SECTION 7 ELECTRICAL SYSTEM

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SECTION 7 ELECTRICAL SYSTEM

GROUP 1 COMPONENT LOCATION



15D9EL01

- 1 Head lamp
- 2 Turn signal lamp
- 3 Horn assembly
- 4 Beacon lamp (opt)
- 5 Combination lamp
- 6 Back buzzer
- 7 Forward-reverse lever
- 8 Cluster

- 9 Start switch
- 10 Head lamp switch Illumination lamp Turn signal switch
- 11 Horn button
- 12 Beacon switch (opt)
- 13 Flasher unit
- 14 MCU

- 15 Buzzer
- 16 Hazard lamp switch (opt)
- 17 Fuse box
- 18 Battery
- 19 Parking switch
- 20 Work lamp switch rear (opt)
- 21 Forced regen switch (opt)
- 22 Inhibit regen switch (opt)

GROUP 2 ELECTRICAL CIRCUIT



15D9EL02

MEMORANDUM

1. POWER CIRCUIT

The negative terminal of the battery is grounded to the machine chassis. When the start switch is in the OFF position, the current flows from the positive battery terminal.

1) OPERATING FLOW

Battery (+) Start motor [CN-45 (B+)] Fusible link [CN-95A (1
$$\rightarrow$$
2)] - Glow relay [CR-24]
Start relay [CR-23 (1)]
Fuse box [CN-36]
Fuse box [CN-36 (1)] Alternator [CN-74 (B+)]
Fuse box [CN-36 (2)] Start key SW [CS-2 (1)]
Fuse box [CN-36 (4)] Main relay [CR-43 (3)]
Fuse box [CN-36 (5)] I/conn [CN-2 (5)] OPS buzzer [CN-113]
Fuse box [CN-36 (6)] Horn [CN-25 (1)]
Fuse box [CN-36 (7)] I/conn [CN-1 (3)] Flasher unit [CR-11]

2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	OFF	① - GND (Battery (+))	
		2 - GND (Fusible link)	10 121/
		③ - GND (Fuse No.1, 2, 3)	10~13v
		④ - GND (Start key)	

* GND : Ground

^{*} The circuit diagram may differ from the equipment, so please check before a repair.

POWER CIRCUIT



* The circuit diagram may differ from the equipment, so please check before a repair.

2. STARTING CIRCUIT

1) OPERATING FLOW

Battery (+) terminal - Start motor [CN-45 (B+)] - Start relay [CR-23 (1)] └── Fuse box [CN-36 (2)] ── I/conn [CN-1 (2)] ── Start key SW [CS-2 (12)]

* The engine can be started only when the gearshift is in neutral position.

(1) When start key switch is in ON position

Start switch ON [CS-2 (1)] → I/conn [CN-1 (8)] → Fuse box [CN-36 (3)] ← Fuse box [CN-36 (16)] → Alternator [CN-74] ← Fuse box [CN-36 (17)] ← Steering column switch [CS-11] ← Head lamp relay [CR-13]

(2) When start key switch is START position

Start switch START[CS-2(2)] -- I/conn [CN-1 (1)]

```
← Fuse box [CN-36 (36)→(33)] ← Neutral relay [CR-5 (3)→(4)] ← Safety relay [CR-23]
↓ //conn [CN-96 (4)] ← ECU [CN-151 (37)]
```

2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running		① - GND (Battery B+) ② - GND (Head Jamp relay)	
	ON	③ - GND (Start key)	10 ~ 14.5V
		4 - GND (Neutral relay)	

※ GND : Ground

STARTING CIRCUIT



* The circuit diagram may differ from the equipment, so please check before a repair.

3. CHARGING CIRCUIT

When the starter is activated and the engine is started, the operator release the start switch to the ON position. Charging current generated by operating alternator flows into the battery.

The current also flows from alternator to each electrical component through the fusible link(CN-95A) and the fuse box.

1) OPERATING FLOW

(1) Warning flow

Alternator [CN-74 (L)] -- I/conn [CN-2 (26)] -- MCU [CN-54 (11)]

(2) Charging flow

Alternator [CN-74 (B+)] -- Fuse box [CN-36 (1)] -- Battery (+) terminal -- Charging

2) CHECK POINT

Engine	Key switch	Check point	Voltage
		① - GND (Alternator B+)	
ON	ON	② - GND (Start switch)	10 ~ 14.5V
		3 - GND (Cluster)	

% GND : Ground

※ Cautions

- 1. When using an arc welder, always disconnect the ground lead from the battery to prevent alternator or battery damage.
- 2. Attach the welding ground clamp as close to the weld area as possible to prevent welding current from damaging the bearings of the alternator.
- 3. Do not disconnect the battery when the engine is running. The voltage surge can damage the diode and resistors in the electrical system.
- 4. Do not disconnect an electric wire before the engine is stopped and the switches are OFF.

