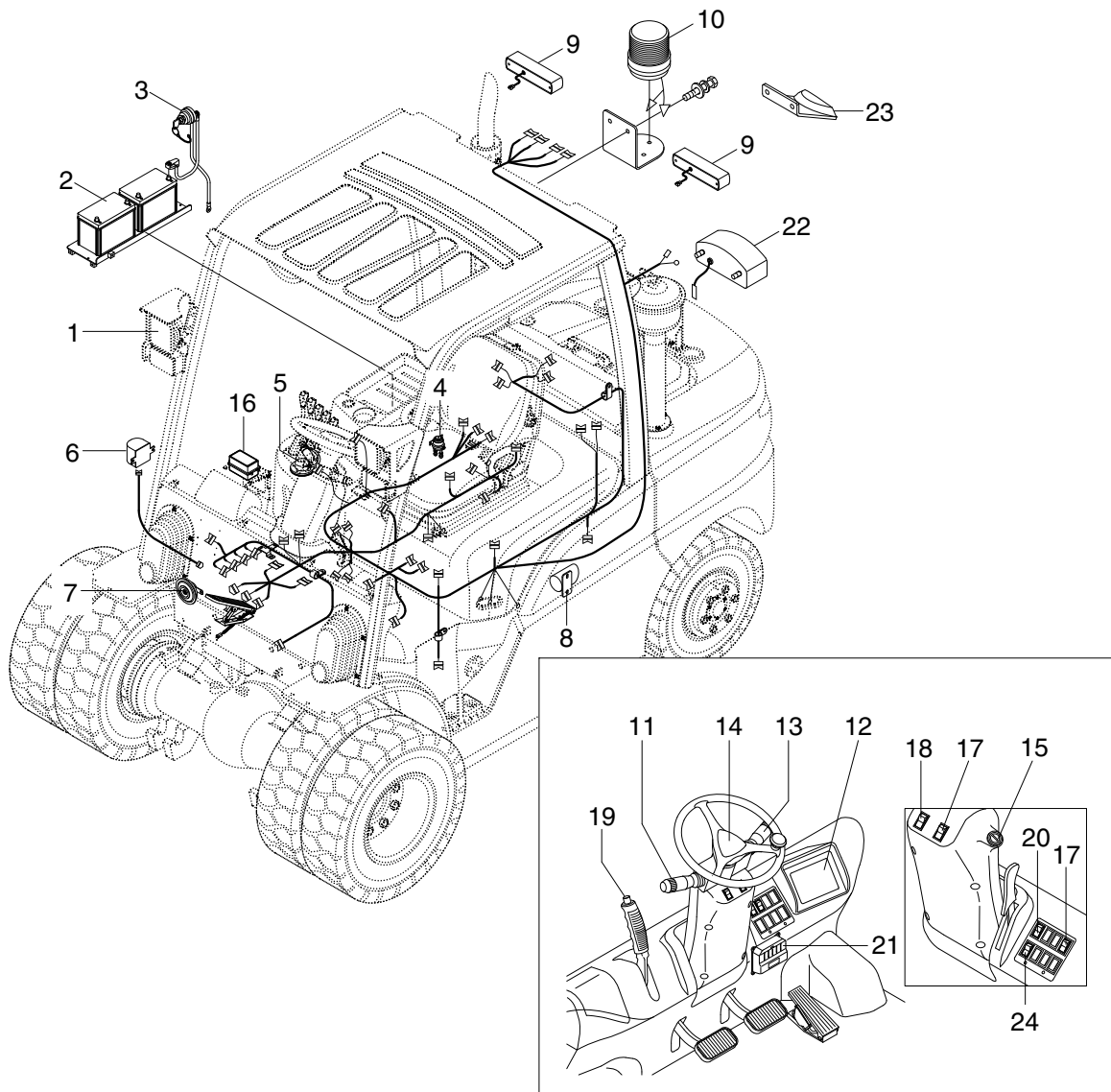


SECTION 7 ELECTRICAL SYSTEM

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SECTION 7 ELECTRICAL SYSTEM

GROUP 1 COMPONENT LOCATION



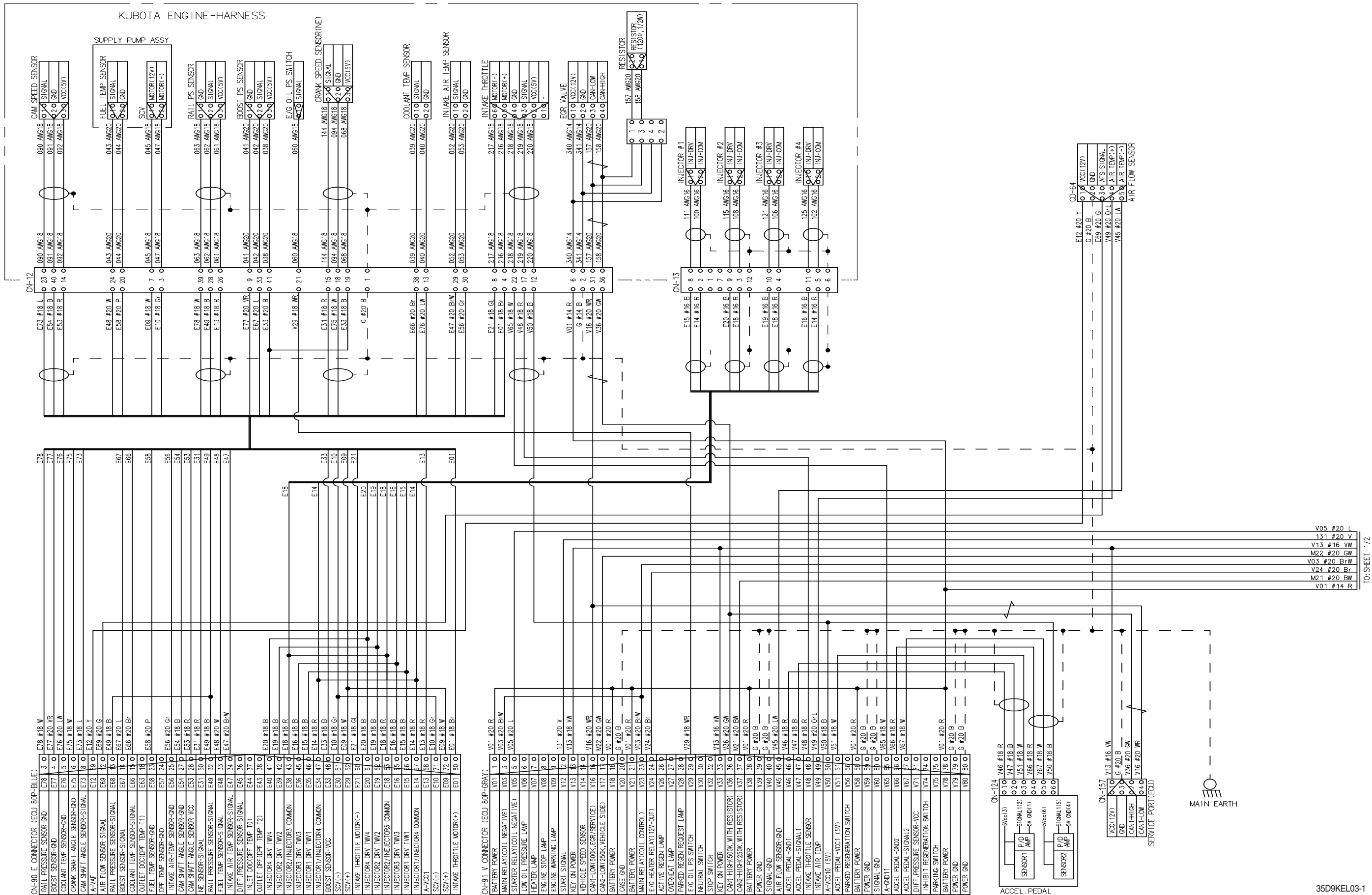
35D9KEL01

- | | | |
|--------------------|--------------------------|--------------------------------------|
