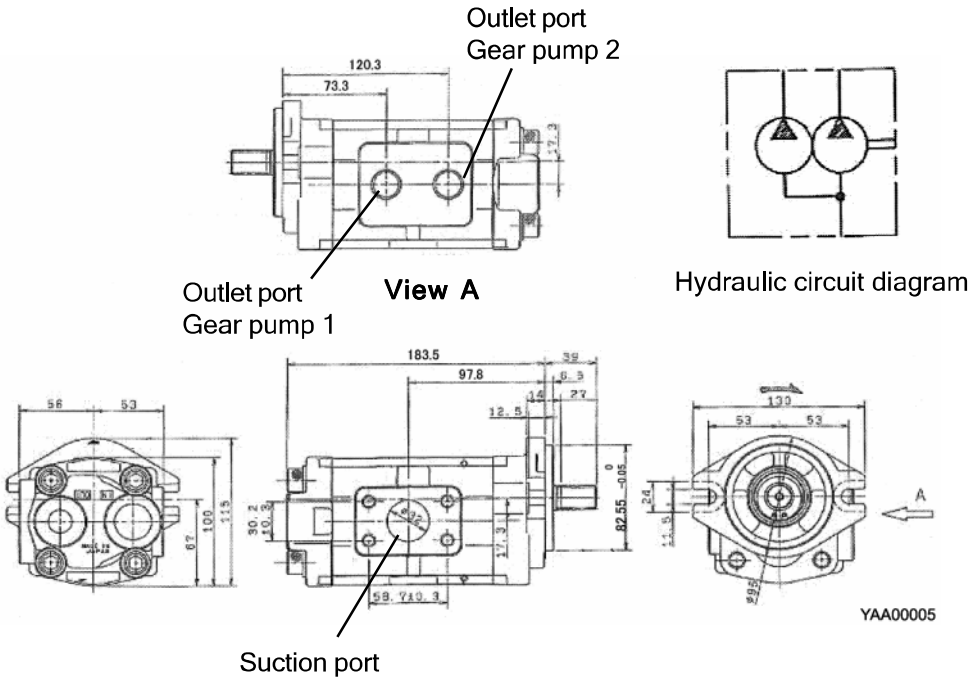


Fig. 3-4 Gear pump

Emergency pump (300-0000065)

DC motor	DC 12 Volts
Rated pressure	17.2 MPa (175 kgf/cm2) [2,500 PSI]
Displacement	1.66 cm3/rev [0.10 in3/rev]

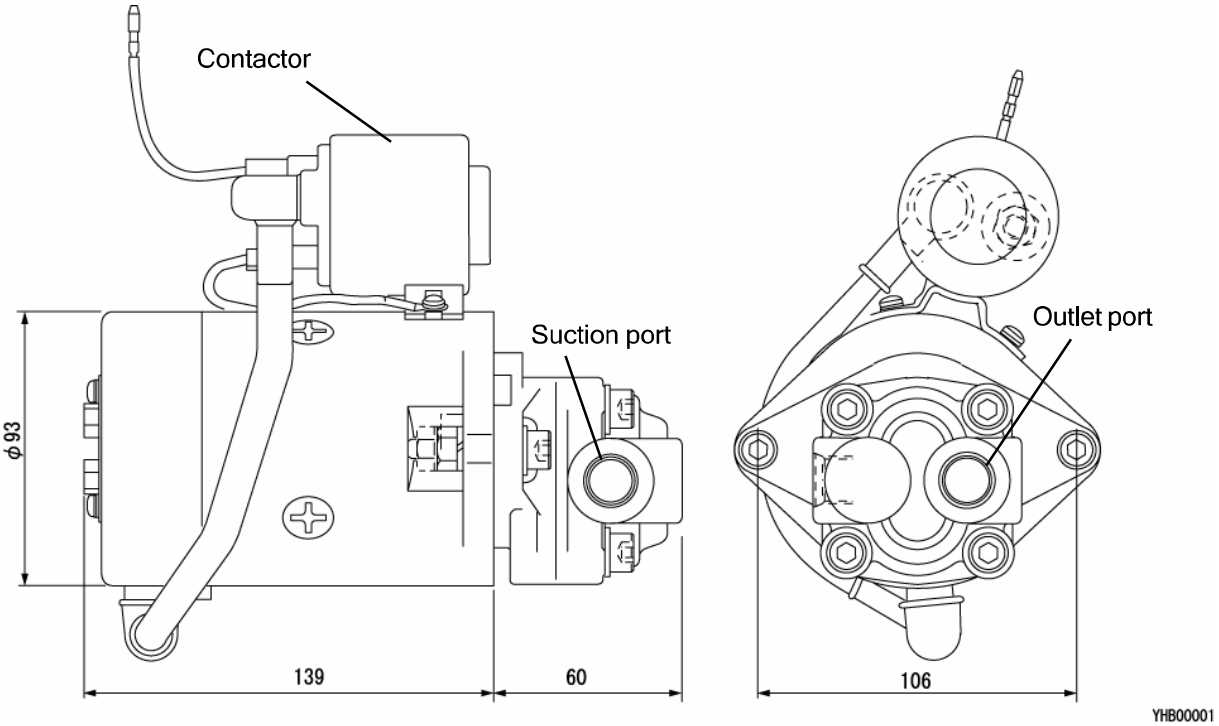


Fig. 3-5 Emergency pump

Hydraulic oil tank (3780000695C)

Oil capacity	190 liters [50.2 gal]
Recommended hydraulic oil	Shell Tellus T22
Oil change interval	Every 1,200 working hours or annually

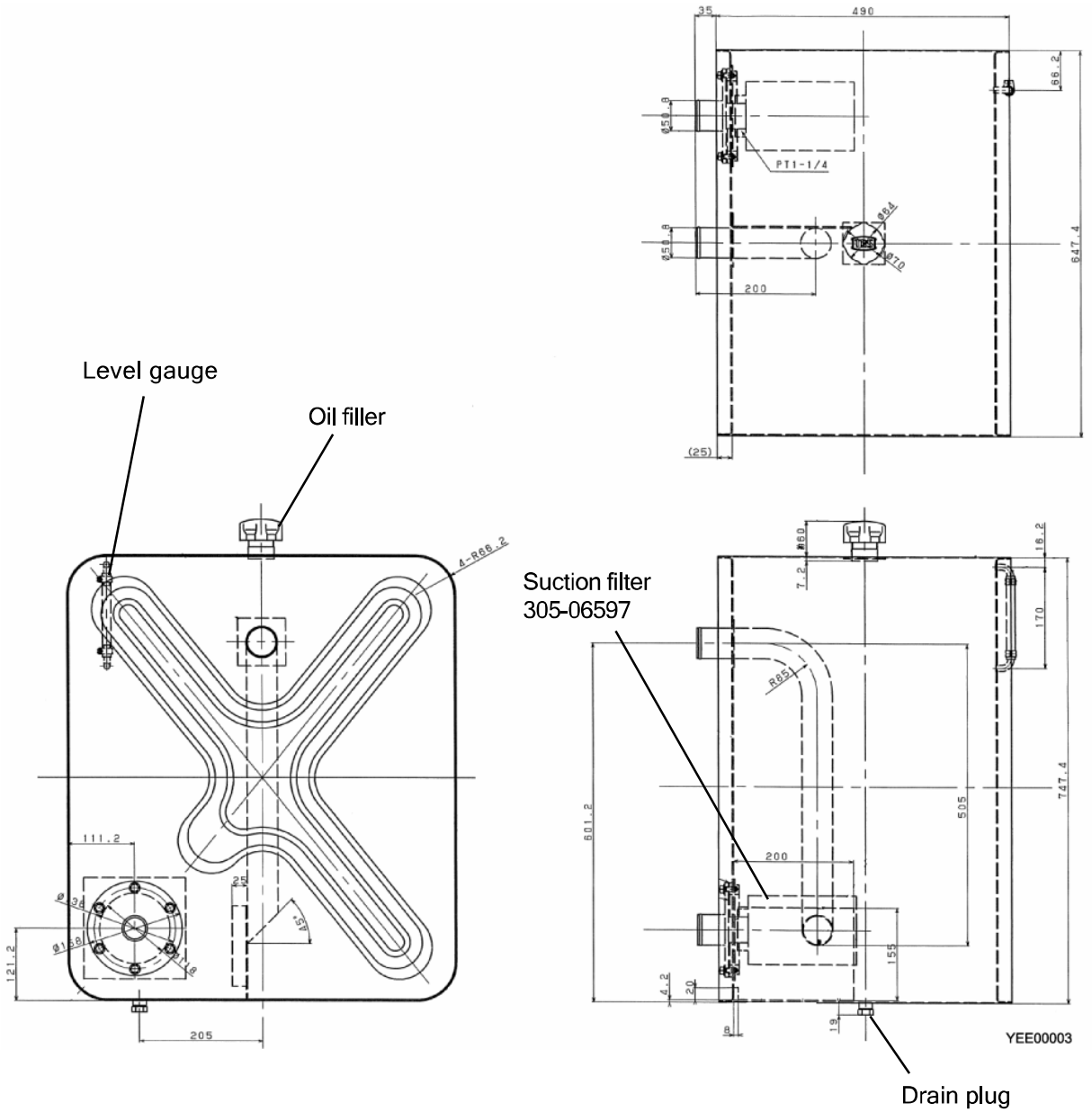


Fig. 3-6 Hydraulic oil tank

Filters

High-pressure filter (305-0000017)

Rated pressure	20.6 MPa (210 kgf/cm2) [3,000 PSI]
Rated flow volume	50 liters / min [13.2 gal / min]
Filteration accuracy	30 microns
By-pass valve cracking pressure	0.5 MPa (5.0 kgf/cm2) [73 PSI]
Replacement interval	Every 1,200 working hours or annually
Element part number	G319050014

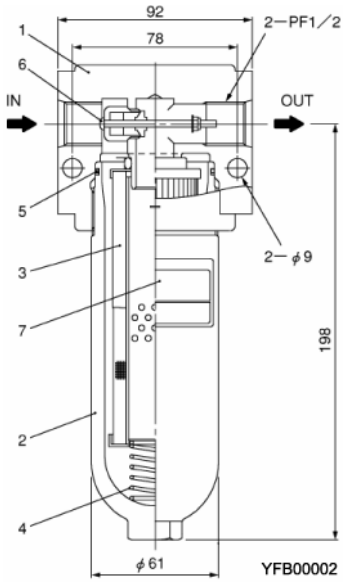


Fig. 3-7 High-pressure filter

Charge filter (305-0000073)

Rated pressure	7 MPa (70 kgf/cm2) [1,000 PSI]
Rated flow volume	50 liters / min [13.2 gal / min]
Filteration accuracy	30 microns
By-pass valve cracking pressure	0.1 MPa (1.0 kgf/cm2) [15 PSI]
Replacement interval	Every 1,200 working hours or annually
Element part number	G319050032

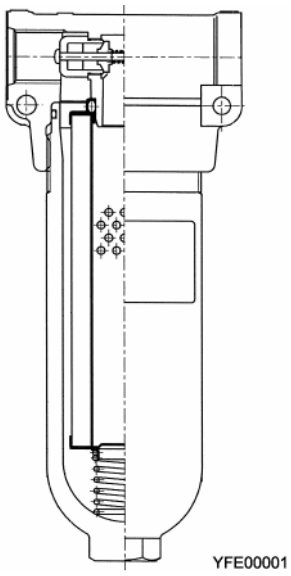


Fig. 3-8 Charge filter

Suction filter (305-06597)

Rated flow volume	200 liters / min [52.8 gal / min]
Filteration accuracy	105 microns
Replacement interval	Every 1,200 working hours or annually

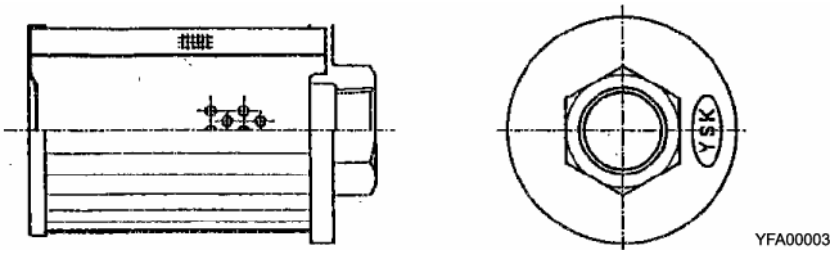


Fig. 3-9 Suction filter

Main control valve (302-0034200A)

Rated pressure		20.6 MPa (210 kgf/cm2) [3,000 PSI]
Rated flow		80 liters/min [21.1 gal/min]
Relief valve pre-set pressure	Main relief valve	20.6 MPa (210 kgf/cm2) [3,000 PSI]
	Port reliaf valve (Telescope, In)	17.6 MPa (180 kgf/cm2) [2,550 PSI]
	Port reliaf valve (Elevation, Down)	14.7 MPa (150 kgf/cm2) [2,150 PSI]
Solenoid	Rated voltage	DC 12 V
	Rated current	1.6 A
	Coil resistance	3.2 ohms (at 20 degrees C)

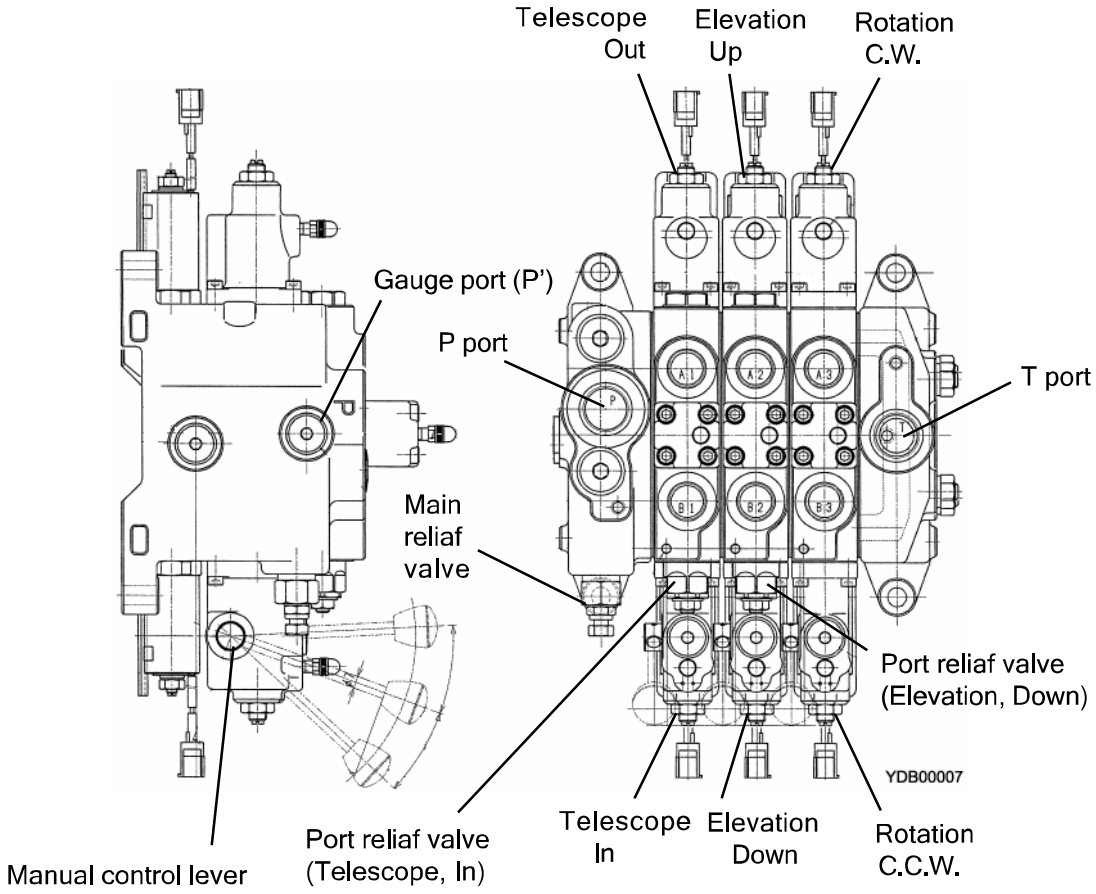


Fig. 3-10 Main control valve

Sectional drawings

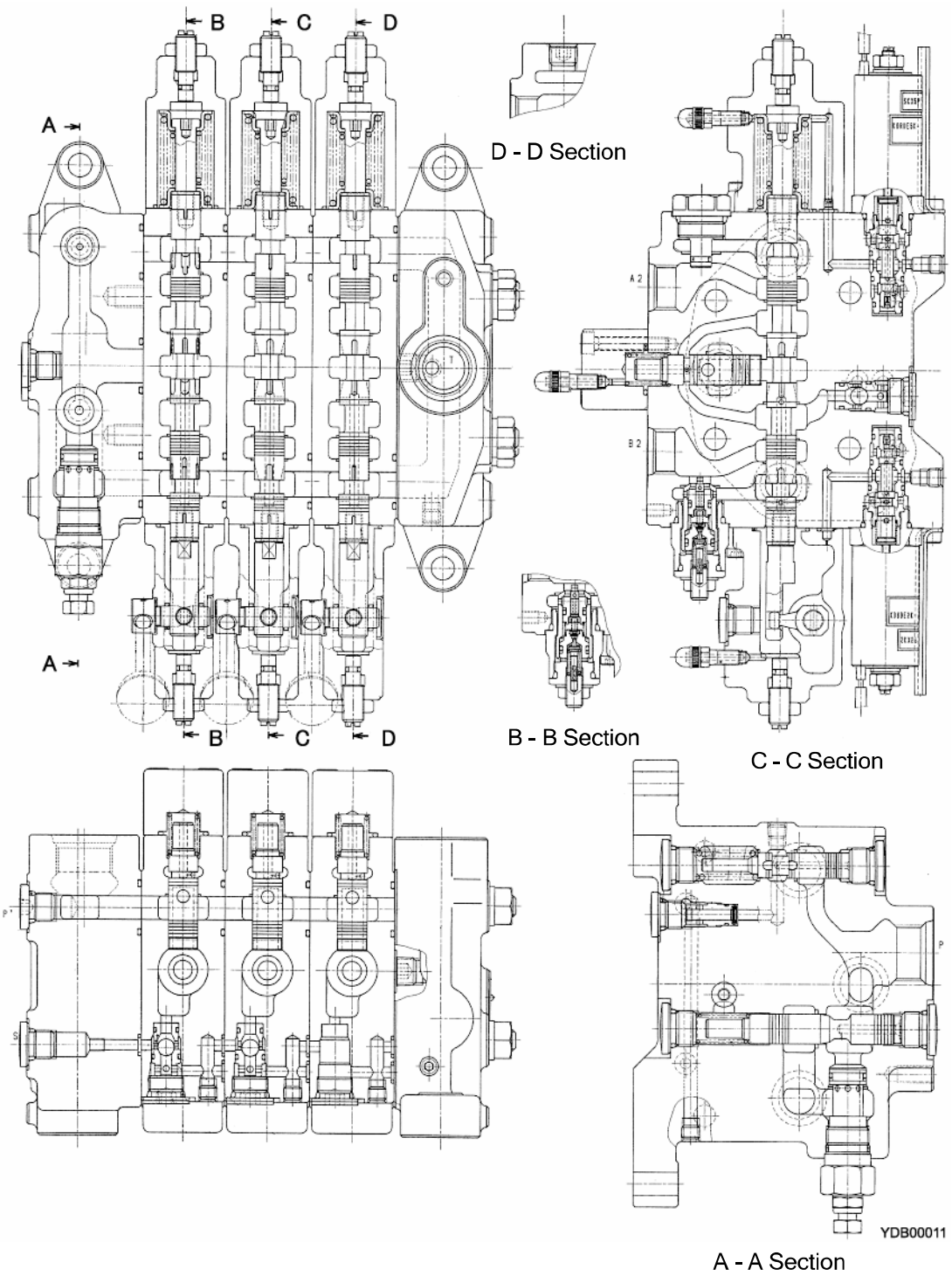


Fig. 3-11 Sectional drawings

Hydraulic circuit

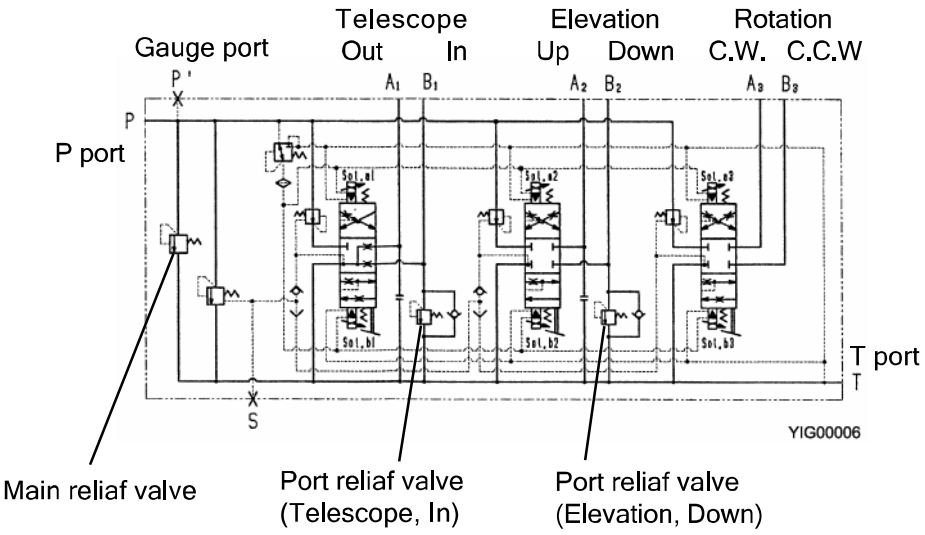
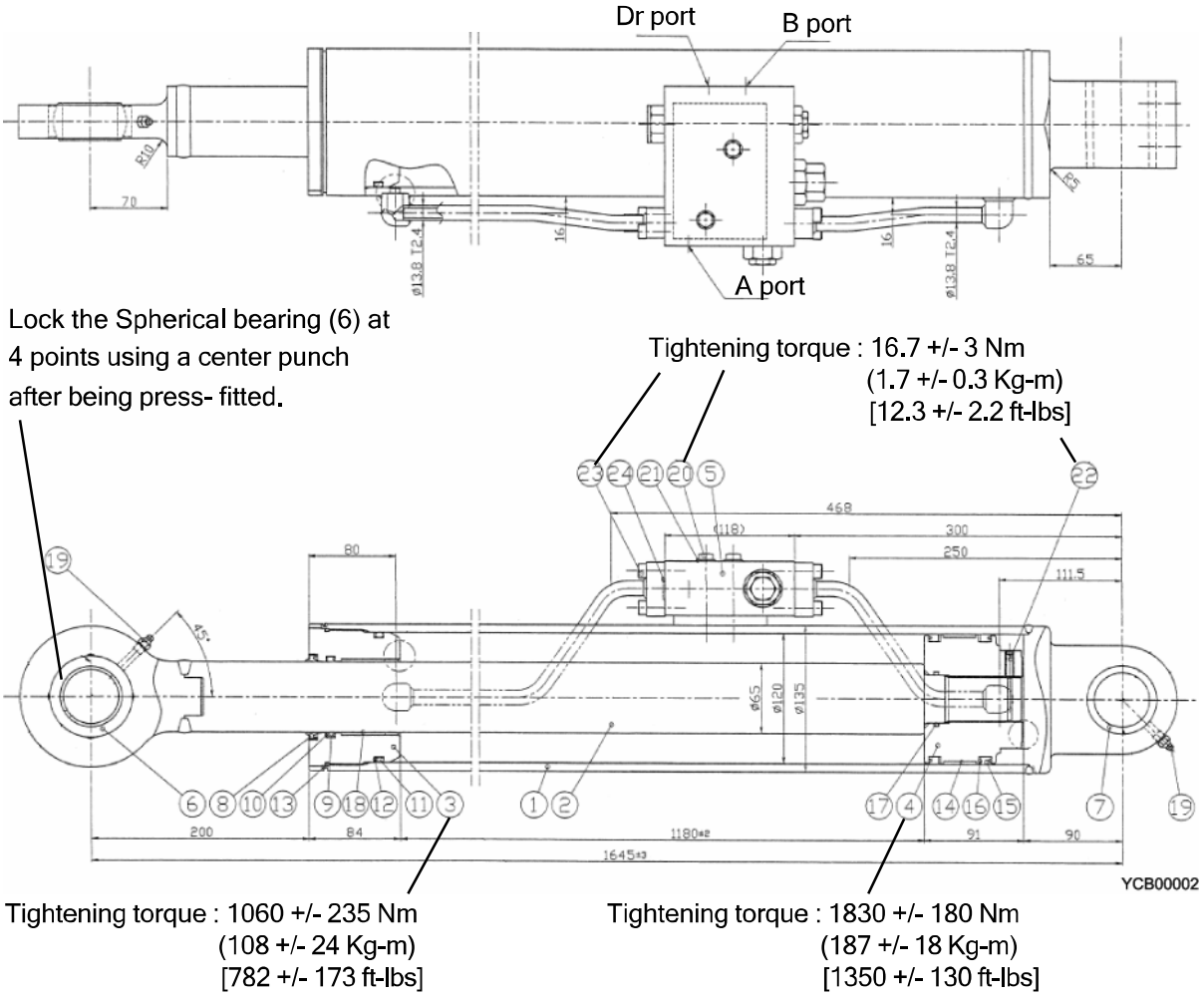


Fig. 3-12 Hydraulic circuit

Elevation cylinder (303-0037400B)



1	Cylinder tube	13	O-ring
2	Piston rod	14	Wear ring
3	Cylinder head	15	U-ring
4	Piston	16	Backup ring
5	Single holding valve	17	O-ring
6	Spherical bushing	18	Bushing
7	Bushing	19	Grease nipple
8	Dust seal	20	Bolt (M8 x 60)
9	U-ring	21	Flat washer
10	Backup ring	22	Set screw (M8 x 25)
11	O-ring	23	Cap screw (M8 x 30)
12	Backup ring	24	O-ring

Hydraulic circuit

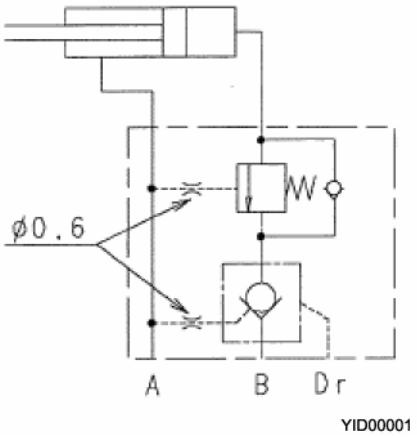
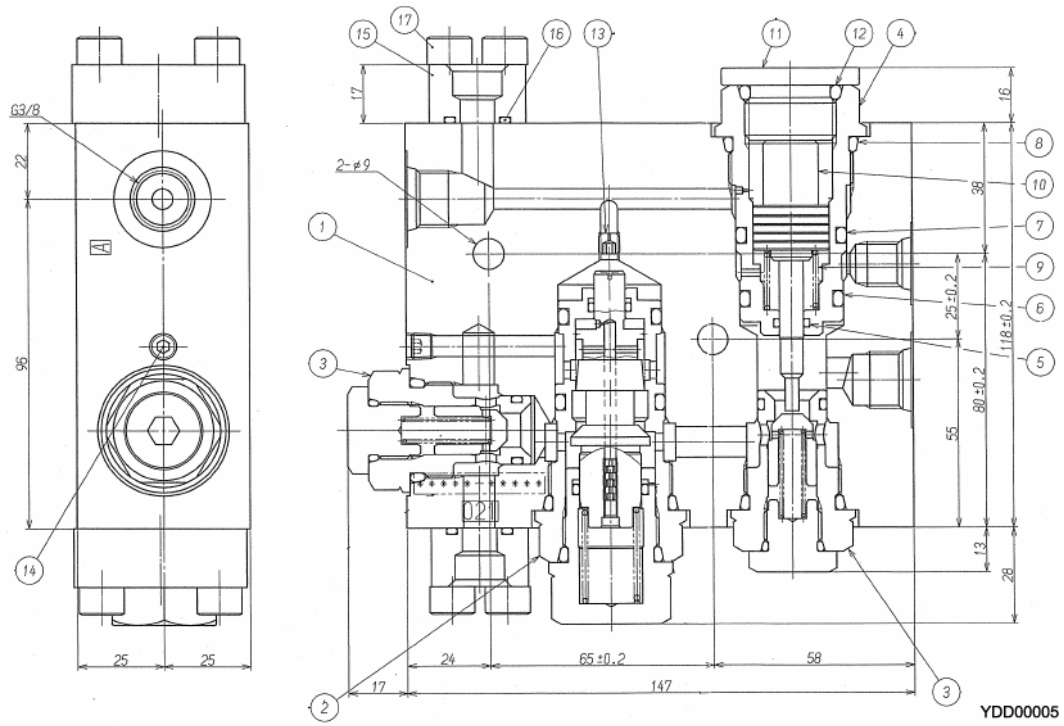


Fig. 3-13 Elevation cylinder

Single holding valve for Elevation cylinder (302-0011702)

The Single holding valve is mounted on the Boom elevation cylinder to prevent the cylinder from natural retraction.

Rated pressure	24.5 MPa (250 kgf/cm2) [3,550 PSI]
Rated flow	30 liters/min [7.9 gal/min]



1	Body	11	Plug
2	Holding valve	12	O-ring
3	Check valve	13	Orifice
4	Cap	14	Plug
5	O-ring	15	Flange
6	O-ring	16	Cap screw
7	O-ring	17	O-ring
8	O-ring		
9	Spring		
10	Piston		

Fig. 3-14 Single holding valve

Inspection procedures

Measure the natural descent of the boom elevation cylinder as follows to check the internal oil leakage of the boom elevation cylinder.

1. Set up the machine on firm and level surface.
2. Raise the boom and set the boom at the boom angle of about 45 degrees, then shut down the engine.
3. Apply the mark on the piston rod of the boom elevation cylinder, then measure the ***Dimension A*** as shown in Fig. 3-15.

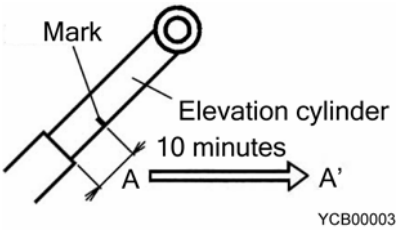


Fig. 3-15 Inspection procedures of natural descent

⚠CAUTION

Do not damage the piston rod when applying the mark.

4. Leave the machine for 10 minutes, and then measure the ***Dimension A'***.

   A - A' = Natural descent

   Serviceable limit of natural descent — 2 mm (0.08 in) / 10 minutes.

5. If the natural descent exceeds the serviceable limit, check the single holding valve and the boom elevation cylinder for internal oil leakage.

   Follow the next procedures to identify which has internal oil leakage, the single holding valve or the boom elevation cylinder.

   1) Support the boom using a crane to prevent the boom from sudden descent.

   2) Disconnect the hydraulic hoses that are connected to the single holding valve.

⚠CAUTION

Loosen the hydraulic hose fittings slowly when disconnecting the hydraulic hoses.

   3) Lower the hoisting hook of the crane to load the boom elevation cylinder with the gravity of the boom, and then check if the hydraulic oil leaks from the single holding valve.

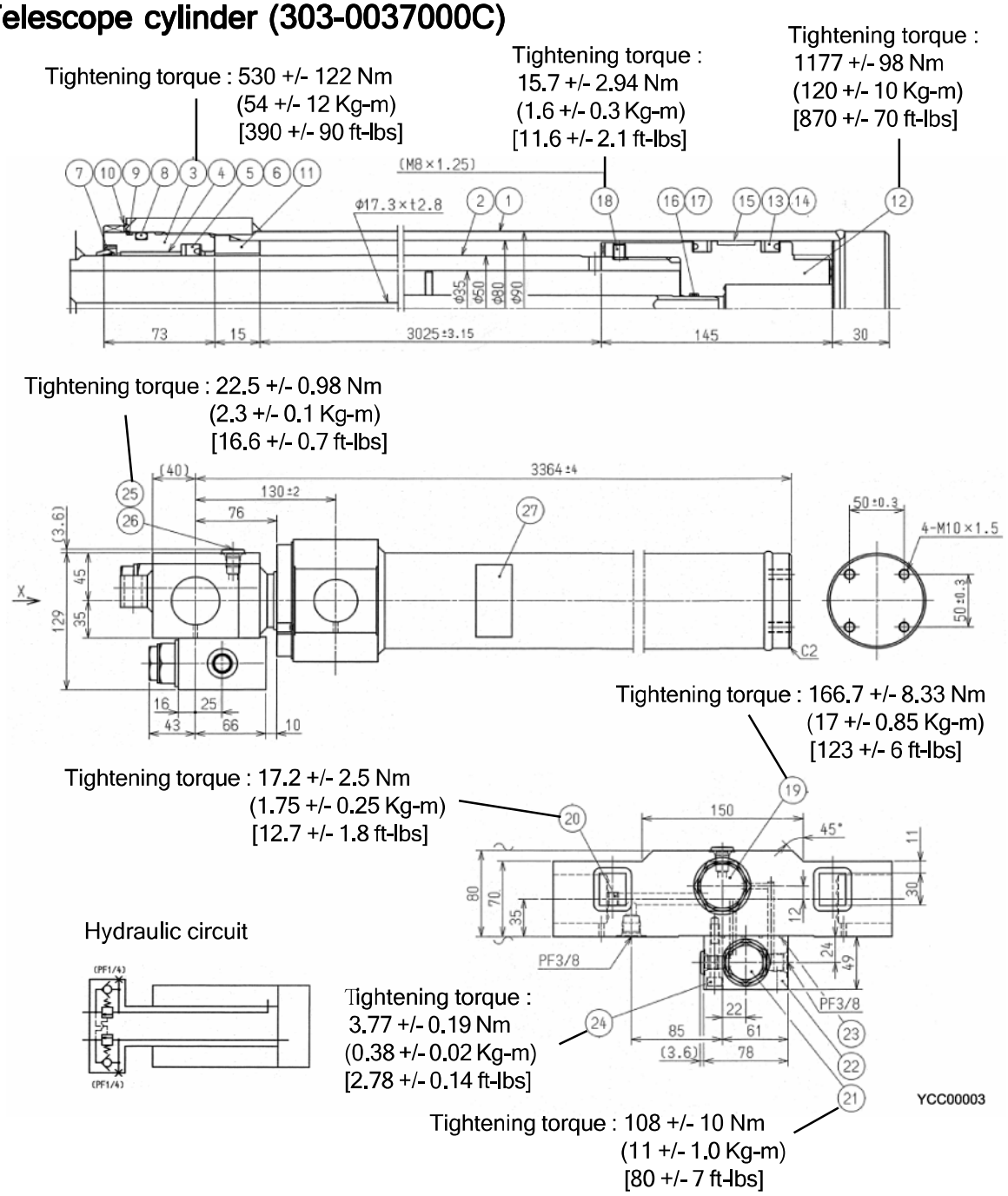
   If the hydraulic oil leaks from the single holding valve, it indicates that the internal oil leakage is in the single holding valve.

   No oil leakage indicates that the internal oil leakage is in the boom elevation cylinder.

⚠DANGER

Do not remove the single holding valve without supporting the boom.
If the single holding valve is removed or loosened, the boom will fall, resulting in death or serious injury.

Telescope cylinder (303-0037000C)



1	Cylinder tube	11	Spacer	21	Holding valve
2	Piston rod	12	Piston	22	Valve body
3	Cylinder head	13	Wear ring	23	O-ring
4	Bushing	14	U-ring	24	Cap screw
5	U-ring	15	Backup ring	25	Plug
6	Backup ring	16	O-ring	26	O-ring
7	Wiper ring	17	Backup ring	27	Name plate
8	O-ring	18	Set screw		
9	O-ring	19	Holding valve		
10	Lock washer	20	Plug		

Fig. 3-16 Telescope cylinder

Inspection procedures

Measure the natural descent of the boom telescope cylinder as follows to check the internal oil leakage of the holding valve.

1. Set up the machine on firm and level surface.
2. Raise the boom fully and extend the boom about 1 meter (3 feet), then shut down the engine.
3. Apply the mark on the 2nd boom section, and then measure the ***Dimension A*** as shown in Fig. 3-17.

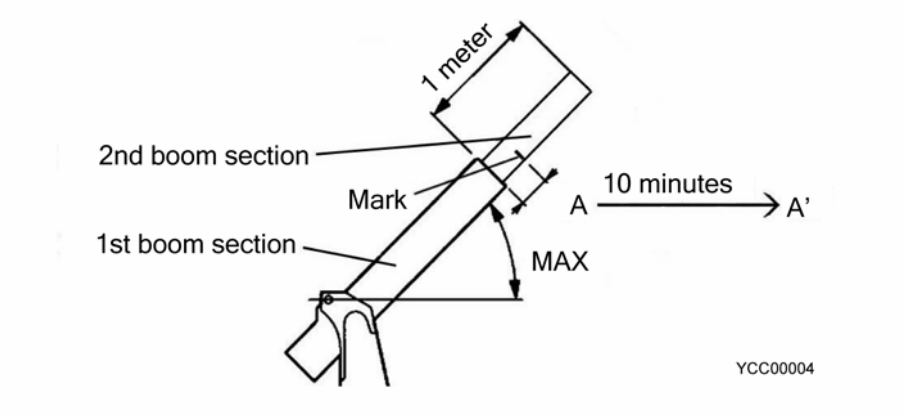


Fig. 3-17 Inspection procedures of natural descent

4. Leave the machine for 10 minutes, and then measure the ***Dimension A'***.

   A - A' = Natural descent

   Serviceable limit of natural descent — 2 mm (0.08 in) / 10 minutes.

5. If the natural descent exceeds the serviceable limit, check the holding valve and the boom telescope cylinder for internal oil leakage.

   Follow the next procedures to identify which has internal oil leakage, the holding valve or the boom telescope cylinder.

   1) Raise the boom fully and extend the boom about 1 meter (3 feet).

   2) Disconnect the hydraulic hoses that are connected to the holding valve, and then check if the hydraulic oil leaks from the holding valve.

⚠CAUTION

Loosen the hydraulic hose fittings slowly when disconnecting the hydraulic hoses.

If the hydraulic oil leaks from the holding valve, it indicates that the internal oil leakage is in the holding valve.

No oil leakage indicates that the internal oil leakage is in the boom telescope cylinder.

⚠WARNING

Retract the boom fully and set it about 5 degrees when removing the holding valve.
If the holding valve is removed or loosened while the boom is not retracted fully or set below horizontal, the 2nd boom section will retract or extend suddenly, may result in death or serious injury.

Boom rotation motor (301-0000022)

The boom rotation motor is installed on the rotation gearbox to rotate the turntable

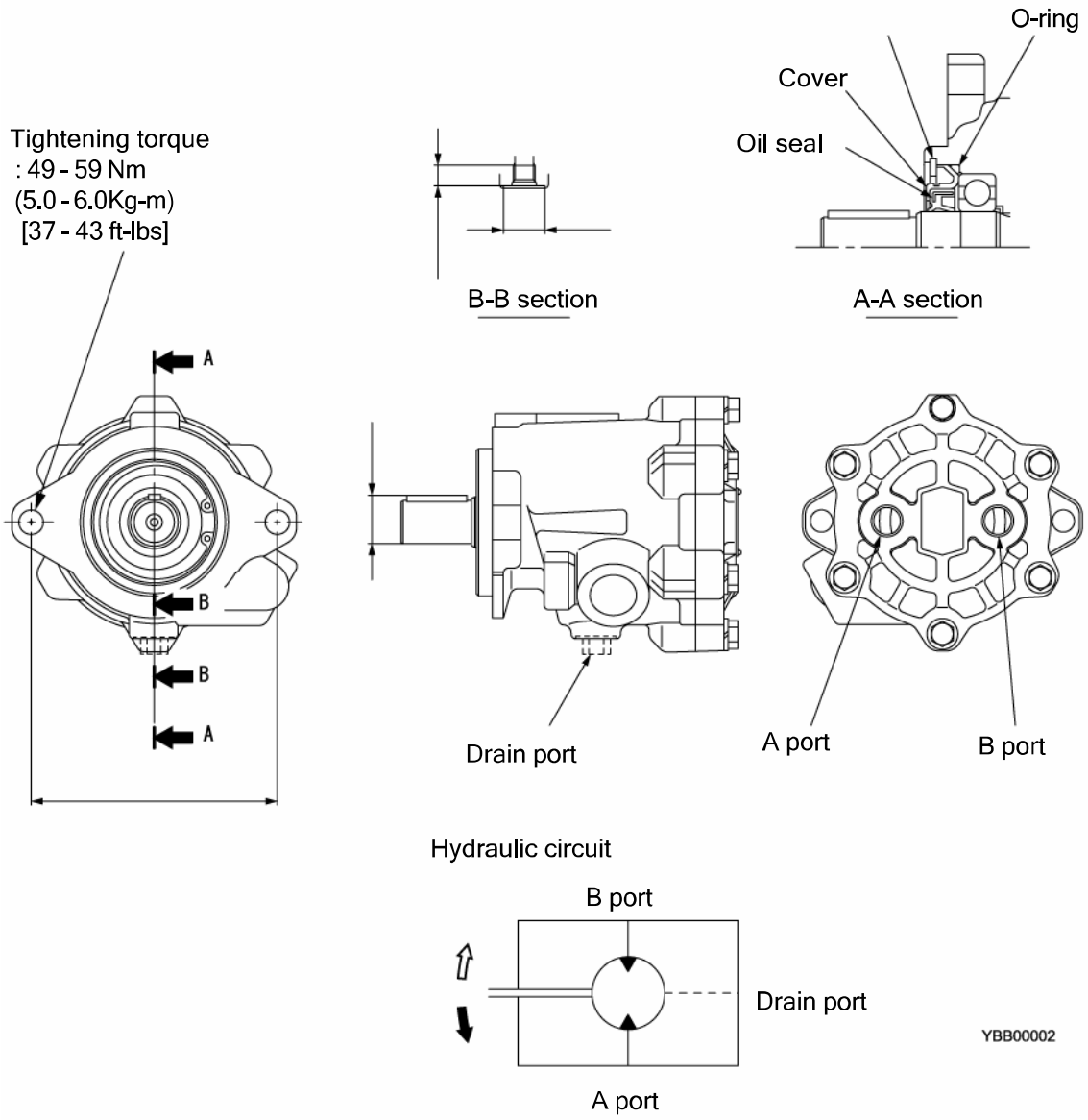
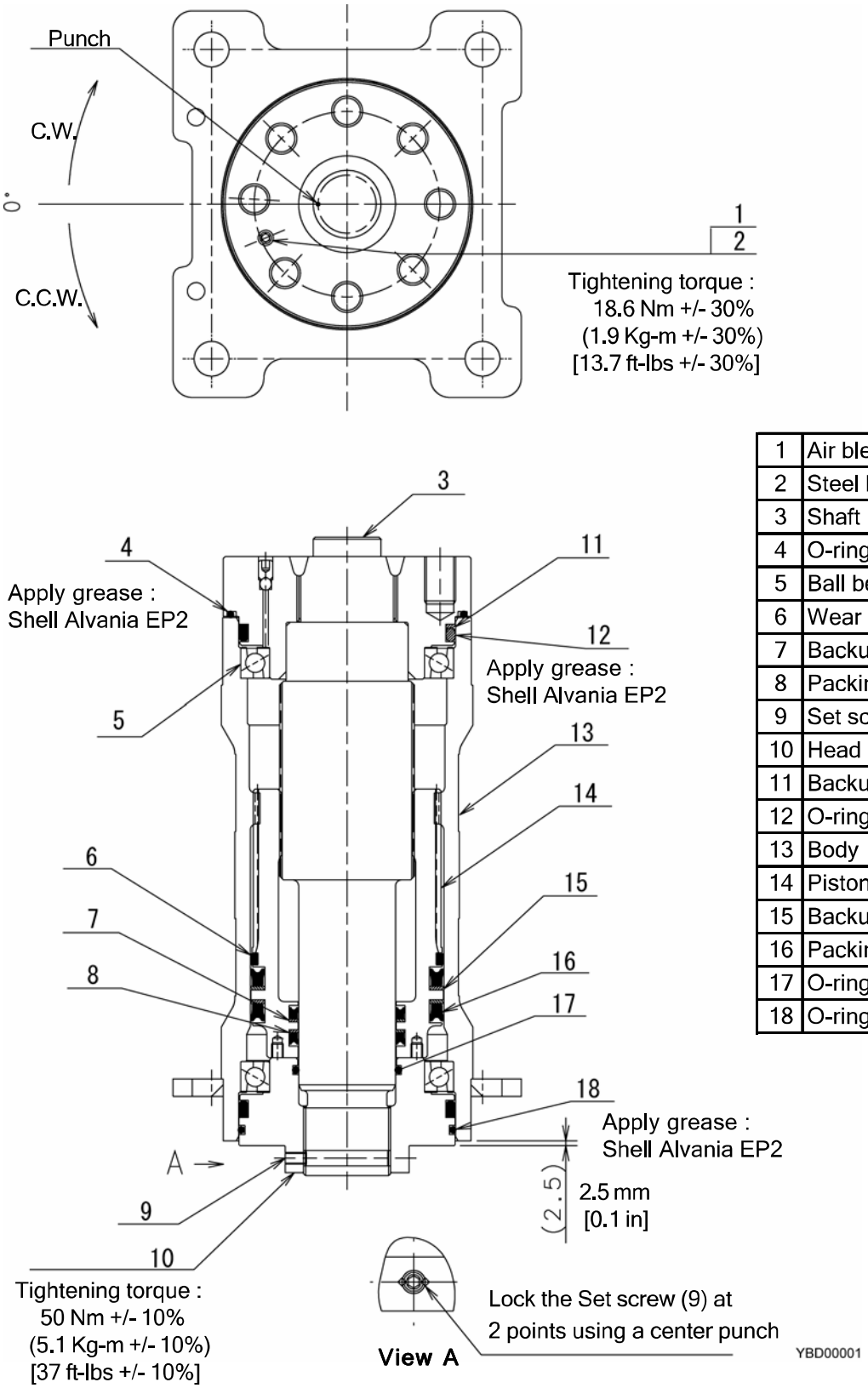


Fig. 3-18 Boom rotation motor

Rotary actuator (407-0000505C)

The Platform rotary actuator is installed between the platform and the top of 3rd boom or Fly- jib to rotate the platform.