CHARGING CIRCUIT



* The circuit diagram may differ from the equipment, so please check before a repair.

GROUP 3 COMPONENT SPECIFICATION

No	Part name	Qty		Specific	ation			Remark
1	Battery	1	12V-CMF100 RC : 190min CCA : 850A					
2	Working lamp	1	12V, Green LED					
3	License lamp	1	12V, 3.4W×12					
4	Rear combination lamp	2	12V, 21W(T/S) 12 12V, 5W (Tail) 12V, 21W(Stop)	2V, 10W(E	Back)			
5	Head lamp	2	12V, 55W					
6	Flasher lamp	2	12V, 23/8W					
7	Flasher unit	1	85±10C/M, (23W+	23W)×2	+3W×2			
8	Backup alarm	1	12V, 90 \pm 5dB, 60 \pm	10C/M				
9	Horn	1	12V, MAX 3.5A, 10	5~120dB				
10	Fuel level sender	1	Reed switch - Magr	net type				
			Float indicate	E	4/8	F]	
			Resistance [\mathcal{Q}]	700	350	50	=	
			Allowance [\mathcal{Q}]	+5%	±5%	- 5%		
11	Master switch	1	180A					
12	Hazard switch	1	12V, Red LED					
13	Start switch	1	12V/24V, 15~28A					
14	OPSS unit	1	12V/24V, MAX 0.5A	(at 12V)				
15	Relay (5P)	8	12V, 20A	<u> </u>				
16	Parking brake switch	1	12V, Red LED lamp)				
17	Inhibit switch	1	12V, Green LED					
18	Forced regen switch	1	12V, Green LED					
19	Beacon lamp switch	1	12V, Green LED					
20	Warning buzzer	1	12V, 50mA MAX, 80	0~90dB				
21	Cluster	1	12V, 15W, TFT LCD TYPE (5.7")					
22	MCU	1	12V/24V, 5W					
23	Combination switch	1	12V/24V, 24V/3.5A					
24	Combination multi switch	1	12V/24V, 24V/2A					
25	Gear selector switch	1	12V/24V, 24V/3.5A					
26	Accelerator pedal	1	17.5° \pm 2°, 5V \pm 2%, 16mA (normal), Load : 3.3 kgf (max)					
27	Start relay	2	12V					
28	Beacon lamp	1	12V					

GROUP 4 CONNECTOR DESTINATION

Connector	Tiree	No. of	Destination	Connecto	or part No.
number	туре	pin	Destination	Female	Male
CN-1	AMP	15	I/conn (Frame harness-dashboard harness)	2-85262-1	85262-1
CN-2	AMP	42	I/conn (Dashboard harness-frame harness)	936421	936429
CN-4	AMP	4	To OHG harness	174257-2	-
CN-5	AMP	4	To OHG harness-RH	174257-2	-
CN-16	DEUTSCH	4	Heater for cabin	-	DT04-4P
CN-17	KET	4	Power output	S810-004201	-
CN-25	AMP	1	Horn	171809-2	-
CN-54	AMP	34	MCU	4-1437290-0	
CN-55	AMP	34	MCU	4-1437290-1	-
CN-56	AMP	14	Cluster	776273-1	-
CN-62	YAZAKI	6	Glow unit	7123-2262	-
CN-65	KET	2	Back buzzer	-	MG640322
CN-71	DEUTSCH	2	Parking solenoid	DT06-2S	-
CN-74	PACKARD	2	Alternator	12162193	-
CN-87	SUMITOMO	2	Fuel stop solenoid	6195-0003	-
CN-91	AMP	4	Seat harness	-	174259-2
CN-95A	KET	2	Fusible link	-	S813-130201
CN-95B	KET	2	Fusible link	-	S813-130201
CN-96	KUM	10	To engine harness	PB625-10027	-
CN-97	KET	2	To engine harness	MG642928-5	-
CN-98	KUM	6	To engine harness	PB625-06027	-
CN-113	KET	2	OPSS buzzer	MG610320	-
CN-122	DEUTSCH	2	Forward solenoid	DT06-2S	-
CN-123	DEUTSCH	2	Reverse solenoid	DT06-2S	-
CN-130	PACKARD	2	Cut off solenoid (Lift, down)	12015792	-
CN-131	PACKARD	2	Cut off solenoid (Tilt, lift)	12015792	-
CN-134	KET	20	Diagnosis port	MG652863	-
CN-144	AMP	6	Accel pedal	174262-2	-
Switch					
CS-2	KET	2	Start switch	MG620281	MG620282
CS-5	-	-	Horn switch	S820-105000	-
CS-6	DAEDONG	10	Heater switch	250-10PRG	-
CS-11	DEUTSCH	6	Gear selector	DT06-6S	-
CS-12	DEUTSCH	6	Combination switch	DT06-6S-P012	-
CS-13	KET	2	Auto leveling switch	MG610320	-
CS-17	CARLING	10	Parking switch	21HN-45010	-