| 1 Work lamp | 10 Beacon lamp | 17 Work lamp switch (opt) |
| 2 Battery | 11 Forward-reverse lever | 18 Hazard lamp switch (opt) |
| 3 Master switch | 12 Cluster | 19 Parking lever |
| 4 Start relay | 13 Head lamp switch | 20 Fuel warmer |
| 5 Fuel sender | Illumination lamp | 21 MCU (Machine control unit) |
| 6 G-sensor | Turn signal switch | 23 Camera |
| 7 High horn | 14 Horn button | 24 Front wiper / washer switch (opt) |
| 8 Back buzzer | 15 Start switch | |
| 9 Combination lamp | 16 Fuse box | |

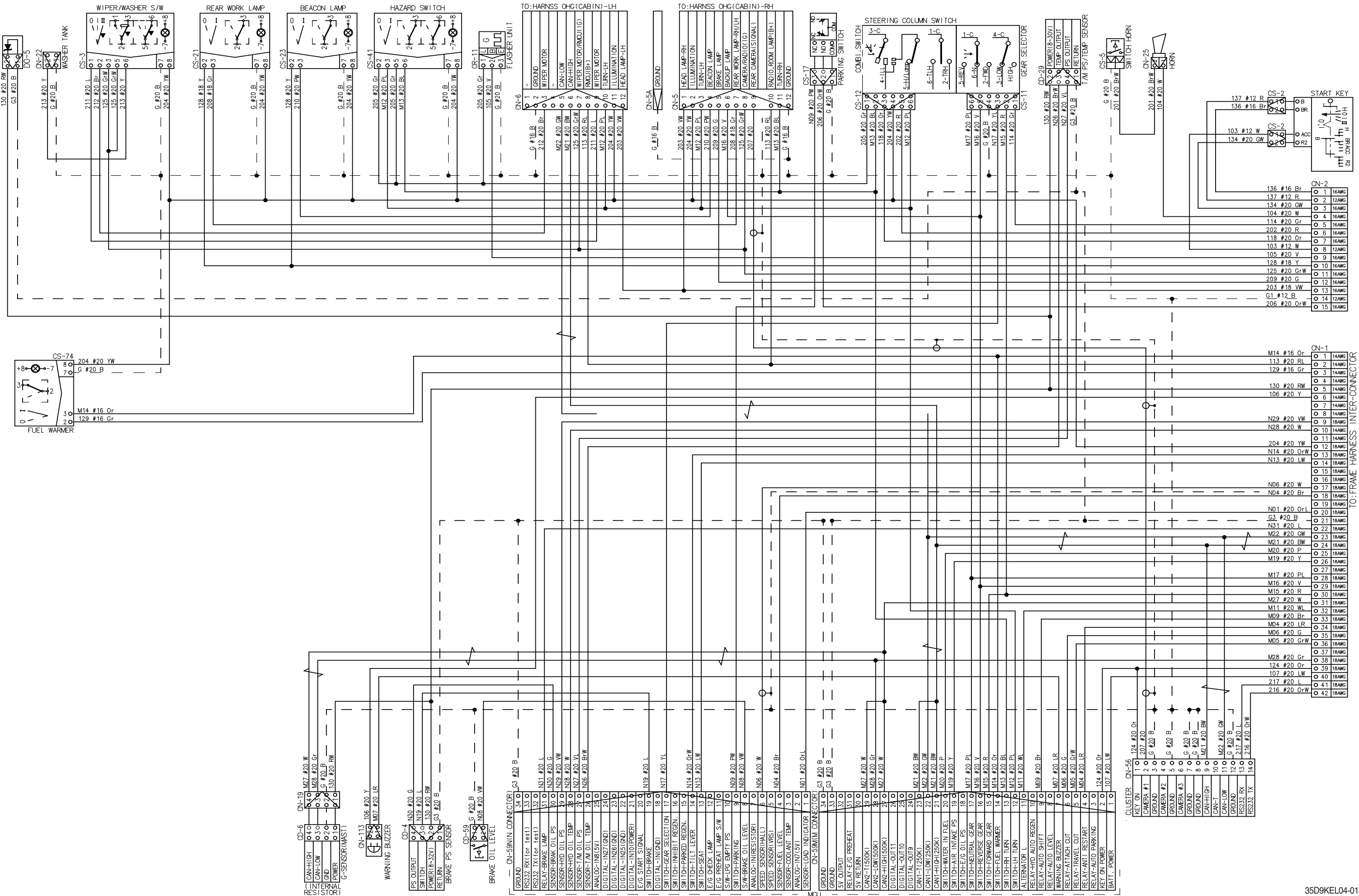
- ELECTRICAL CIRCUIT (1/4)