1	Air bleed plug
2	Steel ball
3	Shaft
4	O-ring
5	Ball bearing
6	Wear ring
7	Backup ring
8	Packing
9	Set screw
10	Head
11	Backup ring
12	O-ring
13	Body
14	Piston
15	Backup ring
16	Packing
17	O-ring
18	O-ring

Fig. 3-19 Rotary actuator

Function of Rotary actuator

1. Clockwise

1) Pressurized oil comes in to the lower room of the rotary actuator and push up the piston as shown in the fig 3-20.
2) The piston and the shaft are threaded and mesh each other.
3) The piston rotates the shaft clockwise while it goes up.

2. Counter clockwise

1) Pressurized oil comes in to the upper room of the rotary actuator and push down the piston as shown in the fig 3-20.
2) The piston rotates the shaft counter clockwise while it goes down.

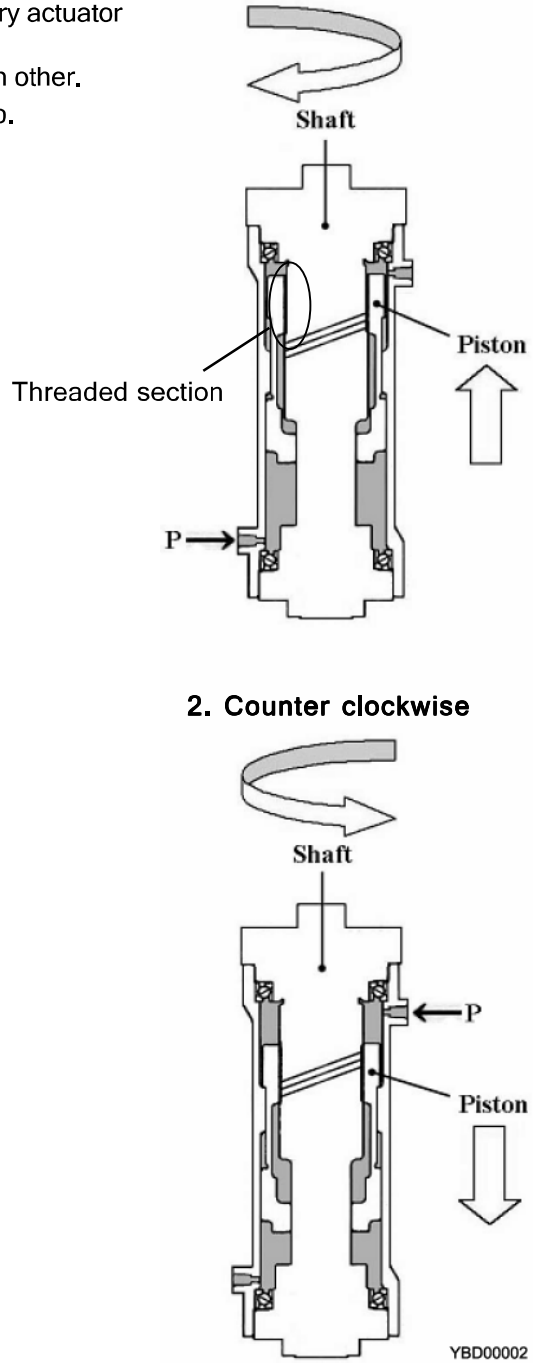


Fig. 3-20 Function of Rotary actuator

Platform rotation solenoid valve (302-0034300) for SP12C/SP400C

This valve is mounted on the Rotary actuator for Platform rotation to control the platform rotation functions.

Solenoid coil resistance	11.3 ohms

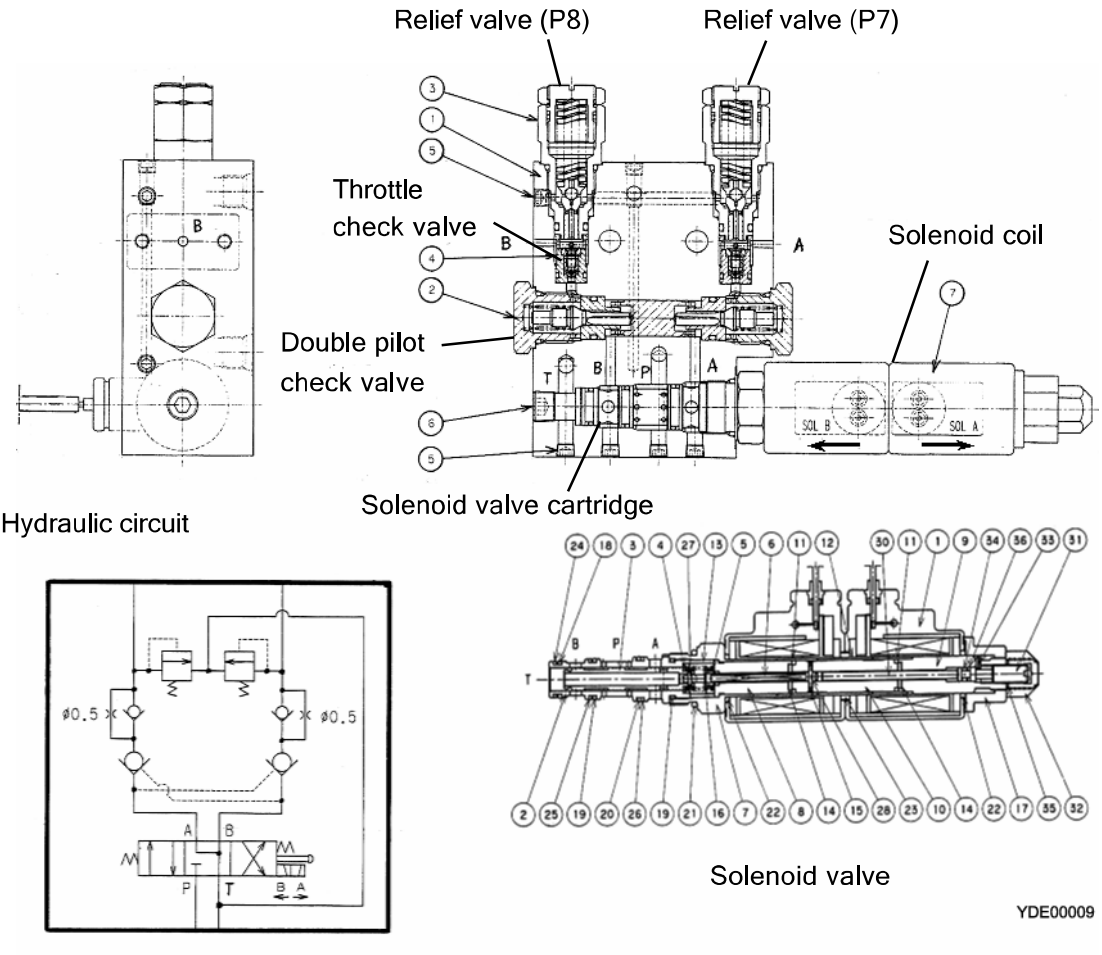


Fig. 3-21 Platform rotation solenoid valve

Solenoid valve installation procedures

Follow the instructions below to install the Solenoid valve onto the manifold.

1. Insert the Solenoid valve cartridge (7) into the manifold, and then tighten the cartridge by the tightening torque of 41 - 43 Nm (4.2 - 4.4 kg-m) [30 - 32 ft-lbs].
2. Install the 2 pieces of the Solenoid coils (1) onto the valve cartridge, and then tighten the Nut (17) by the tightening torque of 4.0 - 5.0 Nm (0.4 - 0.5 kg-m) [3.0 - 3.7 ft-lbs].
3. Turn the Adjust screw (31) counter-clockwise to screw it out fully.
4. Install the Cap nut (32), and tighten it by the tightening torque of 5.0 - 6.0 Nm (0.5 - 0.6 kg-m) [3.6 - 4.4 ft-lbs].

NOTICE

Do not allow the Adjust screw (31) to be turned when tightening the Cap nut (32).

Platform rotation / Fly jib solenoid valve (302-0034400) for SP14CJ/SP460CJ

This valve is mounted on the Rotary actuator to control the platform rotation and Fly jib articulation functions.

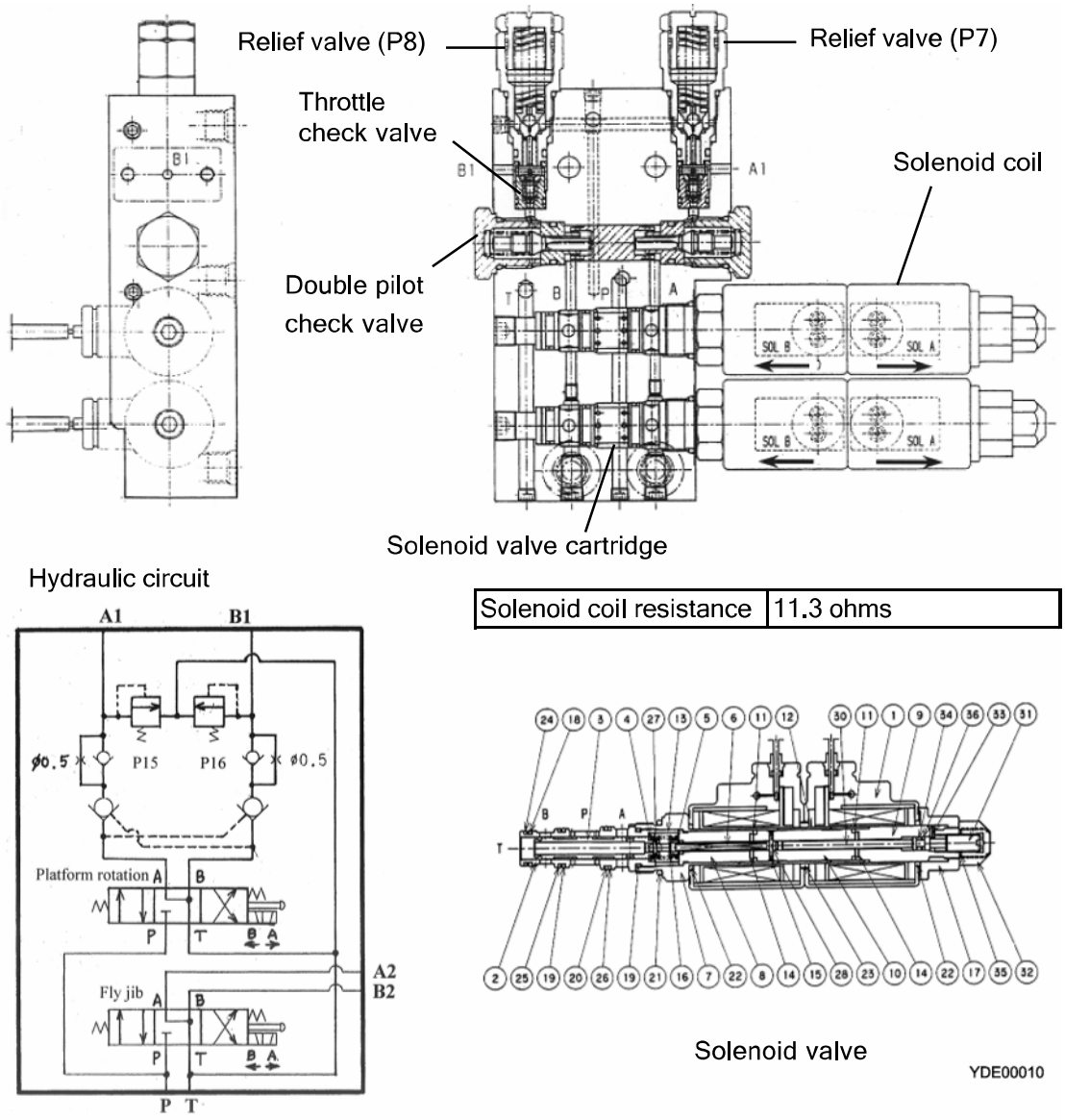


Fig. 3-22 Platform rotation / Fly jib solenoid valve

Solenoid valve installation procedures

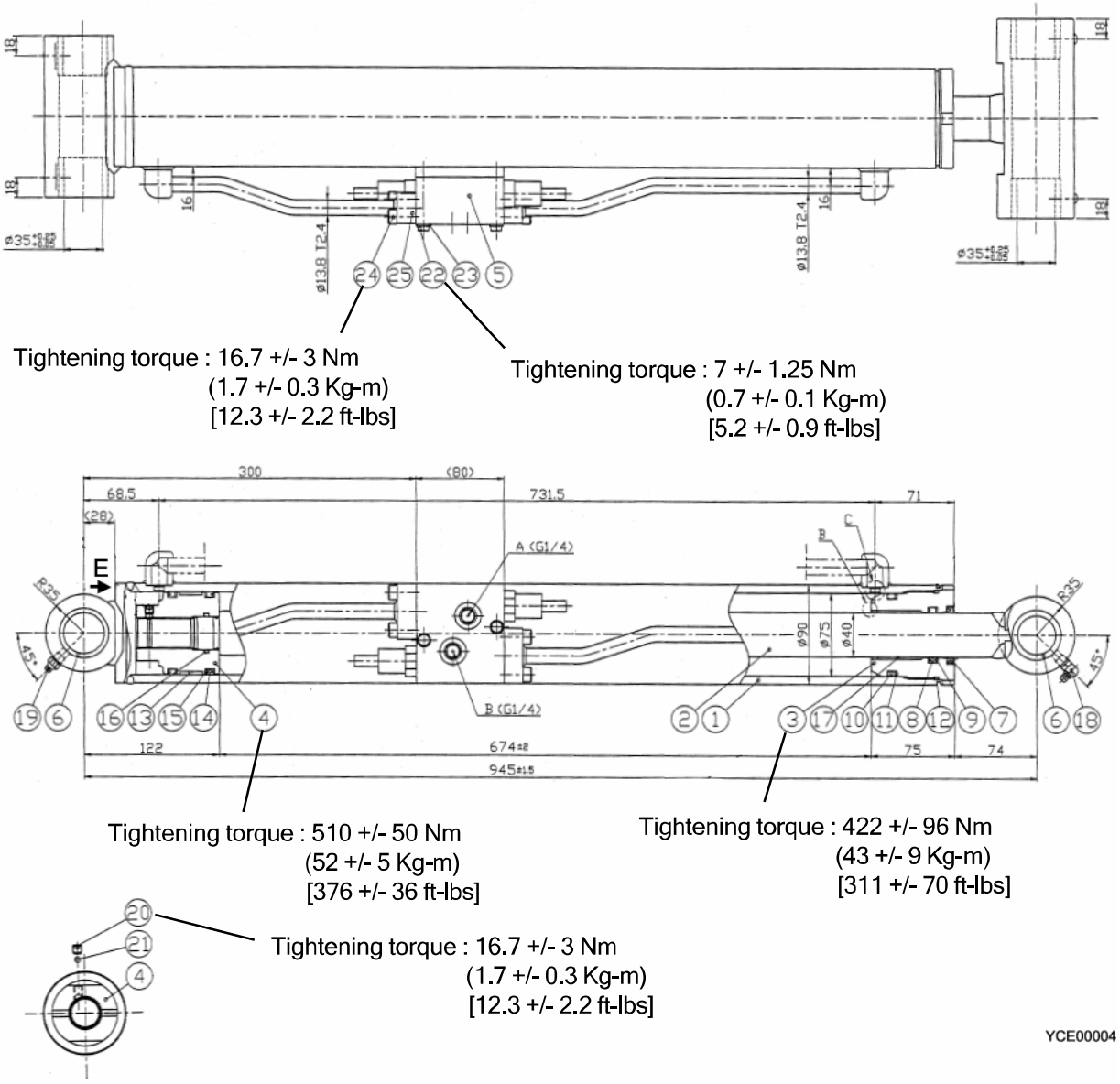
Follow the instructions below to install the Solenoid valve onto the manifold.

1. Insert the Solenoid valve cartridge (7) into the manifold, and then tighten the cartridge by the tightening torque of 41 - 43 Nm (4.2 - 4.4 kg-m) [30 - 32 ft-lbs].
2. Install the 2 pieces of the Solenoid coils (1) onto the valve cartridge, and then tighten the Nut (17) by the tightening torque of 4.0 - 5.0 Nm (0.4 - 0.5 kg-m) [3.0 - 3.7 ft-lbs].
3. Turn the Adjust screw (31) counter-clockwise to screw it out fully.
4. Install the Cap nut (32), and tighten it by the tightening torque of 5.0 - 6.0 Nm (0.5 - 0.6 kg-m) [3.6 - 4.4 ft-lbs].

NOTICE

Do not allow the Adjust screw (31) to be turned when tightening the Cap nut (32).

Fly-jib cylinder (303-0037200) for SP14CJ/SP460CJ

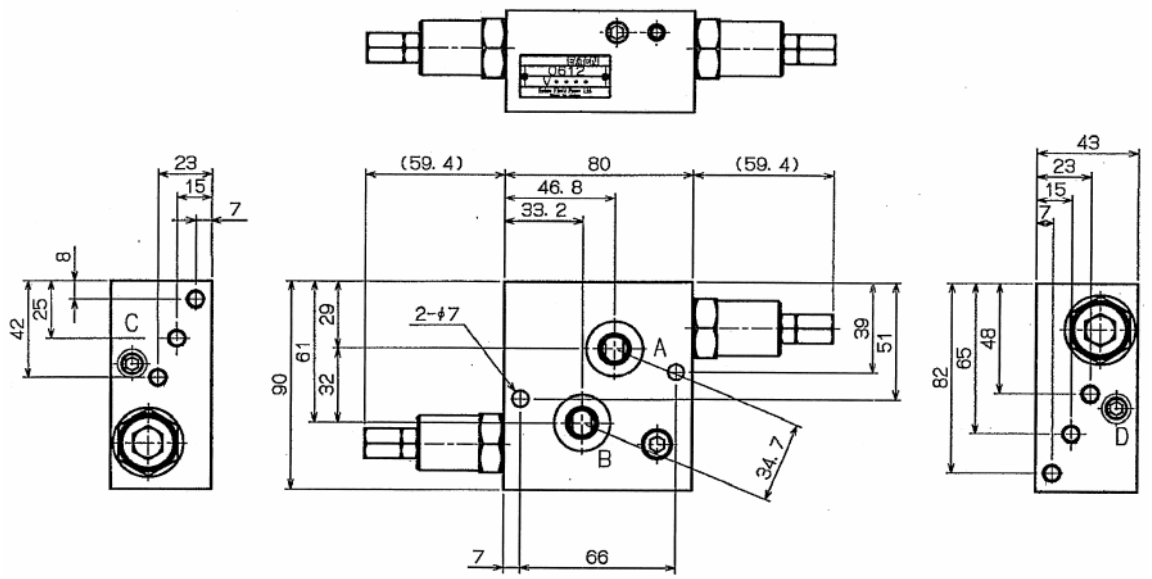


1	Cylinder tube	11	Backup ring	21	Steel ball
2	Piston rod	12	O-ring	22	Bolt
3	Cylinder head	13	Wear ring	23	Flat washer
4	Piston	14	U-ring	24	Cap screw
5	Holding valve	15	Backup ring	25	O-ring
6	Bushing	16	O-ring		
7	Dust seal	17	Bushing		
8	U-ring	18	Grease nipple		
9	Backup ring	19	Grease nipple		
10	O-ring	20	Cap screw		

Fig. 3-23 Fly-jib cylinder

Double holding valve for Fly-jib cylinder (302-0034000) for SP14CJ/SP460CJ

The Double holding valve is equipped on the Fly- jib cylinder to prevent the cylinder from natural retraction and extension.



Hydraulic circuit

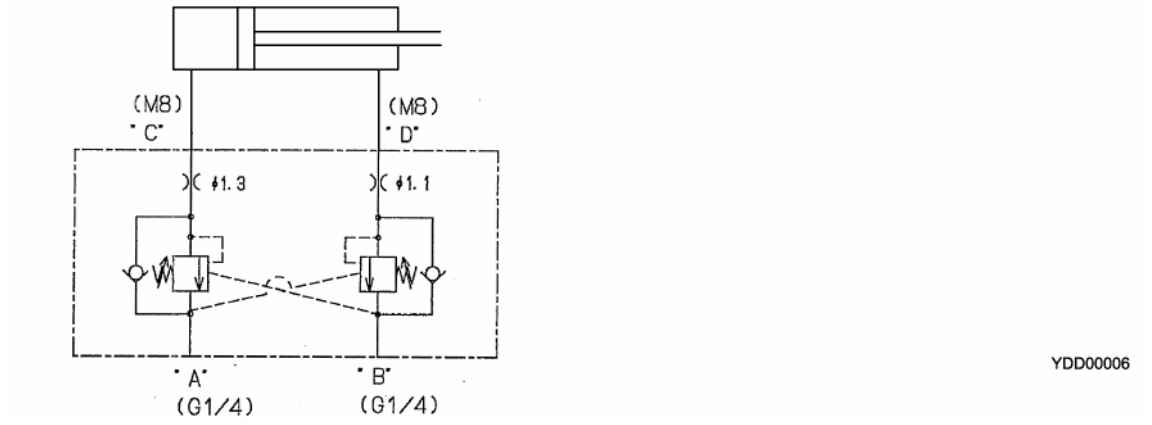
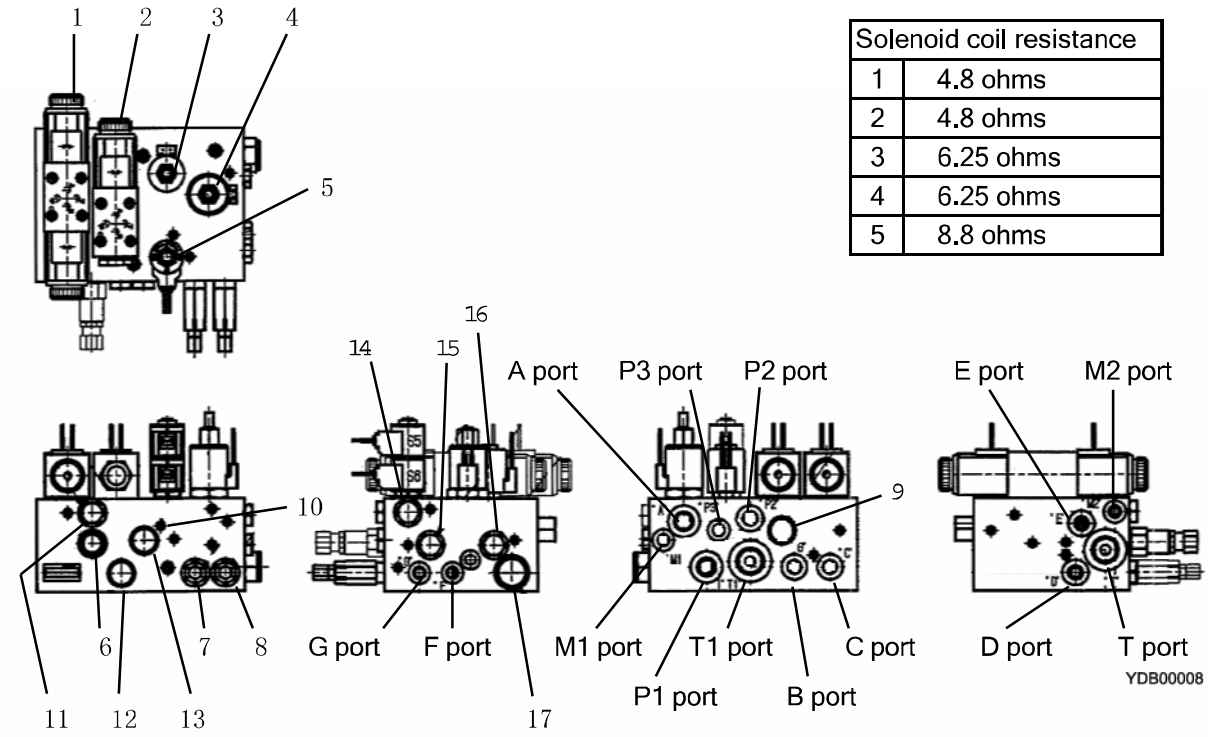


Fig. 3-24 Double holding valve

Valve unit for Platform leveling and Steering (302-0034500A)

The valve unit consists of the five solenoid valves, three relief valves and the flow priority valve to supply pressurized oil to the Main control valve and Platform rotation solenoid valve (SP12C/SP400C) or Platform rotation / Fly jib solenoid valve (SP14CJ/SP460CJ).
The valve also controls Platform leveling and Steering functions.



Solenoid coil resistance	
1	4.8 ohms
2	4.8 ohms
3	6.25 ohms
4	6.25 ohms
5	8.8 ohms

1	Steering solenoid valve
2	Steering / Platform, Fly-jib select solenoid valve
3	Emergency solenoid valve
4	Unloading solenoid valve
5	Platform leveling solenoid valve
6	Relief valve 17.2 MPa (175 kgf/cm2) [2,500 PSI]
7	Relief valve 22.5 MPa (230 kgf/cm2) [3,300 PSI]
8	Relief valve 22.5 MPa (230 kgf/cm2) [3,300 PSI]
9	Flow priority valve
10	Orifice (0.8 mm)
11	Check valve
12	Check valve
13	Check valve
14	Check valve
15	Check valve
16	Check valve
17	Check valve

Port	
A	To Main control valve
B	To Steering cylinder (Right)
C	To Steering cylinder (Left)
D	From Platform rotation solenoid valve or Platform rotation / Fly-jib solenoid valve
E	To Platform rotation solenoid valve or Platform rotation / Fly-jib solenoid valve
F	To Platform leveling cylinders (Down)
G	To Platform leveling cylinders (Up)
P1	From Gear pump P1
P2	From Gear pump P2
P3	From Emergency pump
T	To Hydraulic oil tank
T1	Pluged
M1	Gauge port
M2	Gauge port

Fig. 3-25 Valve unit

Hydraulic circuit

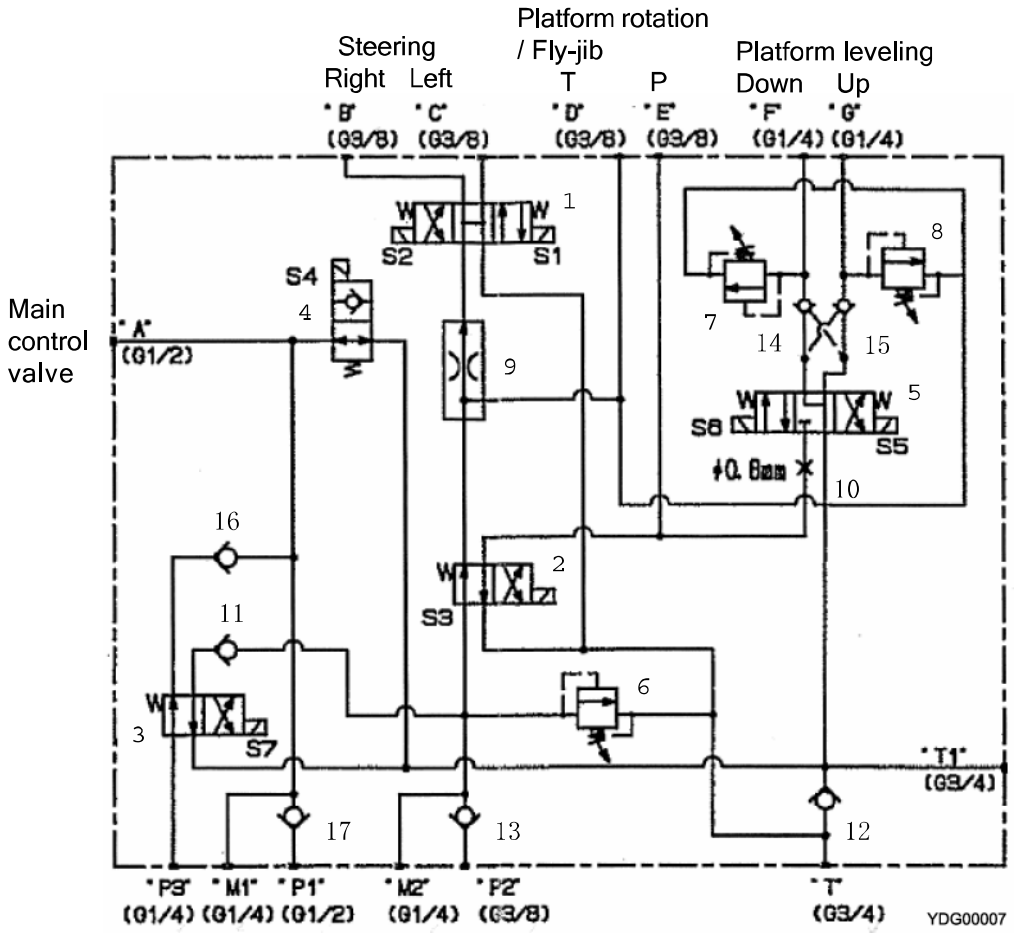
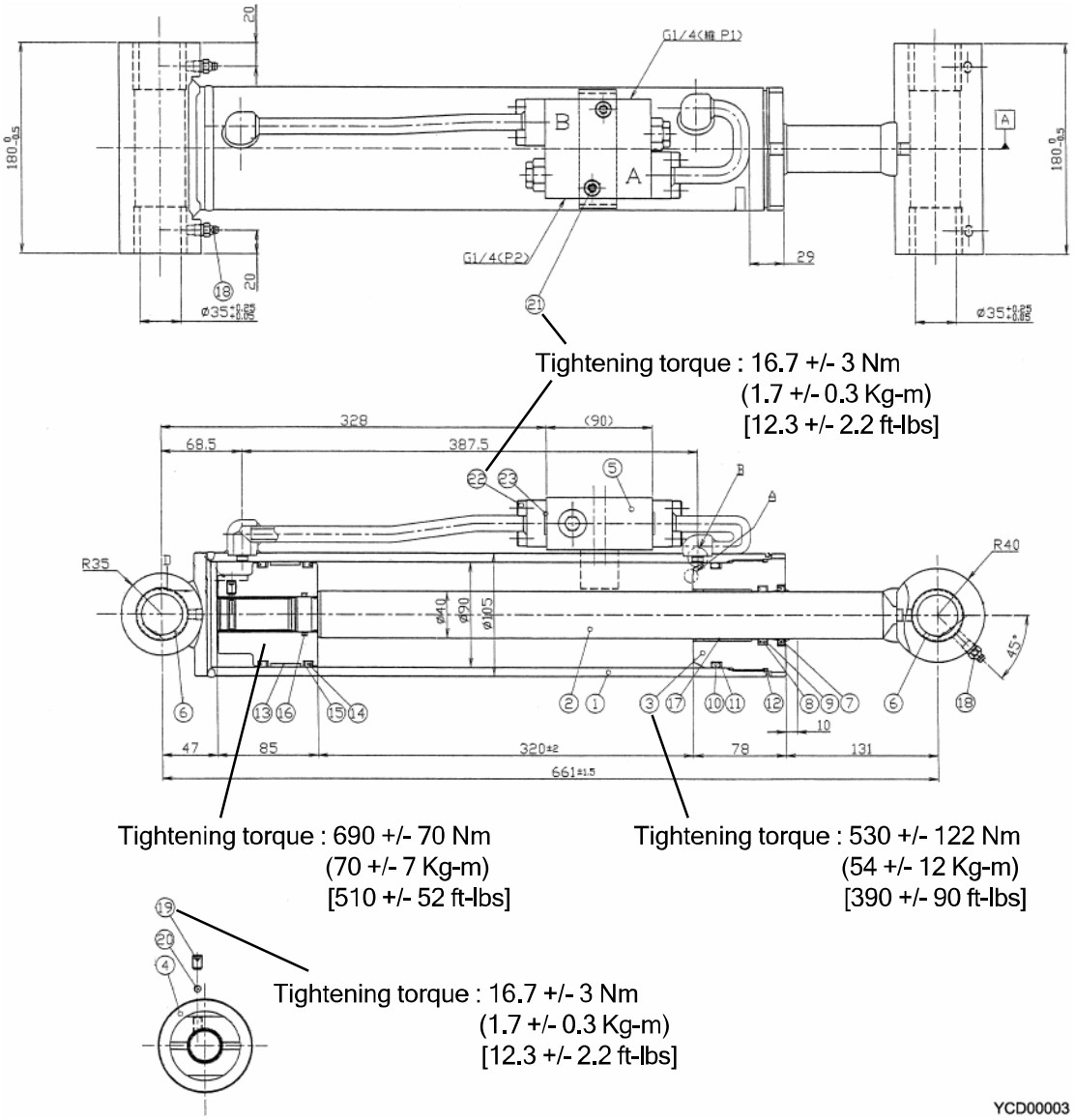


Fig. 3-26 Hydraulic circuit

Platform leveling cylinder, Upper (303-0037100A)



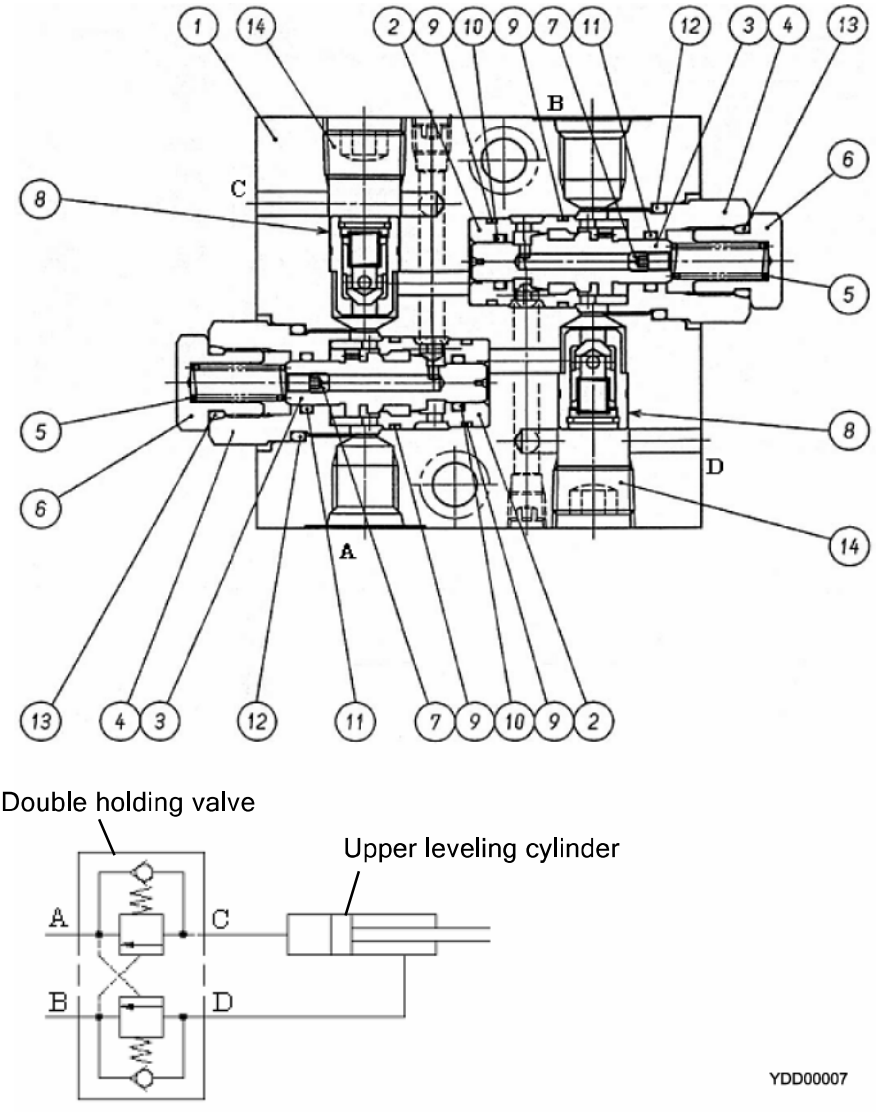
1	Cylinder tube	11	Backup ring	21	Cap screw
2	Piston rod	12	O-ring	22	Cap screw
3	Cylinder head	13	Wear ring	23	O-ring
4	Piston	14	U-ring		
5	Holding valve	15	Backup ring		
6	Bushing	16	O-ring		
7	Dust seal	17	Bushing		
8	U-ring	18	Grease nipple		
9	Backup ring	19	Cap screw		
10	O-ring	20	Steel ball		

Fig. 3-27Platform leveling cylinder (Upper)

Double holding valve for Platform leveling cylinder, Upper (302-05847A)

The Double holding valve is mounted on the Upper leveling cylinder to maintain the platform level in the event of hydraulic hose breakage

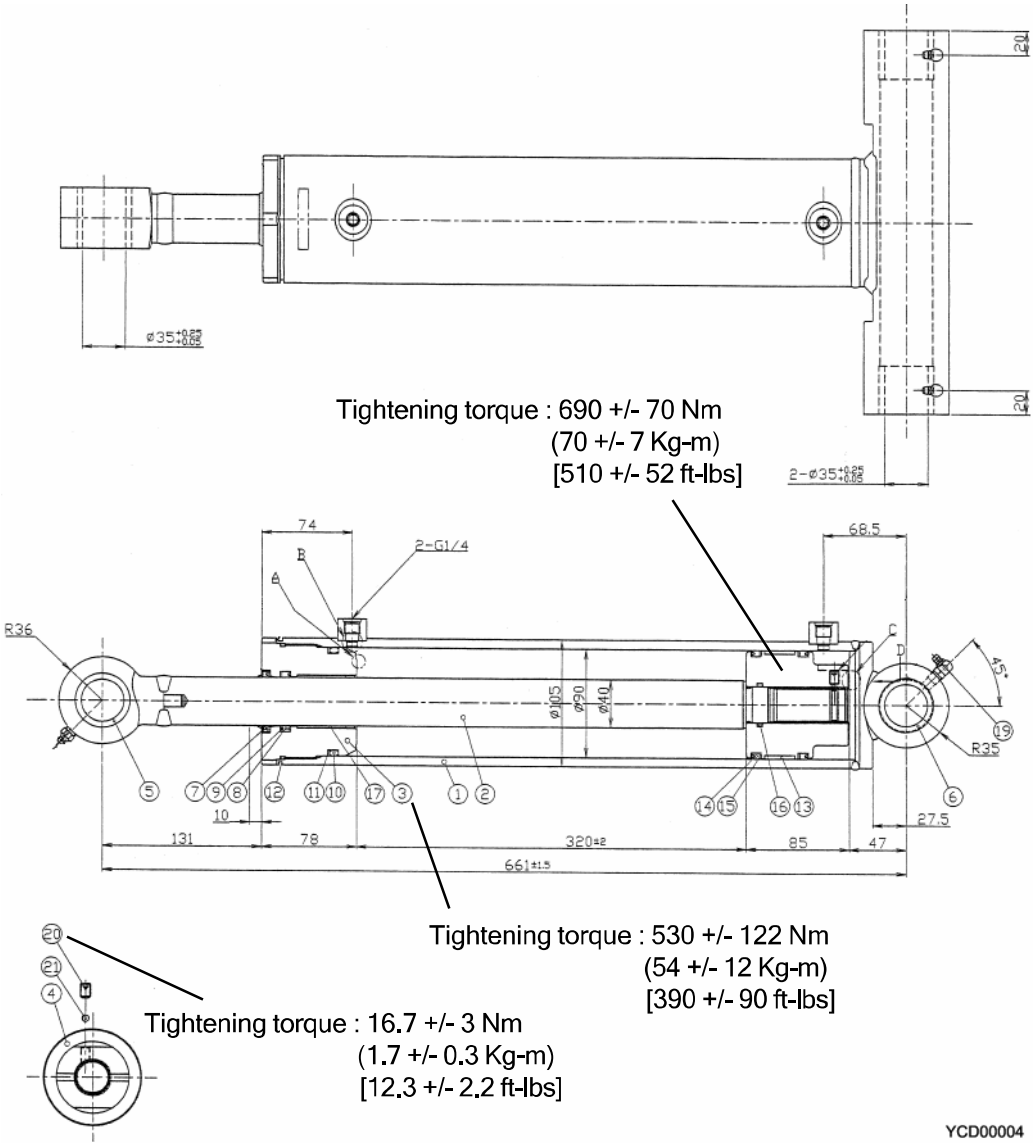
Rated pressure	22.5 MPa (230 kgf/cm2) [3,300 PSI]
Rated flow	10 liters/min (2.64 gal/mi n)



1	Body	6	Cap	11	O-ring
2	Valve seat	7	Orifice	12	O-ring
3	Valve spool	8	Check valve	13	O-ring
4	Cap	9	O-ring	14	Plug
5	Spring	10	O-ring		