Connector	Tuno	No. of	Destination	Connector part No.	
number	туре	pin	Desination	Female	Male
CS-21	AMP	6	Work lamp switch	174262-2	-
CS-23	AMP	10	Beacon lamp switch	174262-2	-
CS-41	CARLING	10	Harzard switch	21HN-45010	-
CS-73	KET	2	Seat switch	S810-002201	-
CS-75	AMP	6	Regeneration switch	174262-2	-
CS-76	AMP	6	Regen inhibit switch	174262-2	-
Lamp					
CL-3	KET	2	Head lamp	S822-014000	S822-114000
CL-7	KET	2	Beacon lamp	S822-014000	S822-114000
CL-15	DAEDONG	6	Combination lamp-LH	110-6PR	-
CL-16	DAEDONG	6	Combination lamp-RH	110-6PR	-
CL-21	KET	2	License lamp	ST730018-6	ST750036-3
CL-23	KET	2	Working lamp	S822-014000	S822-114000
Relay					
CR-5	KET	4	Neutral relay	S810-004201	-
CR-11	DAEDONG	3	Flasher unit relay	312 GIHUNG 3P	-
CR-13	KET	4	Head lamp relay	S810-004201	-
CR-23	KET	2	Starter relay	MG610320	-
CR-24	KET	2	Glow relay	MG610320	-
CR-35	AMP	4	Warning relay	S810-004202	-
CR-50	KET	5	Travel cut relay	MG640927	-
CR-51	KET	5	Attach cut relay	MG640927	-
Sensor and	l pressure swi	tch			1
CD-2	KET	2	Fuel level sensor	MG610320	-
CD-4	DEUTSCH	4	Brake oil pressure sensor	DT06-4S	-
CD-5	DEUTSCH	4	Hydraulic temp sensor	DT06-4S	-
CD-6	AMP	4	G-sensor	174257-2	-
CD-8	AMP	1	Temp sender (For cluster)	S819-010122	-
CD-10	KET	1	Air cleaner switch	ST730057-2	-
CD-18	AMP	1	Engine oil pressure sender	S819-010122	-
CD-26	DEUTSCH	2	Parking pressure switch	DT06-2S	-
CD-29	DEUTSCH	4	T/M temp switch	DT06-4S	-
CD-30	AMP	2	Temp sender (For glow)	85202-1	-
CD-40	AMP	3	Speed sensor	85205-1	-
CD-60	KET	2	Brake oil level	MG610320	-
CD-70	DEUTSCH	3	Load sensor	DTM06-3S	-
Diode			·		
DO-1	QPL	-	Diode	21EA-50550	-

GROUP 5 TROUBLESHOOTING

Trouble symptom	Probable cause	Remedy
Lamps dimming even at maxi-mum engine speed.	 Faulty wiring. 	Check for loose terminal and disconnected wire.
Lamps flicker during engine operation.	Improper belt tension.	 Adjust belt tension.
Charge lamp does not light d-uring normal engine operation.	 Charge lamp defective. Faulty wiring. 	 Replace. Check and repair.
Alternator makes abnormal sounds.	Alternator defective.	· Replace
Starting motor fails to run.	 Faulty wiring. Insufficient battery voltage. 	Check and repair. Recharge battery.
Starting motor pinion repeats going in and out.	Insufficient battery voltage.	Recharge battery.
Excessively low starting motor speed.	 Insufficient battery voltage. Starting motor defective. 	 Recharge battery. Replace
Starting motor comes to a stop before engine starts up.	 Faulty wiring. Insufficient battery voltage. 	 Check and repair. Recharge battery.
Heater signal does not beco-me red.	 Faulty wiring. Glow plug damaged. 	 Check and repair. Replace
Engine oil pressure caution lamp does not light when engi-ne is stopped (with starting switch left in"ON" position).	 Caution lamp defective. Caution lamp switch defective. 	 Replace Replace