• ELECTRICAL CIRCUIT (2/4)

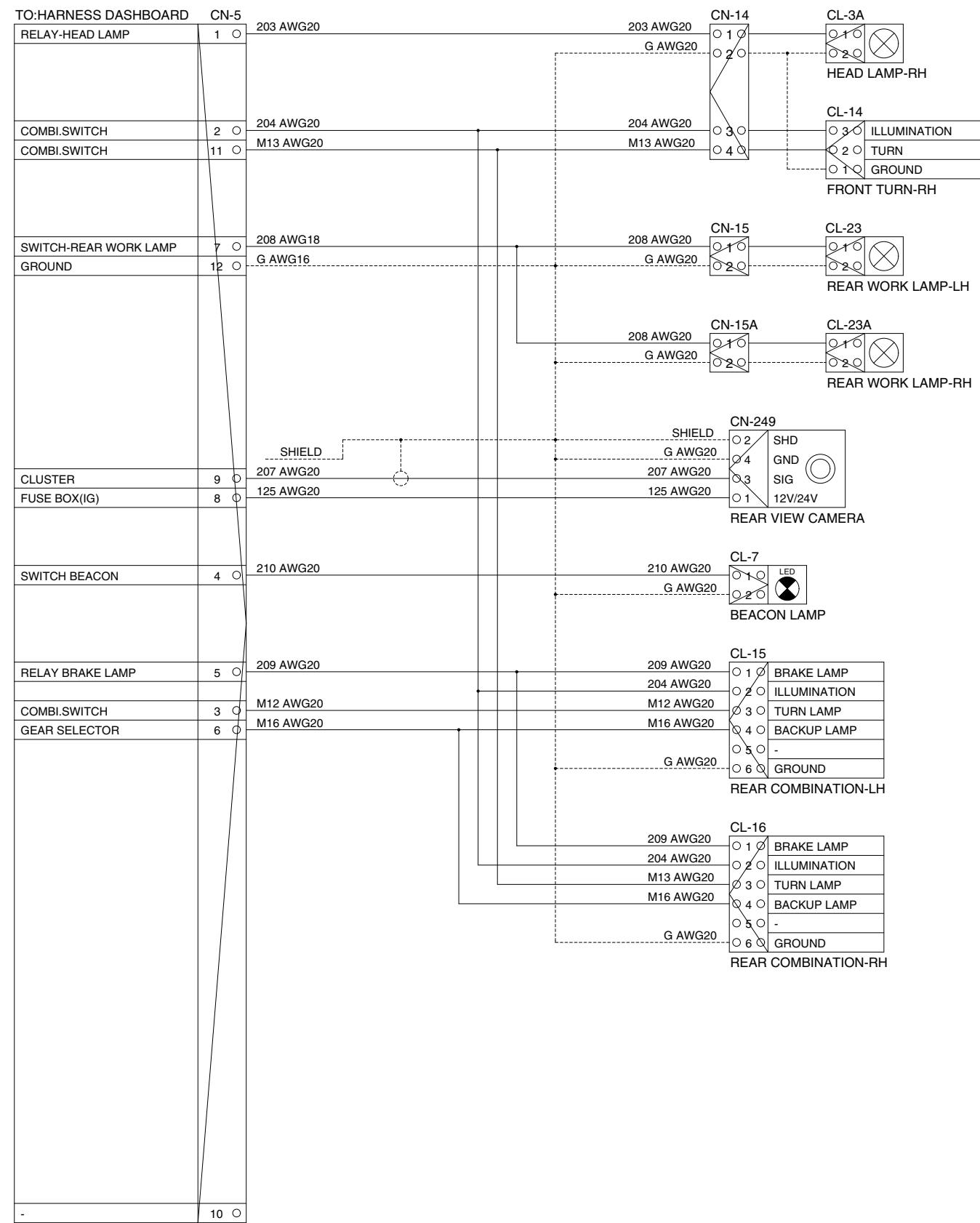


• ELECTRICAL