Fig. 3-28 Double holding valve

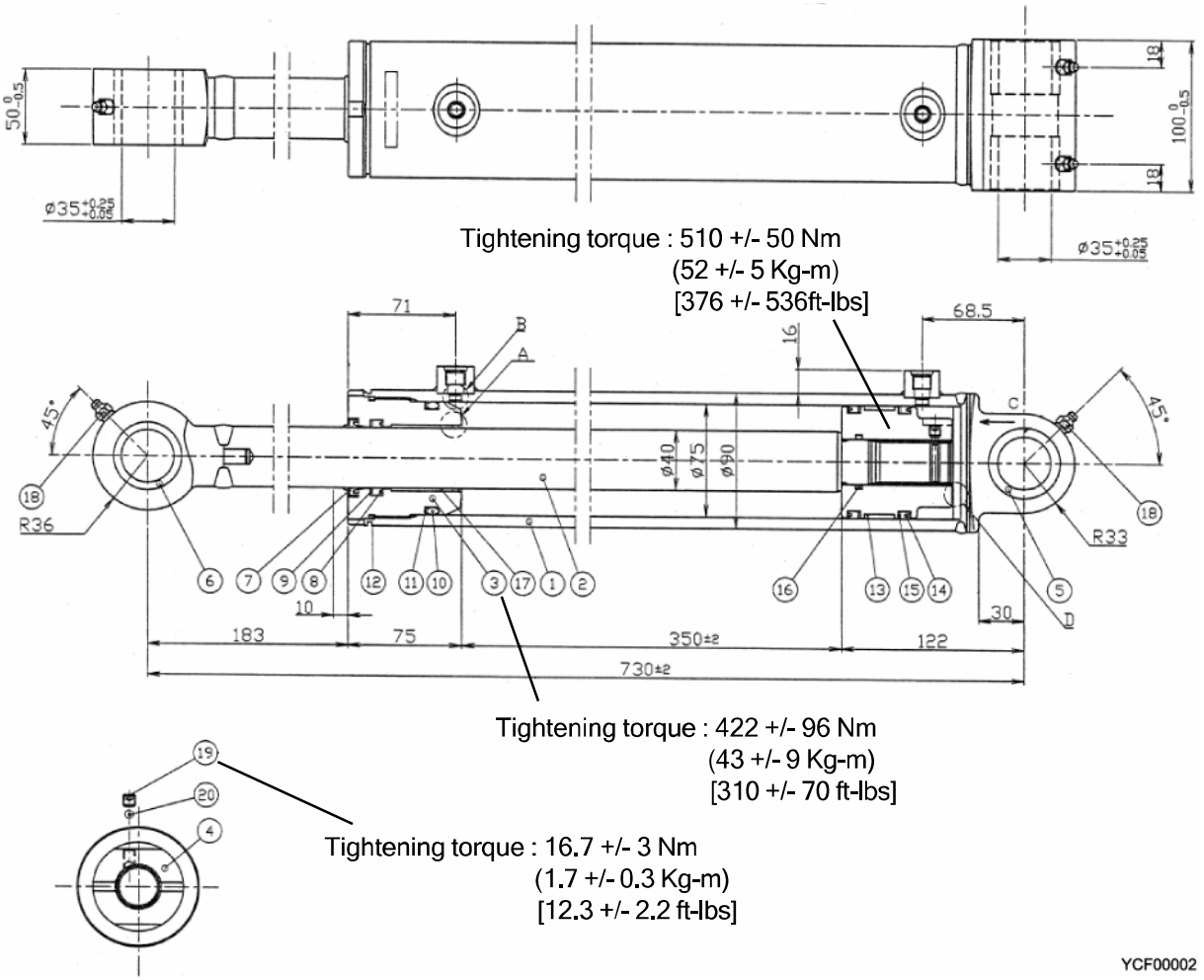
Platform leveling cylinder, Lower (303-0037500C)



1	Cylinder tube	11	Backup ring	21	Steel ball
2	Piston rod	12	O-ring		
3	Cylinder head	13	Wear ring		
4	Piston	14	U-ring		
5	Bushing	15	Backup ring		
6	Bushing	16	O-ring		
7	Dust seal	17	Bushing		
8	U-ring	18	Grease nipple		
9	Backup ring	19	Grease nipple		
10	O-ring	20	Cap screw		

Fig. 3-29 Platform leveling cylinder (Lower)

Steering cylinder (303-0037300A)



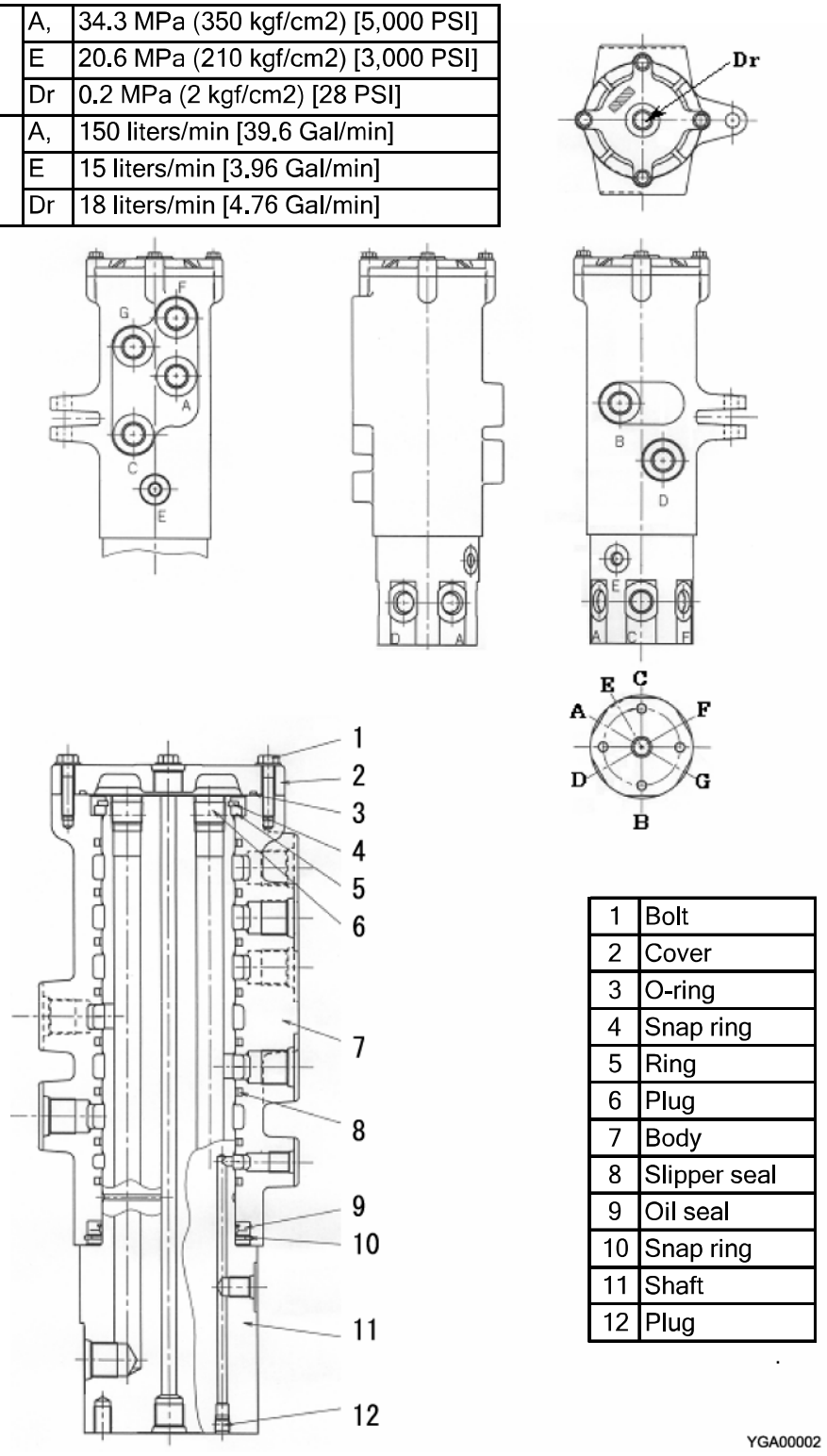
1	Cylinder tube	11	Backup ring
2	Piston rod	12	O-ring
3	Cylinder head	13	Wear ring
4	Piston	14	U-ring
5	Bushing	15	Backup ring
6	Bushing	16	O-ring
7	Dust seal	17	Bushing
8	U-ring	18	Grease nipple
9	Backup ring	19	Cap screw
10	O-ring	20	Steel ball

Fig. 3-30 Steering cylinder

Swivel joint (307-0000113)

The swivel joint is installed at the rotation center of the turntable to provide the hydraulic oil passages between the turntable and chassis.

Rated pressure	A,	34.3 MPa (350 kgf/cm2) [5,000 PSI]
	E	20.6 MPa (210 kgf/cm2) [3,000 PSI]
	Dr	0.2 MPa (2 kgf/cm2) [28 PSI]
Rated flow	A,	150 liters/min [39.6 Gal/min]
	E	15 liters/min [3.96 Gal/min]
	Dr	18 liters/min [4.76 Gal/min]



1	Bolt
2	Cover
3	O-ring
4	Snap ring
5	Ring
6	Plug
7	Body
8	Slipper seal
9	Oil seal
10	Snap ring
11	Shaft
12	Plug

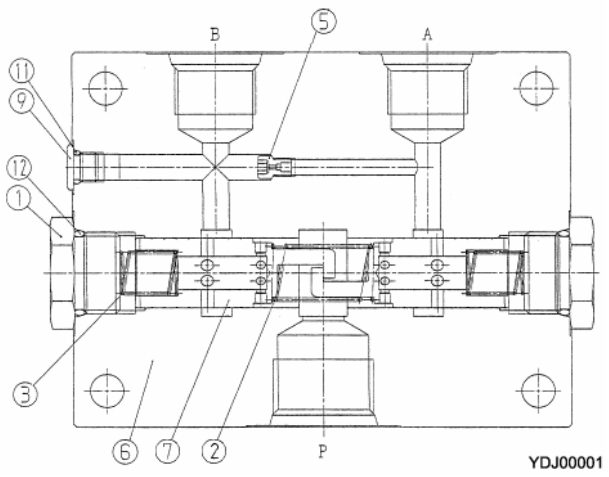
Fig. 3-31 Swivel joint

Flow divider valve (302-0032900B, 302-0033000B)

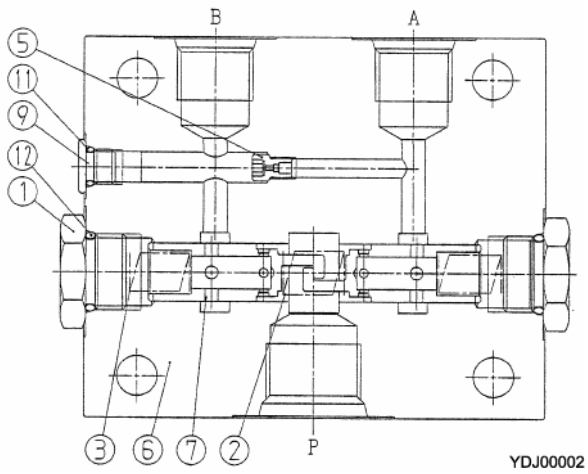
One of Flow divider valve (302-0032900A) and two of Flow divider valves (302-0033000A) are installed in the hydraulic circuit of the Traveling system to supply equal flow to the four of Travel motors.

	302-0032900B	302-0033000B
Rated pressure	34.3 MPa (350 kgf/cm2) [5,000 PSI]	34.3 MPa (350 kgf/cm2) [5,000 PSI]
Rated flow	130 liters/min [34.3 Gal/min]	65 liters/min [17.2 Gal/min]
Flow dividing ratio to A and B ports	1 : 1	1 : 1

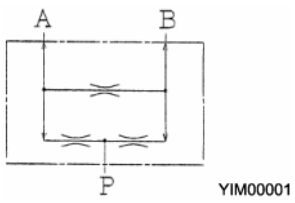
302-0032900B



302-0033000B



Hydraulic circuit



1	Plug
2	Spring
3	Spring
5	Orifice
6	Body
7	Plunger
9	Plug
11	O-ring
12	O-ring

Fig. 3-32 Flow divider valve

Travel motor (301-0000071B)

Hydraulic motor	Motor type		Plunger motor
	Rated pressure		34.3MPa (350 kgf/cm2) [5,000 PSI]
	Displacement	Low	31.5 cm3 [1.92 in3]
		High	18.0 cm3 [1.10 in3]
Gear box	Gear type		Planetary gear
	Reduction ratio		1 : 31.2
	Recommended gear oil		Shell Spirax EP90
	Gear oil capacity		1.0 liter [0.26 gallons]
Parking brake	Rated pressure		4.9 MPa (50 kgf/cm2) [710 PSI]
	Brake releasing pressure		1.5 MPa (15.3 kgf/cm2) [218 PSI]

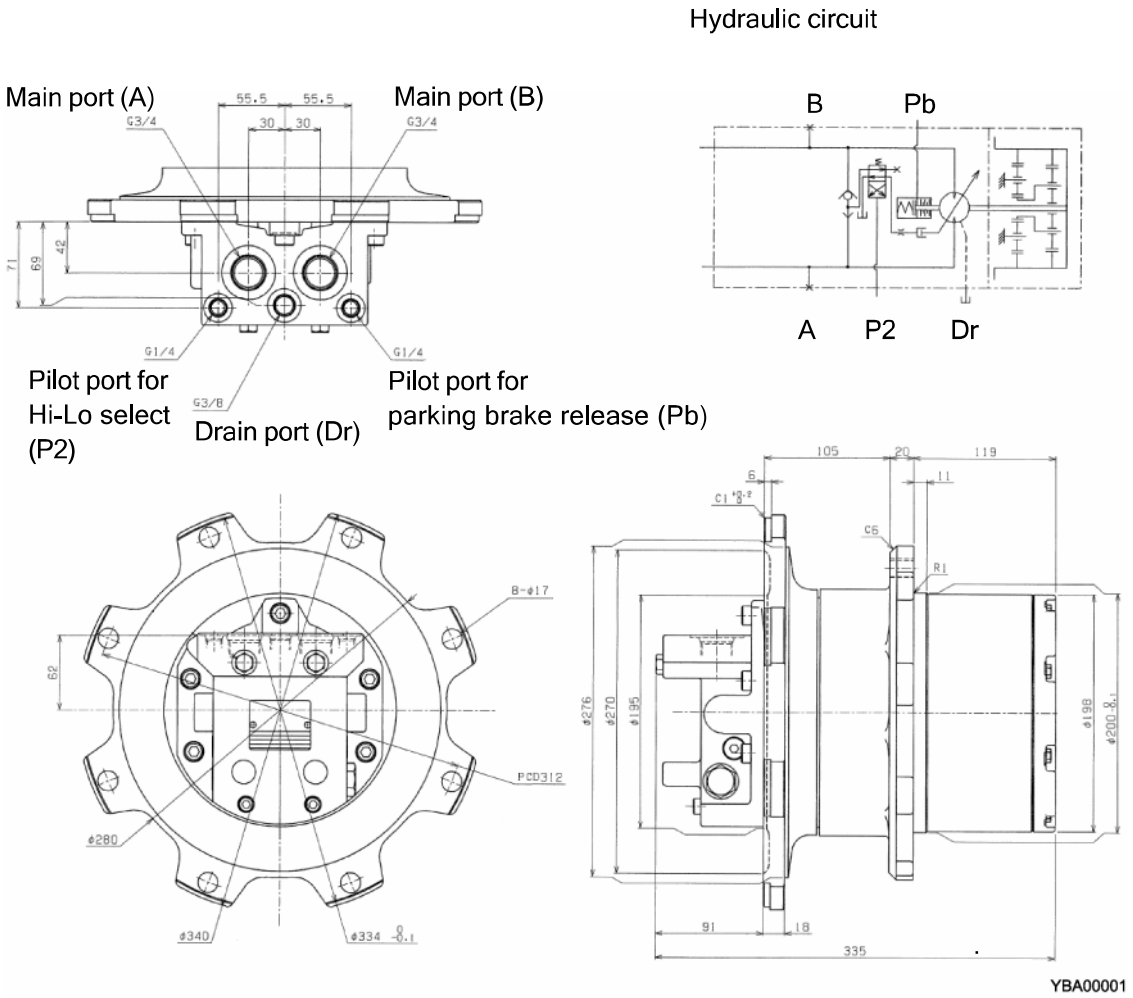


Fig. 3-23 Travel motor

Valve unit for Oscillation axle, Parking brake and Travel speed select

(302-0032500A)

The valve unit consists of three solenoid valves to release the Oscillation axle lock, Parking brake and select Hi-Lo speed of the travel motor.

Rated pressure	4.9 MPa (50 kgf/cm2) [710 PSI]	Rated voltage	DC12V
Rated flow volume	10 liters/min [2.64 gal/min]	Solenoid coil resistance	8.3 ohms

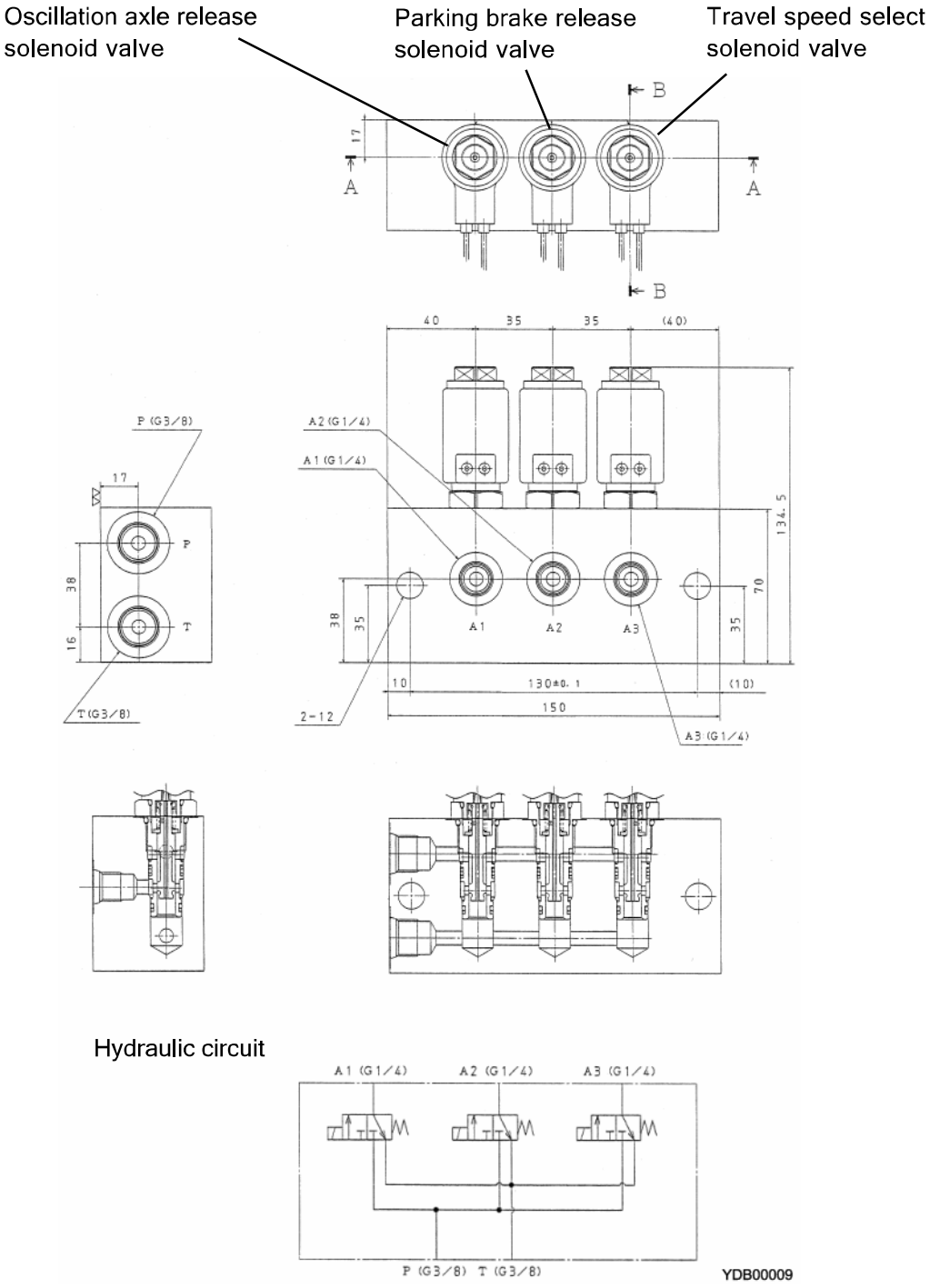


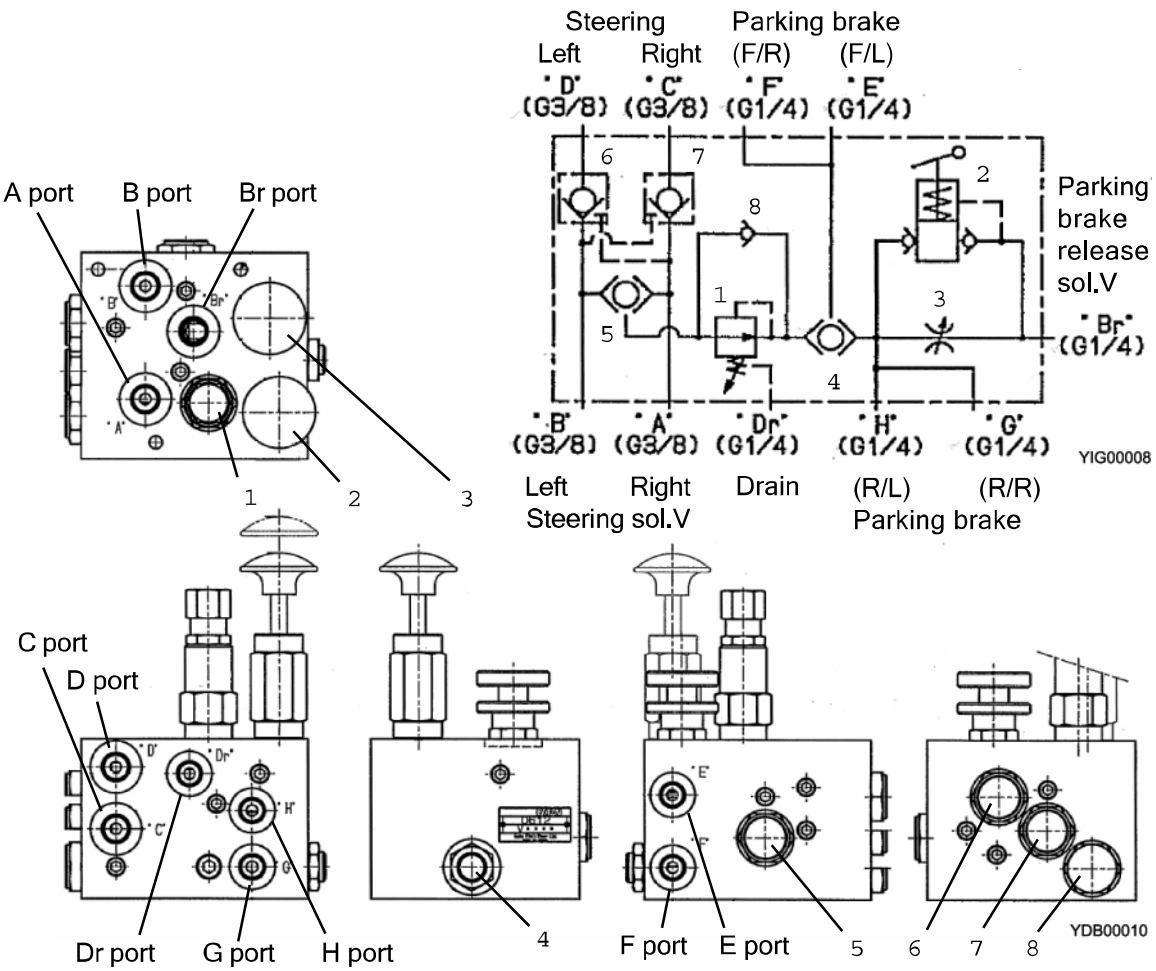
Fig. 3-34 Valve unit

Parking brake release valve (302-0035000)

The Parking brake release valve send the pilot pressure to travel motor to release the parking brake when the travel function or steering is operated.
The valve is equipped with emergency hand pump to release the parking brake that enable to tow the machine when the machine is stuck because of Engine, Hydraulic system or Electric system failure.

Rated pressure	20.6 MPa (210 kgf/cm2) [3,000 PSI]
Reducing valve	3.4 MPa (35 kgf/cm2) [500 PSI]

Hydraulic circuit

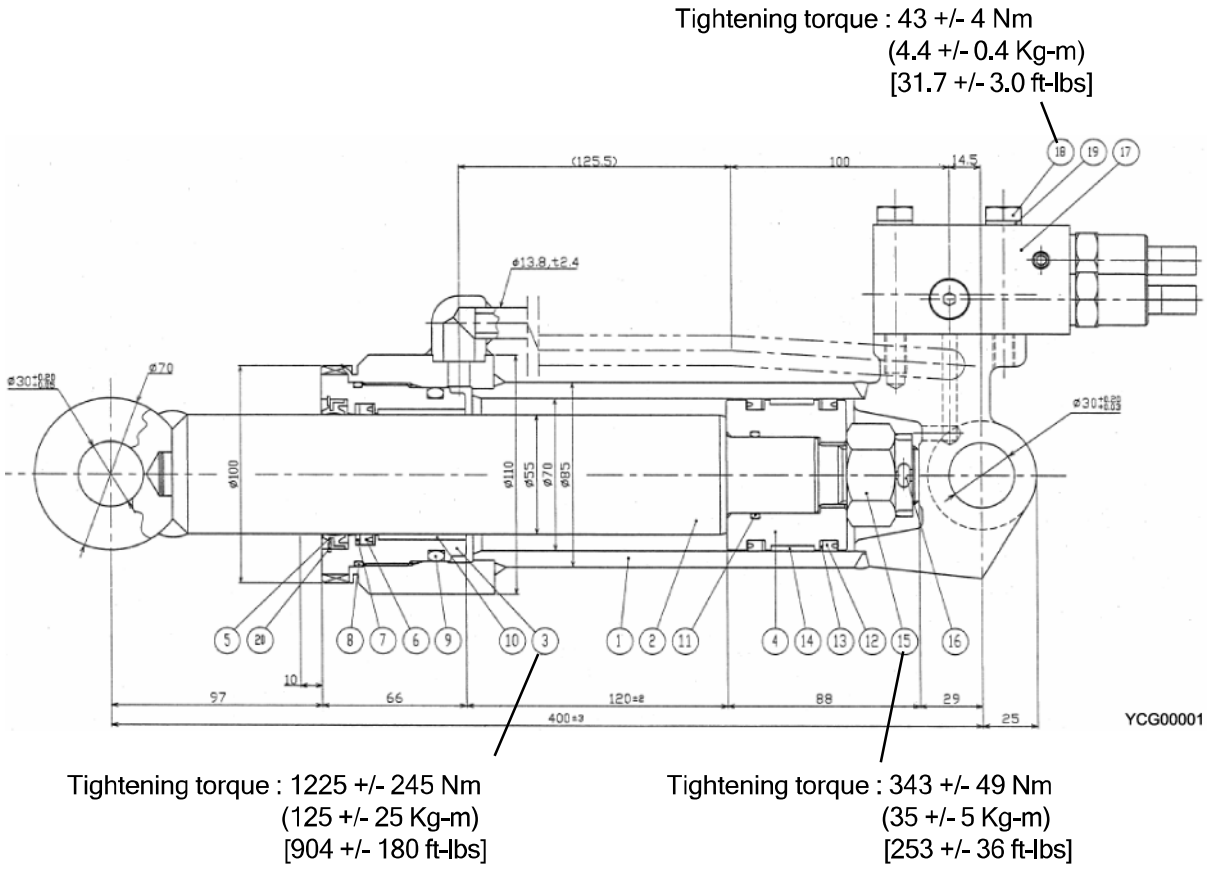


1	Reducing valve
2	Hand pump
3	Needle valve
4	Shuttle valve
5	Shuttle valve
6	Pilot check valve
7	Pilot check valve
8	Check valve

Port	
A	From Valve unit (Steering sol.V, Right)
B	From Valve unit (Steering sol.V, Left)
C	To Steering cylinder (Right)
D	To Steering cylinder (Left)
E	Parking brake (Front/Left)
F	Parking brake (Front/Right)
G	Parking brake (Rear/Right)
H	Parking brake (Rear/Left)
Br	From Valve unit (Parking brake release sol.V)
Dr	To Hydraulic oil tank

Fig. 3-35 Parking brake release valve

Oscillation axle cylinder (303-0036400)



1	Cylinder tube	11	O-ring
2	Piston rod	12	U-ring
3	Cylinder head	13	Backup ring
4	Piston	14	Wear ring
5	Dust seal	15	Nut
6	U-ring	16	Split pin
7	Backup ring	17	Holding valve
8	O-ring	18	Bolt
9	O-ring	19	Washer
10	Bushing	20	Retainer ring

Fig. 3-36 Oscillation axle cylinder

Oscillation axle lock valve (302-0034100A)

Rated pressure	23.5 MPa (240 kgf/cm2) [3,400 PSI]
Rated flow volume	30 L/min [7.9 gal/min]
Counter valance valve cracking pressure	23.5 MPa (240 kgf/cm2) [3,400 PSI]

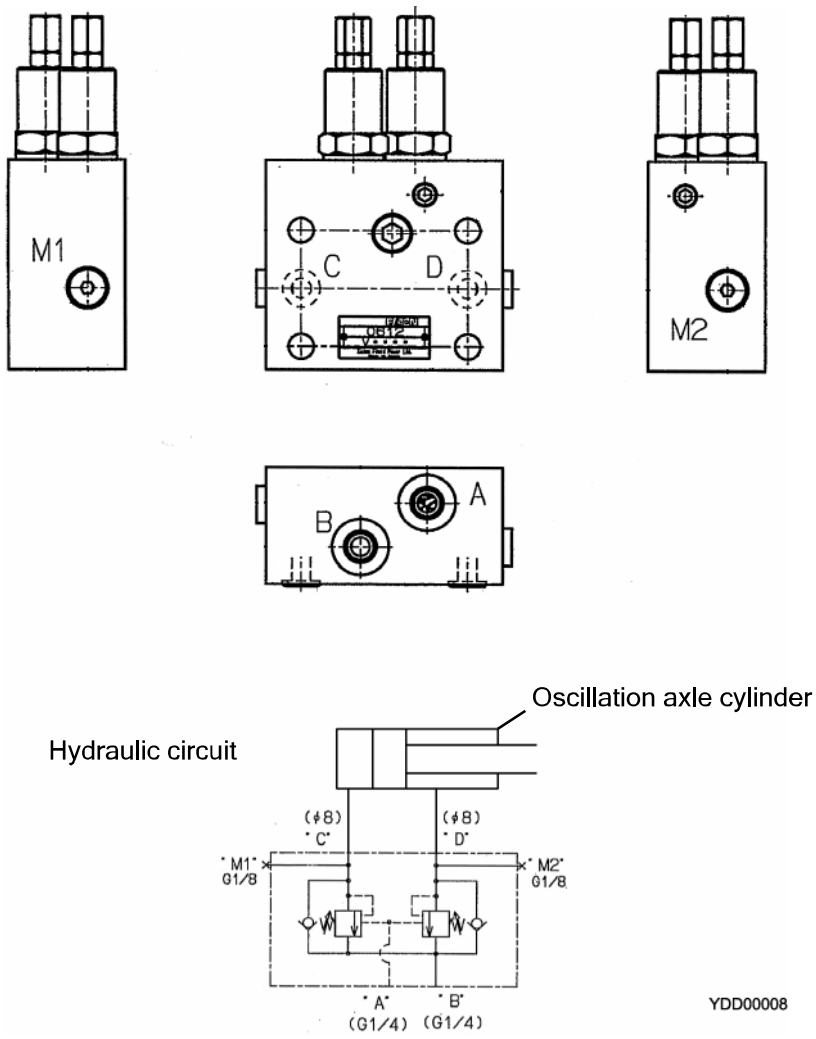


Fig. 3-37 Oscillation axle lock valve

Chapter 4
Electric Components

Locations of Electric components

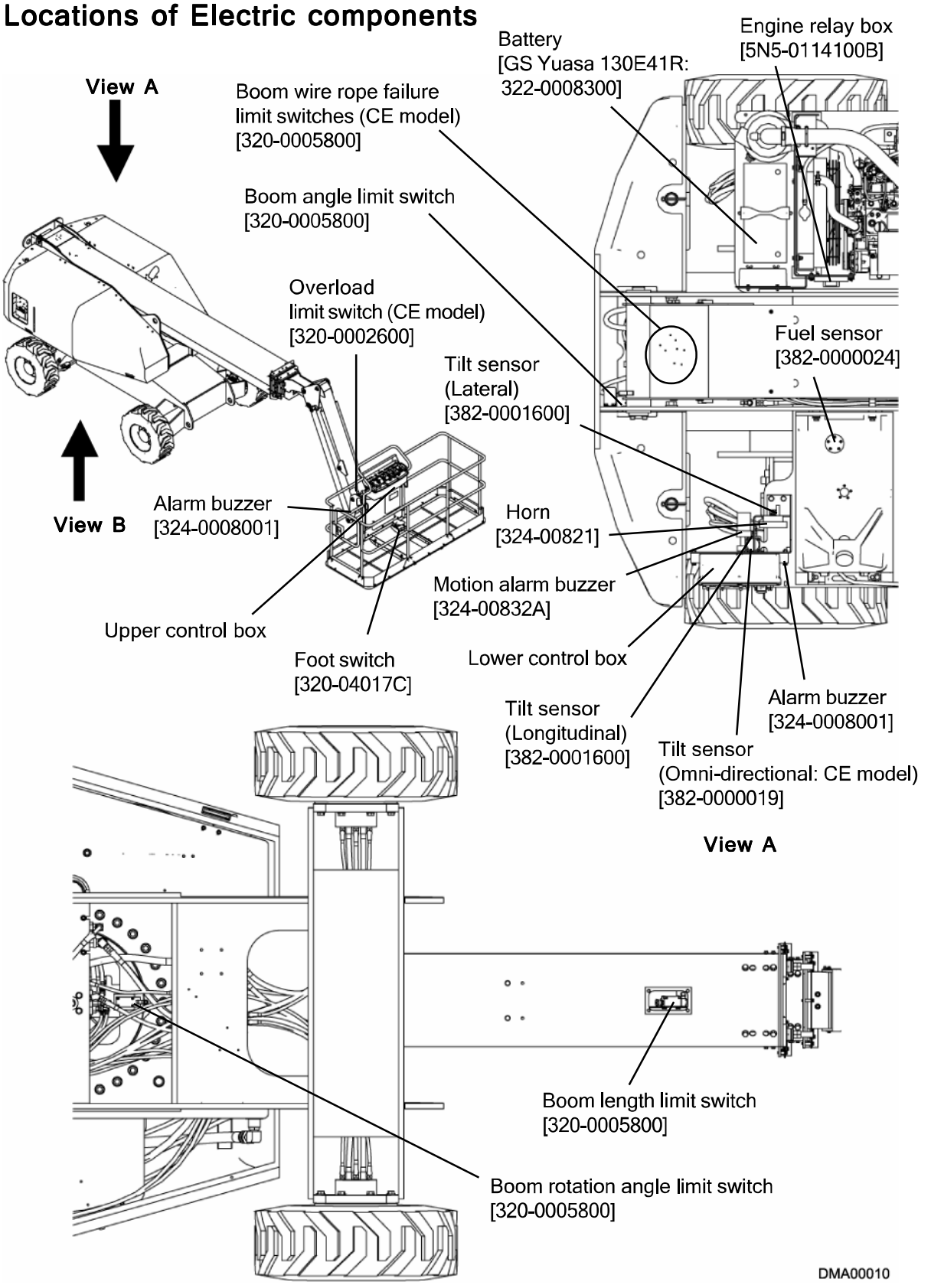
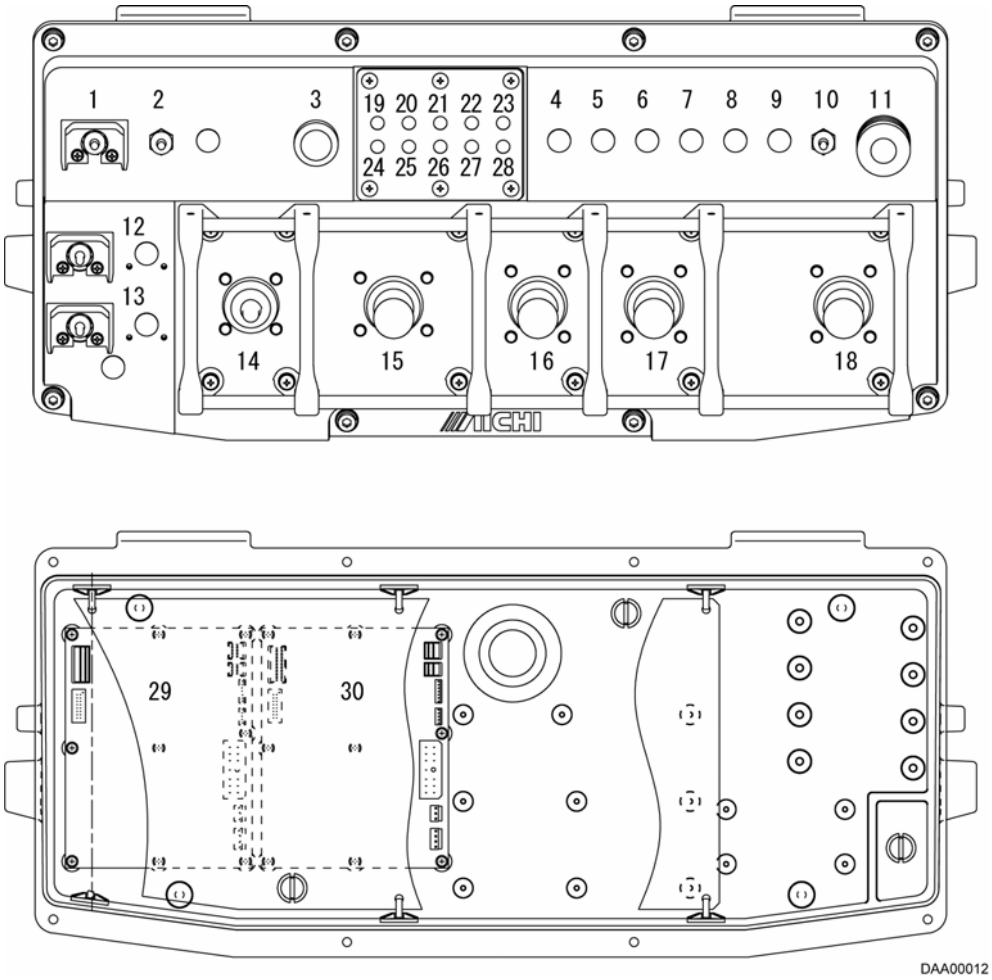


Fig. 4-1 Locations of Electric components

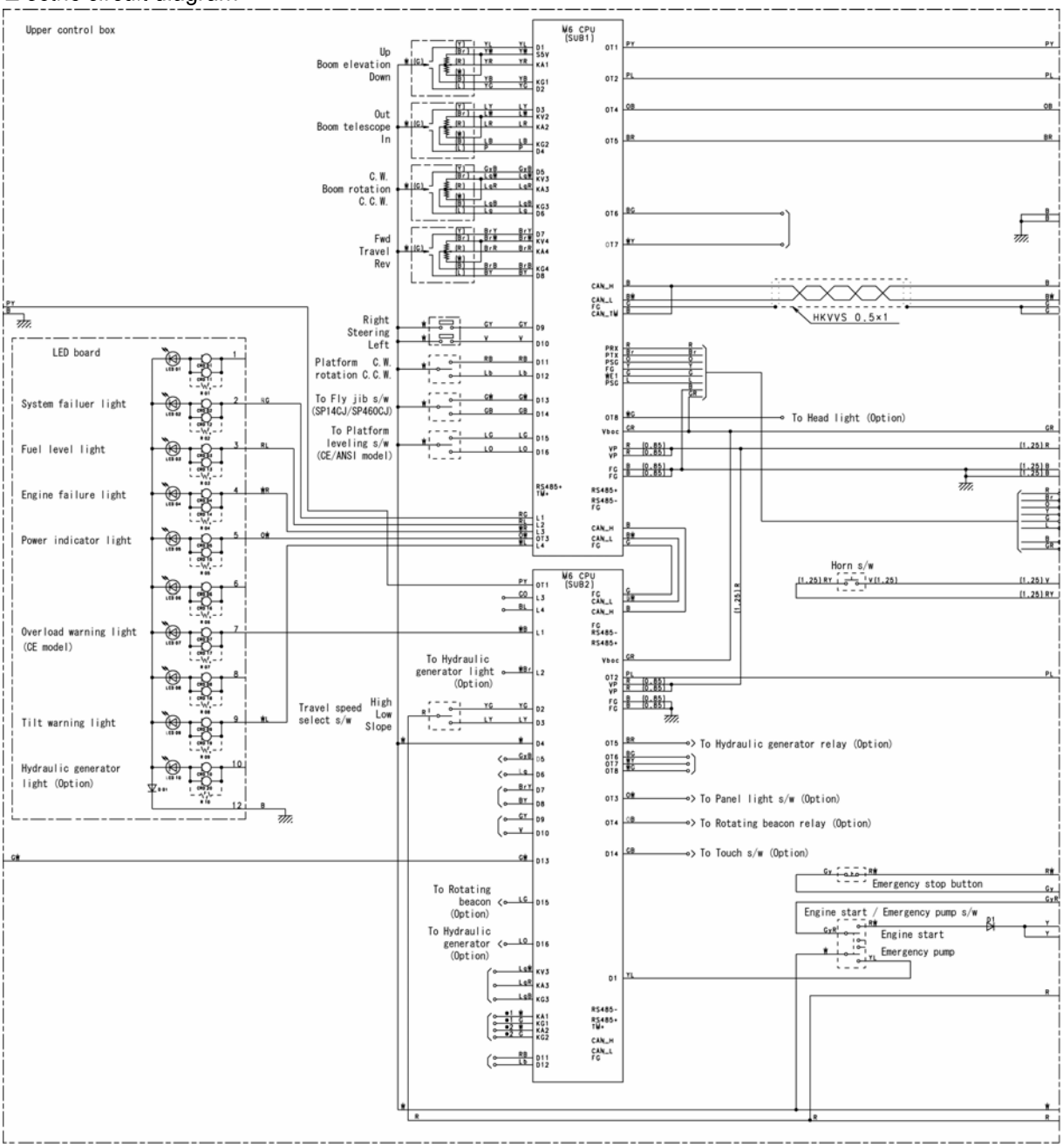
Upper control box



1	Platform leveling s/w	173-01212	16	Joystick controller for Boom telescope	324-0008100
2	Travel speed select s/w	173-01111	17	Joystick controller for Boom elevation	324-0008100
3	Horn s/w	173-51100	18	Joystick controller for Travel	324-0008100
4			19		329-0091300
5	Rotating beacon s/w (Option)	173-00100	20	System failure light	
6	Work light s/w (Option)	173-00100	21	Fuel level light	
7	Head light s/w (Option)	173-00100	22	Engine failure light	
8	Hydraulic generator s/w (Option)	173-00100	23	Power indicator light	
9			24		
10	Engine start / Emergency pump s/w	173-02212	25	Overload warning light (CE model)	
11	Emergency stop button	320-0007201	26		
12	Platform rotation s/w	320-05325	27	Tilt warning light	
13	Fly-jib s/w (for SP14CJ/SP460CJ)	320-05325	28	Hydraulic generator light (Option)	
14	Steering lever	324-0000033	29	CPU board M6 : Sub1	G309290016
15	Joystick controller for Boom rotation	324-0008100	30	CPU board M6 : Sub2	G309290017