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GROUP 1 STRUCTURE

1.2 STAGE MAST (V MAST)



- 1 Outer mast
- 2 Inner mast
- 3 Roller
- 4 Tilt cylinder pin
- 5 Mast support cap
- 6 Bushing

- 7 Chain sheave
- 8 Chain
- 9 Anchor bolt
- 10 Roller
- 11 Retaining ring
- 12 Chain guard

- 13 Clamp
- 14 Back up liner
- 15 Shim (0.5, 1.0t)
- 16 Shim (0.5, 1.0t)

2.3 STAGE MAST (TF MAST)



15D9MS02

- 1 Outer mast
- 2 Middle mast
- 3 Inner mast
- 4 Roller
- 5 Tilt cylinder pin
- 6 Mast support cap
- 7 Bushing
- 8 Chain sheave
- 9 Chain
- 10 Anchor bolt
- 11 Retaining ring
- 12 Chain guard

- 13 Clamp
- 14 Back up liner
- 15 Shim (0.5, 0.1Ton)
- 16 Shim (0.5, 0.1Ton)
- 17 Sheave bracket

3. CARRIAGE, BACKREST AND FORK



15D9MS03

- 1 Backrest
- 2 Carriage

- 3 Load roller
- 4 Side roller
- 5 Fork assembly
- 6 Extension fork

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) FORKS

 (1) Measure thickness of root of forks and check that it is more than specified value.
 EX : l =900 mm (35.4 in) mm (in)

STD Fork assy	Applicable model	Standard	Limit
64FY-12030	15D/18D-9	35 (1.4)	32 (1.3)
64HM-11010	20D-9	40 (1.6)	36 (1.4)



(2) Set forks in middle and measure difference in height at top of forks.

Model	Fork length (mm)	Height difference (mm)
15D/18D/	equal or below 1500	3
20D-9	above 1500	4



(3) Most force is concentrated at root of fork and at hook, so use crack detection method to check cracks.

2. MAST

- 1) Check for cracks at mast stay, tilt cylinder bracket, guide bar, fork carriage and roller shaft weld. Check visually or use crack detection method. Repair any abnormality.
- Set mast vertical, raise forks about 10cm from ground and check front-to-rear clearance and left-toright clearance between inner mast and fork carriage, and between outer mast and inner mast. Use these figures to judge if there is any play at roller or rail.
 - Front-to-rear clearance : Within 2.0 mm (0.08 in)
 - · Left-to-right clearance : Within 2.5 mm (0.10 in)
- 3) Check that there is an oil groove in bushing at mast support.
- Set mast vertical, raise forks about 10cm from ground, and push center of lift chain with finger to check for difference in tension.

If there is any difference in tension, adjust chain stopper bolt.

5) Check visually for abnormalities at thread of chain anchor bolt, and at contact surface between chain wheel and chain.

Rotate chain wheel by hand and check for any play of bearing.

2. TROUBLESHOOTING

1) MAST

Problem	Cause	Remedy
Forks fail to lower.	Deformed mast or carriage.	Disassemble, repair or replace.
Fork fails to elevate	 Faulty hydraulic equipment. Deformed mast assembly. 	 See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system. Disassemble mast and replace damaged parts or replace complete mast assembly.
Slow lifting speed and insufficient handling capacity.	 Faulty hydraulic equipment. 	 See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system.
	 Deformed mast assembly. 	Disassemble mast and replace damaged parts or replace complete mast assembly.
Mast fails to lift smoothly.	 Deformed masts or carriage. Faulty hydraulic equipment. 	 Disassembly, repair or replace. See Troubleshooting Hydraulic Cylinders, pump and control valve in section 6, hydraulic system.
	 Damaged load and side rollers. Unequal chain tension between LH & RH sides. 	 Replace. Adjust chains.
	 LH & RH mast inclination angles are unequal. (Mast assembly is twisted when tilted) 	• Adjust tilt cylinder rods.
Abnormal noise is produced	Broken load roller bearings.	· Replace.
when mast is lifted and lowered.	Broken side roller bearings.	· Replace.
	\cdot Deformed masts.	\cdot Disassemble, repair or replace.
	 Bent lift cylinder rod. 	· Replace.
	\cdot Deformed carriage.	· Replace.
	\cdot Broken sheave bearing.	· Replace.
Abnormal noise is produced	Insufficient lubrication of anchor	Lubricate or replace.
during tilting operation.	pin, or worn bushing and pin.	
	Bent tilt cylinder rod.	· Replace.