CIRCUIT (3/4)

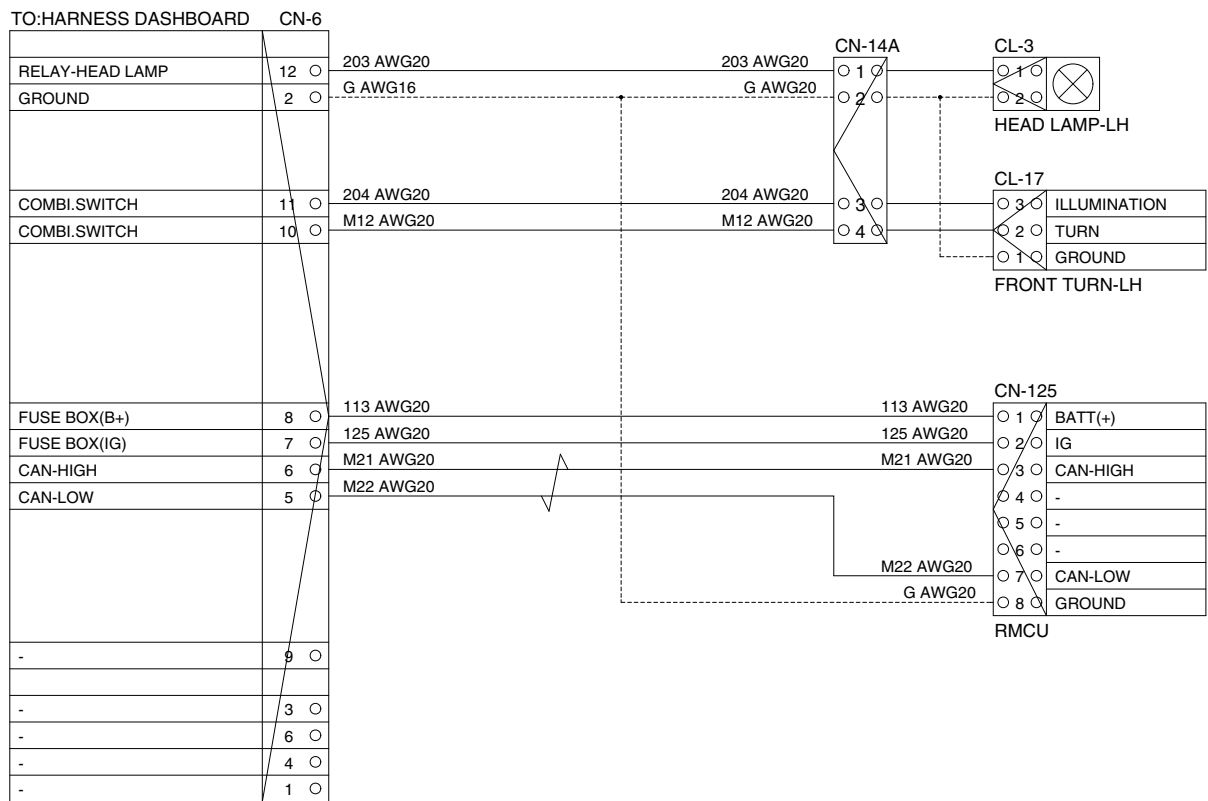


• ELECTRICAL CIRCUIT (4/4)