Fig. 4-2 Upper control box

Electric circuit diagram



Connector

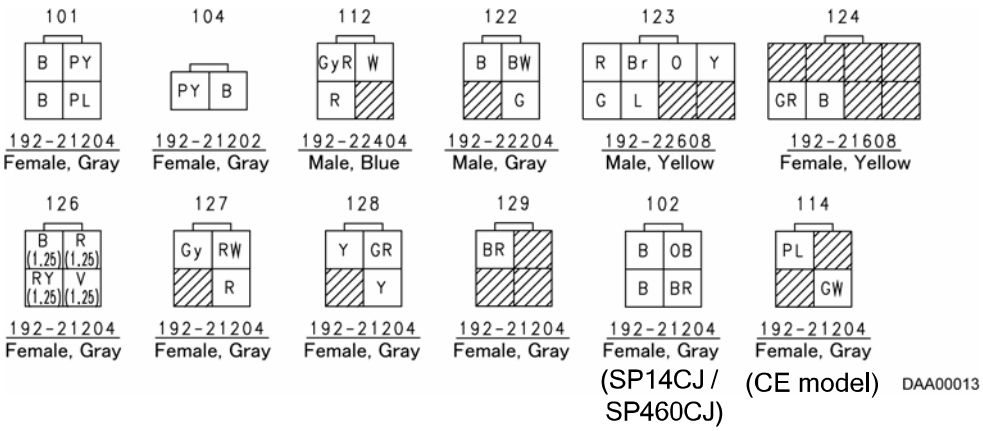
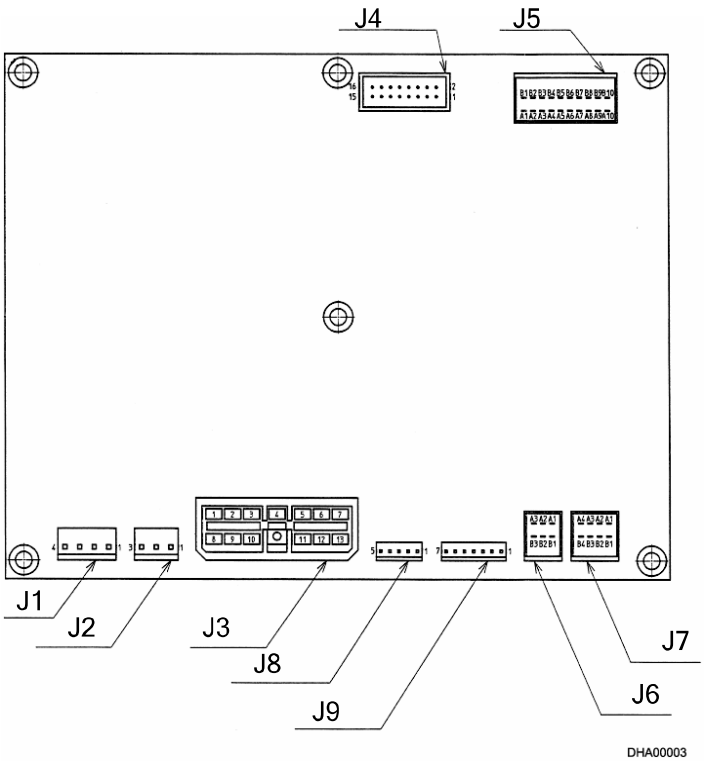


Fig. 4-3 Electric circuit diagram

CPU board “M6” (Sub 1: G309290016, Sub 2: G309290017)



Connectors

J1

Vp	Vp	GND	GND

J2

Vbac	FG

J3

L4	L2			OT6	OT4	OT2
L3	L1	OT8	OT7	OT5	OT3	OT1

J4

D1	D3	D5	D7	D9	D11	D13	D15
D2	D4	D6	D8	D10	D12	D14	D16

J5

KV6	KA6	KG6	KV4	KA4	KG4	KV2	KA2	KG2	
KV5	KA5	KG5	KV3	KA3	KG3	S5V	KA1	KG1	

J6

485_H	486_L	485_TM
485_H	486_L	FG

J7

CAN_H	CAN_L	CAN_TM	FG
CAN_H	CAN_L	CAN_TM	FG

J8

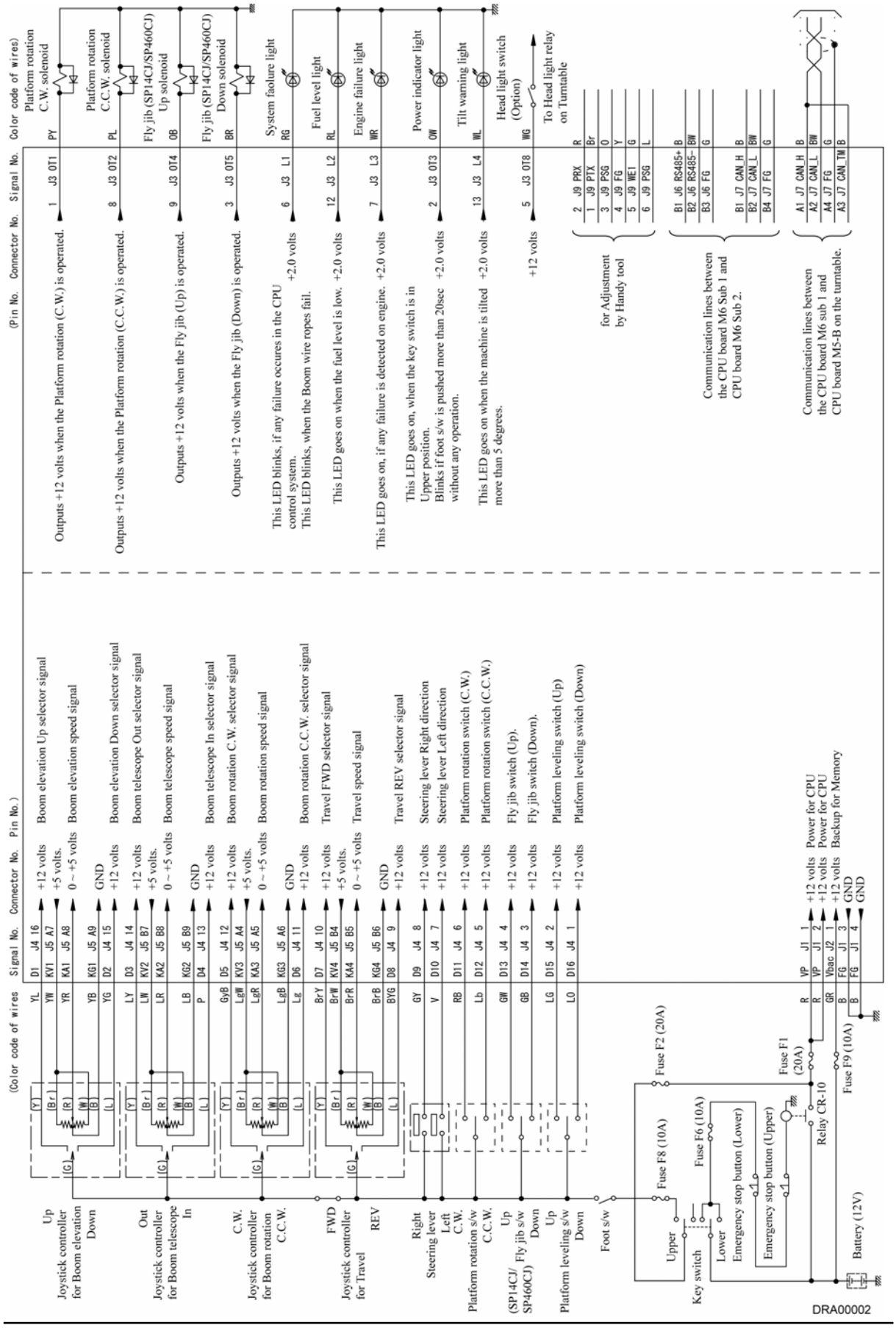
Vcc	/Vpp_EN	FG	/EXRES	/WDT

J9

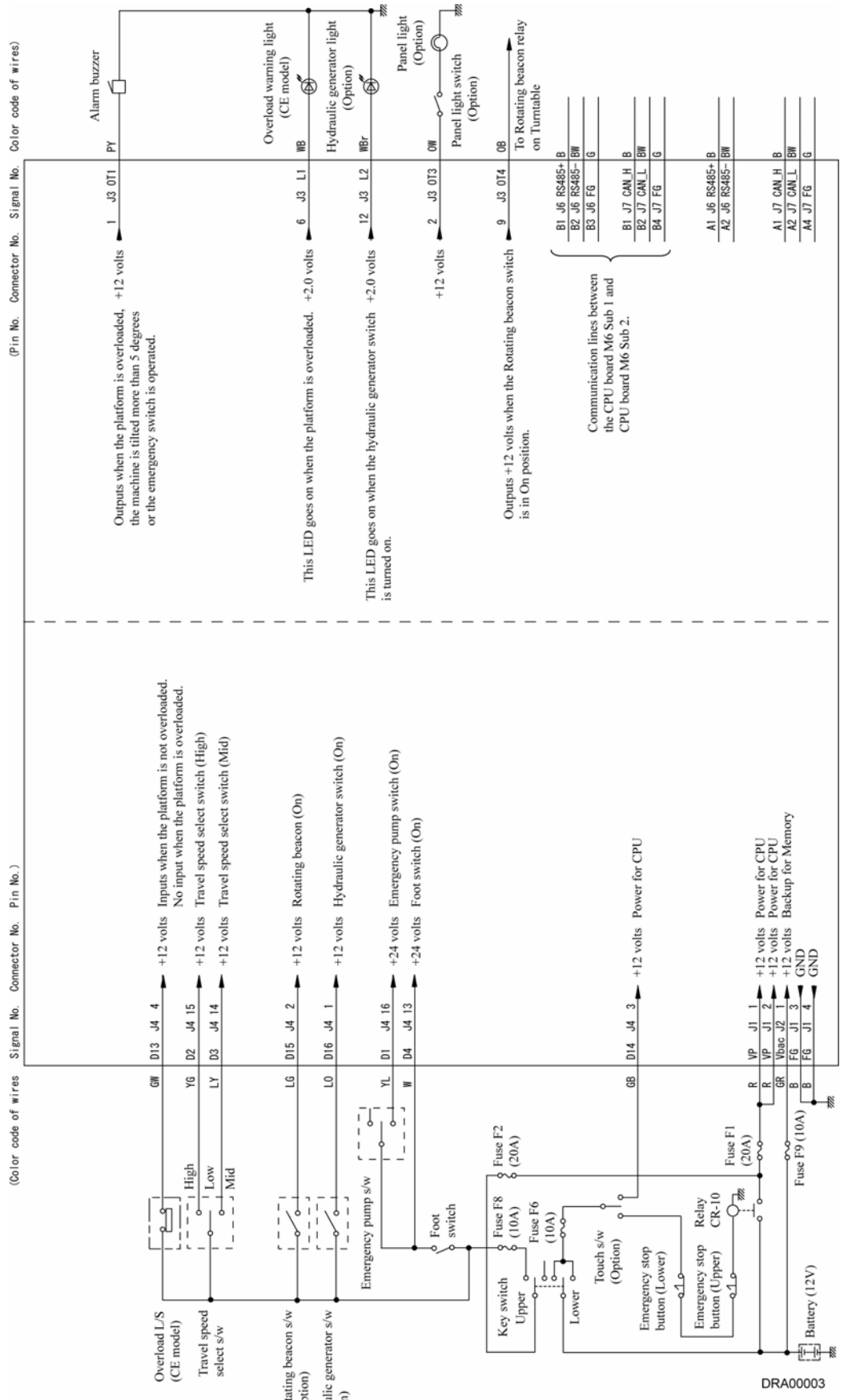
PTX	PRX	PSG	FG	/WE1	PSG	

Fig. 4-4 CPU board “M6”

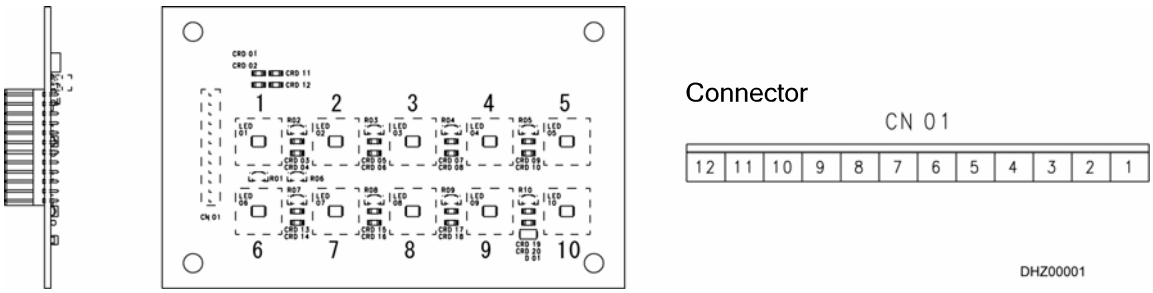
Input / Output characteristics (CPU board M6 : Sub1)



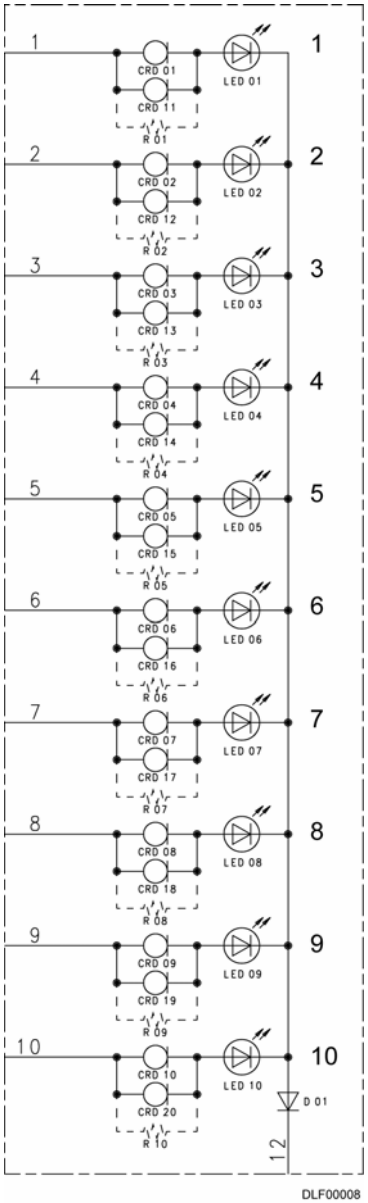
Input / Output characteristics (CPU board M6 : Sub2)



LED board (329-0091300)



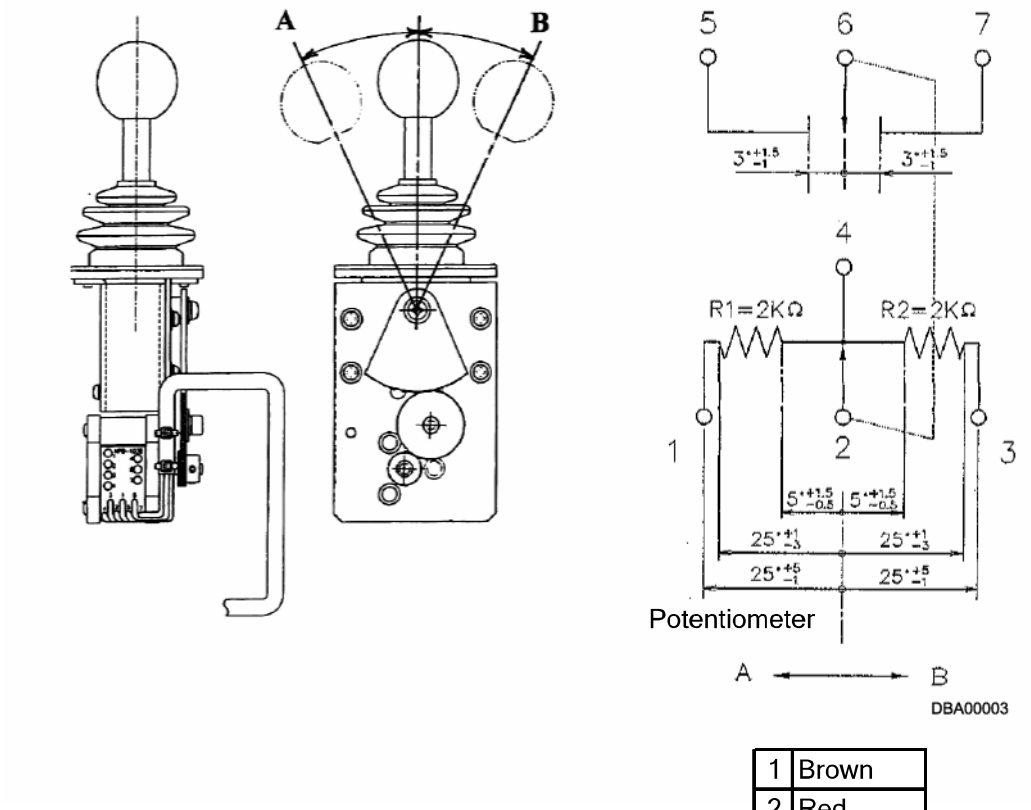
Electric diagram



1	
2	System failure light
3	Fuel level light
4	Engine failure light
5	Power indicator light
6	
7	Overload warning light (CE model)
8	
9	Tilt warning light
10	Hydraulic generator light (Option)

Fig. 4-5 LED board

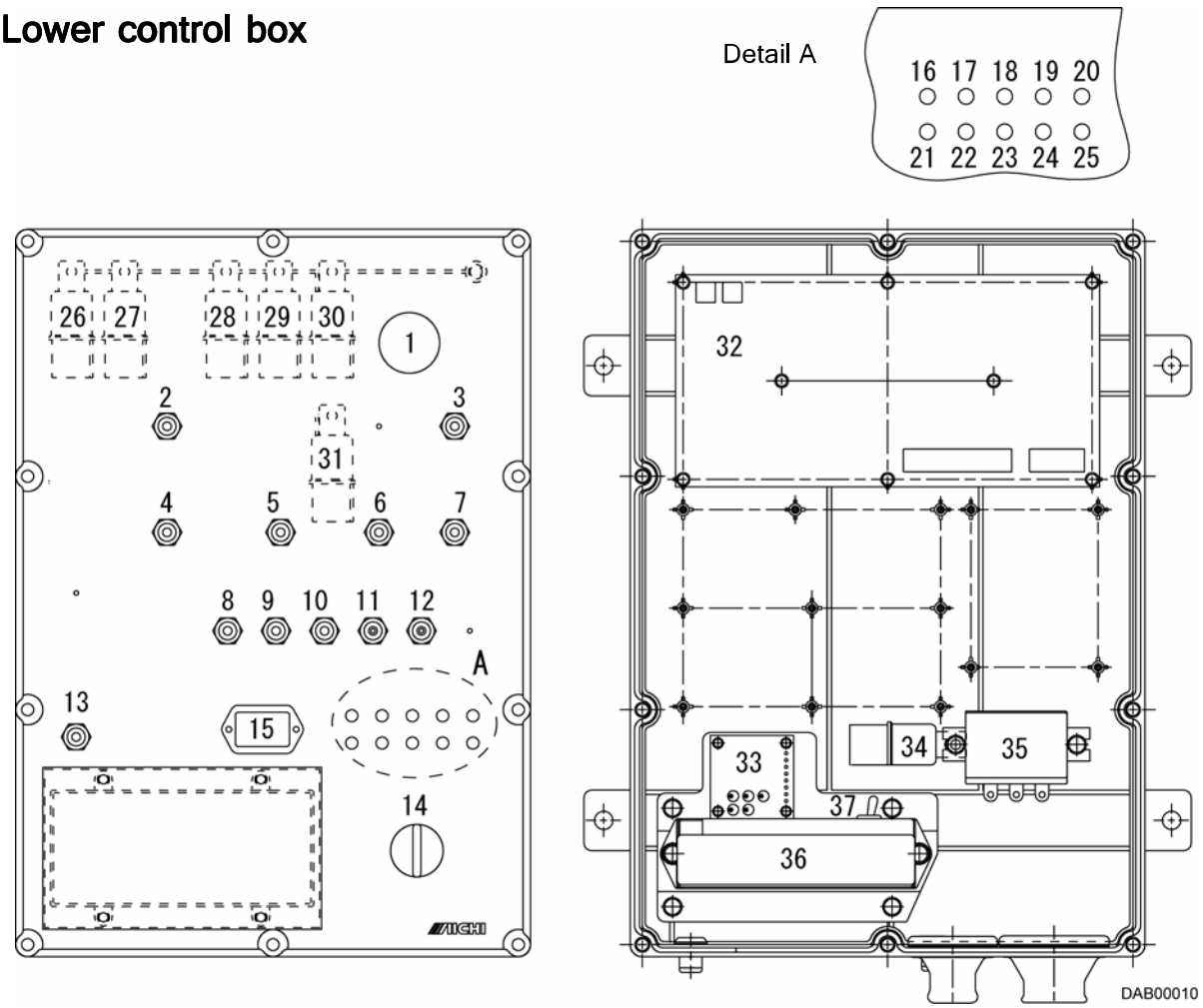
Joystick controller (324-0008100)



1	Brown
2	Red
3	White
4	Black
5	Yellow
6	Green
7	Blue

Fig. 4-6 Joystick controller

Lower control box



1	Emergency stop button	320-0007201	21	Glow light	329-0091300
2	Boom rotation s/w	173-01212	22	Engine oil pressure light	
3	Platform rotation s/w	173-01212	23	Water temp. light	
4	Boom elevation s/w	173-01212	24	Charge light	
5	Boom telescope s/w	173-01212	25	Air cleaner clog light	
6	Fly-jib s/w (SP14CJ/SP460CJ)	173-01212	26	Relay CR-1	320-05306
7	Platform leveling s/w	173-01212	27	Relay CR-2	320-05306
8	Engine start / Emergency pump s/w	173-02212	28	Relay CR-3	320-05306
9	Travel speed select s/w	173-00100	29	Relay CR-4	320-05306
10	Pre-start check s/w	173-02102	30	Relay CR-5	320-05306
11			31	Relay CR-11	320-05306
12	Rotating beacon s/w (Option)	173-00100	32	CPU board M5-B	G309290015
13	Enable s/w	173-01102	33	Accelerator control unit	329-0079701
14	Key s/w	378-0000701	34	Relay CR-12	320-05306
15	Hour meter	381-00112	35	Relay CR-10	320-05781
16	Fuel level light	329-0091300	36	Fuse box	320-0003900
17	Overload warning light (CE model)		37	Emergency s/w	173-02102
18					
19	Tilt warning light				
20	System failure light				

Fig. 4-7 Lower Control box

Electric circuit diagram

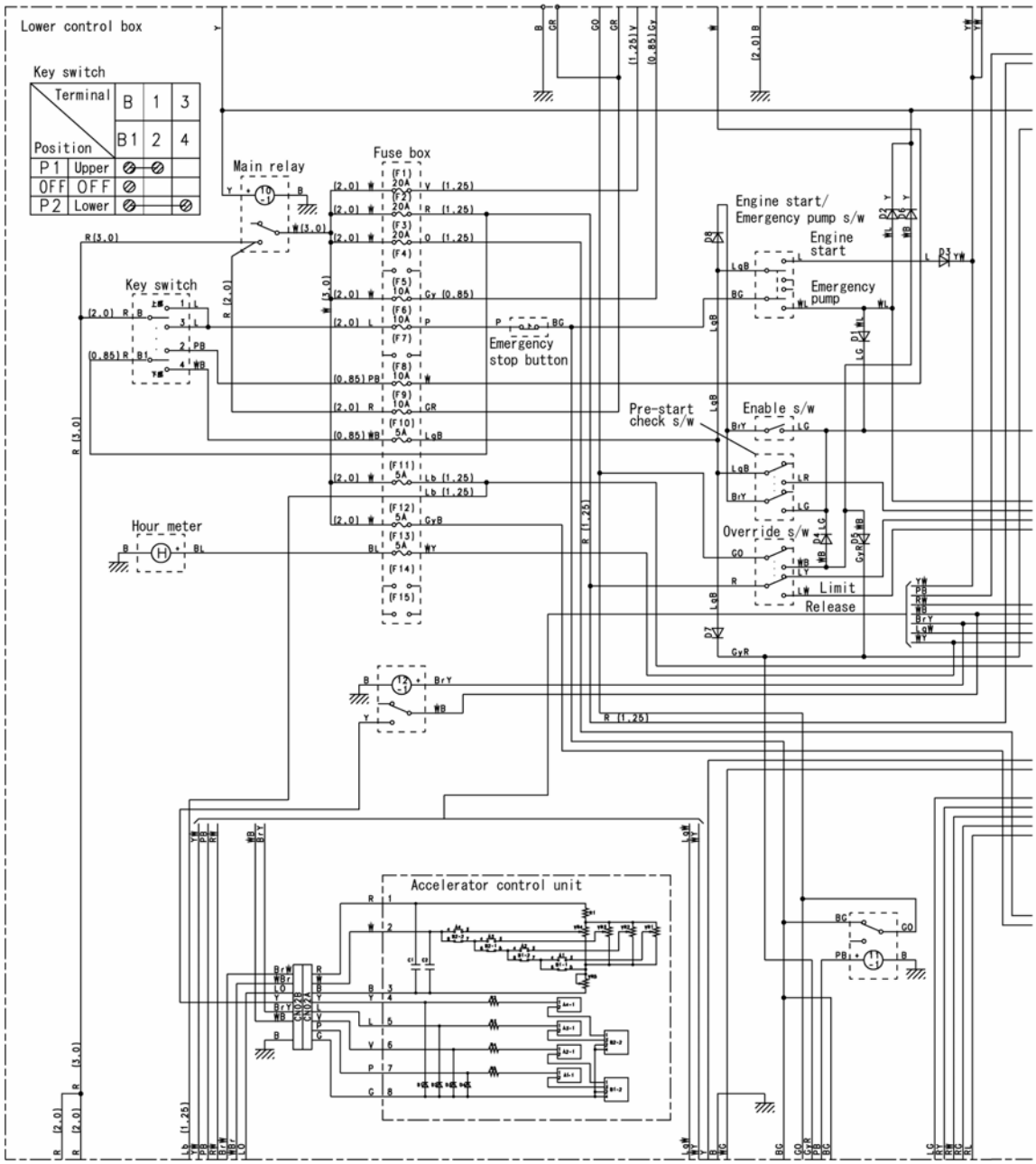


Fig. 4-8 Electric circuit diagram

Electric circuit diagram

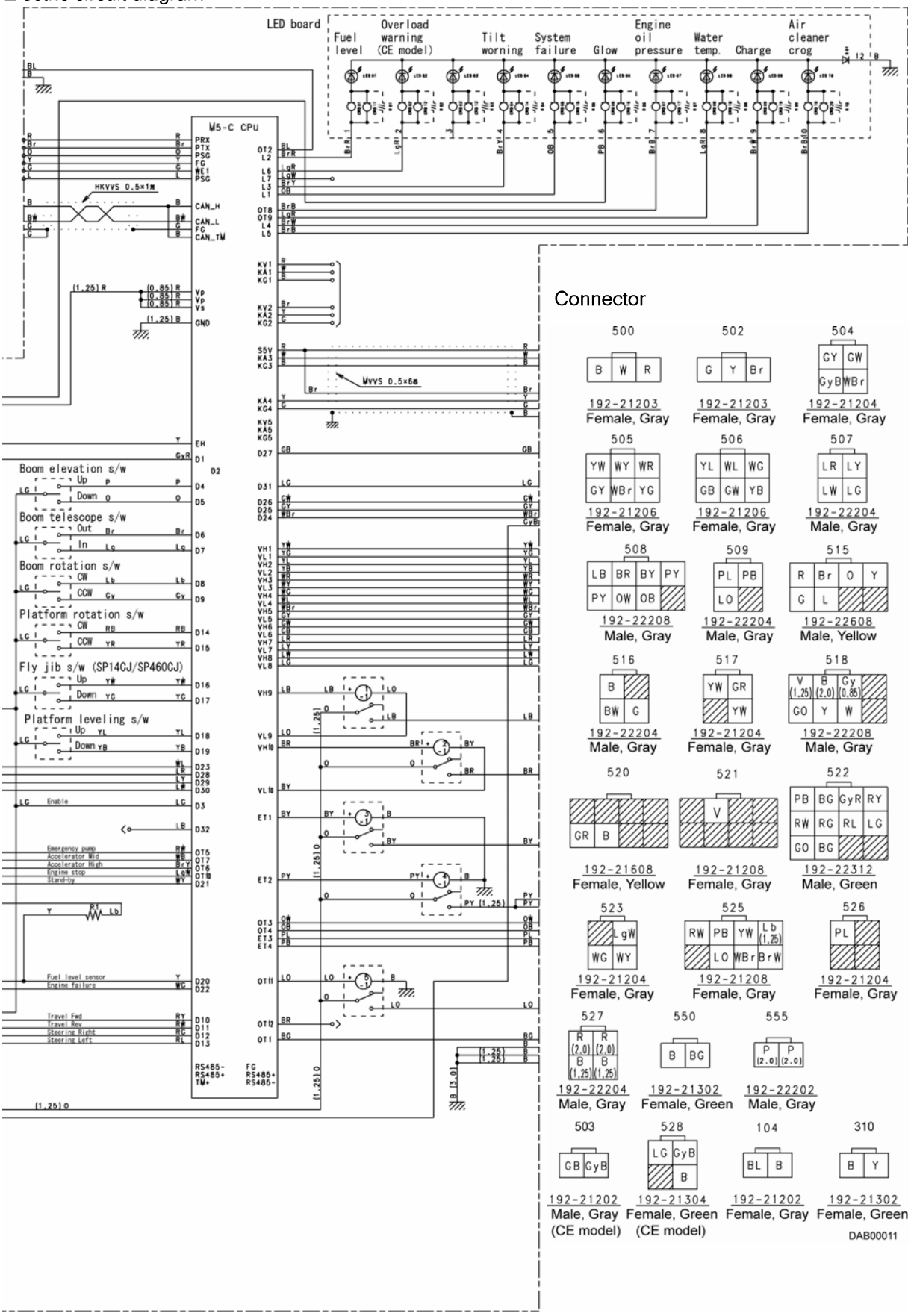
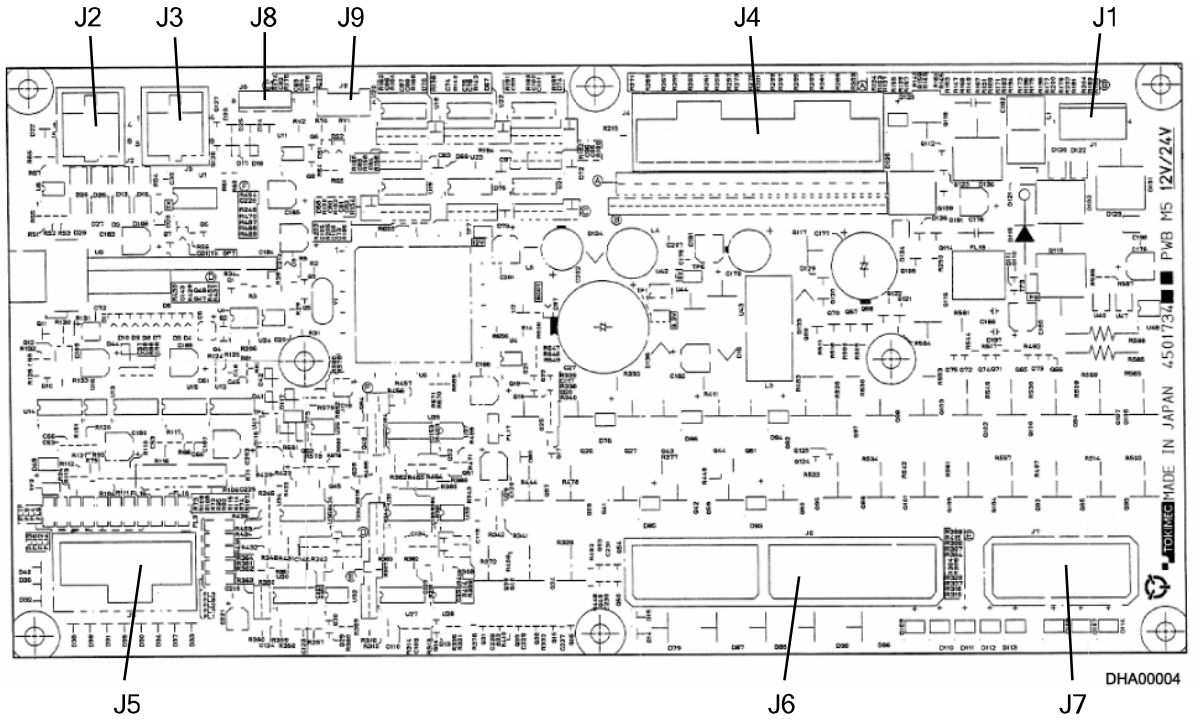


Fig. 4-9 Electric circuit diagram

CPU board “M5-B” (G309290015)



Connectors

J1

Vs	GND	Vp	Vp

J2

RS485+	RS485+	TM+	RS485+
RS485-	FG	FG	RS485-

J3

	PSG	PSG	PTX
WE1		FG	PRX

J8

Vcc	/Vpp_EN	FG	/RESET	/WDT_DIS

J4

EH	D1	D2	D3	D4	D5	D6	D7	D8	
D9	D10	D11	D12	D13	D14	D15	D16	D17	D18

	D19	D20	D21	D22	D23	D24	D25
D26	D27	D28	D29	D30	D31	D32	

J5

KV1	KA1	KG1	KV2	KA2	KG2	KV3	KA3	KG3	
KV4	KA4	KG4	KV5	KA5	KG5				S5V

J7

OT11	ET2	ET1		L3	L2	L1
OT12	ET4	ET3	L8	L7	L6	L5	L4

J6

OT9	OT7	OT5	OT3		VH10	VH9	VH8	VH7
OT10	OT8	OT6	OT4	OT2	OT1	VL10	VL9	VL8	VL7

VH6	VH5		VH3	VH2	VH1
VL6	VL5	VL4	VH4	VL3	VL2	VL1

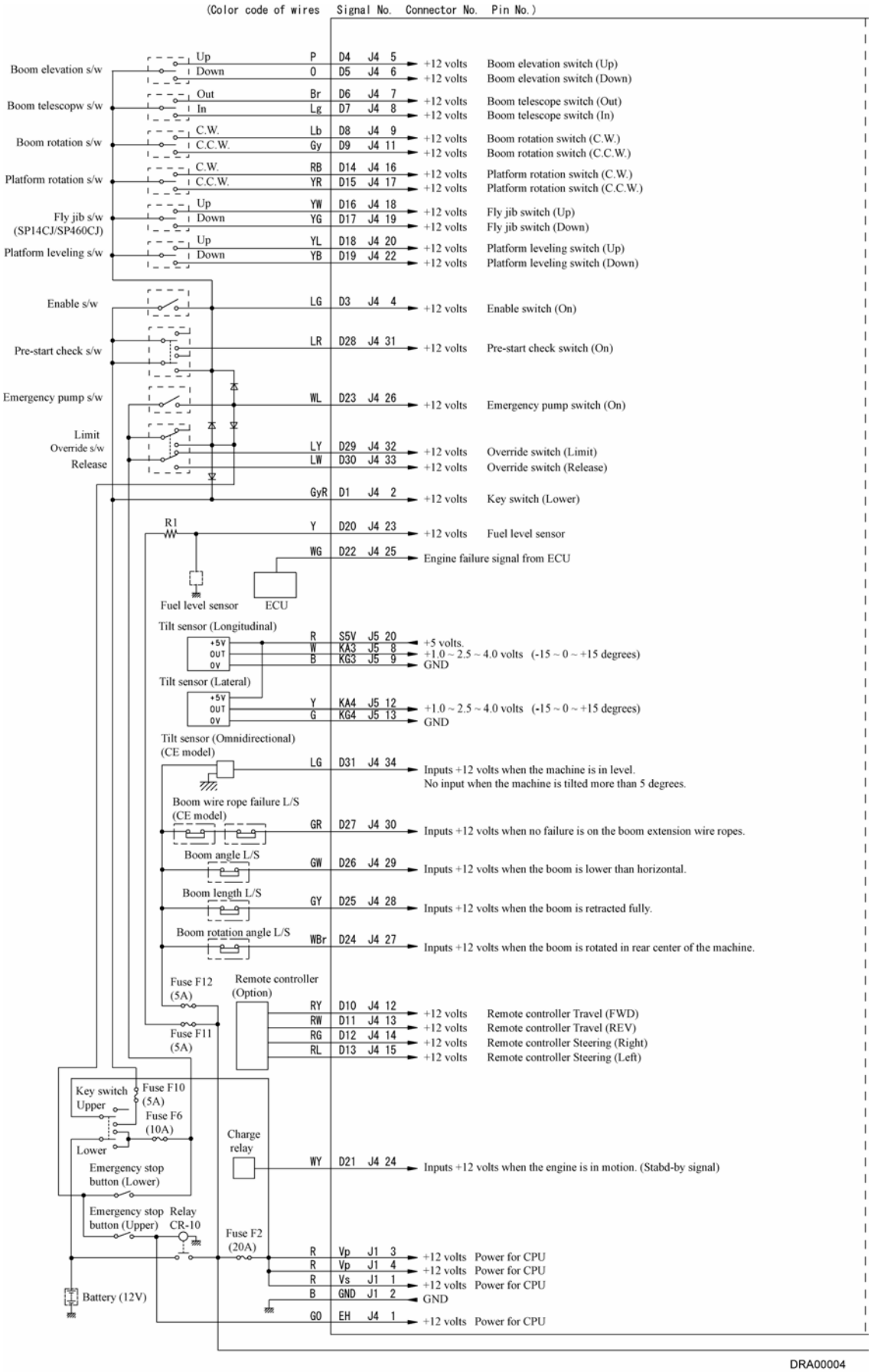
J9

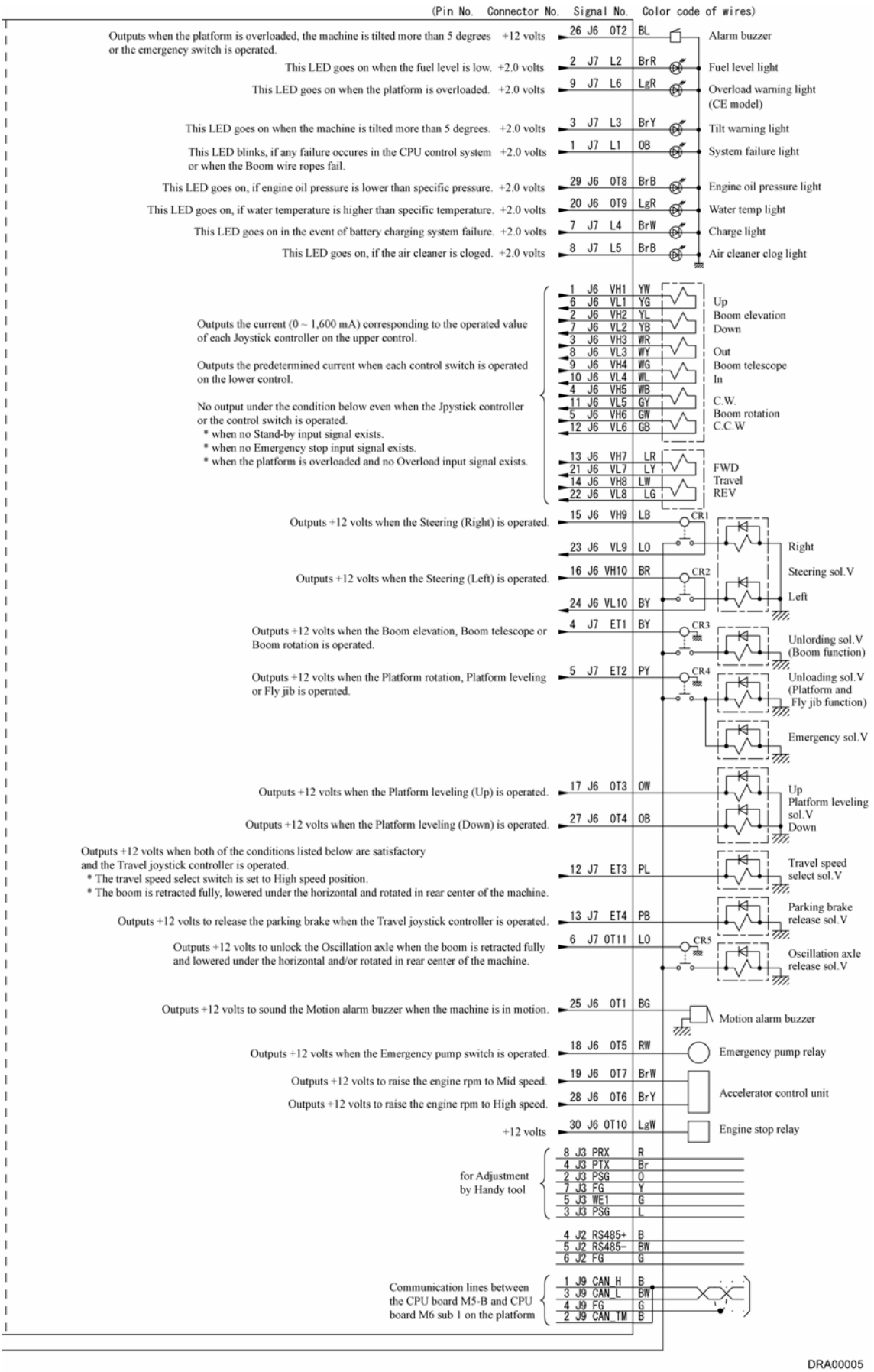
CAN_H	CAN_TM	CAN_L	FG

DHA00005

Fig. 4-10 CPU board “M5-B”

Input / Output characteristics (CPU board M5-B)

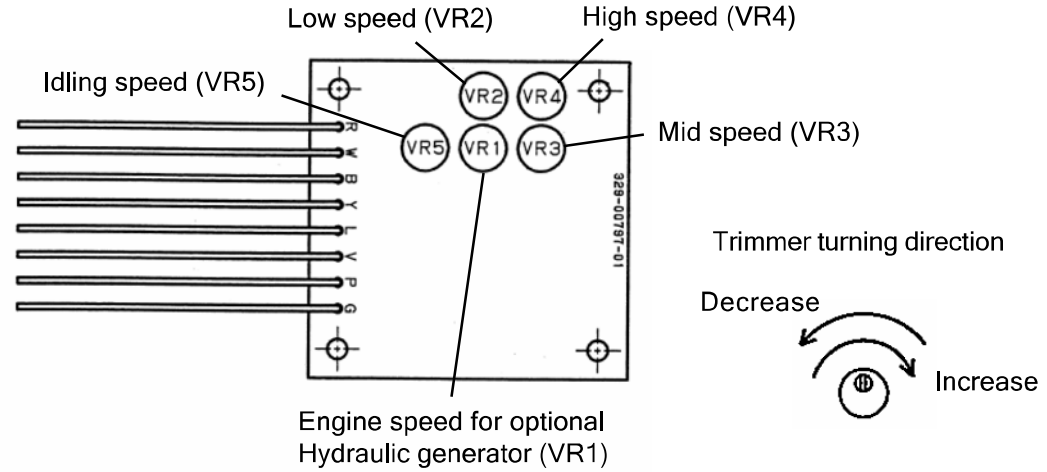



(Pin No. Connector No. Signal No. Color code of wires)
Outputs when the platform is overloaded, the machine is tilted more than 5 degrees or the emergency switch is operated. +12 volts
26 J6 OT2 BL
Alarm buzzer
This LED goes on when the fuel level is low. +2.0 volts
2 J7 L2 BrR
Fuel level light
This LED goes on when the platform is overloaded. +2.0 volts
9 J7 L6 LgR
Overload warning light (CE model)
This LED goes on when the machine is tilted more than 5 degrees. +2.0 volts
3 J7 L3 BrY
Tilt warning light
This LED blinks, if any failure occures in the CPU control system or when the Boom wire ropes fail. +2.0 volts
1 J7 L1 OB
System failure light
This LED goes on, if engine oil pressure is lower than specific pressure. +2.0 volts
29 J6 OT8 BrB
Engine oil pressure light
This LED goes on, if water temperature is higher than specific temperature. +2.0 volts
20 J6 OT9 LgR
Water temp light
This LED goes on in the event of battery charging system failure. +2.0 volts
7 J7 L4 BrW
Charge light
This LED goes on, if the air cleaner is cloged. +2.0 volts
8 J7 L5 BrB
Air cleaner clog light
Outputs the current (0 ~ 1,600 mA) corresponding to the operated value of each Joystick controller on the upper control.
Outputs the predetermined current when each control switch is operated on the lower control.
No output under the condition below even when the Jpystick controller or the control switch is operated.
* when no Stand-by input signal exists.
* when no Emergency stop input signal exists.
* when the platform is overloaded and no Overload input signal exists.
1 J6 VH1 YW
6 J6 VL1 YG
Up
2 J6 VH2 YL
7 J6 VL2 YB
Boom elevation
Down
3 J6 VH3 WR
8 J6 VL3 WY
Out
9 J6 VH4 WG
10 J6 VL4 WL
Boom telescope
In
4 J6 VH5 WB
11 J6 VL5 GY
C.W.
5 J6 VH6 GW
12 J6 VL6 GB
Boom rotation
C.C.W
13 J6 VH7 LR
21 J6 VL7 LY
FWD
14 J6 VH8 LW
22 J6 VL8 LG
Travel
REV
Outputs +12 volts when the Steering (Right) is operated.
15 J6 VH9 LB
CR1
23 J6 VL9 LO
Right
Outputs +12 volts when the Steering (Left) is operated.
16 J6 VH10 BR
CR2
Steering sol.V
24 J6 VL10 BY
Left
Outputs +12 volts when the Boom elevation, Boom telescope or Boom rotation is operated.
4 J7 ET1 BY
CR3
Unlording sol.V (Boom function)
Outputs +12 volts when the Platform rotation, Platform leveling or Fly jib is operated.
5 J7 ET2 PY
CR4
Unloading sol.V (Platform and Fly jib function)
Emergency sol.V
Outputs +12 volts when the Platform leveling (Up) is operated.
17 J6 OT3 OW
Up
Platform leveling sol.V
Outputs +12 volts when the Platform leveling (Down) is operated.
27 J6 OT4 OB
Down
Outputs +12 volts when both of the conditions listed below are satisfactory and the Travel joystick controller is operated.
* The travel speed select switch is set to High speed position.
* The boom is retracted fully, lowered under the horizontal and rotated in rear center of the machine.
12 J7 ET3 PL
Travel speed select sol.V
Outputs +12 volts to release the parking brake when the Travel joystick controller is operated.
13 J7 ET4 PB
Parking brake release sol.V
Outputs +12 volts to unlock the Oscillation axle when the boom is retracted fully and lowered under the horizontal and/or rotated in rear center of the machine.
6 J7 OT11 LO
CR5
Oscillation axle release sol.V
Outputs +12 volts to sound the Motion alarm buzzer when the machine is in motion.
25 J6 OT1 BG
Motion alarm buzzer
Outputs +12 volts when the Emergency pump switch is operated.
18 J6 OT5 RW
Emergency pump relay
Outputs +12 volts to raise the engine rpm to Mid speed.
19 J6 OT7 BrW
Outputs +12 volts to raise the engine rpm to High speed.
28 J6 OT6 BrY
Accelerator control unit
+12 volts
30 J6 OT10 LgW
Engine stop relay
for Adjustment by Handy tool
8 J3 PRX R
4 J3 PTX Br
2 J3 PSG O
7 J3 FG Y
5 J3 WE1 G
3 J3 PSG L
4 J2 RS485+ B
5 J2 RS485- BW
6 J2 FG G
Communication lines between the CPU board M5-B and CPU board M6 sub 1 on the platform
1 J9 CAN_H B
3 J9 CAN_L BW
4 J9 FG G
2 J9 CAN_TM B

DRA00005

Accelerator control unit (329-0079701)

Accelerator control unit is installed in the lower control box to send the signal to ECU to change the engine speed.