2) FORKS

Problem	Cause		Remedy
Abrasion	Long-time operations causes the fork to wear and reduces the thickness of the fork. Inspection for thickness is needed. • Wear limit : Must be 90% of fork thickness		If the measured value is below the wear limit, replace fork.
Distortion	Forks are bent out of shape by a number of reasons such as overloading, glancing blows against walls and objects, and picking up load unevenly.• Difference in fork tip heightFork length (mm)Height difference (mm) equal or below 1500• above 15004		If the measured value exceeds the allowance, replace fork.
Fatigue	 Fatigue failure may result from the fatigue crack even though the stress to fork is below the static strength of the fork. Therefore, a daily inspection should be done. Crack on the fork heel. Crack on the fork weldments. 		Repair fork by expert. In case of excessive distortion, replace fork.

GROUP 3 ADJUSTMENT

1. MAST LOAD ROLLER (V MAST)

1) INNER/OUTER MAST ROLLER CLEAR-ANCE ADJUSTMENT

- (1) Measure the clearance with the mast overlap at near 480mm.
- (2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner/outer mast roller shim.
 - Standard clearance A, B = $0.3 \sim 0.6$ mm
 - Shim thickness 0.5, 1.0 mm
- (3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.
- (4) After the adjustment, check that the inner mast moves smoothly in the outer mast.





2. MAST LOAD ROLLER (TF MAST)

1) INNER AND MIDDLE MAST ROLLER CLEARANCE ADJUSTMENT

- (1) Measure the clearance with the mast overlap at near 480 mm.
- (2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner and middle mast roller shim, respectively.
 - \cdot Standard clearance A = 0.3~0.6 mm
 - Shim thickness 0.5, 1.0 mm
- (3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.
- (4) After the adjustment, check that the inner mast moves smoothly in the middle mast, and the middle mast moves smoothly in the outer mast.

2) OUTER AND MIDDLE MAST UPPER ROLLER CLEARANCE ADJUSTMENT.

- (1) Measure the clearance with the mast overlap at near 480mm.
- (2) Shift the inner mast to one side to bring the roller into contact with the middle mast and the inner mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the outer and middle mast roller shim, respectively.
 - \cdot Standard clearance B = 0.3~0.6 mm
 - Shim thickness 0.5, 1.0 mm





- (3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.
- (4) After the adjustment, check that the inner mast moves smoothly in the middle mast, and the middle mast moves smoothly in the outer mast.

3) CARRIAGE LOAD ROLLER

- Measure the clearance when the center of the carriage upper roller is 100mm from the top of the inner mast.
- (2) Measure the clearance at upper, lower rollers after loosen the adjust screws from the side rollers. Shift the carriage to one side to bring the roller into contact with the inner mast, and measure the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the carriage roller shim.
 - Standard clearance C = 0.3~0.6 mm
 - Shim thickness 0.5, 1.0 mm
- (3) Distribute the shim thickness equally to the left and right roller. Refer to Carriage assembly.
- (4) After the adjustment, the carriage should move smoothly along the overall mast length.

4) MAST BACK UP LINER

- (1) Measure the clearance with the inner mast at the bottom position.
- (2) With the inner mast in contact with the outer mast roller, adjust the clearance between the mast back up liner and inner mast to the following value by inserting the back up liner shim.
 - Standard clearance E = 0.2~0.6 mm
 - Shim thickness 0.5, 1.0 mm
- (3) After the adjustment, the mast should move smoothly.





GROUP 4 REMOVAL AND INSTALLATION

1. FORKS

- 1) Lower the fork carriage until the forks are approximately 25mm(1inch) from the floor.
- Turn the knob up and slide forks, one by one, toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
- 3) Remove the fork one by one. On larger forks it may be necessary to use a block of wood.
- 4) Reverse the above procedure to install load forks.



2. BACKREST

- Remove bolts securing backrest to fork carriage. Lift backrest straight up and remove from carriage.
- 2) Position backrest on carriage and lower in place. Install and tighten bolts.