*ELEC.DIAGRAM OF HARNESS CABIN-RH



*ELEC.DIAGRAM OF HARNESS CABIN-LH

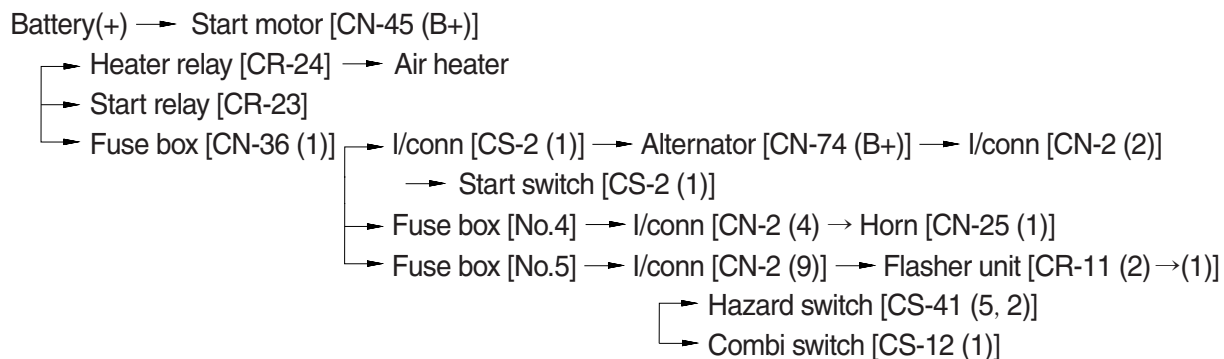


1. POWER CIRCUIT

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



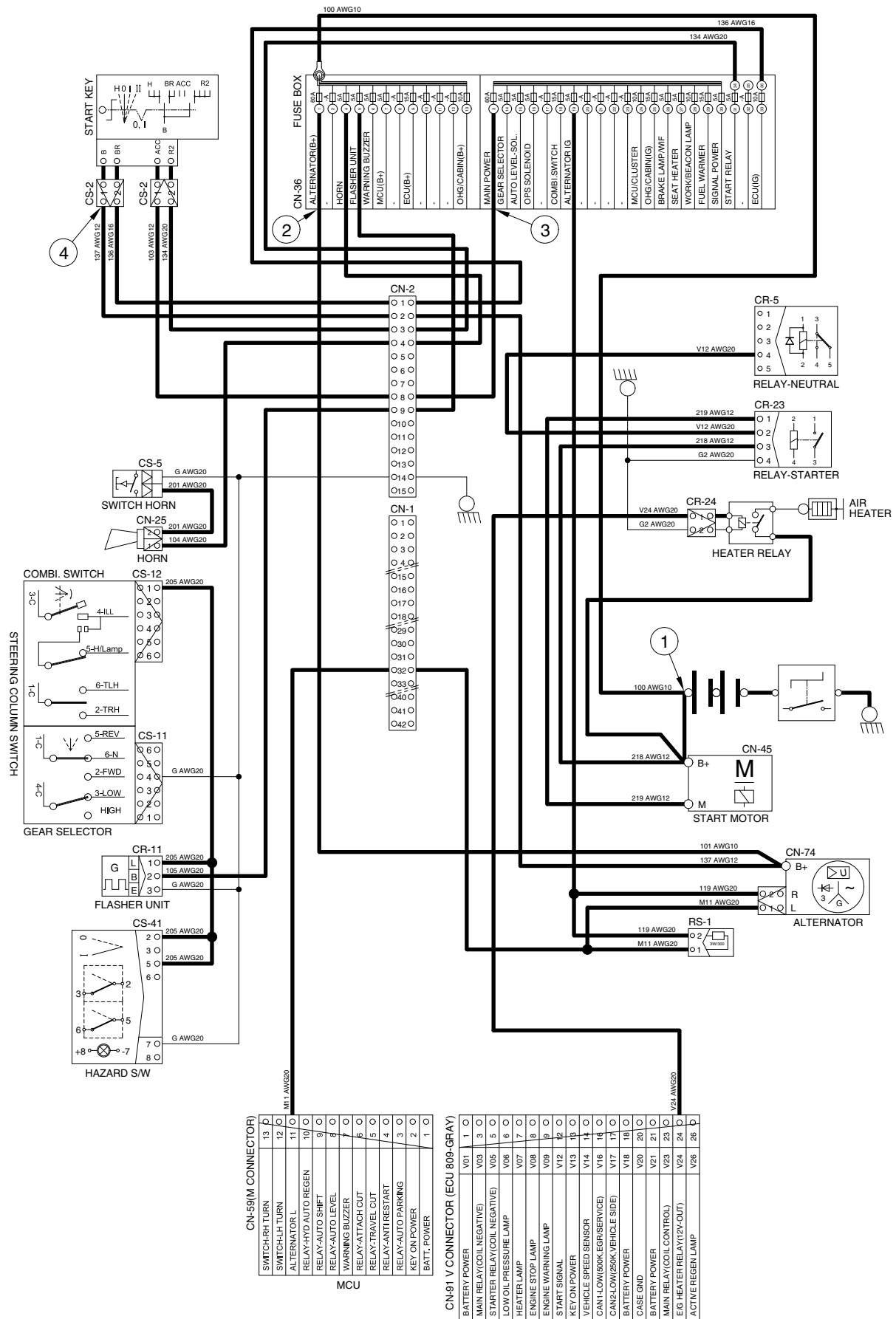
2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	OFF	① - GND (Battery(+)) ② - GND (Fuse No.1) ③ - GND (Fuse No.3) ④ - GND (Start key)	24V