Electric diagram

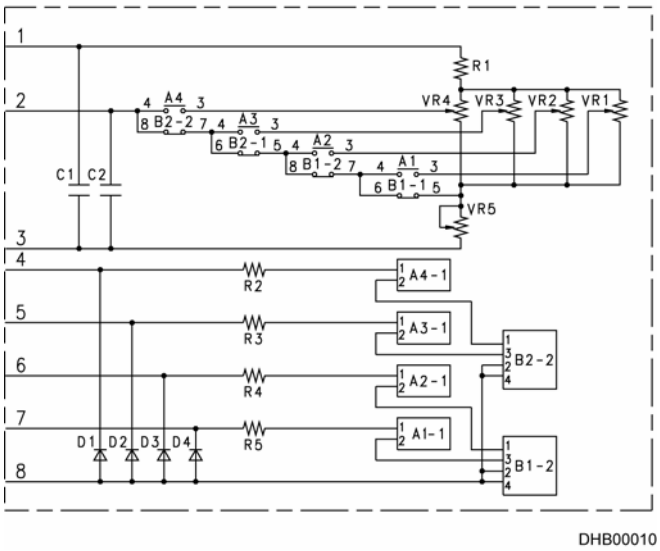


Fig. 4-11 Accelerator control unit

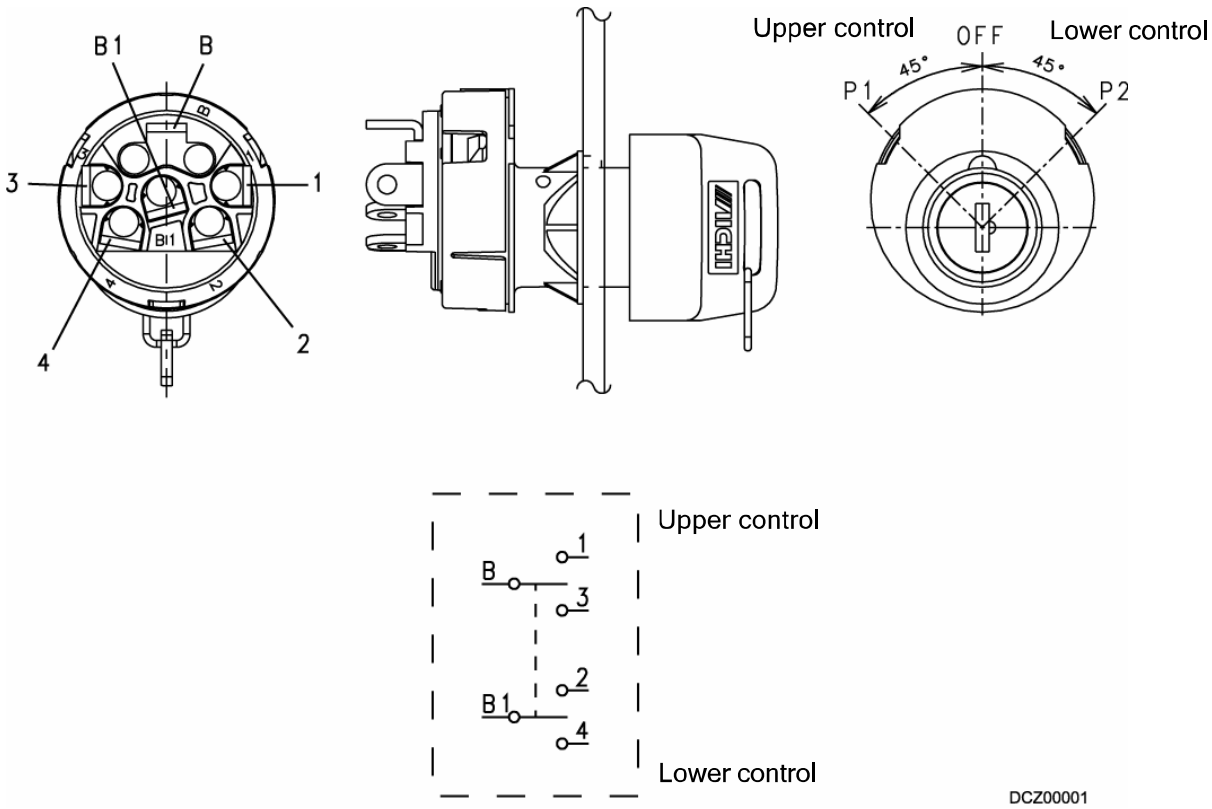
Engine speed Adjustment procedures

1. Warm up the engine.
2. Turn the trimmer VR5 to adjust the Idling speed to 1,050 rpm.
3. Turn the trimmer VR2 to adjust the Low speed to 1,800 rpm.
4. Turn the trimmer VR3 to adjust the Mid speed to 2,200 rpm.
5. Turn the trimmer VR4 to adjust the High speed to 2,700 rpm.
6. Turn the trimmer VR1 to adjust the engine speed for hydraulic generator to 1,400 rpm if it is equipped.

See page 6-2 for engine speed measurement procedures.

Key switch (378-0000701)

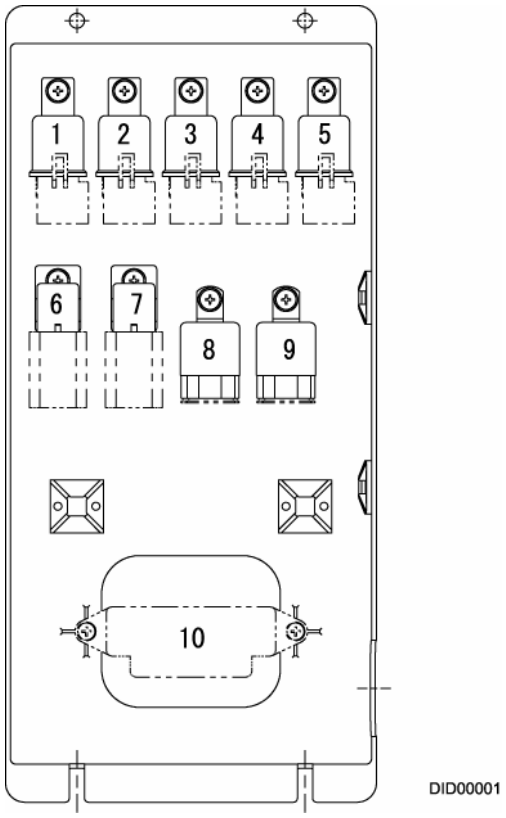
Key switch is installed on the lower control box to select the upper or lower control.



Position	Control position	Connection
OFF	OFF	--------
P1	Upper control	B - 1, B1 - 2
P2	Lower control	B - 3, B1 - 4

Fig. 4-12 Key switch

Engine relay box (5N5-0114100B)

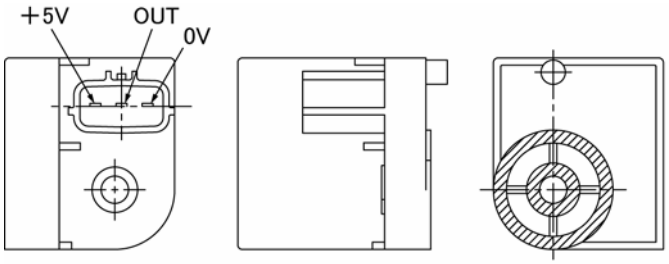


1	Key switch ON relay	320-05306
2	Engine start relay	320-05306
3	Engine stop relay	320-05306
4	Glow light relay	320-05306
5	Charge relay	320-05306
6	Starter relay	G031780002
7	Glow relay	G031780002
8	Rack actuator relay	G031780003
9	Main relay	G031780003
10	Fuse box	----------

Fig. 4-13 Engine relay box

Tilt sensor (Longitudinal, Lateral) (382-0001600)

Two analog tilt sensors are installed on the turntable to sense the tilt angle of the machine in longitudinal direction and lateral direction.
Tilt alarm buzzer sounds when the actual machine tilt angle (calculated from longitudinal and lateral tilt angle) is more than 5 degrees.



Output characteristics

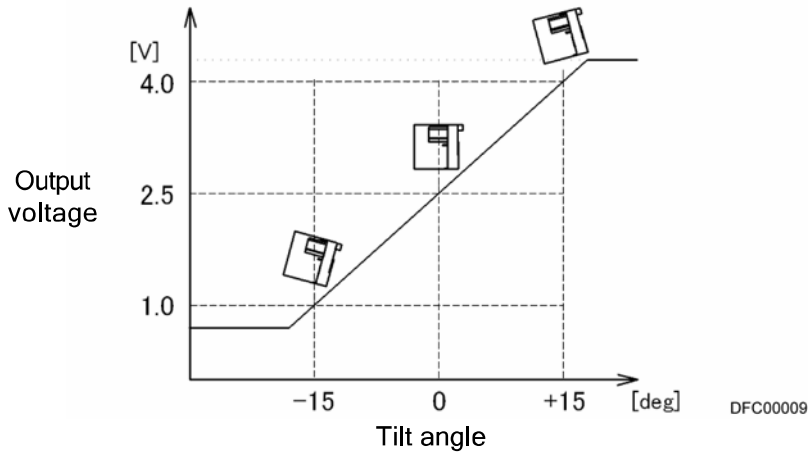


Fig. 4-14 Tilt sensor (Longitudinal, Rateral)

Specifications

Rated voltage : DC 5 +/- 0.5 volts
Output voltage : 0.1 V/1 degree [2.5 volts when the machine is in level]

Tilt sensor (Omni-directional) (382-0000019) CE model

The tilt sensor (Omni-directional) is installed on the turntable to detect the machine tilt angle of 5 degrees.

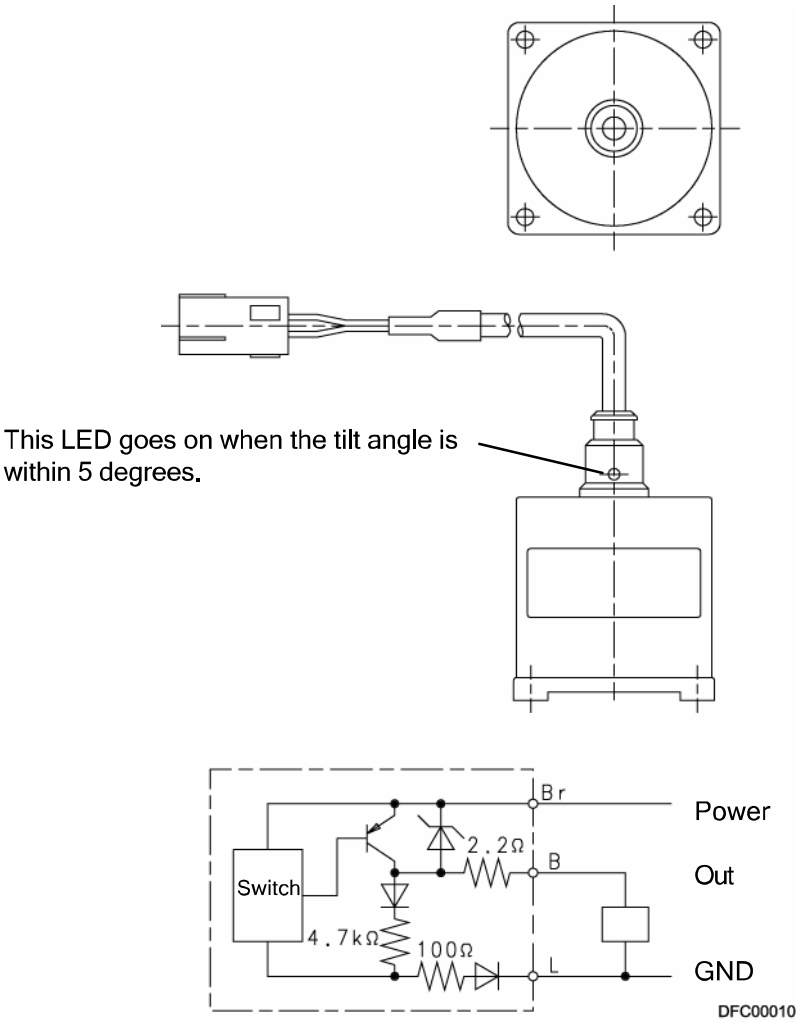


Fig. 4-15 Tilt sensor (Omni-directional)

Limit switches (320-0002600, 320-0005800)

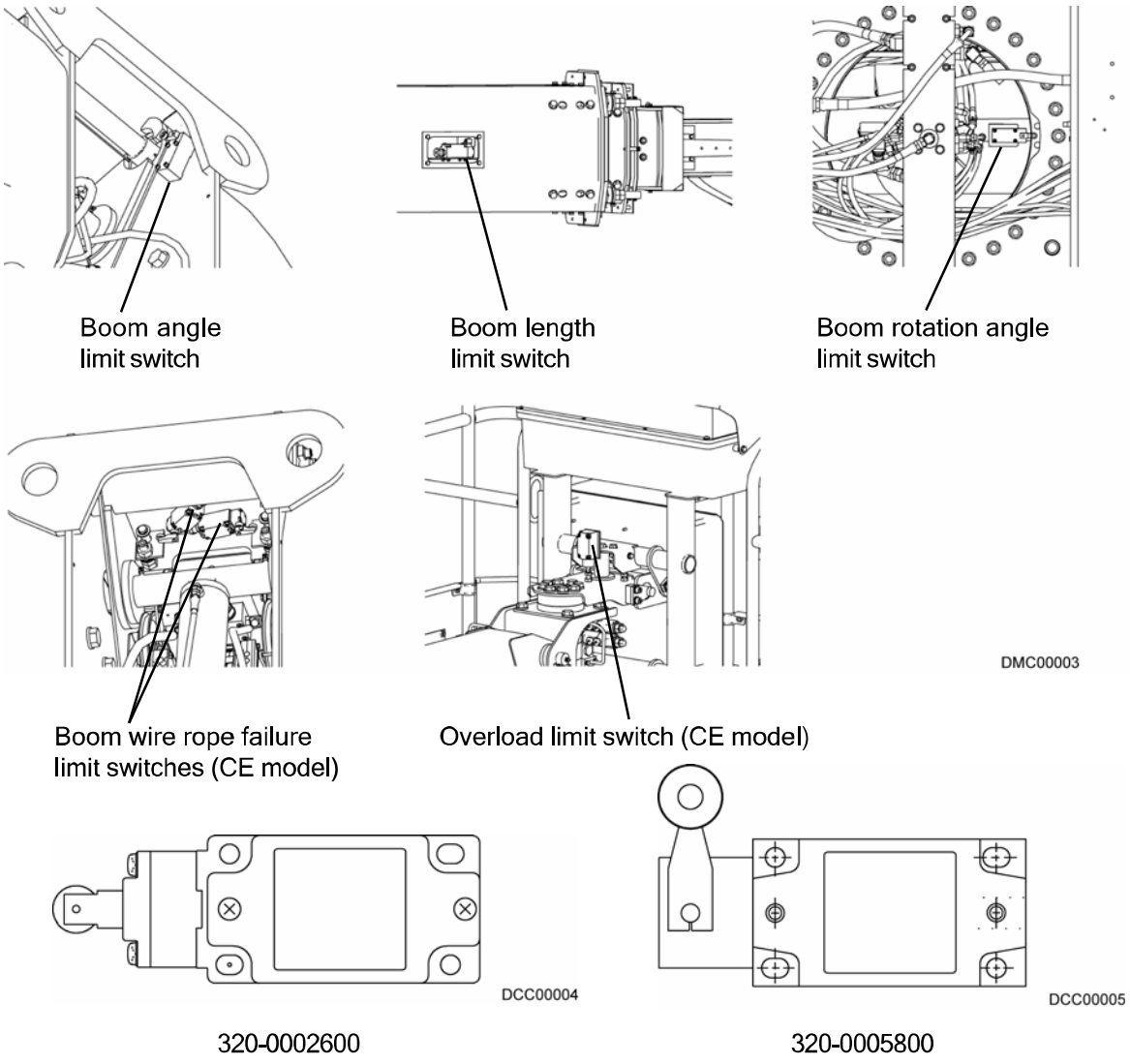


Fig. 4-16 Limit switches

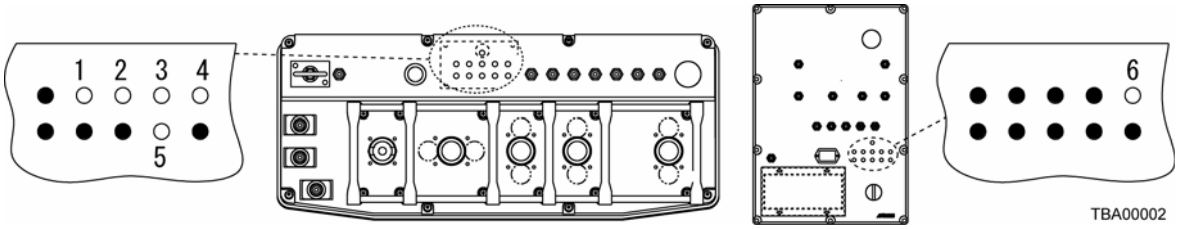
Boom angle limit switch	Opens when the boom angle is higher than 5 +/- 4 degrees.	Travel speed is limited at Low speed, when one of these limit switches is opened.	320-00005800
Boom length limit switch	Opens when the boom is extended more than 600 mm.	Oscillation axle is locked, * When the Boom length limit switch is opened. * When the Boom angle limit switch and Boom rotation angle limit switch are opened.	320-00005800
Boom rotation angle limit switch	Opens when the boom rotation angle exceeds 7.5 degrees from the rear center of the machine.		320-00005800
Boom wire rope failure limit switches (CE model)	Open when the boom extension wire is cut or loose.	Boom telescope Out function is disabled.	320-00005800
Overload limit switch (CE model)	Opens when the platform is overloaded.	All of the functions are disabled.	320-00002600

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Chapter 5
Trouble shooting

Trouble shooting by LED indication on Upper / Lower control box

LEDs on the Upper and Lower control panel goes on or blink as shown in the table below to indicate the system error.



Upper control box Lower control box

Fig. 5-1 Locations of LEDs

No.	Locations	Descriptions
1	Upper control panel	System failure light
2	Upper control panel	Fuel level light
3	Upper control panel	Engine failure light
4	Upper control panel	Power indicator light
5	Upper control panel	Tilt warning light
6	Lower control panel	System failure light

LED status			
Off	LED stays off	B9	LED blinks 9 times
On	LED goes on	B1	LED blinks 10 times
BC	LED blinks continuously	B1	LED blinks 11 times
B2	LED blinks twice	B1	LED blinks 12 times
B3	LED blinks 3 times	B1	LED blinks 13 times
B4	LED blinks 4 times	B1	LED blinks 14 times
B5	LED blinks 5 times	B1	LED blinks 15 times
B6	LED blinks 6 times	B1	LED blinks 16 times
B7	LED blinks 7 times	B1	LED blinks 17 times
B8	LED blinks 8 times		

Error descriptions	LED status 1	2	3	4	5	6	Causes	Countermeasures
Foot switch time out	Off	Off	Off	**BC**	Off	Off	No function is operated for more than 20 seconds in spite of the foot switch is pressed.	Release the foot switch.
Communication error (M5B - M6 Sub1)	**BC**	Off	Off	Off	Off	**B2**	CPU board M5-B and M6 (Sub1) fail to communicate each other. 1. Faulty communication line between CPU board M5-B and M6 (Sub1). 2. Faulty CPU board M6 (Sub1). 3. Faulty CPU board M5-B.	1. Rectify the communication line. 2. Replace the CPU board M6 (Sub2). 3. Replace the CPU board M5-B.
Communication error (M5B - M6 Sub2)	**On**	Off	Off	**B4**	Off	**B2**	CPU board M5-B and M6 (Sub2) fail to communicate each other. 1. Faulty communication line between CPU board M6 (Sub1) and M6 (Sub2). 2. Faulty CPU board M6 (Sub2).	1. Rectify the communication line. 2. Replace the CPU board M6 (Sub2).
Communication error (M5B - M6 Sub3)	**On**	Off	Off	**B5**	Off	**B2**	CPU board M5-B and M6 (Sub2) fail to communicate each other. 1. Faulty communication line between CPU board M6 (Sub2) and M6 (Sub3). 2. Faulty CPU board M6 (Sub3).	1. Rectify the communication line. 2. Replace the CPU board M6 (Sub3).

Error descriptions	LED status						Causes	Countermeasures
	1	2	3	4	5	6		
Communication error (M5B - M6 Sub4)	**On**	Off	Off	**B6**	Off	**B2**	CPU board M5-B and M6 (Sub4) fail to communicate each other. 1. Faulty communication line between CPU board M5-B and M6 (Sub4). 2. Faulty CPU board M6 (Sub4). 3. Faulty CPU board M5-B.	1. Rectify the communication line. 2. Replace the CPU board M6 (Sub4). 3. Replace the CPU board M5-B.
EEPROM error	**On**	**B3**	Off	Off	Off	**B15**	1. Incorrect or damaged parameters are memorized in the CPU board M5-B. 2. Faulty CPU board M5-B.	1. Write the correct parameters into the CPU board M5-B, using the Handy tool. 2. Replace the CPU board M5-B.
PWM error	**On**	**B4**	Off	Off	Off	**B15**	The CPU board M5-B has output to the solenoids for Boom elevation, Boom telescope, Boom rotation and/or Travel in spite of no command. 1. Short circuit in the output lines to the solenoid(s). 2. Faulty solenoid(s). 3. Faulty CPU board M5-B.	1. Rectify the output lines to the solenoid(s). 2. Replace the faulty solenoid(s). 3. Replace the CPU board M5-B.
ET error	**On**	**B5**	Off	Off	Off	**B15**	The CPU board M5-B has output to the Relays for unloading solenoid valves, Travel speed select solenoid and/or Parking brake release solenoid in spite of no command. 1. Short circuit in the output lines to the Relay(s) and/or solenoid(s). 2. Faulty relay(s) 3. Faulty solenoid(s). 4. Faulty CPU board M5-B.	1. Rectify the output lines to the Relay(s) and/or solenoid(s). 2. Replace the faulty relay(s). 3. Replace the faulty solenoid(s). 4. Replace the CPU board M5-B.
CPU error	**On**	Off	Off	Off	Off	**B15**	Faulty CPU board M5-B	Replace the CPU board M5-B.
Water temp. error	**On**	Off	**B2**	Off	Off	**B10**	1. Water (Coolant) temperature is higher 110 degrees C. Water temp sensor signal is more than 4.8 volts or less than 0.2 volts. 2. Faulty electric lines between Water temp sensor and ECU. 3. Faulty water temp sensor.	1. Stop the engine and wait to cool down the engine. 2. Rectify the electric lines. 3. Replace the Water temp sensor.
Engine oil pressure error	**On**	Off	**B3**	Off	Off	**B10**	Oil pressure switch in not turned on while engine is stopped. Oil pressure switch is not turned on while engine is running. 1. Faulty electric lines to Oil pressure switch. 2. Faulty Oil pressure switch.	Turn off the key switch once, and then turn on it. If the error still occurs, check followings. 1. Rectify the electric lines. 2. Replace the Oil pressure switch.
Charge error	**On**	Off	**B4**	Off	Off	**B10**	Battery charging switch in not turned on while engine is stopped. Battery charging switch is not turned on while engine is running. 1. Faulty electric lines between Alternator and ECU. 2. Faulty Alternator.	Turn off the key switch once, and then turn on it. If the error still occurs, check followings. 1. Rectify the electric lines. 2. Replace the Alternator.

Error descriptions	LED status						Causes	Countermeasures
	1	2	3	4	5	6		
Air cleaner error	**On**	Off	**B5**	Off	Off	**B10**	1. Air cleaner is clogged. 2. Faulty electric lines between Air cleaner sensor and ECU. 3. Faulty Air cleaner sensor.	1. Clean or replace the air cleaner element. 2. Rectify the electric lines. 3. Replace the Air cleaner sensor.
Accelerator sensor error	**On**	Off	**B6**	Off	Off	**B10**	Input from Accelerator control unit is more than 4.6 volts or less than 0.2 volts. 1. Incorrect adjustment of accelerator control unit. 2. Faulty electric lines between Accelerator control unit and ECU. 3. Faulty Accelerator control unit.	1. Adjust the accelerator control unit. 2. Rectify the electric lines. 3. Replace the accelerator control unit.
Engine speed sensor error	**On**	Off	**B7**	Off	Off	**B10**	Faulty electric lines between Engine speed sensor and ECU.	Turn off the key switch once, and then turn on it again. If the error still occurs, check and rectify electric lines if necessary. Ask Yanmar distributor to detail check.
Rack position sensor error	**On**	Off	**B8**	Off	Off	**B10**	Faulty electric lines between Rack position sensor and ECU.	Turn off the key switch once, and then turn on it again. If the error still occurs, check and rectify electric lines if necessary. Ask Yanmar distributor to detail check.
Rack actuator error	**On**	Off	**B9**	Off	Off	**B10**	Faulty electric lines between Rack actuator and ECU.	Turn off the key switch once, and then turn on it again. If the error still occurs, check and rectify electric lines if necessary. Ask Yanmar distributor to detail check.
CAN error	**On**	Off	**B10**	Off	Off	**B10**	Faulty CAN communication lines.	Check and rectify electric lines if necessary. Ask Yanmar distributor to detail check.
EGR valve error	**On**	Off	**B11**	Off	Off	**B10**	Faulty electric lines between EGR valve and ECU.	Turn off the key switch once, and then turn on it again. If the error still occurs, check and rectify electric lines if necessary. Ask Yanmar distributor to detail check.
CSD solenoid valve error	**On**	Off	**B12**	Off	Off	**B10**	Faulty electric lines between CSD solenoid valve and ECU.	Turn off the key switch once, and then turn on it again. If the error still occurs, check and rectify electric lines if necessary. Ask Yanmar distributor to detail check.

Error descriptions	LED status						Causes	Countermeasures
	1	2	3	4	5	6		
Relay error	**On**	Off	**B13**	Off	Off	**B10**	1. Faulty electric lines between Main relay and ECU, 2. Faulty electric lines between Rack actuator relay and ECU 3. Faulty electric lines between Glow relay (Starting aid relay) and ECU	Turn off the key switch once, and then turn on it again. If the error still occurs, check and rectify electric lines if necessary. Ask Yanmar distributor to detail check.
Power supply voltage error	**On**	Off	**B15**	Off	Off	**B10**	Power supply to ECU is higher than 16 volts or lower than 10 volts. Power supply to sensors are higher than 5.5 volts or lower than 4.5 volts. 1. Faulty electric lines between Battery and ECU. 2. Faulty Battery. 3. Faulty ECU.	1. Rectify the electric lines. 2. Charge the battery. Replace the battery if necessary. 3. Ask Yanmar distributor to detail check.
ECU error	**On**	Off	**B17**	Off	Off	**B10**	Faulty ECU.	Turn off the key switch once, and then turn on it. If the error still occurs, ask Yanmar distributor to detail check.
Pre-start check error	**On**	Off	Off	Off	**B2**	**B3**	Input from Tilt sensors (Longitudinal) and/or (Lateral) are out of specific range during pre-start check. 1. Pre-start check switch is operated when the machine is tilted . 2. Incorrect calibration of the Tilt sensors. 3. Faulty Tilt sensors.	1. Release the pre-start check switch. 2. Perform the Tilt sensor calibration using handy tool. 3. Replace the Tilt sensors.
Tilt sensor error (Longitudinal)	**On**	Off	Off	Off	**B3**	**B4**	Input from Tilt sensor (Longitudinal) is out of specific range. 1. Incorrect calibration of the Tilt sensor. 2. Faulty electric lines between Tilt sensor (Longitudinal) and CPU board M5-B. 3. Faulty Tilt sensor (Longitudinal).	1. Perform the Tilt sensor calibration using handy tool. 2. Rectify the electric lines between Tilt sensor (Longitudinal) and CPU board M5-B. 3. Replace the Tilt sensor (Longitudinal)
Tilt sensor error (Lateral)	**On**	Off	Off	Off	**B4**	**B4**	Input from Tilt sensor (Lateral) is out of specific range. 1. Incorrect calibration of the Tilt sensor. 2. Faulty electric lines between Tilt sensor (Lateral) and CPU board M5-B. 3. Faulty Tilt sensor (Lateral).	1. Perform the Tilt sensor calibration using handy tool. 2. Rectify the electric lines between Tilt sensor (Lateral) and CPU board M5-B. 3. Replace the Tilt sensor (Lateral)

Error descriptions	LED status						Causes	Countermeasures
	1	2	3	4	5	6		
Tilt sensor duplication error	**On**	Off	Off	Off	**B5**	**B4**	The difference of detected angle between Tilt sensors (Longitudinal/Lateral) and Tilt sensor (Omni directional) exceed specific angle. 1. Incorrect calibration of the Tilt sensors. 2. Faulty electric lines between Tilt sensors (Longitudinal, Lateral and/or Omni directional) and CPU board M5-B. 3. Faulty Tilt sensors (Longitudinal, Lateral and/or Omni directional).	1. Perform the Tilt sensor calibration using handy tool. 2. Rectify the electric lines between Tilt sensor (Longitudinal, Lateral and/or Omni directional) and CPU board M5-B. 3. Replace the Tilt sensor (Longitudinal, Lateral and/or Omni directional)
Emergency switch error	**On**	Off	Off	Off	**B6**	**B5**	Both Limit and Release signal input at the same time. 1. Faulty electric lines between Emergency switch and CPU board M5-B. 2. Faulty Emergency switch.	1. Rectify the electric lines between Emergency switch and CPU board M5-B. 2. Replace the Emergency switch.
Boom wire rope failure error	**On**	Off	Off	Off	**B7**	**B6**	No input from the Boom wire rope failure L/S. 1. Faulty electric lines between Boom wire rope L/S and CPU board M5-B. 2. Faulty Boom wire rope failure L/S.	1. Rectify the electrical lines between Boom wire rope failure L/S and CPU board M5-B. 2. Replace the Boom wire rope failure L/S.

Emergency operations

When the Boom, Fly-jib, Platform, Travel and/or Steering functions are disabled because of any problem, operate the machine following the instruction desclibed in this clause to escape from working site.

⚠DANGER

Lower the platform and unload it before towing the machine.

Towing the machine with the platform raised and / or loaded make the machine unstable and may tip over result in death or serious injury.

⚠WARNING

Do not perform Emergency operations desclibed in this clause unless in case of emergency.

These operations disable the safety devices described in each item and allow unsafe movement of the machine,

may cause the death or serious injury.

Emergency pump

1. Lower the platform using emergency pump in case of engine or hydraulic system failure

If the machine does not work due to the engine or main pump failure, use the emergency pump to lower the platform. It is not necessary to turning on the dead-man switch when operating the boom from the lower control with using the emergency pump.

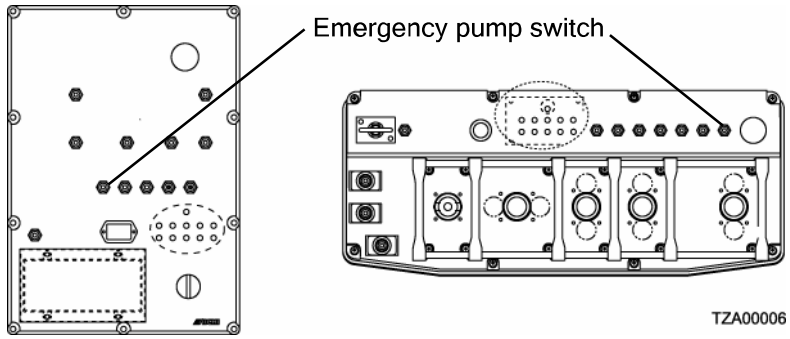


Fig. 5-2 Emergency pump switch

NOTICE

The emergency pump can only be used for only 30 seconds or less at a time, with a rest period over 30 seconds between uses.

Do not use the emergency pump for normal work because it puts a great load on the pump.

Override switch

1. Lower the platform using override switch when the System failure occurs.
When the system failure occurs, System failure light on upper and lower control box blinks and some functions may be disabled.
If the boom function is disabled due to system failure, use the override switch to lower the platform as follows.

1) Take the cover on the lower control panel off.
2) Hold the override switch and make sure that the warning buzzer sounds.
3) Operate the boom telescope switch with holding override switch to retract the boom.
4) Operate the boom elevation switch with holding override switch to lower the boom.

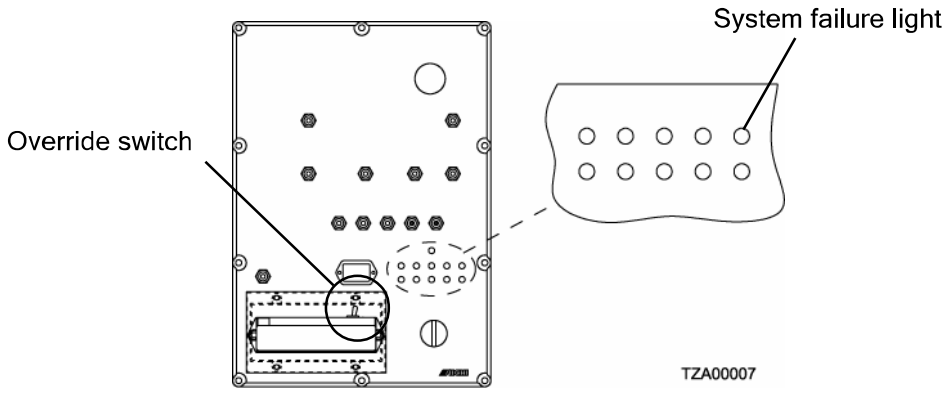


Fig. 5-3 Override switch

WARNING

Platform overload sensing system is disabled when the override switch is operated.
Do not put more weight on the platform or the machine may tip over result in death or serious injury.
Retract the boom first and then lower the boom to keep the working radius in minimum.

Manual control lever

1. Lower the platform using manual control lever in case of electric system failure
If the boom function is disabled due to electric system failure, use the manual control lever to lower the platform as follows.

1) Start the engine.
2) Open the turntable cover (Left, Rear).
3) Take the lever from the lever holder, and then put it into the hole under the solenoid valve.
4) Push the red button on unloading valve.
5) Operate the lever to control the boom function.

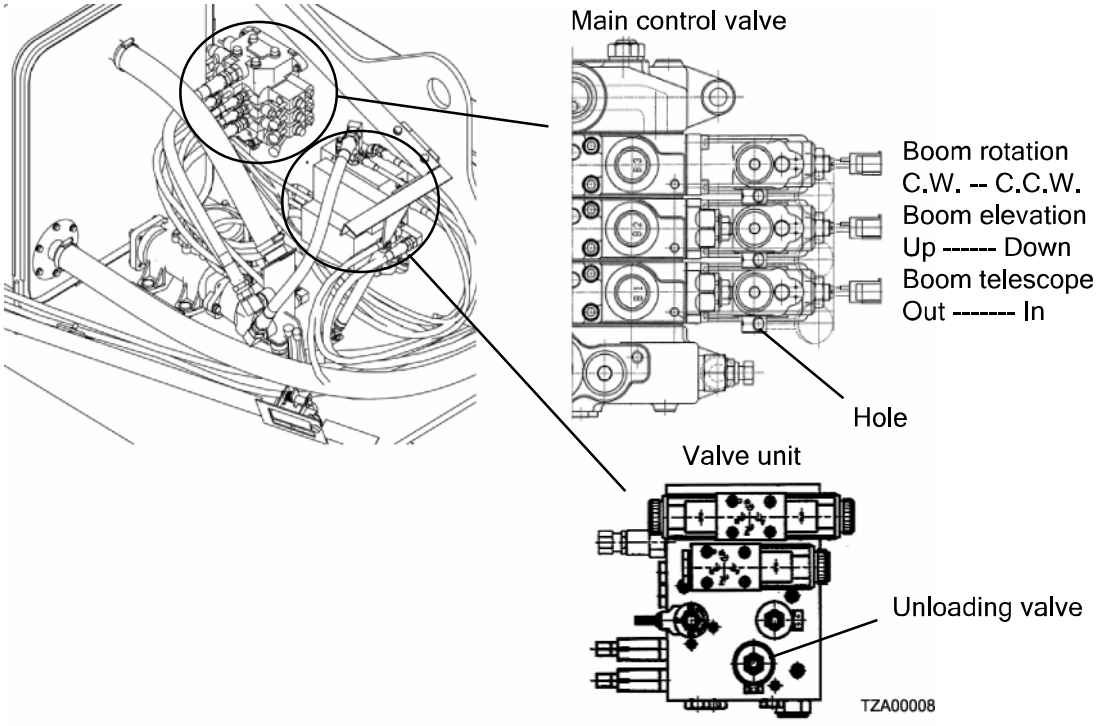


Fig. 5-4 Manual control lever

⚠WARNING

Platform overload sensing system does not disable the manual control lever operation.
Do not put more weight on the platform or the machine may tip over result in death or serious injury.
Retract the boom first and then lower the boom to keep the working radius in minimum.

Parking brake release hand pump

Free the parking brake and steering linkage, then tow the machine to escape the machine from working site, when the travel function is disabled.

⚠DANGER

Retract the boom fully, Lower it under horizontal and unload the platform before towing the machine.

Towing the machine with the boom raised, extended and/or the platform loaded make the machine unstable and may tip over result in death or serious injury.

Do not free the parking brake when the machine is on the slope or the machine may run away result in death or serious injury.

Free the steering linkage
1) Remove the steering lock pin

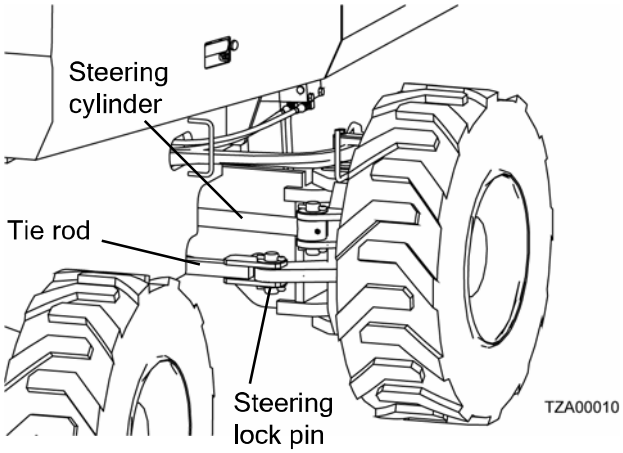


Fig. 5-5 Steering lock pin

Free the parking brake by Parking brake release hand pump
1) Set up the wheel chocks in front and rear of all tires.
2) Open the right rear cover.
3) Loosen the lock nut behind the HST pump, and then screw in the bolt to push the HST pump release pin on the relief valve R1 and R2.

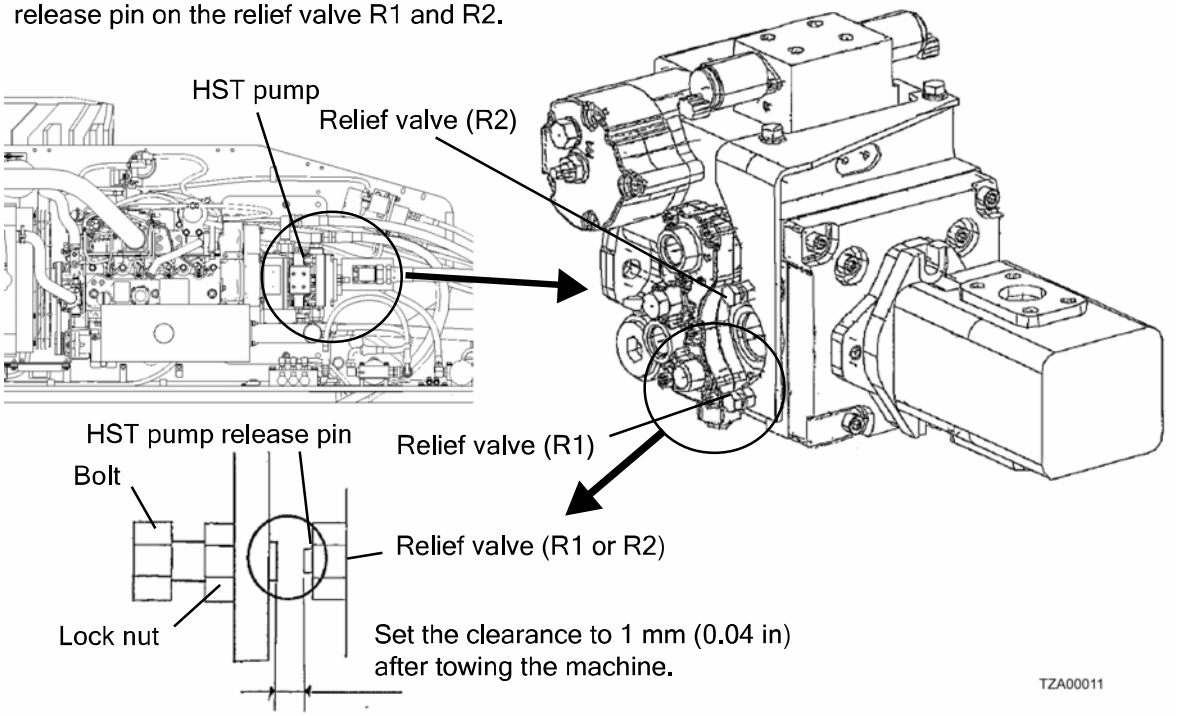


Fig. 5-6 HST pump release pin

4) Take the chassis cover (Rear).
5) Turn the needle valve clockwise to close it.
6) Push the hand pump until it becomes moderately hard.
7) Attach the sling chain or wire rope to the towing ring.
8) Remove the wheel chocks carefully and then tow the machine slowly.
9) After towing the machine, turn the needle valve counterclockwise to open it.