3. CARRIAGE ASSEMBLY

1) CARRIAGE

- (1) With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast is raised.
- (2) While supporting lift chains, remove the split pin and slide out chain anchor pins from the chain anchors of stationary upright.
- (3) Pull the chains out of the sheaves and drape them over the front of the carriage.
- (4) Slowly raise elevating upright until mast clears top of fork carriage. Move carriage to work area and lower mast.

A Make sure carriage remains on floor and does not bind while mast is being raised.

- (5) Inspect all parts for wear or damage. Replace all worn or damaged pars.
- (6) Reverse the above steps to reinstall.

A Replace the split pin of chain anchor with new one.

2) SIDE ROLLER

- (1) Remove carriage as outlined in the carriage assembly and removal paragraph.
- (2) Loosen and remove nuts, adjust screws and side rollers from carriage side pate.
- (3) Thoroughly clean, inspect and replace all worn or damaged parts.
- (4) Reverse the above procedure to assembly.
- * Adjustment
- Once carriage is properly installed, loosen nuts and adjust screws, (if not already done) allowing carriage to be centered in the inner mast.
- Adjust side roller by tightening screw until side roller just makes contact with mast. Back off approximately 1/10 turn on screw and tighten nut to lock screw in place.
- Run carriage up and down for the inner mast to be sure the carriage has free movement and does not stick. Also, make sure chains are properly adjusted. Refer to chain adjustment paragraph. Make adjustment when necessary and recheck operation of carriage.

3) CARRIAGE LOAD ROLLER

- (1) Remove carriage as outlined in the carriage assembly removal paragraph.
- (2) Loosen and remove flat head bolts and plain washers from top load roller bracket.
- (3) Using a pryer, remove load rollers from load roller bracket.
- (4) Reverse the above procedure to assemble. Refer to MAST ROLLER ADJUSTMENT paragraph.





4) MAST LOAD ROLLER AND BACK UP LINER

- (1) 2 stage mast (V mast)
- ① Remove the carriage assembly and move them to one side.
- ② Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.
- ③ Loosen and remove hexagon bolts and nuts securing lift cylinders to inner mast.
- ④ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
- ⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and them with ropes to the outer mast.
- ⑥ Using the overhead hoist, lower inner mast until top and bottom rollers and back up liners are exposed.
- ⑦ Using a pryer, remove load rollers from load roller bracket. Remove back up liners and shims.
- ⑧ Thoroughly clean, inspect and replace all worn or damaged parts.
- ③ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



(2) 3 stage mast (TF mast)

- Remove the carriage assembly and move it to one side.
- ② Loosen and remove hexagon bolt securing bottom cylinder from outer mast.
- ③ Loosen and remove hexagon bolt and special washers securing lift cylinders to middle mast. Remove the spring pin.
- ④ Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.
- ⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and tie them with ropes to the outer mast.
- (6) Using the overhead hoist raise inner and middle masts. Place 4 inch block of wood under the free lift cylinder bracket of the inner mast then lower mast sections (this will create slack in the chains).
- ⑦ Remove retaining rings securing chain sheaves to sheave support brackets. While support chains, remove chain sheaves and let chains hang free. The upper outer and lower middle mast rollers and back up liners are now exposed.
- ⑧ Using a player, remove load rollers from load bracket. Remove back up liners and shims.
- ④ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist, slowly raise the middle mast until top and bottom rollers are exposed.
- ① Using a pryer, remove load rollers from load roller bracket.
- Thoroughly clean, inspect and replace all worn or damaged parts.
- 12 Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



5) ELEVATING MAST

(1) Inner mast (V mast)

- ① After completing all necessary steps for load rollers and back up liner removal use an overhead hoist and sling or chain around upper crossmember of the inner mast section.
- ② Lift inner mast upright straight up and out of outer mast section.
- ③ Replace and reverse above procedure to install. Make all necessary measurements and adjustments.

(2) Inner and middle mast (TF mast)

- ① After completing all necessary steps for load rollers and back up liner removal. Remove rear chains and sheave support if not already done.
- 2 Disconnect free lift cylinder hose. Drain hose into a suitable pan or container and cap hose.
- ③ While supporting free lift cylinder assembly, remove bolts and washers securing cylinder to mast crossmember.
- ④ Place a sling around free lift cylinder and attach to an overhead hoist. Slowly raise and move cylinder to one side.
- ^⑤ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of middle mast section.
- ⁽⁶⁾ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of outer mast section.
- O Replace upright and reverse above procedure to install. Make all necessary measurements and adjustments.