※ GND : Ground

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

POWER CIRCUIT



35D9KEL06

※ 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]
→ Fuse box [CN-36 (1)] → Alternator [CN-74 (B+)] → I/conn [CN-2 (2)]
→ Start switch [CS-2 (1)]

※ 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 (2)] → I/conn [CN-2 (1)] → Fuse box [No.36 →33] → ECU (IG)

(2) When start key switch is START position

Start switch START [CS-2 (2)] → I/conn [CN-2 (3)] → Fuse box [No. 34 →31]

→ Neutral relay [CR-5(3) → (4)] → Start relay [CR-23]
→ ECU [CN-91 (12)]

2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running	ON	① - GND (Battery B+) ② - GND (Start key) ③ - GND (Neutral relay)	24V

※ GND : Ground

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

※ 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 fuse box.

1) OPERATING FLOW

(1) Warning flow

Alternator [CN-74 (L)] → I/conn [CN-1 (32)] → MCU [CN-59 (11)]

(2) Charging flow

Alternator [CN-74 (B+)] → Fuse box [CN-36 (1)] → Starter [CN-45 (B+)] → Battery (+) terminal
→ Charging

2) CHECK POINT

Engine	Key switch	Check point	Voltage
ON	ON	① - GND (Alternator B+) ② - GND (Start switch) ③ - GND (Cluster)	24V

※ 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.

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

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



4. PREHEATING CIRCUIT

Combustion chamber air heater are used in order to give satisfactory starting of low ambient temperatures.

1) OPERATING FLOW

Battery (+) terminal → Fuse box [CN-36 (1)] → Alternator [CN-74 (B+)]
→ I/conn [CN-2 (2)] → I/conn [CS-2(1)] → Start switch
→ Heater relay [CR-24] → Air heater

※ When you turn the start switch to the ON position, the air heater relay makes the air heater operated and the air heater of the cluster turned ON.

Start switch ON [CS-2 (1)] → I/conn [CN-2 (8)] → Fuse box [CN-36 (3)] → I/conn [CN-1 (39)]
→ Cluster [CN-56 (1)] → Key ON
→ MCU [CN-59 (2)] → Key ON power

2) CHECK POINT

Engine	Key switch	Check point	Voltage
Stop	HEAT	① - GND (Battery B+) ② - GND (Air heater) ③ - GND (Air heater relay) ④ - GND (Start switch) ⑤ - GND (Cluster)	24V