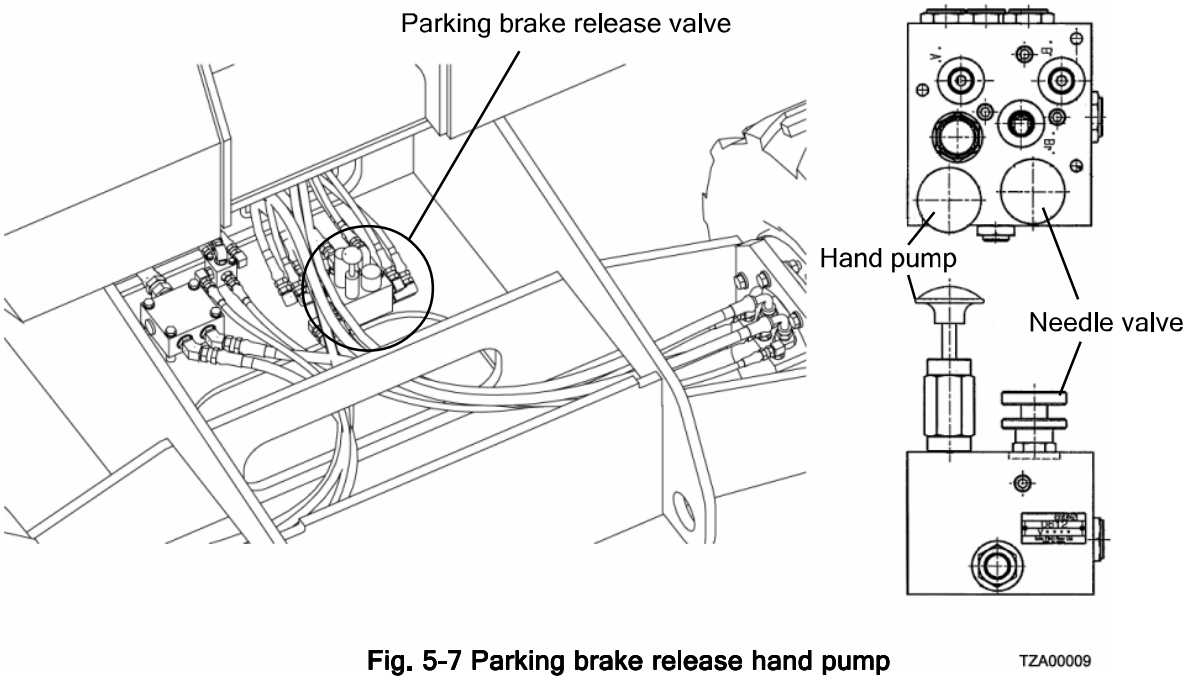


Fig. 5-7 Parking brake release hand pump

10) Set the clearance to 1 mm (0.04 in) between HST pump release pin and bolt, and then lock the lock nut.

⚠DANGER

Make sure that the parking brakes work correctly after opening the needle valve and setting clearance of HST pump release pin, or the machine may run away result in death or serious injury.

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Chapter 6
Inspection and Adjustment

Engine speed measurement procedures

Specific engine speed

	Engine speed (rpm)
Idling speed	1,050 +50/-0
Low speed	1,800 +50/-0
Mid speed	2,200 +50/-0
High speed	2,700 +50/-0
for Hydraulic generator (Option)	1,400 +50/-0

Engine speed measurement procedures

See page 4-16 for engine speed adjustment procedures

1. Set the machine on firm and level surface.
2. Warm up the engine and operate the machine to raise the hydraulic oil temperature to 50 +/- 10 degrees C (104-140 degrees F).
3. Measure the engine **Idling speed** without loading the engine.
4. Measure the engine **Low speed** as follows.
   1) Retract the boom fully.
   2) Measure the engine Low speed while operating **Boom telescope In** to activate the relief valve.
5. Measure the engine **Mid speed** as follows.
   1) Retract the boom fully and raise the boom fully.
   2) Measure the engine Mid speed while operating **Boom telescope In** and **Boom elevation Up** simultaneously to activate the relief valve.
6. Measure the engine **High speed** as follows.
   1) Set the wheel chocks in front and rear of all tires as shown in the figure below.

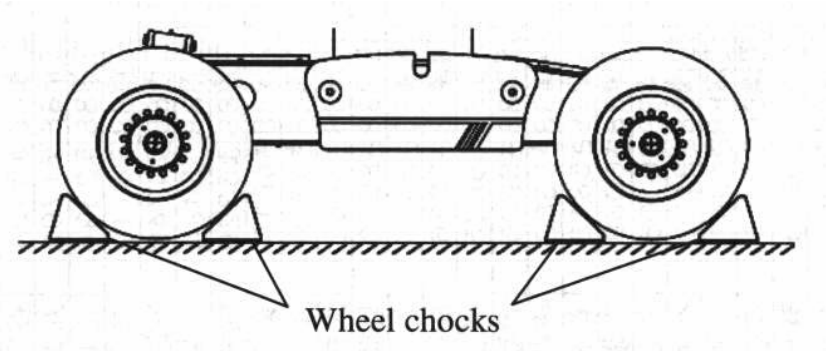


Fig. 6-1 Wheel chocks

   2) Disconnect the connector (No.549, Gray, 4 poles) from Valve unit for Travel functions (See page 3-2 for location of the valve unit) to lock the parking brake.
   3) Retract the boom fully and lower the boom fully.
   4) Measure the engine High speed while operating **Boom elevation Down** and **Travel FWD or REV** simultaneously to activate the relief valve.
   5) Connect the connector No.549 after measureing the engine High speed.
7. Measure the engine speed for **Hydraulic generator** as follows if it is equipped.
   1) Turn on the Hydraulic generator switch.
   2) Measure the engine speed while using electric tool to load the hydraulic generator.

Relief valve pre-set pressure measurement and adjustment procedures

Specific pre-set pressure

Relief valve	Pre-set pressure	Relief valve locations	Gauge port (Size)	Pump speed	Functions
R1	34.3 - 34.8 MPa (350 - 355 kg/cm2) [4,980 - 5,050 PSI]	HST pump	M1 (9/16-18 UNF)	High (2,700 rpm)	Travel FWD
R2	34.3 - 34.8 MPa (350 - 355 kg/cm2) [4,980 - 5,050 PSI]	HST pump	M2 (9/16-18 UNF)	High (2,700 rpm)	Travel REV
R5	17.2 - 17.7 MPa (175 - 180 kg/cm2) [2,500 - 2,570 PSI]	Valve unit for Platform leveling and Steering	M2 (1/4)	Low (1,800 rpm)	Platform rotation Platform leveling Fly-jib, Steering
R8	20.6 - 21.1 MPa (210 - 215 kg/cm2) [2,990 - 3,060 PSI]	Main control valve	P' (1/4)	Mid (2,200 rpm)	Boom elevation Up Boom telescope In Boom rotation
PR1	17.6 - 18.1 MPa (180 - 185 kg/cm2) [2,550 - 2,620 PSI]	Main control valve	P' (1/4)	Mid (2,200 rpm)	Boom telescope Out
PR2	14.7 - 15.2 MPa (150 - 155 kg/cm2) [2,130 - 2,200 PSI]	Main control valve	P' (1/4)	Low (1,800 rpm)	Boom elevation Down

Pre-set pressure measurement procedures

Before measuring each pre- set pressure, set the machine on firm and level surface, start the engine, and then operate the machine to warm up the hydraulic system.

1. Pre-set pressure of the Relief valve R1 and R2

1) Stop the engine, connect the pressure gauge to gauge port "**M1**" and "**M2**" of the HST pump.
(See page 3-3 for location of the HST pump)

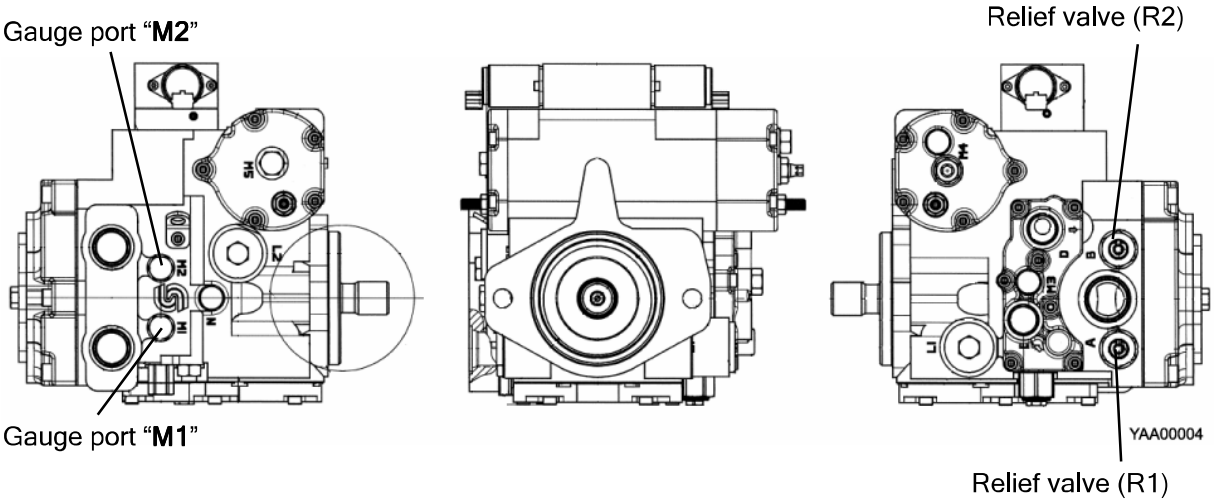


Fig. 6-2 HST pump

2) Set up the wheel chocks in front and rear of all tires as shown in the Fig. 6-1.
3) Start the engine.
4) Retract the boom fully and lower it under the horizontal.
5) Set the travel speed select switch to its High- speed position.
6) Operate the Travel joystick controller to Forward direction to activate the relief valve R1.
7) Read the Pressure gauge connected to the gauge port "**M1**" and make sure that the pre- set pressure of the relief valve (R1) is within the specific value.
   - Specific pre-set pressure: 34.3 - 34.8 MPa (350 - 355 kg/cm2) [4,980 - 5,050 PSI]
8) Operate the Travel joystick controller to Reverse direction to activate the relief valve R2.
9) Read the Pressure gauge connected to the gauge port "**M2**" and make sure that the pre- set pressure of the relief valve (R2) is within the specific value.
   - Specific pre-set pressure: 34.3 - 34.8 MPa (350 - 355 kg/cm2) [4,980 - 5,050 PSI]

2. Pre-set pressure of the Relief valve R5

1) Stop the engine, connect the pressure gauge to gauge port "**M2**" of the Valve unit for Platform leveling and Steering.
   (See page 3-3 for location of the Valve unit for Platform leveling and Steering.)

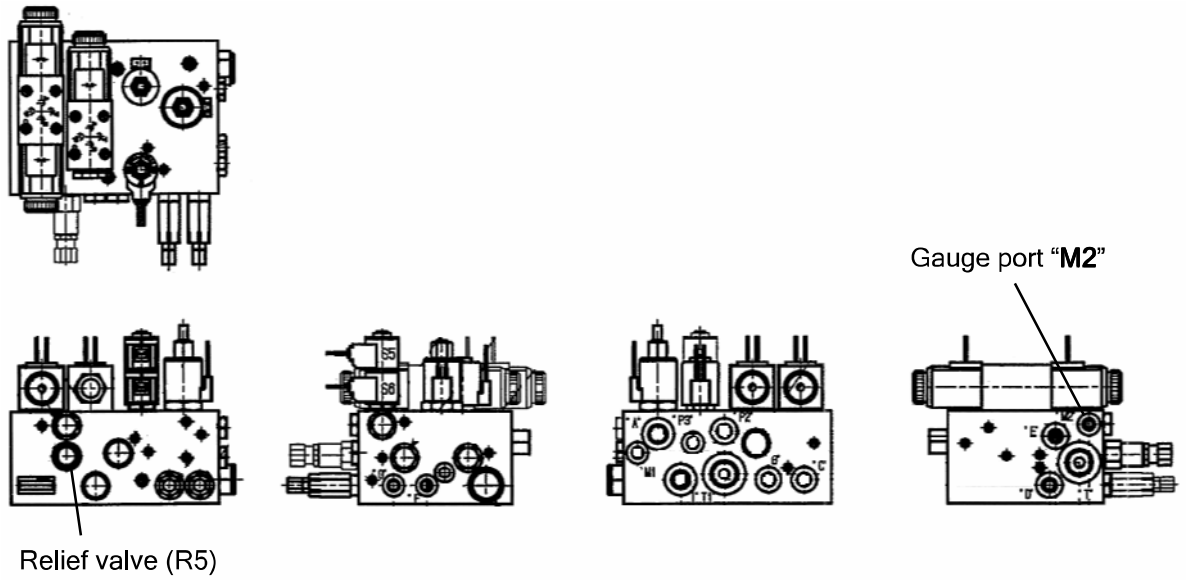


Fig. 6-3 Valve unit for Platform leveling and Steering

2) Start the engine.
3) Steer the front wheel to Left or Right end to activate the relief valve R5.
4) Read the Pressure gauge and make sure that the pre- set pressure of the relief valve (R5) is within the specific value.
   - Specific pre-set pressure: 17.2 - 17.7 MPa (175 - 180 kg/cm2) [2,500 - 2,570 PSI]

3. Pre-set pressure of the Relief valve R8

1) Stop the engine, connect the pressure gauge to gauge port "**P**" of the Main control valve.
(See page 3-3 for location of the Main control valve.)

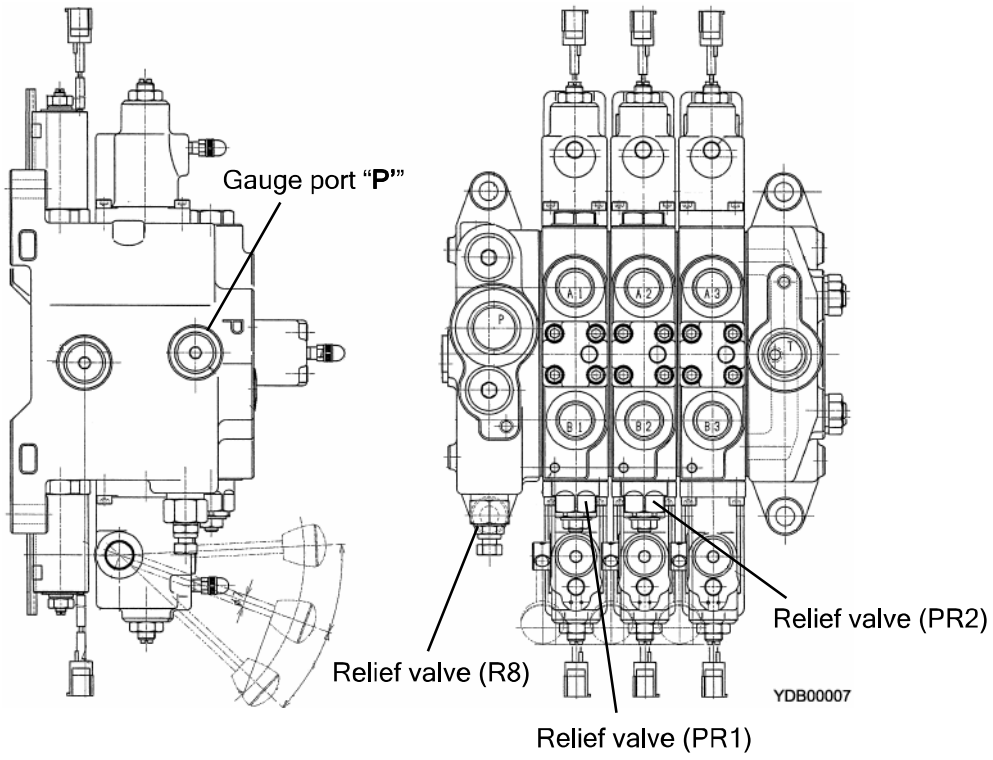


Fig. 6-4 Main control valve

2) Start the engine.
3) Retract the boom fully and then raise it fully.
4) Operate the Boom elevation Up and Boom telescope In simultaneously to activate the relief valve R8.
5) Read the Pressure gauge and make sure that the pre- set pressure of the relief valve (R8) is within the specific value.
   - Specific pre-set pressure: 20.6 - 21.1 MPa (210 - 215 kg/cm2) [2,990 - 3,060 PSI]

4. Pre-set pressure of the Relief valve PR1

1) Stop the engine, connect the pressure gauge to gauge port "**P**" of the Main control valve.
(See page 3-3 for location of the Main control valve.)
2) Start the engine.
3) Raise the boom fully and then extend it fully.
4) Operate the Boom telescope Out to activate the relief valve PR1.
5) Read the Pressure gauge and make sure that the pre- set pressure of the relief valve (PR1) is within the specific value.
   - Specific pre-set pressure: 17.6 - 18.1 MPa (180 - 185 kg/cm2) [2,550 - 2,620 PSI]

5. Pre-set pressure of the Relief valve PR2

1) Stop the engine, connect the pressure gauge to gauge port "**P**" of the Main control valve.
   (See page 3-3 for location of the Main control valve.)
2) Start the engine.
3) Retract the boom fully and then lower it fully.
4) Operate the Boom elevation Down to activate the relief valve PR2.
5) Read the Pressure gauge and make sure that the pre- set pressure of the relief valve (PR2) is within the specific value.
   - Specific pre-set pressure: 14.7 - 15.2 MPa (150 - 155 kg/cm2) [2,130 - 2,200 PSI]

Pre-set pressure adjustment procedures

Adjust the relief valve as follows, if the pre- set pressure is not within the specific value.
1. Loosen the lock nut.
2. Adjust the pre- set pressure by turning the adjusting screw.
   To increase the pressure, turn the adjusting screw clockwise.
   To decrease the pressure, turn the adjusting screw counter- clockwise.
3. Lock the adjusting screw by the lock nut, and then check the pre- set pressure again and make sure that the pressure is within the specific value.

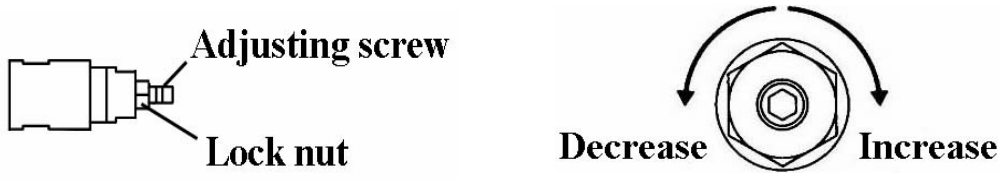


Fig. 6-5 Adjustment of relief valve

Chapter 7
Scheduled maintenance

Scheduled inspection table

1. Engine maintenance

Items			Daily	Every 50 hrs	Every 250 hrs	Every 500 hrs	Every 1,000 hrs or annually	Every 1,500 hrs	Every 2,000 hrs or every 2 years
Cooling system	Coolant	Coolant Level, Replenish	1						
		Replacement					1		
	Radiator fin	Check, Clean			1				
	Fan belt	Tension		1*	1				
	Radiator hoses	Replacement							1#
Engine oil	Engine oil	Oil level	1						
		Replacement		1*	1				
	Oil filter	Replacement		1*	1				
Fuel	Fuel	Fuel level, Replenish	1						
	Fuel filter	Replacement				1			
	Fuel hoses	Replacement							1#
	Fuel tank	Drain			1				
	Water sedimentor	Check	1						
		Drain		1					
		Clean				1			
Air cleaner	Element	Clean			1				
		Replacement				1			
Cylinder head	Adjust Intake / Exhaust valve clearance						1#		
	Lap Intake / Exhaust valve seats								1#
Emission control	Inspect, clean and test Fuel injectors							1#	
	Inspect Crankcase breather system							1#	

1* For new machine, Perform these maintenance after 50 working hours for first time.
1# Ask your authorized Yanmar industrial engine dealer or distributor to perform these maintenance.
See Chapter 9 "Engine" for the detail.

2. Other maintenance

Items		Daily inspection	Monthly inspection	Annual inspection
Battery box	Battery	Battery charge level, Battery fluid level	Damage, Corrosion on terminals	Specific gravity
Hydraulic system	Hydraulic oil tank	Oil level, Oil leakage	←	Replacement of hydraulic oil
	Hydraulic filters	Oil leakage	←	Replacement
	Hydraulic pump	Abnormal noise, Oil leakage	Looseness of bolts and nuts	←
Chassis	Chassis frame	Cracks, Deformations	←	←
	Tire, Wheel	Wear, Cut	←	←
	Wheel nuts	Looseness	←	←
	Travel motor, Gearbox	Abnormal noise, Damage,	Oil leakage, Looseness of nuts	Replacement of gear oil
	Parking brake	Function	←	←
	Steering linkage	Cracks, Deformations	Looseness of stopper bolt	←
	Steering cylinder	Damage, Oil leakage	←	←
	Wire harnesses, Hoses	Oil leakage, Damage	←	←
	Oscillation axle	Cracks, Deformations, Movement	←	←

Items		Daily inspection	Monthly inspection	Annual inspection
Chassis	Oscillation axle cylinder	Damage, Oil leakage	←	←
	pivot pins for axle and cylinder	Damage	←	←
Turntable	Turntable bearing	Wear, Crack	Looseness of bolts and nuts, Lubrication	←
	Boom rotation gearbox	Abnormal noise	Oil leakage, Looseness of nuts	Backlash Replacement of gear oil
	Turntable	Cracks, Deformations	Looseness of bolts and nuts	←
	Swivel joint	Oil leakage	Looseness of bolts and nuts, Lubrication	←
Cylinder	Elevation, Telescope, Fly jib cylinders	Damage, Oil leakage, Natural descent	←	←
Boom	Boom	Cracks, Deformations, Abnormal noise, Movement	←	Disassemble the boom for detailed inspection every 5 years
	Fly jib	Cracks, Deformations, Abnormal noise, Movement	←	←
	Pivot pins	Damage	←	←
	Extension /retraction wire ropes		Damage, Corrosion, Tension	←
	Cable guide	Abnormal noise	Movements, Damage	←
	Wear pads			Wear
Platform	Platform	Cracks, Deformations	←	←
	Hand rail	Cracks, Deformations	←	←
	Rotary actuator	Oil leakage, Abnormal noise, Movement	←	←
Platform leveling system	Leveling cylinder	Oil leakage	←	←
	Functions	Functions	←	←
Lower control	Switches	Damage, Function, Smoothness	←	←
	Functions	Function, Abnormal noise, Vibration	←	←
	Emergency stop button	Damage, Function	←	←
	LEDs	Damage, Legibility	←	←
	Decals	Legibility	←	←
Upper control	Switches, Joystick controllers	Damage, Function, Smoothness	←	←
	Functions	Function, Abnormal noise, Vibration	←	←
	Emergency stop button	Damage, Function	←	←
	LEDs	Damage, Legibility	←	←
	Decals	Legibility	←	←
Safety devices	Foot switch	Function	←	←
	Motion alarm buzzer	Sound	←	←
	Tilt alarm buzzer	Sound	←	←
	Emergency pump	Function	←	←
	Alarm horn	Sound	←	←
	Overload sensing system		Function	←
Decals		Legibility	←	←

Lubrications

Lubrication intervals

Location	Lubricating point	Interval	Lubricant	Quantity
Chassis	Hydraulic oil tank	1,200 working hours or annually. For new machine (Initial replacement) After 300 working hours or 3 months	Hydraulic oil (ISO VG22)	190 litters [1.4 gal]
	Travel motor gear box		Gear oil (SAE 90)	1.0 litter x4 [0.26 gallons x4]
Turntable	Boom rotation gear box		Gear oil (SAE 90)	1.0 litter [0.26 gallons]
Refer "Greasing point"	1	100 hours	Molybdenum grease	----------
	2 to 14		General grease	----------

Recommended lubricant

Manufacturers	Hydraulic oil	Gear oil	Molybdenum grease	General grease
Shell oil	Tellus oil T22	Spirax EP 90	Alvania HDX 2	Alvania EP grease 2
Mobil oil	DTE 22	Pegasus gear oil 90	Mobilgrease special	Mobilux EP2

Greasing point

1	2nd and 3rd boom section upper tail ware pads (Take off the grommet on the 1st boom section upper surface to lubricate the 3rd boom section ware pads.)
2	Turntable bearing
3	Elevation cylinder - 1st boom section pivot pin
4	Jib bracket - Upper jib pivot pin (SP14CJ / SP460CJ)
5	Upper jib - Platform base pivot pin (SP14CJ / SP460CJ)
6	Elevation cylinder - Turntable pivot pin
7	1st boom section pivot pin
8	Lower leveling cylinder - 1st boom section pivot pin
9	Lower leveling cylinder - Turntable pivot pin
10	Steering cylinder - Chassis pivot pin
11	Steering cylinder - Wheel bracket pivot pin
12	3rd boom section - Platform base / Jib bracket pivot pin Leveling cylinder - Platform base / Jib bracket pivot pin
13	Fly-jib cylinder - Upper jib pivot pin (SP14CJ / SP460CJ)
14	Lower jib - Platform base pivot pin (SP14CJ / SP460CJ)
15	Fly-jib cylinder - Jib bracket pivot pin (SP14CJ / SP460CJ) Jib bracket - Lower jib pivot pin (SP14CJ / SP460CJ)

Greasing point

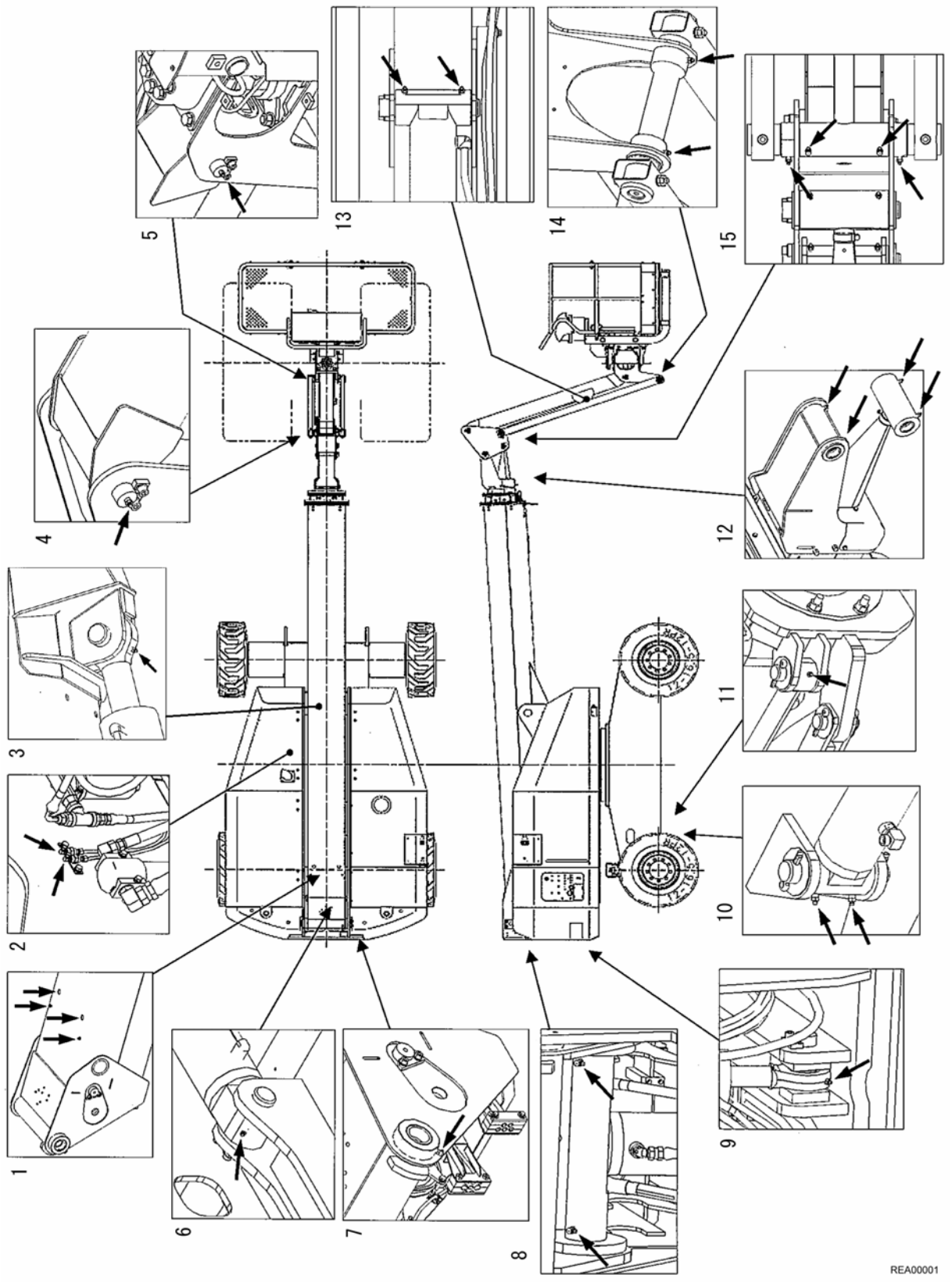


Fig. 7-1 Greasing point

Scheduled replacement parts

The parts listed in the table below are related to safety devices and must be replaced at designated intervals.

Location	Items	Interval	Part number	Quantity
Turntable	**High pressure filter**	Every 1 year or 1,200 working hours	305-0000017 (G319050014)	1
	Charge filter	Every 1 year or 1,200 working hours	305-0000073 (G319050032)	1
	Suction filter	Every 1 year or 1,200 working hours	305-06597	1
	Tilt angle sensor Longitudinal, Lateral	Every 8 years or 9,600 working hours	382-0001600	2
	Tilt angle sensor Omni-directional (CE model)	Every 8 years or 9,600 working hours	382-0000019	1
	Boom angle limit switch	Every 4 years or 4,800 working hours	320-0005800	1
Boom	**Boom length limit switch**	Every 4 years or 4,800 working hours	320-0005800	1
Chassis	**Boom rotation angle limit switch**	Every 4 years or 4,800 working hours	320-0005800	1
Platform base	**Overload limit switch (CE, Japan model)**	Every 4 years or 4,800 working hours	320-0002600	1
Lower control box	**Emergency stop button**	Every 4 years or 4,800 working hours	320--0007201	1
Upper control box	**Emergency stop button**	Every 4 years or 4,800 working hours	320--0007201	1

( ) : Element

The parts listed in the table below are important for machine's main function and highly recommended to replace at designated intervals.

Location	Items	Interval	Part number	Quantity
Platform	Foot switch	Every 4 years or 4,800 working hours	320-04017	1
Lower control box	Enable switch	Every 4 years or 4,800 working hours	173-01102	1
	Engine start /Emergency pump switch		173-02212	1
	Boom elevation switch		173-01212	1
	Boom telescope switch		173-01212	1
	Boom rotation switch		173-01212	1
	Platform rotation switch		173-01212	1
	Platform leveling switch		173-01212	1
	Fly-jib switch (SP14C/SP460CJ)		173-01212	1
Upper control box	Engine start /Emergency pump switch	Every 4 years or 4,800 working hours	173-02212	1
	Platform rotation switch		320-05325	1
	Platform leveling switch		173-01212	1
	Fly-jib switch (SP14C/SP460CJ)		320-05325	1
	Steering lever		324-0000033	1
	Boom elevation joystick controller	Every 5 years or 6,000 working hours	324-0008100	1
	Boom telescope joystick controller		324-0008100	1
	Boom rotation joystick controller		324-0008100	1
	Travel joystick controller		324-0008100	1

Daily inspection check sheet

Model : _____ Serial number : _____ Year : _____ Month : _____

Date			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Engine	Coolant	Level																															
	Engine oil	Level																															
	Fuel	Level, Water sedimentor																															
Battery	Battery charge level, Battery fluid level																																
Hydraulic system	Hydraulic oil tank	Hydraulic oil level, Oil leakage																															
	Hydraulic filters	Oil leakage																															
	Hydraulic pump	Oil leakage, Abnormal noise																															
Chassis	Chassis frame	Cracks, Deformations																															
	Tires, Wheels, Wheel nuts	Wear, Guts, Looseness																															
	Travel motor, Gearbox	Abnormal noise, Damage																															
	Parking brake	Function																															
	Steering cylinder, Linkage	Oil leakage, Damage, Cracks, Deformations																															
	Wire harnesses, Hoses	Oil leakage, damage																															
	Oscillation axle, Pivot pins Oscillation axle cylinder	Cracks, Deformations, Damage Movement, Oil leakage																															
Turntable	Turntable bearing, Boom rotation gearbox, Turntable, Swivel joint	Cracks, Deformations, Abnormal noise, Oil leakage																															
Cylinder	Elevation, Telescope, Fly-jib cylinder	Damage, Oil leakage, Natural descent																															
Boom	Boom, Fly-jib, Pivot pins Cable guide	Cracks, Deformations, Damage Abnormal noise, Movement																															
Platform	Platform, Hand rail	Cracks, Deformations																															
	Rotary actuator	Oil leakage, Abnormal noise, Movement																															
Lower control	Control switches	Function, Abnormal noise, Vibration																															
	Emergency stop button	All functions are disabled when pushed																															
	LEDs	Damage, Legibility																															
Upper control	Control levers, switches	Function, Abnormal noise, Vibration																															
	Emergency stop button	All functions are disabled when pushed																															
	LEDs	Damage, Legibility																															
Safety devices	Foot switch	Function																															
	Motion alarm buzzer	Sound																															
	Tilt alarm buzzer	Sound																															
	Emergency pump	Function																															
	Alarm horn	Sound																															
Decals	Legibility																																

Periodical inspection check sheet

Model	Spec No.	Serial No.	Hour meter	Date	Inspector

The items marked (*) should be inspected only on the annual inspections.

Items		Monthly inspection	Result	Remarks
Engine	Coolant	Coolant level		Replacement interval Every 1,000 hours or annually
	Fan belt	Check tension every 250 hours		
	Radiator hoses			Replacement interval Every 2 years or 2,000 hours
	Engine oil	Oil level		Replacement interval Every 250 hours
	Oil filter			
	Fuel filter			Replacement interval Every 500 hours
	Fuel tank	Drain every 250 hours		
	Water sedimentor	Drain every 50 hours		
		Clean every 500 hours		
	Air cleaner element	Clean every 250 hours		Replacement interval Every 500 hours
Battery	Battery	Battery charge level		
		Battery fluid level		
		Damage		
		Corrosion on terminals		
		Specific gravity *		1.28 at 20 degrees C
Hydraulic system	Hydraulic oil tank	Oil leakage		Replacement interval Every 1,200 hours or annually
		Hydraulic oil level		
	Hydraulic filters	Oil leakage		
	Hydraulic pump	Abnormal noise, Oil leakage		
		looseness of bolts and nuts		
Chassis	Chassis frame	Cracks, Deformations		
	Tire, Wheel	Wear, Cut		
	Wheel nuts	Looseness		
	Travel motor, Gearbox	Abnormal noise		Replacement interval of gear oil Every 1,200 hours or annually
		Damage		
		Oil leakage		
		Looseness of nuts		
	Parking brake	Function		
	Steering linkage	Cracks, Deformations		
		Looseness of stopper bolt		
	Steering cylinder	Damage, Oil leakage		
	Wire harnesses, Hoses	Oil leakage		
		Damage		
	Oscillation axle	Cracks, Deformations		
		Movement		
	Oscillation axle cylinder	Damage		
		Oil leakage		
	Pivot pins for axle & cylinder	Damage		

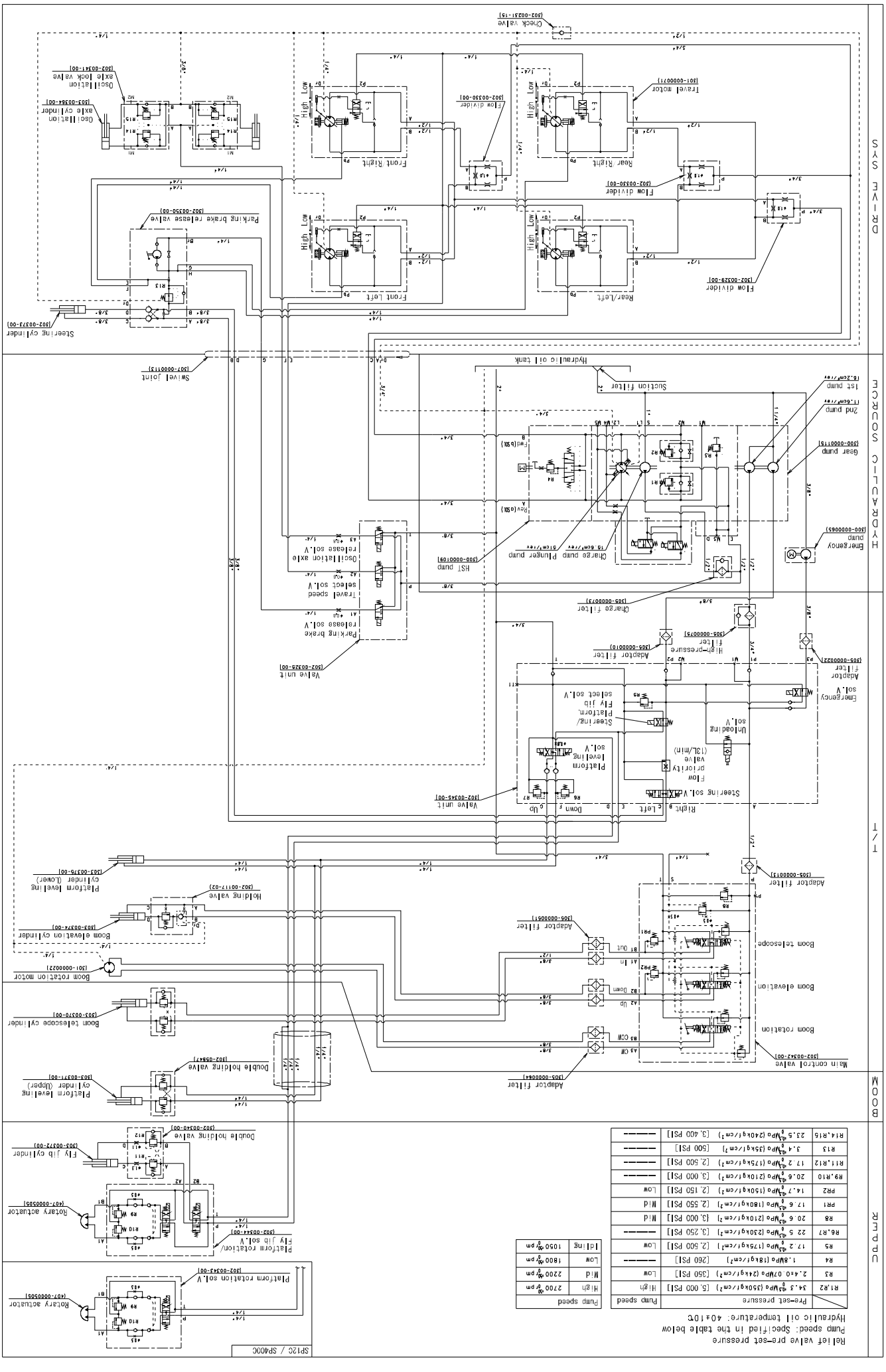
The items marked (*) should be inspected only on the annual inspections.