6) CHAIN

(1) Chain sheave (V mast)

- Place a sling around carriage and attach to an overhead hoist. Lift carriage high enough so that the tension on the chain over sheaves is relieved after the carriage is blocked. Position wooden blocks under the carriage and lower it.
- Remove the split pin securing the chain anchor pins and discard.
 While supporting the chains, remove the chain anchor pins and drape the chains over the carriage.
- ③ Remove retaining ring securing sheaves to sheave support. Remove sheaves with bearings.
- ④ Remove bearing retaining ring from sheave and press bearings from sheaves.
- ⑤ Thoroughly clean, inspect and replace all worn or damaged parts.
- ⑥ Reverse the above to assemble and install. Use new split pins in chain anchor pins.

(2) Rear chain sheave (TF mast)

- ① Raise and securely block carriage and inner mast section.
- ② Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins from outer mast section.
- 3 Remove chains.
- ④ Remove retaining ring securing chain sheaves to sheave support. Pry off sheaves with bearings.
- ⑤ Remove bearing retaining ring from sheave and press bearings from sheaves.
- ⑥ Thoroughly clean, inspect and replace all worn or damaged parts.
- ⑦ Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.





(3) Chain wheel bearing support (TF mast)

- ${\scriptstyle (\!\!\!\!)}$ Remove the carriage assembly and move to one side.
- ② After removing bolt to securing chain wheel bearing support assembly to free lift cylinder. After a sling to the chain wheel bearing support assembly. Using an overhead hoist, lift support assembly straight up and off of free lift cylinder. Move assembly to work area.
- ③ Remove retaining ring securing chain wheel bearing to chain wheel bearing support.
- ④ Remove bearing retaining ring from chain wheel bearing and press bearings from chain wheel bearings.
- (5) Thoroughly clean, inspect and replace all worn or damaged parts.
- 6 Reverse the above procedure to install.

(4) Rear chain (TF mast)

- ① Remove the carriage assembly and move to one side. Refer to carriage removal and installation.
- ② Raise and securely block truck approximately 6 inches from the floor.
- ③ Using a sling or chain around inner mast section attached to an overhead hoist, slowly raise inner mast until there is enough slack in the chains to remove them. Block inner mast section.
- ④ Remove split pins and chain anchor pins securing chains to chain anchor (part of inner mast).
- ^⑤ While supporting the chains, remove split and chain anchor pins securing chains to chain anchors attached to outer mast section.
- 6 Remove chains.
- ⑦ Reverse the above to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.

(5) Carriage chain

- ① Place a sling around carriage front plate and attach to an overhead hoist. Lift and secure carriage high enough so that split and chain anchor pins on carriage can be easily be removed. Remove chain anchor pins from carriage and drape chains out over carriage.
- ② Place a wooden block under the carriage and lower the carriage on the block.
- ③ While supporting the chains, remove split pins and chain anchor pins from chain anchors.
- ④ Remove chains and wash them with solvent. Refer to this section for Load chain inspection and maintenance.
- ⑤ Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.

(6) Load chain inspection and maintenance

After every 200 hours of truck operation, lift chains should be inspected and lubricated inspect for the following chain conditions :

① Wear

As the chain flexes on and off the chain wheel bearings, the joints very gradually wear. The stretch a chain develops in service is due to material being worn off pin outer diameter and pitch hole inner diameter on the inside plate.

Chain wear can be measured using a wear scale or steel tape. When chains have elongated 2%, they should be discarded. When checking chain wear, be sure to measure a segment of chain that operates over a sheave. Do not repair chains by cutting our the worn section and splicing in a new piece. If part of the chain is worn, replace all the chains on the truck.

② Rust and corrosion

Chains used on lift trucks are highly stressed precision components. It is very important that the "as-manufactured" ultimate strength and fatigue strength be maintained throughout the chain service life. Corrosion will cause a major reduction in the load-carrying capacity of lift chain or roller chain because corrosion causes side plate cracking.

③ Cracked plate

The most common cause of plate cracking is fatigue failure. Fatigue is a phenomenon that affects most metals and many plastics. After many repeated heavy loads, the plates may crack and the chains will eventually break. Fatigue cracks are almost always found through the pitch holes perpendicular to the pitch line. Contrast this failure mode to the random failures caused by stress-corrosion cracking. If cracks are present, replace all the chain on the truck. Noise in the chain indicates that the plate is on the verge of cracking and will be failed before long.