Items		Daily inspection	Result	Remarks
Turntable	Turntable bearing	Wear, Crack		
		looseness of bolts and nuts		
		Lubrication		
	Boom rotation gearbox	Abnormal noise		Replacement interval of gear oil Every 1,200 hours or annually (See page 2-5)
		Oil leakage		
		Looseness of nuts		
		Backlash *		
	Turntable	Cracks, Deformations		
		looseness of bolts and nuts		
	Swivel joint	Oil leakage		
		looseness of bolts and nuts		
Boom	Boom	Cracks, Deformations		
		Abnormal noise, Movement		
	Fly jib	Cracks, Deformations		
		Abnormal noise, Movement		
	Pivot pins	Damage		
	Extension/retraction wire ropes	Damage, Corrosion		
		Tension		See page 2-12
	Cable guide	Abnormal noise		
		Movement, Damage		
	Wear pads	**Wear (Thickness) ***		See page 2-9
Platform	Platform	Cracks, Deformations		
	Hand rail	Cracks, Deformations		
	Rotary actuator	Oil leakage		
		Abnormal noise, Movement		
Lower control	Switches	Damage, Function, Smoothness		
	Functions	Function		
		Abnormal noise, Vibration		
	Emergency stop button	Damage, Function		
	LEDs	Damage, Legibility		
	Decals	Legibility		
Upper control	Switches, Joystick controller	Damage, Function, Smoothness		
	Functions	Function		
		Abnormal noise, Vibration		
	Emergency stop button	Damage, Function		
	LEDs	Damage, Legibility		
	Decals	Legibility		
Safety devices	Foot switch	Function		
	Motion alarm buzzer	Sound		
	Tilt alarm buzzer	Sound		
	Emergency pump	Function		
	Alarm horn	Sound		
	Overload sensing system	Function		
Decals		Legibility		

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Chapter 8
Appendix

Hydraulic circuit diagram (601-0014900A)

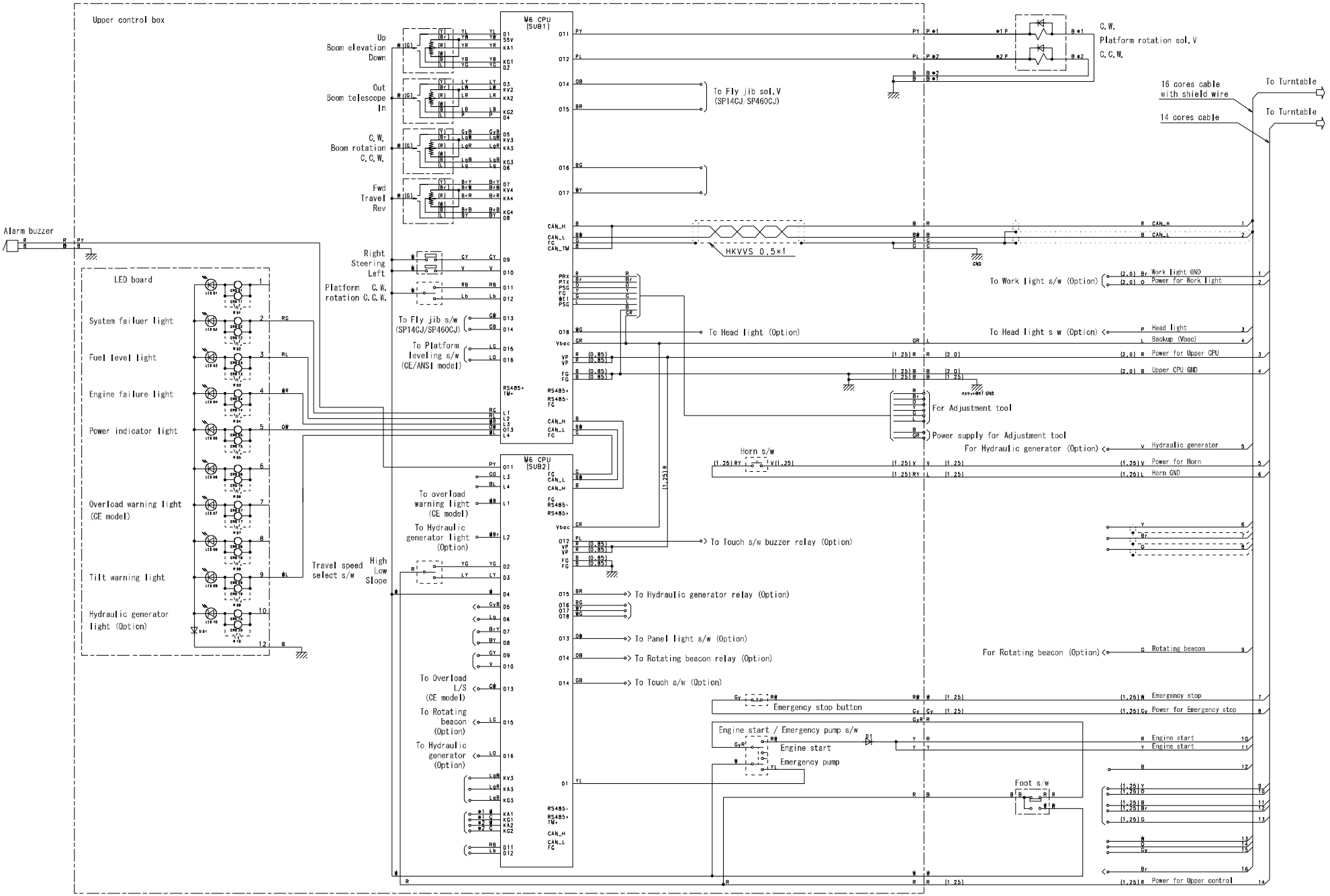


Relief valve pre-set pressure
Pump speed: Specified in the table below
Hydraulic oil temperature: 40±10°C

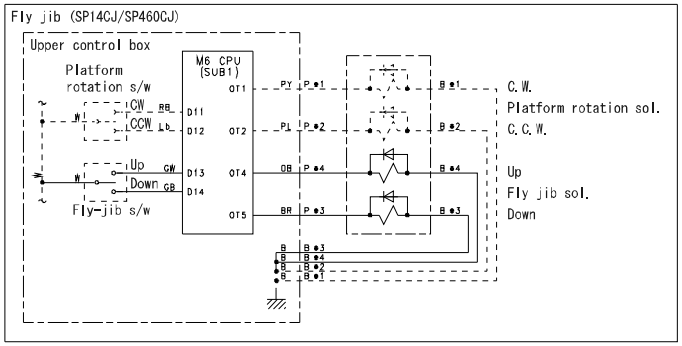
	Pre-set pressure	Pump speed
R1,R2	34.3 $^{0}_{+3.5}$MPa (350kgf/cm²) [5,000 PSI]	High
R3	2.4±0.07MPa (24kgf/cm²) [350 PSI]	Low
R4	1.8MPa (18kgf/cm²) [260 PSI]	———
R5	17.2 $^{0}_{+3.5}$MPa (175kgf/cm²) [2,500 PSI]	Low
R6,R7	22.5 $^{0}_{+3.5}$MPa (230kgf/cm²) [3,290 PSI]	———
R8	20.6 $^{0}_{+3.5}$MPa (210kgf/cm²) [3,000 PSI]	Mid
PR1	17.6 $^{0}_{+3.5}$MPa (180kgf/cm²) [2,550 PSI]	Mid
PR2	14.7 $^{0}_{+3.5}$MPa (150kgf/cm²) [2,150 PSI]	Low
R9,R10	20.6 $^{0}_{+3.5}$MPa (210kgf/cm²) [3,000 PSI]	———
R11,R12	17.2 $^{0}_{+3.5}$MPa (175kgf/cm²) [2,500 PSI]	———
R13	3.4 $^{0}_{+3.5}$MPa (35kgf/cm²) [500 PSI]	———
R14,R15	23.5 $^{0}_{+3.5}$MPa (240kgf/cm²) [3,400 PSI]	———

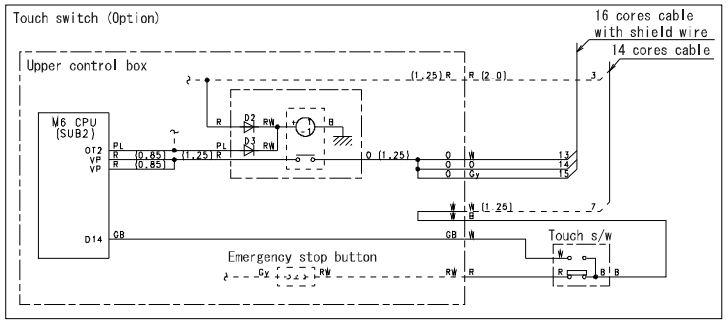
	Pump speed
High	2700 $^{0}_{-90}$rpm
Mid	2200 $^{0}_{-90}$rpm
Low	1800 $^{0}_{-90}$rpm
Idling	1050 $^{0}_{-90}$rpm

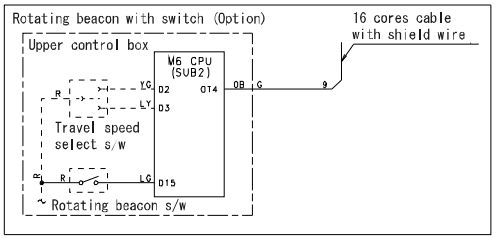
Electric circuit diagram, Upper (602-0071100A) 1/2

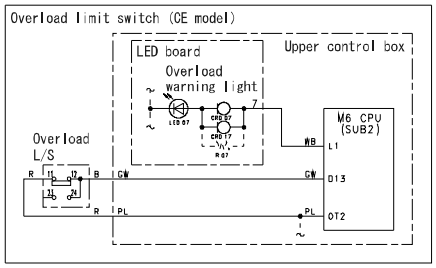


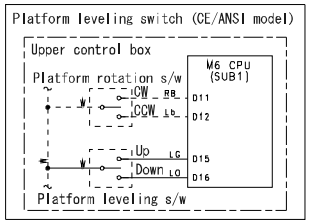
Electric circuit diagram, Upper (602-0071100A) 2/2

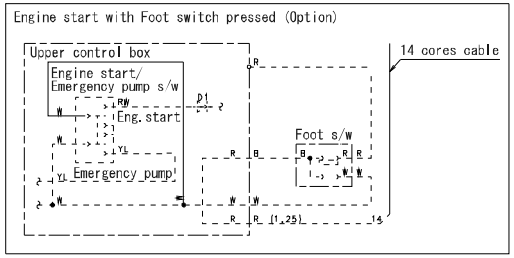


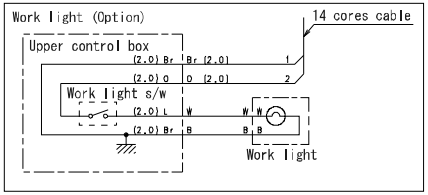


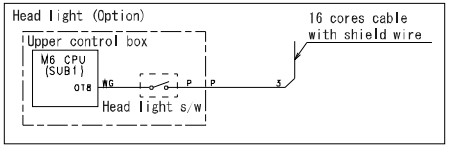


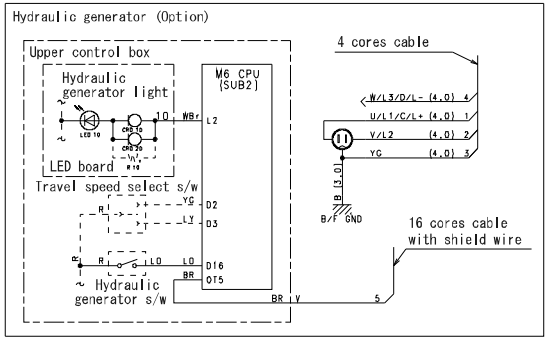


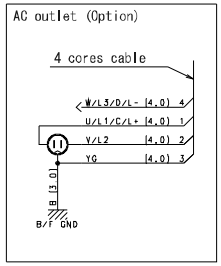


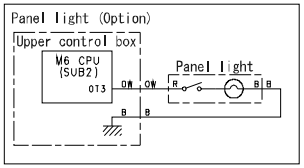




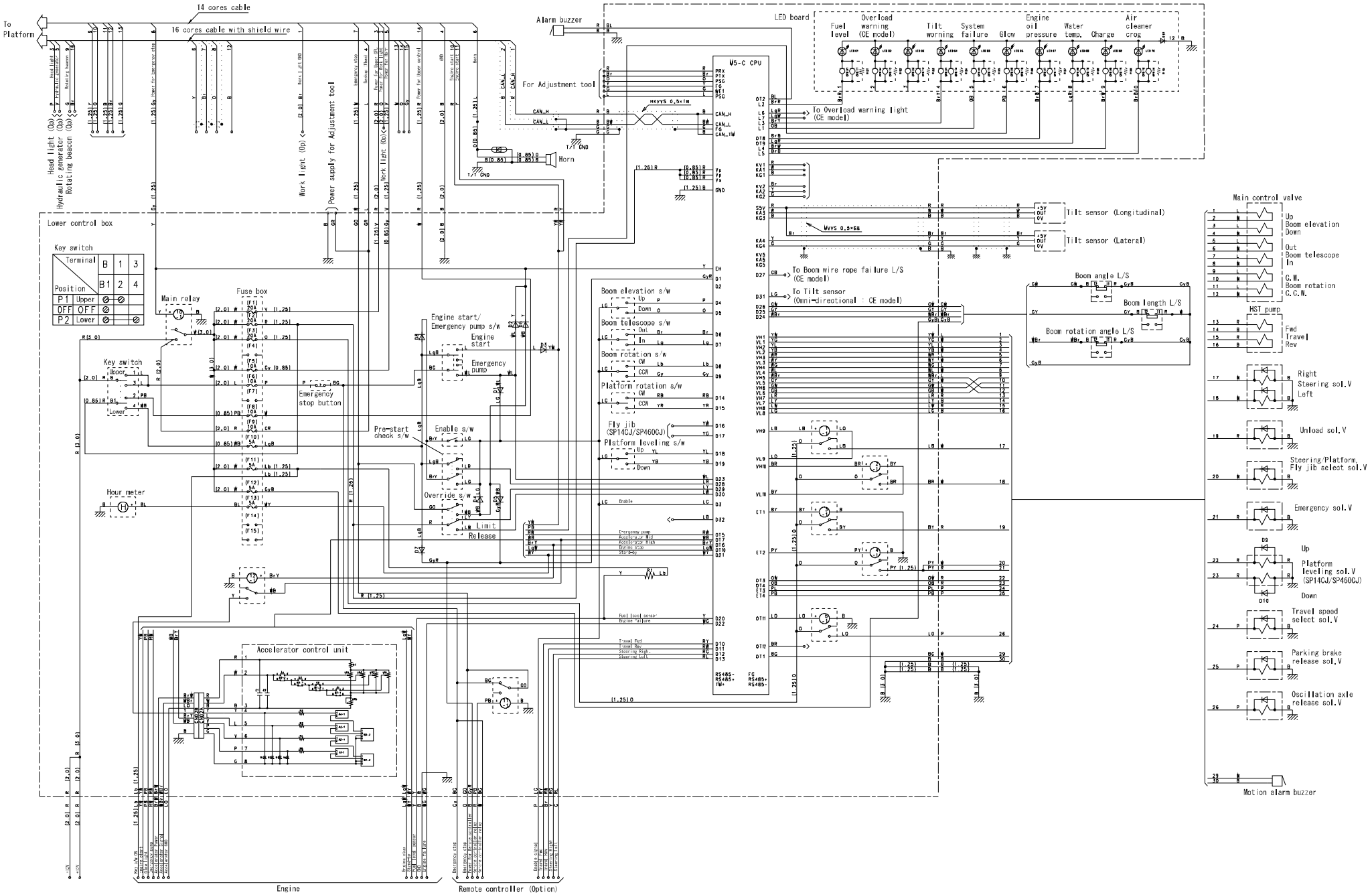




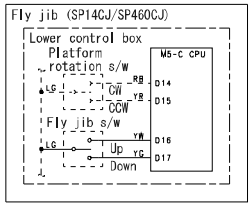


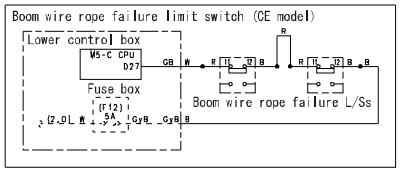


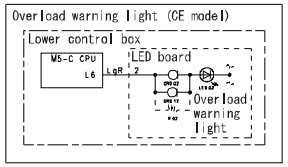
Electric circuit diagram, Lower (602-0071200A) 1/2

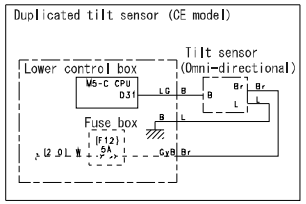


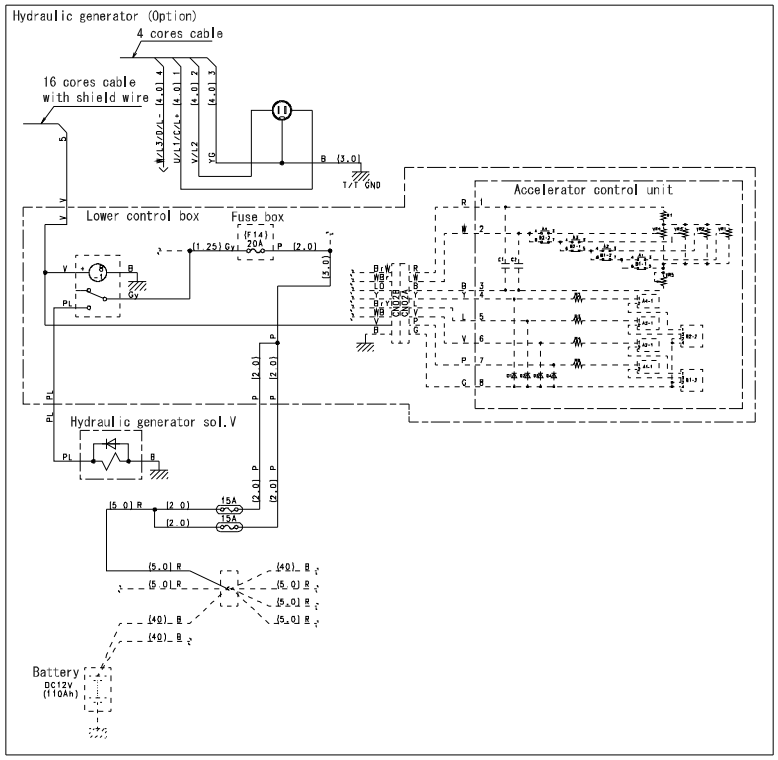
Electric circuit diagram, Lower (602-0071200A) 2/2

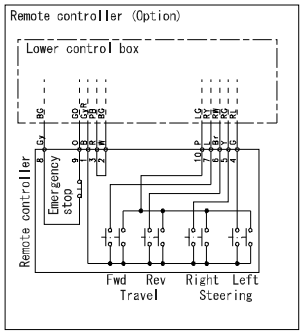


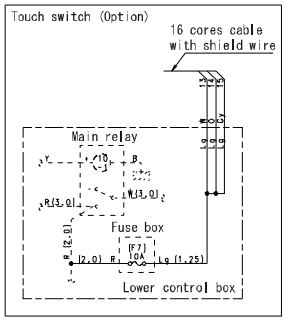


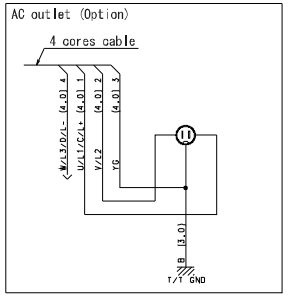


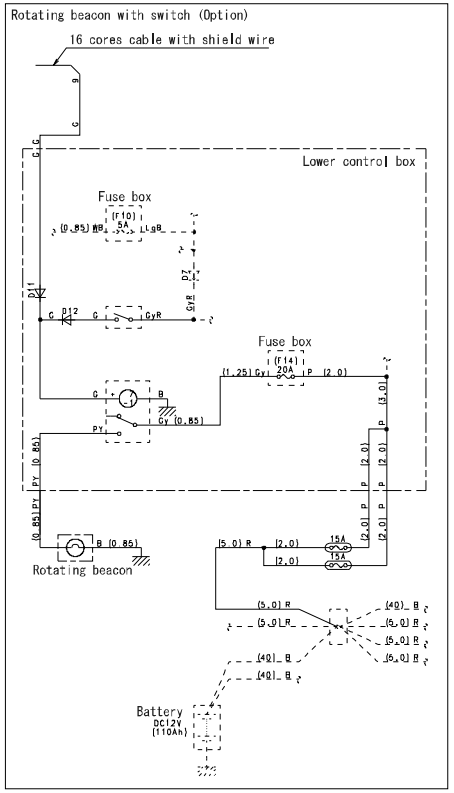


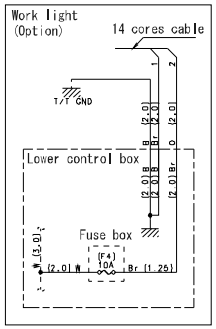


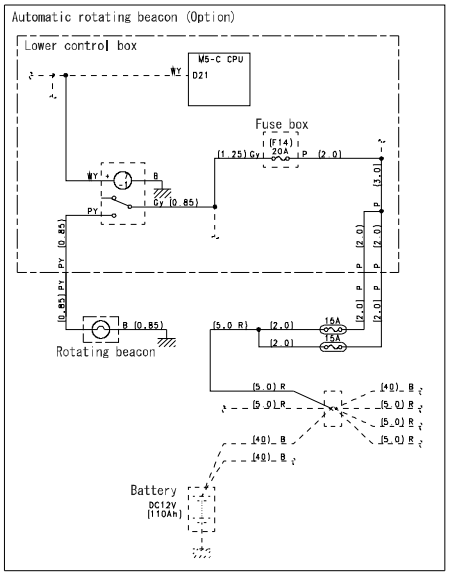


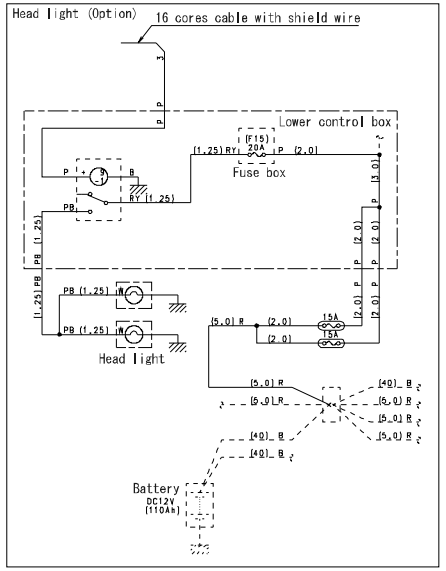




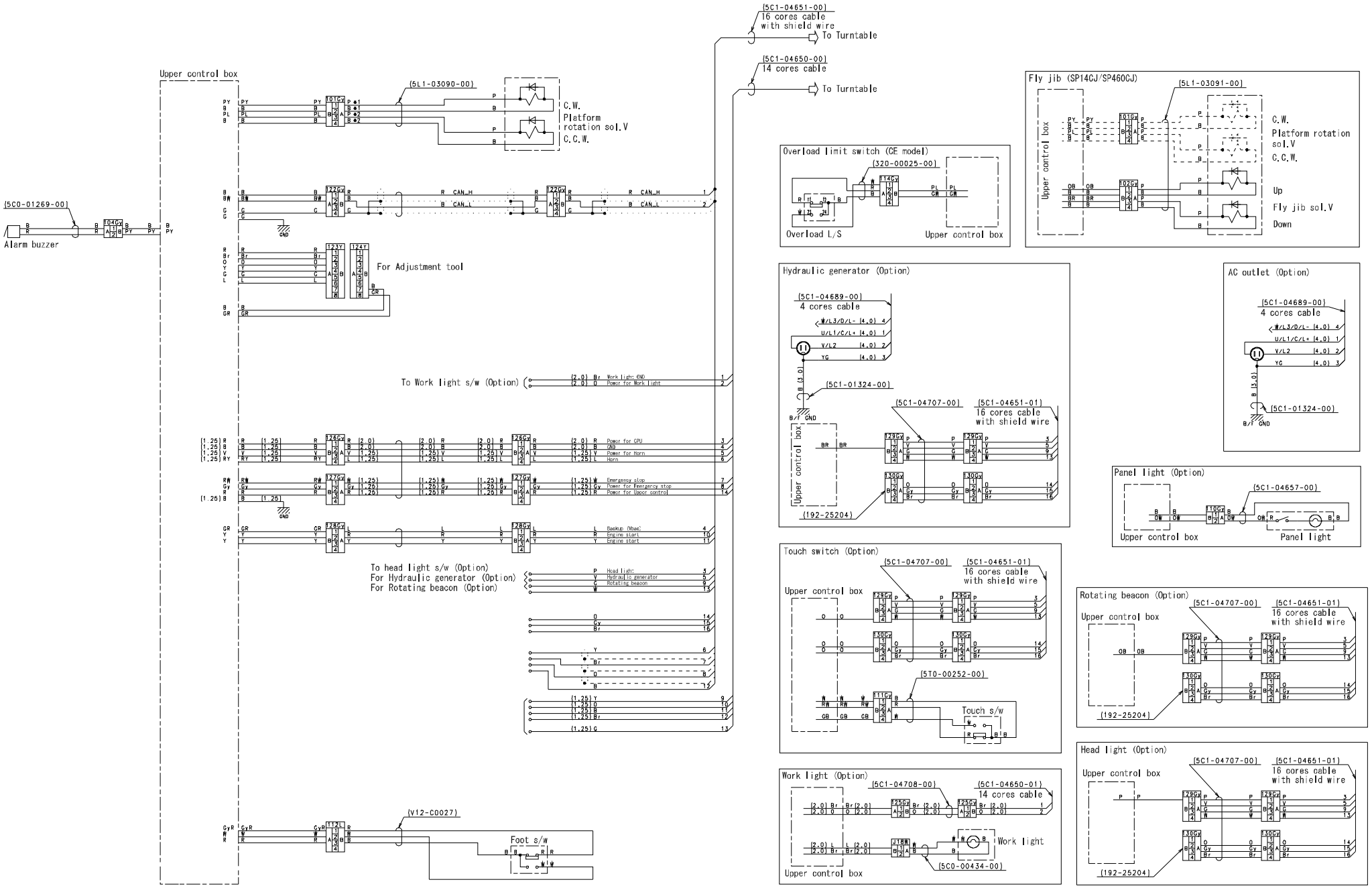




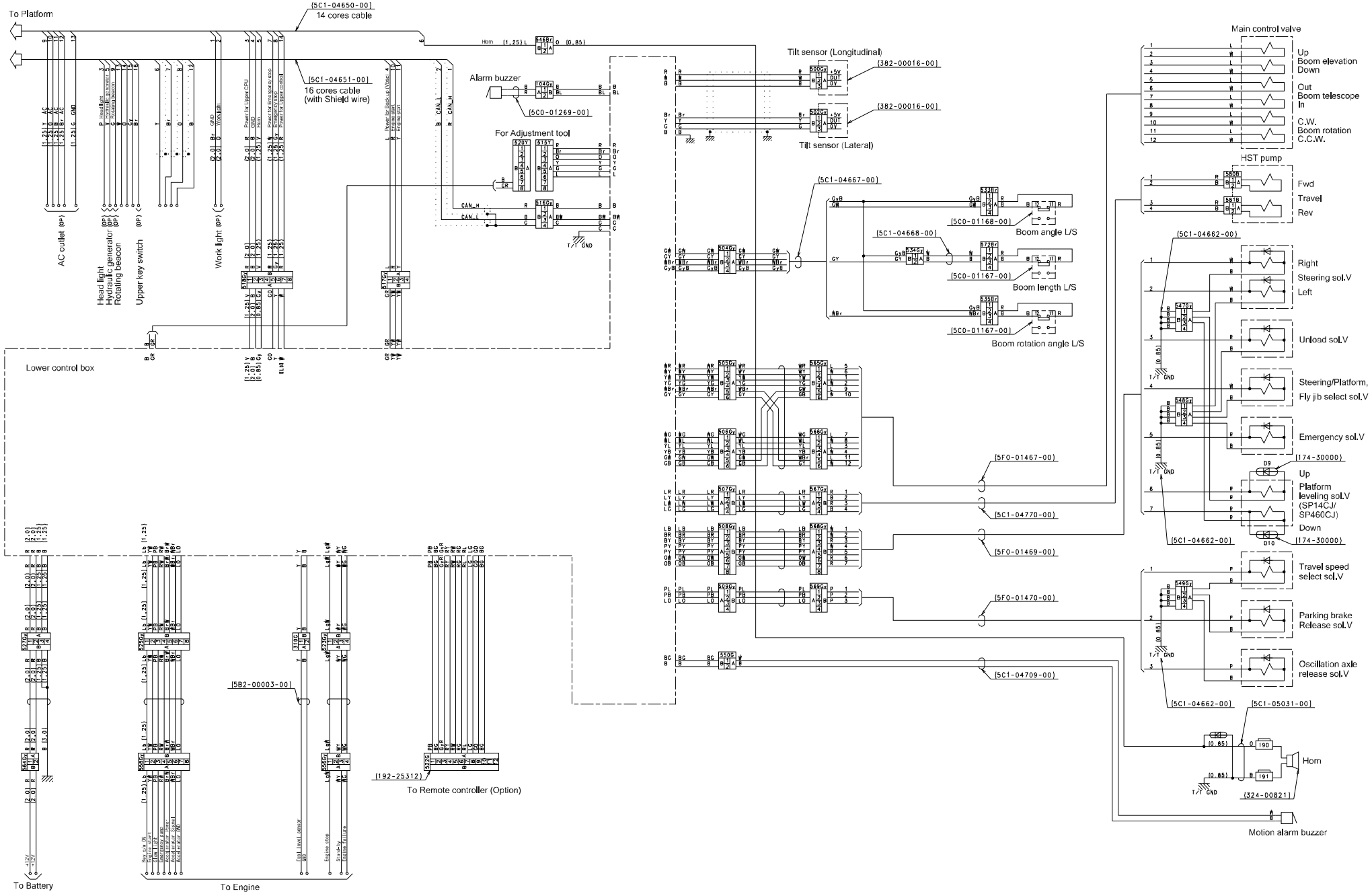




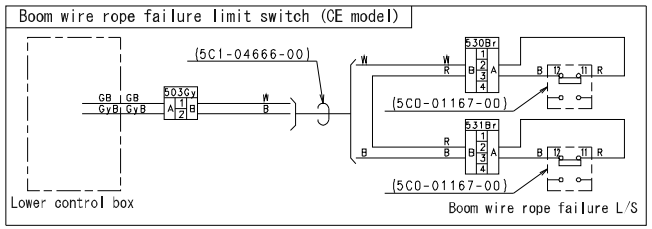
Electric Wiring diagram, Upper (602-0076600A)

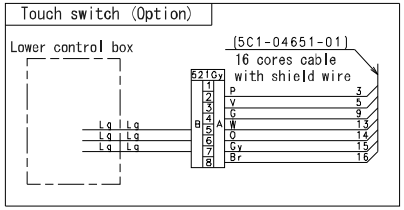


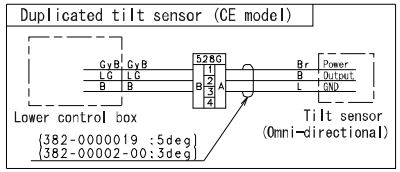
Electric circuit diagram, Lower (602-0076700A) 1/2

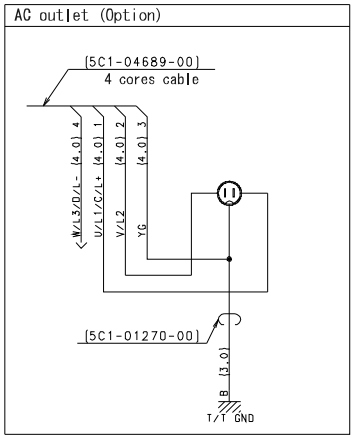


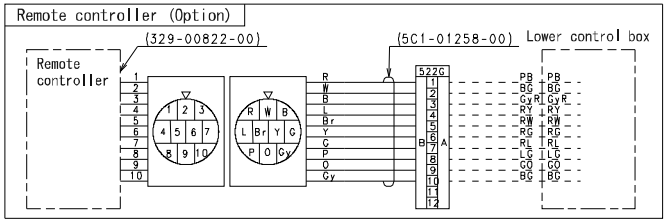
Electric circuit diagram, Lower (602-0076700A) 2/2

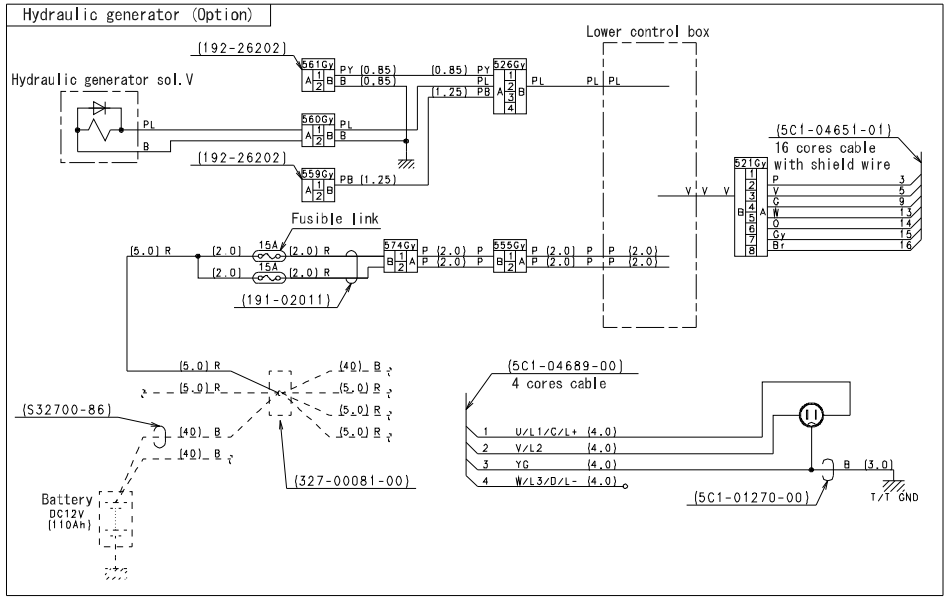


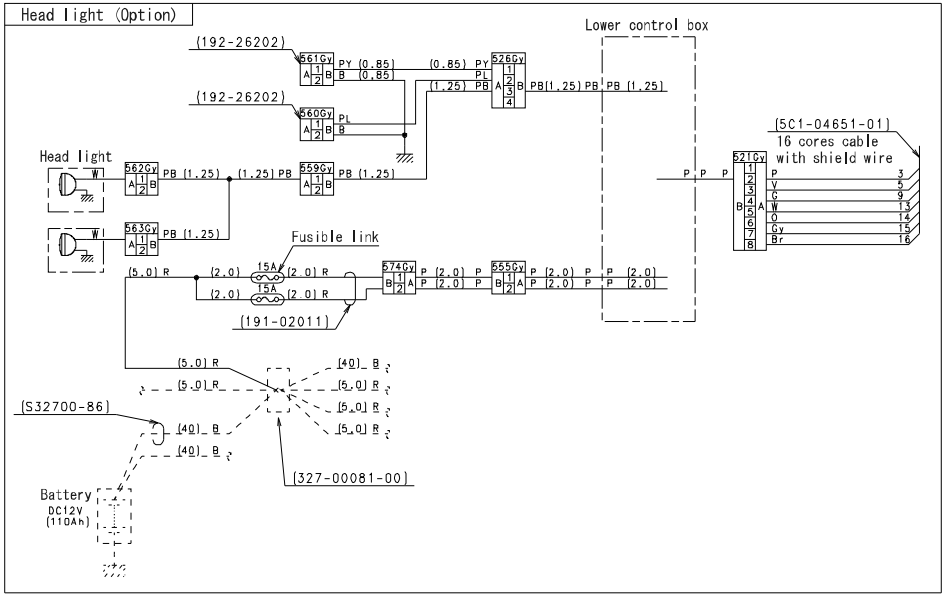


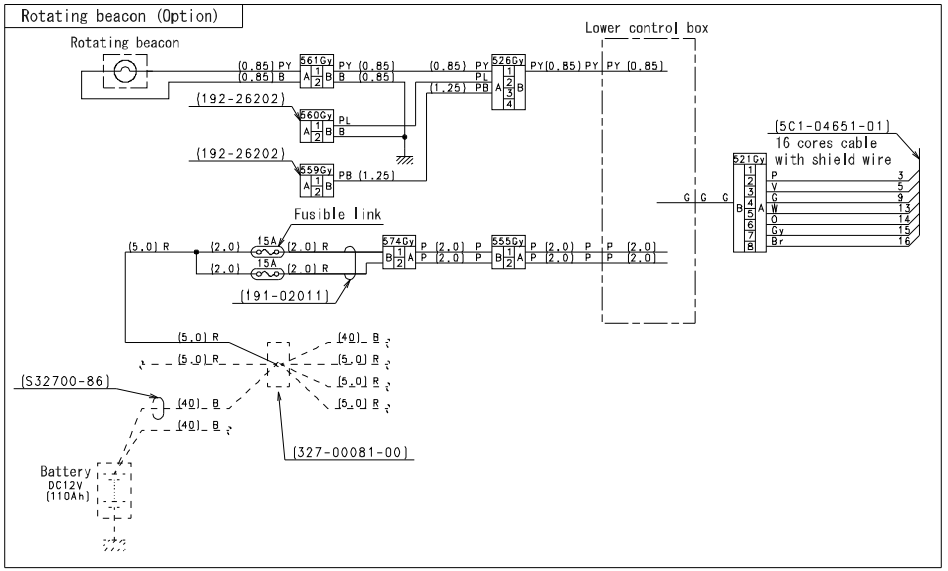


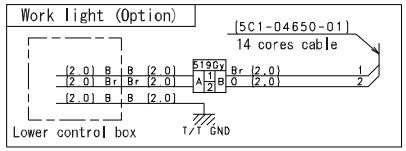




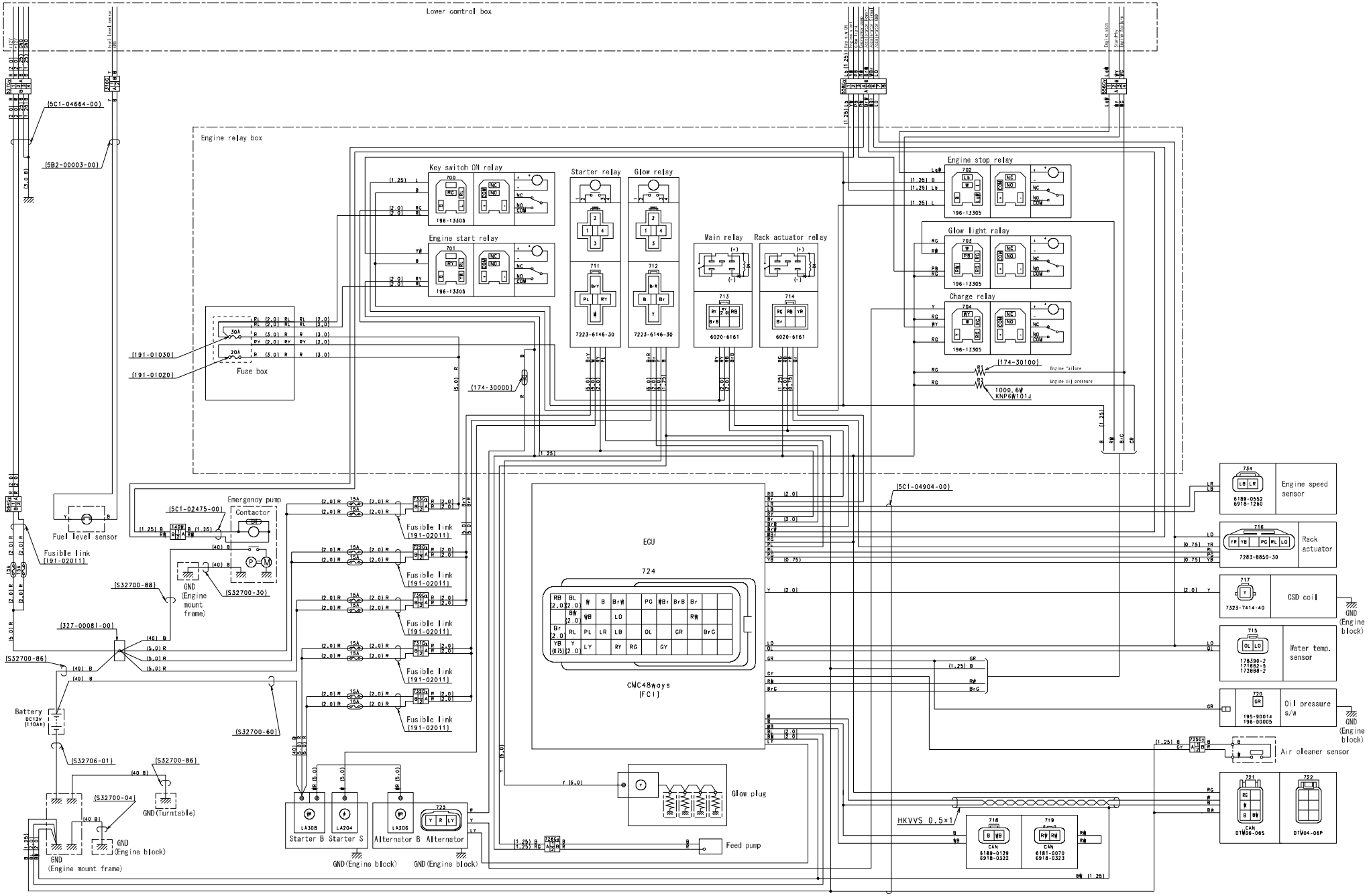








Electric wiring diagram, Engine (602-0076800B)



Water proof connector

Female housing

Number of pole	Color	Part number
2 poles	White	192-21102
	Gray	192-21202
	Green	192-21302
	Blue	192-21402
	Brown	192-21502
	Yellow	192-21602
4 poles	White	192-21104
	Gray	192-21204
	Green	192-21304
	Blue	192-21404
	Brown	192-21504
	Yellow	192-21604
6 poles	White	192-21106
	Gray	192-21206
	Green	192-21306
	Blue	192-21406
	Brown	192-21506
	Yellow	192-21606
8 poles	White	192-21108
	Gray	192-21208
	Green	192-21308
	Blue	192-21408
	Brown	192-21508
	Yellow	192-21608
12 poles	White	192-21112
	Gray	192-21212
	Green	192-21312

Male housing

Number of pole	Color	Part number
2 poles	White	192-22102
	Gray	192-22202
	Green	192-22302
	Blue	192-22402
	Brown	192-22502
	Yellow	192-22602
4 poles	White	192-22104
	Gray	192-22204
	Green	192-22304
	Blue	192-22404
	Brown	192-22504
	Yellow	192-22604
6 poles	White	192-22106
	Gray	192-22206
	Green	192-22306
	Blue	192-22406
	Brown	192-22506
	Yellow	192-22606
8 poles	White	192-22108
	Gray	192-22208
	Green	192-22308
	Blue	192-22408
	Brown	192-22508
	Yellow	192-22608
12 poles	White	192-22112
	Gray	192-22212
	Green	192-22312

Male housing (with Flange)

Number of pole	Color	Part number
4 poles	White	192-24104
	Gray	192-24204
	Green	192-24304
	Blue	192-24404
	Brown	192-24504
	Yellow	192-24604
6 poles	White	192-24106
	Gray	192-24206
	Green	192-24306
	Blue	192-24406
	Brown	192-24506
	Yellow	192-24606
8 poles	White	192-24108
	Gray	192-24208
	Green	192-24308
	Blue	192-24408
	Brown	192-24508
	Yellow	192-24608
12 poles	White	192-24112
	Gray	192-24212
	Green	192-24312

Others

Description	Part number	Remarks
Terminal (Female)	327-03607	
Terminal (Male)	327-03608	
Grommet S (Blue)	327-03660	for wire diameter: 1.5 ~ 2.0 mm
Grommet M (Brown)	327-03609	for wire diameter: 2.0 ~ 2.9 mm
Dummy plug	327-03663	

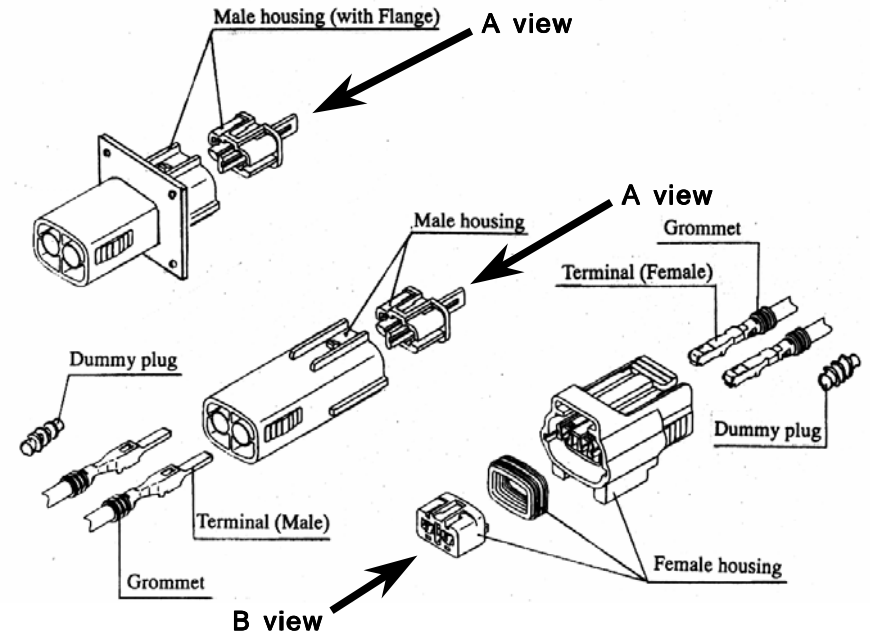
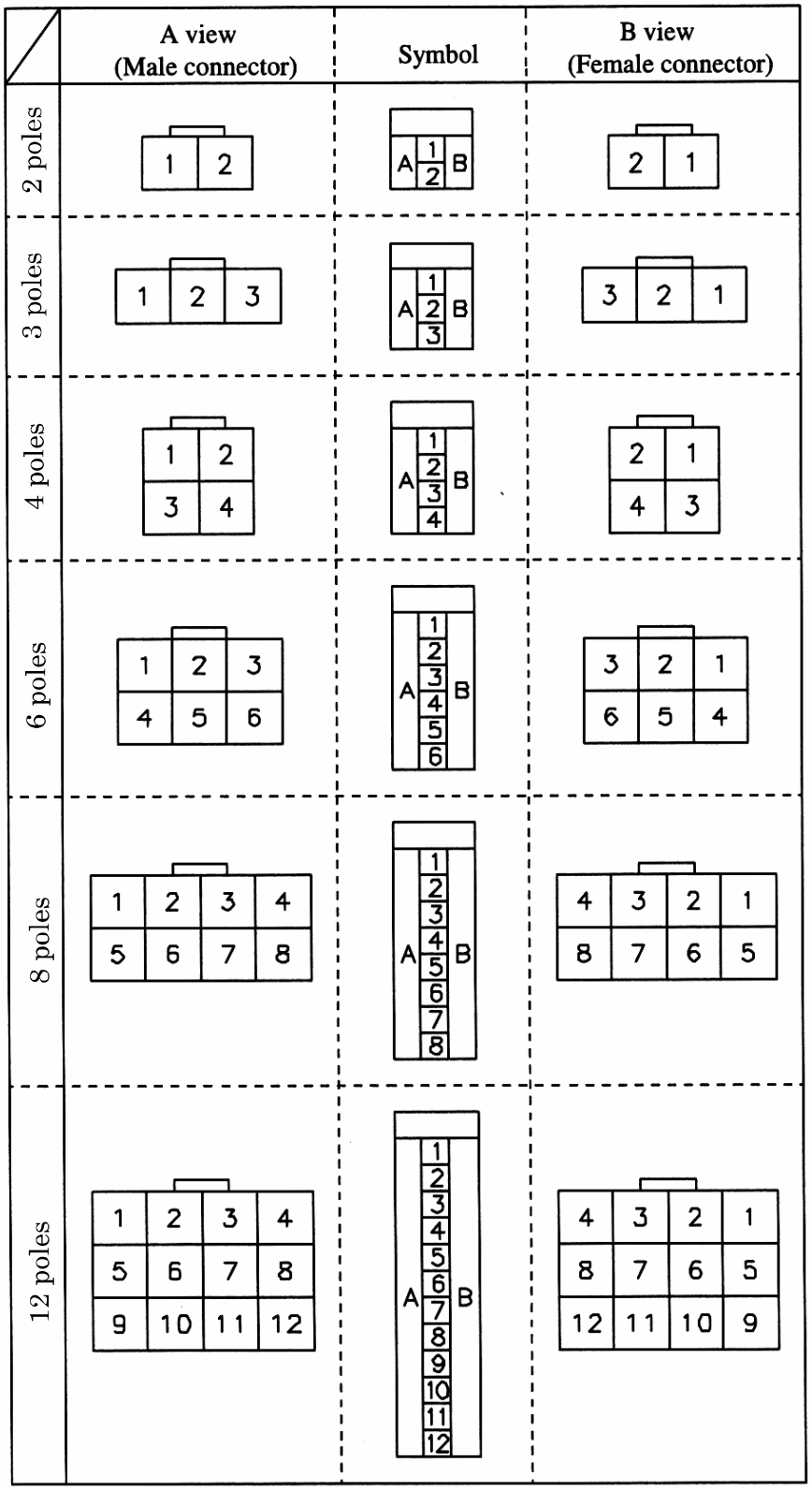


Fig. 7-1 Water proof connector

Pin arrangements of Water proof connector

See the table below to specify the pin arrangements of water proof connectors when reading "electric wiring diagram".



Color code of wires

See the table below to specify the colors of wires from the “Color codes”.

No.	Color codes	Color	No.	Color codes	Color
1	R	Red	31	GY	Green/ Yellow
2	Y	Yellow	32	GW	Green/ White
3	W	White	33	GB	Green/ Black
4	G	Green	34	GO	Green/ Orange
5	L	Blue	35	LR	Blue/ Red
6	B	Black	36	LY	Blue/ Yellow
7	V	Violet	37	LW	Blue/ White
8	P	Pink	38	LG	Blue/ Green
9	O	Orange	39	LB	Blue/ Black
10	Br	Brown	40	LO	Blue/ Orange
11	Lg	Light green	41	BR	Black/ Red
12	Lb	Light blue	42	BY	Black/ Yellow
13	Gy	Gray	43	BW	Black/ White
14	RY	Red/ Yellow	44	BG	Black/ Green
15	RW	Red/ White	45	BL	Black/ Blue
16	RG	Red/ Green	46	PY	Pink/ Yellow
17	RL	Red/ Blue	47	PL	Pink/ Blue
18	RB	Red/ Black	48	PB	Pink/ Black
19	YR	Yellow/ Red	49	OW	Orange/ White
20	YW	Yellow/ White	50	OB	Orange/ Black
21	YG	Yellow/ Green	51	BrR	Brown/ Red
22	YL	Yellow/ Blue	52	BrY	Brown/ Yellow
23	YB	Yellow/ Black	53	BrW	Brown/ White
24	WR	White/ Red	54	BrB	Brown/ Black
25	WY	White/ Yellow	55	LgR	Light green/ Red
26	WG	White/ Green	56	LgW	Light green/ White
27	WL	White/ Blue	57	LgB	Light green/ Black
28	WB	White/ Black	58	GyR	Gray/ Red
29	WBr	White/ Brown	59	GyB	Gray/ Black
30	GR	Green/ Red			

Tightening torque standard

Hexagon headed bolts (8T or 8.8T) and nuts (6T)

	Bolt	Nut
Strength grade	8T or 8.8T	6T
Material	S45C	S45C
Tensile strength	80 kg/cm^2	80 kg/cm^2

Size (mm)	Pitch (mm)	Tightening torque		
		N-m	kg-m	ft-lbs
5	0.8	3.71 - 5.87	0.32 - 0.60	2.31 - 4.34
6	1.0	5.42 - 10.0	0.56 - 1.04	4.05 - 7.52
8	1.25	13.0 - 24.2	1.33 - 2.47	9.62 - 17.9
10	1.5	25.7 - 47.6	2.59 - 4.81	18.7 - 34.8
12	1.75	44.6 - 82.7	4.55 - 8.45	32.9 - 61.1
14	2.0	71.2 - 132	7.00 - 13.00	50.6 - 94.0
16	2.0	109 - 201	11.2 - 20.8	81.0 - 150
18	2.5	157 - 291	16.1 - 29.9	116 - 216
20	2.5	220 - 407	22.4 - 41.6	162 - 301
22	2.5	296 - 549	30.1 - 55.9	218 - 404
24	3.0	379 - 703	38.5 - 71.5	278 - 517

Hexagon headed bolts (10.9T) and nuts (8T)

	Bolt	Nut
Strength grade	10.9T	8T
Material	SCM435	SCM435
Tensile strength	100 kg/cm^2	100 kg/cm^2

Size (mm)	Pitch (mm)	Tightening torque		
		N-m	kg-m	ft-lbs
5	0.8	7.21 - 8.79	0.73 - 0.90	5.28 - 6.51
6	1.0	12.3 - 15.1	1.26 - 1.54	9.11 - 11.1
8	1.25	29.7 - 36.2	3.06 - 3.74	22.1 - 27.1
10	1.5	58.5 - 71.3	5.94 - 7.26	43.0 - 52.5
12	1.75	102 - 124	9.90 - 12.10	71.6 - 87.5
14	2.0	162 - 197	16.2 - 19.8	117 - 143
16	2.0	247 - 302	25.2 - 30.8	182 - 223
18	2.5	364 - 422	35.1 - 42.9	254 - 310
20	2.5	483 - 589	49.5 - 60.5	358 - 438
22	2.5	652 - 795	66.6 - 81.4	482 - 589
24	3.0	835 - 1018	84.6 - 103	612 - 745

Hexagon socket headed cap screws (10.9T)

	Bolt
Strength grade	10.9T
Material	SCM435
Tensile strength	100 kg/cm^2

Size (mm)	Pitch (mm)	Tightening torque		
		N-m	kg-m	ft-lbs
5	0.8	4.81 - 5.87	0.49 - 0.60	3.54 - 4.34
6	1.0	8.24 - 10.0	0.81 - 0.99	5.86 - 7.16
8	1.25	19.8 - 24.2	2.07 - 2.53	15.0 - 18.3
10	1.5	39.0 - 47.6	3.96 - 4.84	28.6 - 35.0
12	1.75	67.8 - 82.7	6.93 - 8.47	50.1 - 61.3
14	2.0	108 - 132	10.8 - 13.2	78.1 - 95.5
16	2.0	165 - 201	17.1 - 20.9	124 - 151
18	2.5	239 - 291	24.3 - 29.7	176 - 215
20	2.5	333 - 407	34.2 - 41.8	247 - 302
22	2.5	450 - 549	45.9 - 56.1	332 - 406
24	3.0	576 - 703	58.5 - 71.5	423 - 517

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Chapter 9
Engine

Safety warnings for Engine maintenance

⚠DANGER

FIRE AND EXPLOSION HAZARD!

- **Diesel fuel is flammable and explosive under certain conditions.**
- **When you remove any fuel system component to perform maintenance (such as changing the fuel filter) place an approved container under the opening to catch the fuel.**
- **NEVER use a shop rag to catch the fuel. Vapors from the rag are flammable and explosive.**
- **Wipe up any spills immediately.**
- **Wear eye protection. The fuel system is under pressure and fuel could spray out when you remove any fuel system component.**
- **NEVER use diesel fuel as a cleaning agent.**
- **Failure to comply will result in death or serious injury.**

⚠DANGER

SCALD HAZARD!

- **NEVER remove the radiator cap if the engine is hot. Steam and hot engine coolant will spurt out and seriously burn you. Allow the engine to cool down before you attempt to remove the radiator cap.**
- **Tighten the radiator cap securely after you check the radiator. Steam can spurt out during engine operation if the cap is loose.**
- **ALWAYS check the level of the engine coolant by observing the reserve tank.**
- **Failure to comply will result in death or serious injury.**

⚠WARNING

BURN HAZARD!

- If you must drain the engine oil while it is still hot, stay clear of the hot engine oil to avoid being burned.
- ALWAYS wear eye protection.
- Failure to comply could result in death or serious injury.

⚠WARNING

BURN HAZARD!

- Wait until the engine cools before you drain the engine coolant.
  Hot engine coolant may splash and burn you.
- Failure to comply could result in death or serious injury.

⚠CAUTION

FLYING OBJECT HAZARD!

- ALWAYS wear eye protection when servicing the engine and when using compressed air or high-pressure water. Dust, flying debris, compressed air, pressurized water or steam may injure your eyes.
- Failure to comply may result in minor or moderate injury.

⚠CAUTION

COOLANT HAZARD!

- Wear eye protection and rubber gloves when you handle long life or extended life engine coolant. If contact with the eyes or skin should occur, flush eyes and wash immediately with clean water.
- Failure to comply may result in minor or moderate injury.

Component Identification

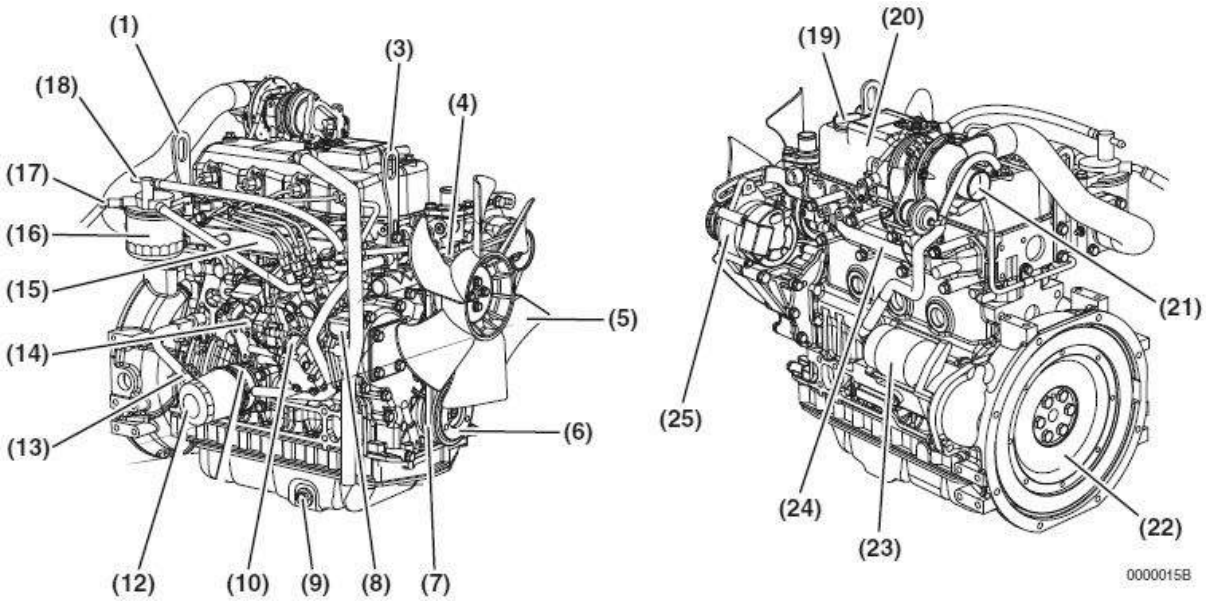


Fig.9-1

1 - Lifting Eye (Flywheel End)
3 - Lifting Eye (Engine Cooling Fan End)
4 - Engine Coolant Pump
5 - Engine Cooling Fan
6 - Crankshaft V-Pulley
7 -V-Belt
8 - Side Filler Port (Engine Oil)
9 - Drain Plug (Engine Oil)
10 - Fuel Injection Pump
12 -Engine Oil Filter
13 - Dipstick (Engine Oil)
14 -Governor Lever
15 - Intake Manifold
16 - Fuel Filter
17 - Fuel Inlet
18 - Fuel Return to Fuel Tank
19 - Top Filler Port (Engine Oil)
20 -Rocker Arm Cover
21 -Air Intake Port (From Air Cleaner)
22 - Flywheel
23 - Starter Motor
24 -Exhaust Manifold
25-Alternator

For detailed engine information, see Yanmar engine Operation manual / Service manual
Yanmar TNV series Operation Manual: Part number **0ATNV-G00101**
Yanmar TNV series Service Manual: Part number **0BTNV-G00101**

Periodical maintenance procedures

After initial 50 hours of operation

1) Replace Engine Oil and Engine Oil Filter

The engine oil on a new engine becomes contaminated from the initial break-in of internal parts. It is very important that the initial oil change is performed as scheduled.

Note: The oil drain plug may be in another location if an optional oil pan is used.

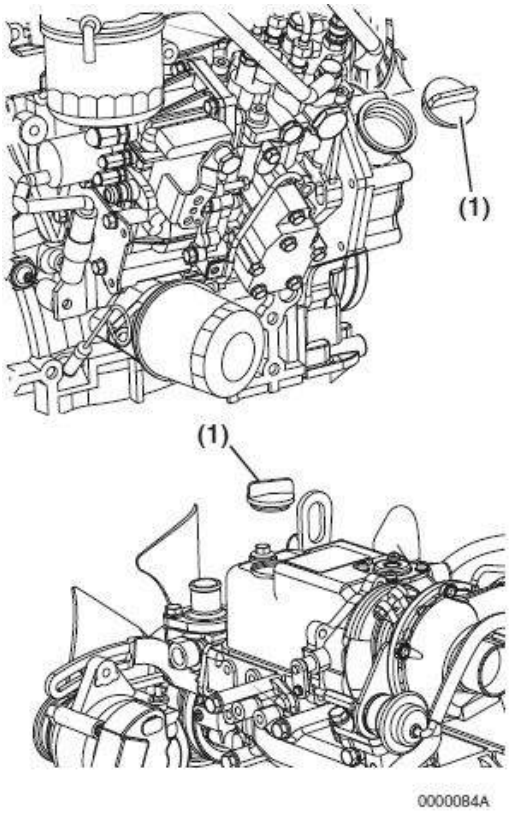


Fig.9-2

Drain the engine oil as follows:

1. Make sure the engine is level.
2. Start the engine and bring it up to operating temperature.
3. Stop the engine.
4. Remove one of the oil filler caps **(Fig.9-2, (1))** to vent the engine crankcase and allow the engine oil to drain more easily.
5. Position a container under the engine to collect waste oil.6. Remove the oil drain plug **(Fig.9-3, (1))** from the engine oil pan. Allow oil to drain.
7. After all oil has been drained from the engine, reinstall the oil drain plug **(Fig.9-3, (1))** and tighten to 40-47 ft-lb (53.9-63.7 N·m, 5.5-6.5 kgf/m).
8. Dispose of used oil properly.

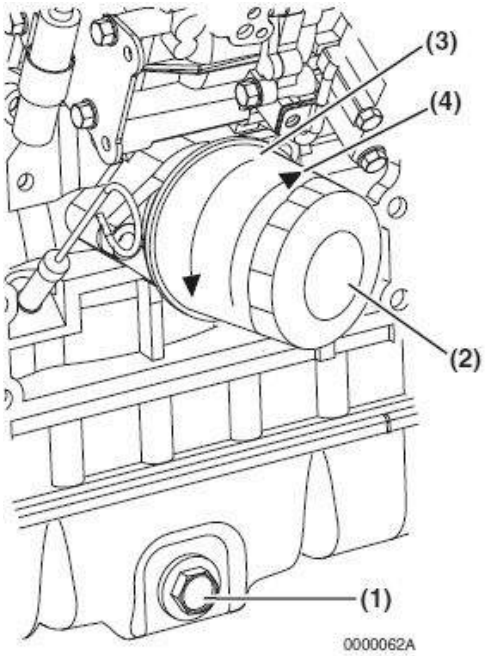


Fig.9-3

Remove the engine oil filter as follows:

1. Turn the engine oil filter **(Fig.9-3, (2))** counterclockwise **(Fig.9-3, (3))** using an oil filter wrench.
2. Clean the engine oil filter mounting face.
3. Lightly coat the gasket on the new oil filter with engine oil. Install the new engine oil filter manually by turning it clockwise **(Fig.9-3, (4))** until it contacts the mounting surface. Tighten to 14-17 ft-lb (19.6-23.5 N·m, 2.0-2.4 kgf/m) or one additional turn using the oil filter wrench.

Engine oil filter part number:
129150-35153

4. Add new engine oil to the engine through either of the oil filler ports as specified in **Fig.9-4.**
5. Warm up the engine by running it for 5 minutes and check for any engine oil leaks.6. After engine is warm, shut it off and let it sit for 10 minutes.
7. Recheck the engine oil level.
8. Add engine oil to engine oil filler port **(Fig.9-5, (5))** as needed until the level is between the upper **(Fig.9-5, (2))** and lower lines **(Fig.9-5, (3))** shown on the dipstick **(Fig.9-5, (1)).**
9. Reinstall the oil filler cap **(Fig.9-5, (4)).** If any engine oil is spilled, wipe it away with a clean cloth.

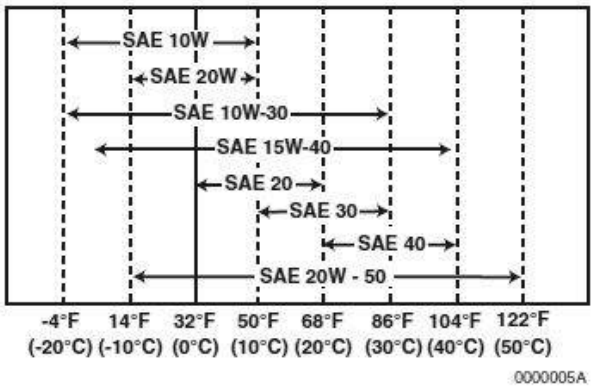


Fig.9-4

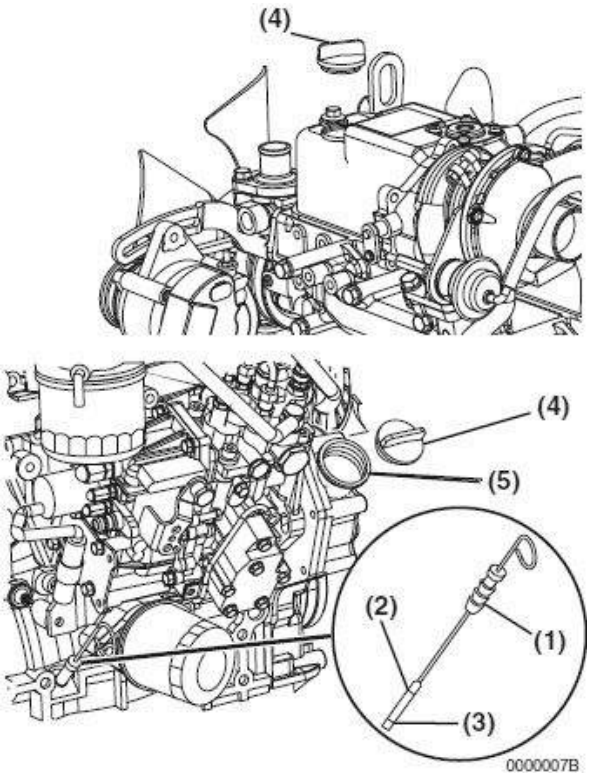


Fig.9-5

⚠CAUTION

- Only use the engine oil specified. Other engine oils may affect warranty coverage, cause internal engine components to seize and / or shorten engine life.
- Prevent dirt and debris from contaminating the engine oil. Carefully clean the oil cap / dipstick and the surrounding area before you remove the cap.
- NEVER mix different types of engine oil. This may adversely affect the lubricating properties of the engine oil.
- NEVER overfill. Overfilling may result in white exhaust smoke, engine overspeed or internal damage.

2) Check and Adjust Cooling Fan V-Belt

The V-belt will slip if it does not have the proper tension. This will prevent the alternator from generating sufficient power. Also, the engine will overheat due to the engine coolant pump pulley slipping.

Check and adjust the V-belt tension (deflection) as follows:

1. Press the V-belt down with your thumb with a force of approximately 22 ft-lb (98 N·m, 10 kgf/m) to check the deflection.
   There are three positions to check for V-belt tension **(Fig.9-6, (A), (B) and (C))**. You can check the tension at whichever position is the most accessible. The proper deflection of a used V-belt at each position is:
   (A) 10-14 mm [3/8 - 1/2 in]
   (B) 7-10 mm [1/4-3/8 in]
   (C) 9-13 mm [5/16-1/2 in]
2. If necessary, adjust the V-belt tension. Loosen the adjusting bolt **(Fig.9-7, (1))** and move the alternator **(Fig.9-7, (2))** with a pry bar **(Fig.9-7, (3))** to tighten the V-belt to the desired tension. Then tighten the adjusting bolt.
3. Tighten the V-belt to the proper tension. There must be clearance **(Fig.9-8, (1))** between the V-belt and the bottom of the pulley groove. If there is no clearance **(Fig.9-8, (2))** between the V-belt and the bottom of the pulley groove, replace the V-belt.
4. Check the V-belt for cracks, oil or wear. If any of these conditions exist, replace the V-belt.
5. Install the new V-belt and adjust the proper deflection.
   The proper deflection of a new V-belt at each position is:
   (A) 8-12 mm [5/16 - 7/16 in]
   (B) 5-8 mm [3/16-5/16 in]
   (C) 7-11 mm [1/4-7/16 in]
6. After adjusting, run the engine for 5 minutes or more. Check the tension again using the specifications for a used V-belt.

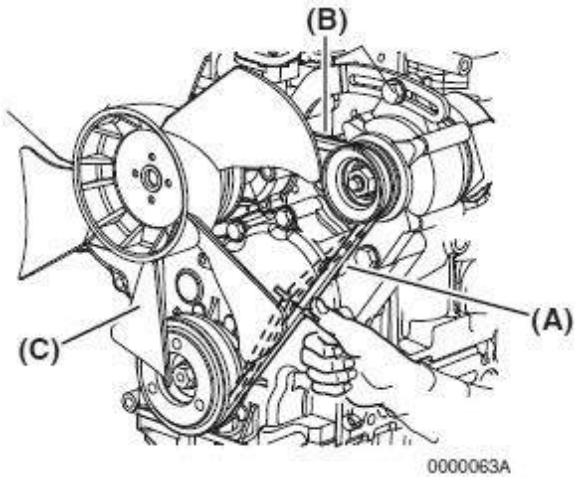


Fig.9-6

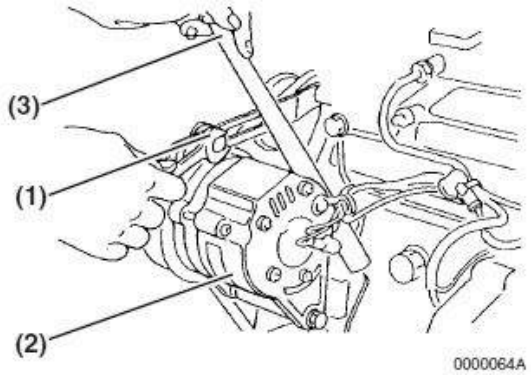


Fig.9-7

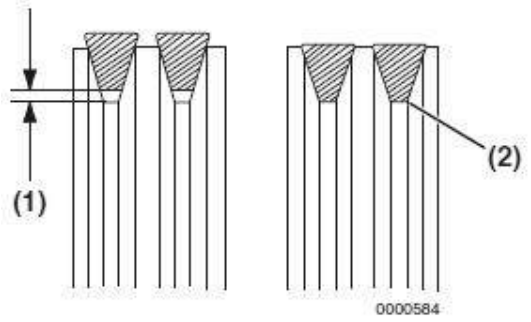


Fig.9-8

Every 50 hours of operation

1) Drain Fuel Filter / Water Separator

Drain the fuel filter / water separator whenever there are contaminants, such as water, collected in the bottom of the cup.
NEVER wait until the scheduled periodic maintenance if contaminants are discovered.
The separator cup is made from semi-transparent material. In the cup is a red-colored float ring.
The float ring will rise to the surface of the water to show how much needs to be drained.
Also, some optional fuel filter / water separators are equipped with a sensor to detect the amount of contaminants. This sensor sends a signal to an indicator to alert the operator.

Drain the fuel filter / water separator as follows:

1. Position an approved container under the fuel filter / water separator **(Fig.9-9, (1))** to collect the contaminants.
2. Close **(Fig.9-9, (2))** the fuel cock **(Fig.9-9, (3))**.
3. Loosen the drain cock **(Fig.9-9, (4))** at the bottom of the fuel filter / water separator. Drain any water collected inside.
4. Hand-tighten the drain cock.
5. Open the fuel cock **(Fig.9-9, (3))**.
6. Turn the key to the ON position for 10 to 15 seconds to prime the diesel fuel system by the electric fuel pun when you are done.
7. Check for fuel leaks.

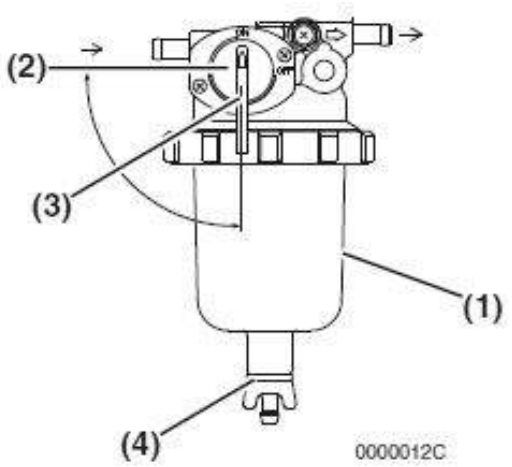


Fig.9-9

⚠CAUTION

NEVER use the starter motor to crank the engine in order to prime the fuel system.
This may cause the starter motor to overheat and damage the coils, pinion and / or ring gear.

⚠CAUTION

If no water drips when the fuel filter / water separator drain cock is opened, loosen the air vent screw on the top of the fuel filter / water separator by using a screwdriver to turn it counterclockwise 2-3 turns.
This may occur if the fuel filter / water separator is positioned higher than the fuel level in the fuel tank.
After draining the fuel filter / water separator, be sure to tighten the air vent screw.

Every 250 hours of operation

1) Drain Fuel tank

1. Position an approved container under the diesel fuel tank **(Fig.9-10, (1))** to collect the contaminants.
2. Take the drain hose **(Fig.9-10, (2))** from the clamp **(Fig.9-10, (3))**, and then put the end of the hose into the container.
3. Remove the fuel cap **(Fig.9-10, (4))**.
4. Remove the drain plug **(Fig.9-10, (5))** from the hose end to drain the contaminants (water, dirt, etc.) from the bottom of the tank.
5. Drain the tank until clean diesel fuel with no water or dirt flows out. Reinstall and tighten the drain plug firmly.
6. Reinstall the fuel cap.
7. Fix the drain hose by clamp.
8. Check for leaks.

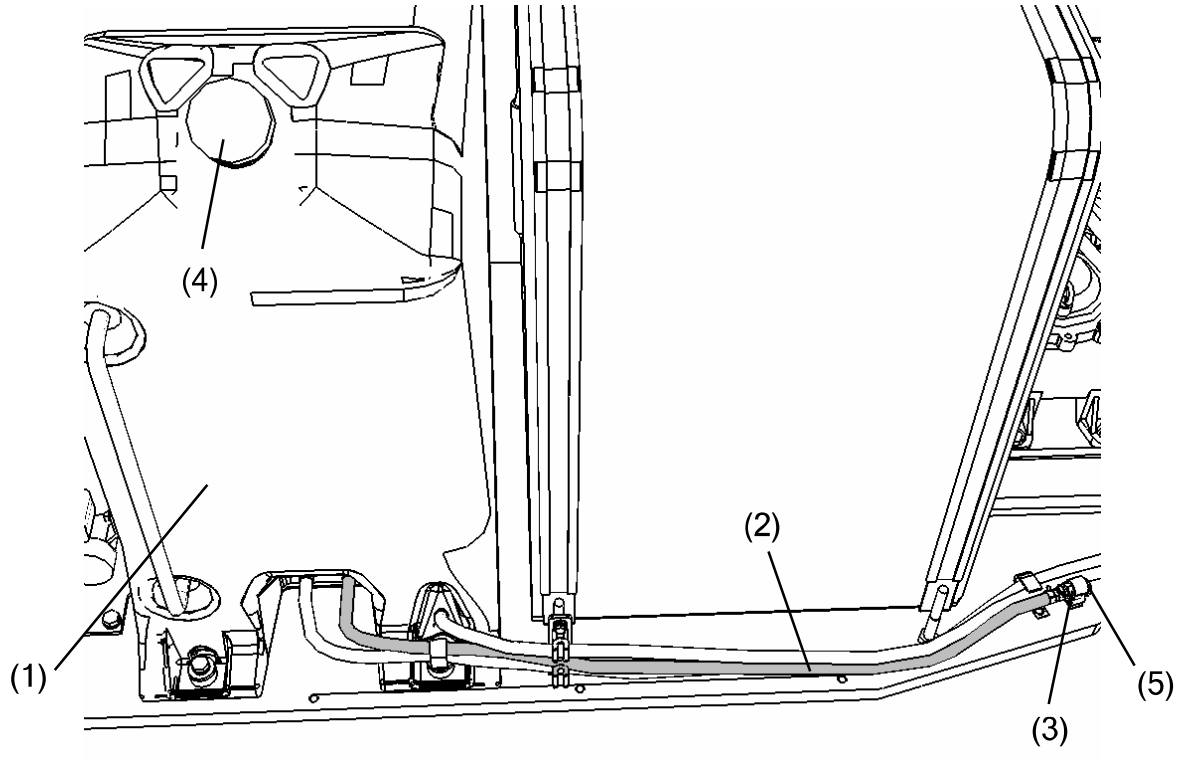


Fig.9-10

2) Replace Engine Oil and Engine Oil Filter

Change the engine oil every 250 hours of operation after the initial change at 50 hours.

Replace the engine oil filter at the same time.

See Replace Engine Oil and Engine Oil Filter on page 9-5.

3) Check and Clean Radiator Fins

Dirt and dust adhering to the radiator fins reduce the cooling performance, causing overheating. Make it a rule to check the radiator fins daily and clean as needed.

Blow off dirt and dust from fins and radiator with 28 psi (0.19 MPa, 2 kgf/cm2) or less of compressed air **(Fig.9-11, (1))**. Be careful not to damage the fins with the compressed air.
If there is a large amount of contamination on the fins, apply detergent, thoroughly clean and rinse with tap water.

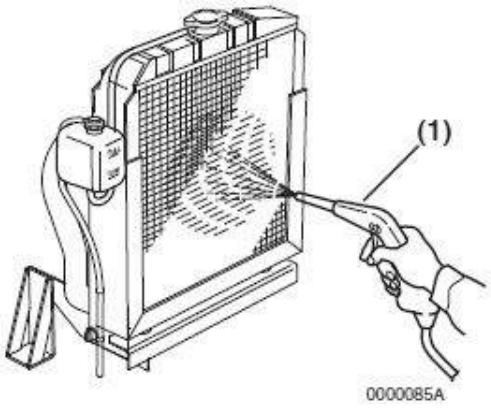


Fig.9-11

⚠CAUTION

NEVER use high-pressure water or compressed air at greater than 28 psi (193 kPa; 19 686 mmAq) or a wire brush to clean the radiator fins. Radiator fins damage easily.

4) Check and Adjust Cooling Fan V-Belt

Check and adjust the cooling fan V-belt every 250 hours of operation after the initial 50 hour V-belt maintenance.
See Check and Adjust Cooling Fan V-Belt on page 9-7.

5) Clean Air Cleaner Element

Note that a typical air cleaner is shown in **Fig.9-12** and **Fig.9-13** for illustrative purposes only.
The engine performance is adversely affected when the air cleaner element is clogged with dust. Be sure to clean the air filter element periodically.

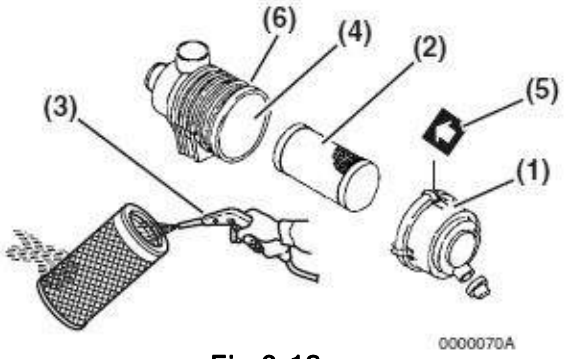


Fig.9-12

1. Unlatch and remove the air cleaner cover **(Fig.9-12, (1)).**
2. Remove the element **(Fig.9-12, (2))** (outer element if equipped with two elements).
3. Blow air **(Fig.9-12, (3))** through the element from the inside out using 42-71 psi (0.29-0.49 MPa, 3.0-5.0 kgf/cm2) compressed air to remove the particulates. Use the lowest possible air pressure to remove the dust without damaging the element.
4. If the air cleaner is equipped with a double element, only remove and replace the inner element (Fig.9-13, (1)) if the engine lacks power or the dust indicator actuates (if equipped).

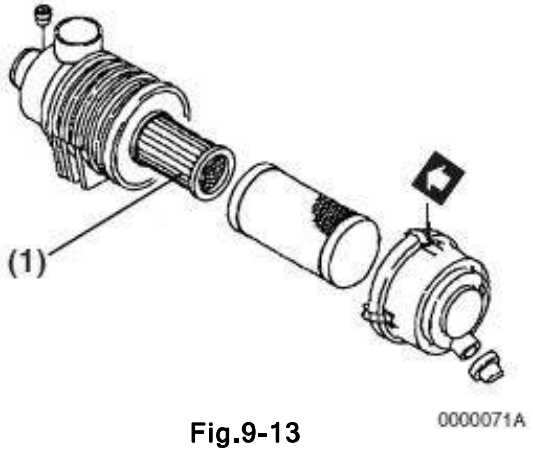


Fig.9-13

Note:
The inner element should not be removed when cleaning or replacing the outer element.
The inner element is used to prevent dust from entering the engine while servicing the outer element.

5. Replace the element with a new one if the element is damaged, excessively dirty or oily.
6. Clean inside of the air cleaner cover.
7. Reinstall the element into the air cleaner case **(Fig.9-12, (4)).**
8. Reinstall the air cleaner cover making sure you match the arrow **(Fig.9-12, (5))** on the cover with the arrow on the case **(Fig.9-12, (6)).**
9. Latch the air cleaner cover to the case.

⚠CAUTION

- When the engine is operated in dusty conditions, clean the air cleaner element more frequently.
- NEVER operate the engine with the air cleaner element(s) removed.
  This may allow foreign material to enter the engine and damage it.

Every 500 hours of operation

1) Replace Air Cleaner Element

Replace the air cleaner element **(Fig.9-12, (2))** every 500 hours even if it is not damaged or dirty.
When replacing the element, clean the inside of the air cleaner case **(Fig.9-12, (4)).**
If the air cleaner is equipped with a double element, only remove and replace the inner element **(Fig.9-13, (1))** if the engine lacks power or the dust indicator actuates (if equipped).
This is in addition to replacing the outer element.

Air cleaner element part number:
119005-12571

2) Replace Fuel Filter

Replace the fuel filter at specified intervals to prevent contaminants from adversely affecting the diesel fuel flow.

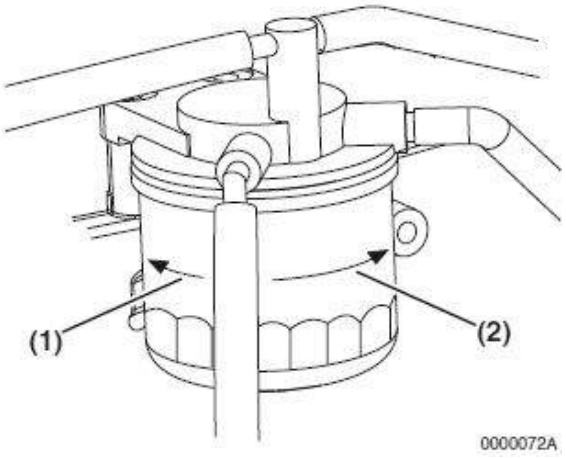


Fig.9-14

1. Stop the engine and allow it to cool.
2. Close the fuel cock of the fuel filter / water separator.
3. Remove the fuel filter using a filter wrench to turn it to the left **(Fig.9-14, (1)).** When removing the fuel filter, carefully hold it to prevent the fuel from spilling. Wipe up all spilled fuel.
4. Clean the filter mounting surface and apply a small amount of diesel fuel to the gasket of the new fuel filter.
5. Install the new fuel filter. Hand-tighten it to the right **(Fig.9-14, (2))** until it comes in contact with the mounting surface. Use a filter wrench and tighten to 14-17 ft-lb (19.6-23.5 N•m, 2.0-2.4 kgf/m) or one additional turn using the filter wrench.
6. Open the fuel cock of the fuel filter / water separator.
7. Turn the key to the ON position for 10 to 15 seconds to prime the diesel fuel system by the electric fuel pump.
8. Check for fuel leaks.

Engine oil filter part number:
119802-55801

3) Clean Fuel Filter / Water Separator

Periodically clean the fuel filter / water separator element and inside the cup.

1. Position an approved container under the cup **(Fig.9-15, (1))** of the fuel filter / water separator to collect the contaminants.
2. Close **(Fig.9-15, (2))** the fuel cock **(Fig.9-15, (3))**.
3. Loosen the drain cock **(Fig.9-15, (4))** and drain the contaminants. See Drain Fuel Filter / Separator on page 9-5.
4. Turn the retaining ring **(Fig.9-15, (5))** to the left **(Fig.9-15, (10))** and remove the cup **(Fig.9-15, (1))**. If equipped, disconnect the sensor wire **(Fig.9-15, (7))** from the cup before removing the cup.
5. Carefully hold the cup to prevent fuel from spilling. If you spill any fuel, clean up the spill completely.
6. Remove the float ring **(Fig.9-15, (8))** from the cup. Pour the contaminants into the container and dispose of it properly.
7. Clean the element **(Fig.9-15, (9))** and inside cup. Replace the element if it is damaged.

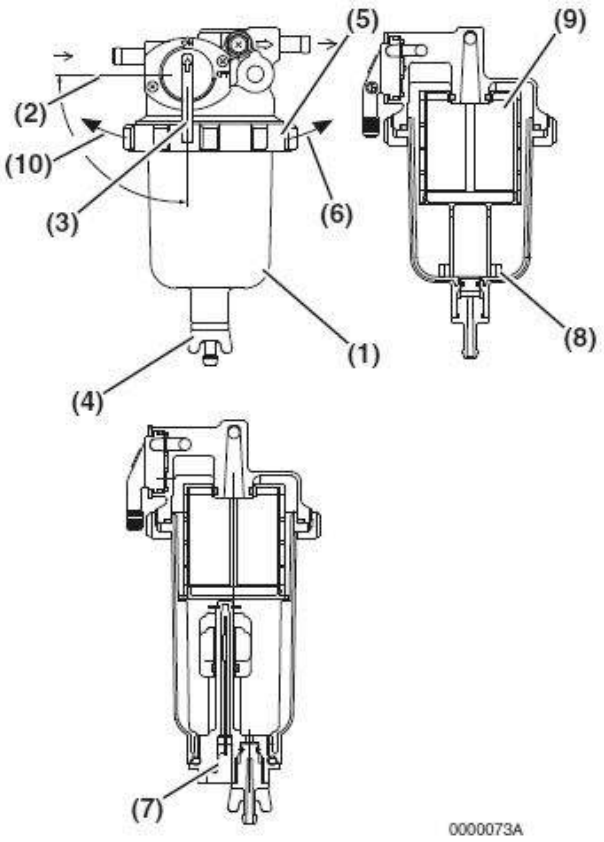


Fig.9-15

Element part number
119802-55710

8. Install the element and O-ring in the bracket.
9. Position the float ring in the cup.
10. Check the condition of the O-ring. Replace if necessary.
11. Install the cup to the bracket by tightening the retaining ring to the right **(Fig.9-15, (6))** to 11-15 ft-lb (15-20 N·m, 1.5-2.0 kfg/m).
12. Close the drain cock. Reconnect the sensor wire if equipped.
13. Open the fuel cock **(Fig.9-15, (3))**.
14. Turn the key to the ON position for 10 to 15 seconds to prime the diesel fuel system by the electric fuel pump.
15. Check for leaks.

Every 1,000 hours of operation

1) Drain, Flush and Refill Cooling System With New Coolant

Engine coolant contaminated with rust or water scale reduces the cooling effect. Even when extended life engine coolant is properly mixed, the engine coolant gets contaminated as its ingredients deteriorate. Drain, flush and refill the cooling system with new coolant every 1000 hours or once a year, whichever comes first.

1. Allow engine and coolant to cool.
2. Remove the radiator cap **(Fig.9-16, (1))**.
3. Remove the drain plug or open the drain cock **(Fig.9-16, (2))** at the bottom of the radiator and drain the engine coolant.
4. Drain the coolant from the engine block. remove the coolant drain plug **(Fig.9-17, (1))** from the engine block.
5. After draining the engine coolant, flush the radiator and engine block to remove any rust, scale and contaminants. Then reinstall and tighten the drain plug or close the drain cock in the radiator. Reinstall and tighten the engine block drain plug or reconnect the coolant hose at the oil cooler.
6. Fill radiator and engine with engine coolant.

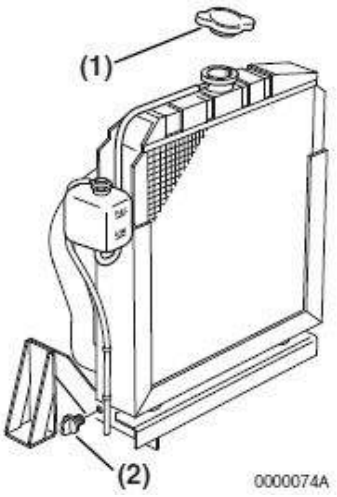


Fig.9-16

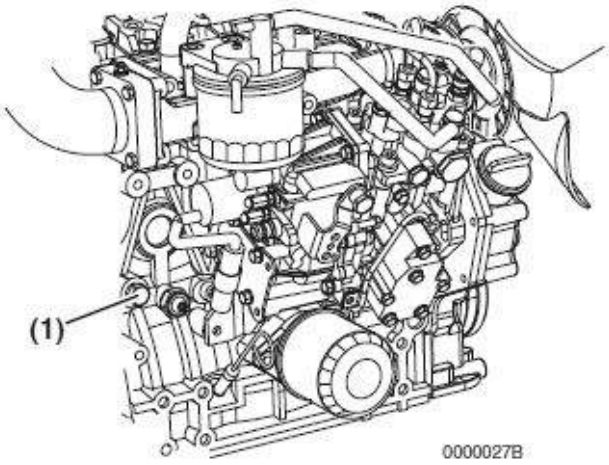


Fig.9-17

2) Adjust Intake / Exhaust Valve Clearance

Proper adjustment is necessary to maintain the correct timing for opening and closing the valves. Improper adjustment will cause the engine to run noisily, resulting in poor engine performance and engine damage. Ask your authorized Yanmar industrial engine dealer or distributor to adjust the intake / exhaust valve clearance.

Every 1,500 hours of operation

1) Inspect, Clean and Test Fuel Injectors

Proper operation of the fuel injectors is required to obtain the optimum injection pattern for full engine performance. The EPA / ARB requires that you have the injectors inspected, cleaned and tested every 1500 hours. Ask your authorized Yanmar industrial engine dealer or distributor for this service.

2) Inspect Crankcase Breather System

Proper operation of the crankcase breather system is required to maintain the emission requirements of the engine. The EPA / ARB requires that you have the crankcase breather system inspected every 1500 hours. Ask your authorized Yanmar industrial engine dealer or distributor for this service.

Every 2,000 hours of operation

1) Check and Replace Fuel Hoses and Engine Coolant Hoses

Regularly check the fuel system and engine coolant system hoses. If they are cracked or degraded, replace them. Replace the hoses at least every two years. Ask your authorized Yanmar industrial engine dealer or distributor to replace fuel hoses and engine coolant system hoses.

2) Lap the Intake and Exhaust Valves

Adjustment is necessary to maintain proper contact of the valves and seats. Ask your authorized Yanmar industrial engine dealer or distributor to lap the valve seats.

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