④ Tight joints

All joints in lift chain should flex freely. Tight joints resist flexure, increase internal friction, thus increasing chain tension required to lift a given load. Increased tension accelerates wear and fatigue problems.

Tight joints in lift chains can be caused by :

- \cdot Bent pins or plates.
- · Rusty joints.
- \cdot Peened plate edges.

Oil rusty chains and replace chains with bent or peened components.

5 Protruding or turned pins

Heavily loaded chains operating with lube generate tremendous friction between pins and plates. In extreme cases, the frictional torque in the joint can actually turn pins in the press-fit outside plates. If chain is allowed to operate in this condition, the pins slowly work out of the chain causing chain failure. Turned pins can be quickly spotted because the flats on the V heads are no longer in line. Chains with turned or protruding pins should be replaced immediately. Do not attempt to repair the chain by driving pins back into the chain.

6 Chain side wear

A wear pattern on pin heads and outside plates indicates misalignment. This condition damages chain and sheaves as well as increasing internal friction in the chain system.

O Chain anchors and chain wheel bearings

An inspection of the chain system includes a close examination of chain anchors and chain wheel bearings. Check chain anchors for wear, breakage and misalignment.

Anchors with worn or broken fingers should be replaced. Anchors should be adjusted to eliminate twisting or other misalignment in the chain. When chain is misaligned, load is not distributed uniformly between the plates. Prolonged operation will result in premature fatigue failure. Chain wheel bearings with badly worn flanges and outside diameter should be replaced. Heavy flange wear indicates chain misalignment.

8 Chain wear scale

The chain can be checked for wear or stretching with the use of a chain wear scale. Stretching of a chain is due to the elongation of the pitch holes and wearing of the pin O.D. The greatest amount of stretching occurs at the areas of the chain that flex over the sheaves most frequently. Check the chain at this point with a scale. The wear scale has instructions printed on the sides for use in determining chain stretch and are as follows :

- · Determine pitch length of chain using 6 inch scale on one side of wear scale.
- If pitch is 1/2 (12.7 mm), 3/4 (19.05 mm), 1 (25.4 mm), 1-1/2 (38.1 mm), 2 (50.8 mm), use side A of scale.
- If pitch is 5/8 (15.875 mm), 1-1/4 (31.75 mm) or 2 (50.8 mm), use side B.
- · Align point A or B to center of a pin and note position of the opposite A or B point.
- · If other point also lines up with a pin, the chain is worn and should be replaced.

If any of the above conditions exists (cracked plates, turned pins, stretching etc), the chains should be replaced in pairs as a complete assembly. Order chains by part number to insure the correct chain length, pitch and material specifications.

(7) Load chain lubrication and adjustment

1 Lubrication

The most important consideration in field maintenance of lift chains is lubrication. Hard working, heavily loaded chains cannot be expected to give satisfactory wear life without scheduled periodic re-lubrication. Like all bearing surfaces, the precision manufactured, hardened steel, joint-wearing surfaces require a film of oil between mating parts to prevent rapid wear. Oil must penetrate the chain joint to prevent wear. Applying oil to external surfaces will prevent rust, but oil must flow into the live bearing surfaces for maximum wear life. Frequency of re-lube will vary with operating conditions and environment, the best estimate of lube period is 200 hours. Trucks parked outdoors or trucks in extremely severe service, may require more frequent re-lube to maintain an oil film on all chain surface.

 \cdot Wipe off the old oil with a clean cloth and blow out the remaining dirt with compressed air.

A Wear eye protection.

· With a clean brush, apply EP-140 extreme pressure lubricant or heavy motor oil (40W).

② Replacement

Replace chains as a pair. It will be virtually impossible to maintain uniform loading between the strands if a new chain is put into service opposite an old chain. The joints in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don't steam clean or decrease new chains. The manufacturer's grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and chain wheel bearing. Broken, cracked or worn anchor must be replaced using the new anchor pin and split pin. Do not paint newly replaced chain after it has been installed.

③ Adjustment

Chain adjustments are important for the following reasons :

- · Equal loading of chain.
- \cdot Proper sequencing of mast.
- · Prevent over-stretching of chains.
- \cdot Prevent chains from jumping off sheaves if they are too loose.

④ Adjustment procedure

- \cdot With mast in its fully collapsed and vertical position, lower the fork to the floor.
- \cdot Adjust the chain length by loosening or tightening nut on the chain anchor.

After making adjustment on the mast, be sure to tighten the nut.