※ GND : Ground

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

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



GROUP 3 COMPONENT SPECIFICATION

No	Part name	Qty	Specification												
1	Battery	2	12V×96 AH×2 EA RC : 130 min CCA : 630A												
2	Working lamp	1	24V, 70W												
3	License lamp	1	24V, 3W×2												
4	Rear Combination lamp (LED)	2	24V, 1.2/0.7W (Stop/Tail) 24V, 2.4W (Turn) 24V, 1.2W (Back Up)												
5	Head lamp	2	24V, 70W												
6	Flasher lamp	2	24V, 0.7/3.4W (posi/turn signal)												
7	Beacon lamp (opt)	1	24V, max. 0.560A												
8	Beacon lamp (LED)	1	12~30V, max. 0.800A												
9	Camera (opt)	1	24V, 2.5W												
10	Start relay	1	24V, 300A												
11	Relay (4P)	3	24V, 20A												
12	Relay (5P)	3	24V, 6A												
13	Flasher Unit	1	24V, 85±10 CM, (21W + 21W) × 2 + 3W × 2												
14	Back buzzer	1	24V, 90±5 dB, 60±10 C/M												
15	Horn	1	24V, MAX 1.5A, 100 ~ 115 dB												
16	Cluster	1	24V, 15W												
17	G-sensor (Mast angle) (opt)	1	24V, 5W												
18	Fuel level sender	1	<table border="1"> <tr> <td>Float indicator</td><td>E</td><td>4/8</td><td>F</td></tr> <tr> <td>Resistance (Ω)</td><td>700</td><td>350</td><td>50</td></tr> <tr> <td>Tolerance (Ω)</td><td>0% +5%</td><td>+5%</td><td>0% -5%</td></tr> </table>	Float indicator	E	4/8	F	Resistance (Ω)	700	350	50	Tolerance (Ω)	0% +5%	+5%	0% -5%
Float indicator	E	4/8	F												
Resistance (Ω)	700	350	50												
Tolerance (Ω)	0% +5%	+5%	0% -5%												
19	Master switch	1	24V, 180A												
20	Gear selector switch	1	24V, 3.5A												
21	Combination switch	1	Direction : 24V, 3.5A Multi-function switch : 24V, 2A												
22	Brake switch	1	24V, 50W												
23	Working lamp switch	1	24V, 15A												
24	Hazard switch	1	24V, 15A												
25	Start switch	1	24V, 30A												
26	Parked regeneration switch	1	24V, 15A												
27	Inhibit regeneration switch	1	24V, 15A												
28	Fuel warmer switch	1	24V, 15A												
29	Beacon lamp switch (opt)	1	24V, 15A												
30	Wiper/washer switch (opt)	1	24V, 15A												

GROUP 4 CONNECTOR DESTINATION

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-1	AMP	42	I/conn (Frame harness-dashboard harness)	936421	936429
CN-2	AMP	15	I/conn (Dashboard harness-frame harness)	2-85262-1	368301-1
CN-5	KET	12	I/conn (Cabin harness-dashboard harness)	MG610346	MG640348
CN-6	KET	12	I/conn (Cabin harness-dashboard harness)	MG610346	MG640348
CN-12	AMP	42	Engine harness	936421	-
CN-13	MOLEX	12	Injection harness	33472-1206	-
CN-14	DAEDONG	4	Head/Turn lamp harness	110-4PR	110-4PT
CN-14A	DAEDONG	2	Head lamp (LH)	110-2PR	-
CN-15	DAEDONG	2	Work lamp harness (LH)	110-2PR	-
CN-15A	DAEDONG	2	Work lamp harness (RH)	110-2PR	-
CN-16	AMP	3	I/conn (Load sensor-frame harness)	174357-2	-
CN-17	KET	2	I/conn (Frame harness-tilt lever switch)	MG610320	-
CN-18	AMP	2	12V socket	174352-2	174354-2
CN-19	AMP	4	I/conn (G-sensor-dashboard harness)	174257-2	174259-2
CN-25	MOLEX	2	Horn	35825-0211	-
CN-36	QPL	-	Fuse box	21HN-55010	-
CN-45	KET	2	Start motor (B+)	S820-208000	-
			Start motor (M)	171809-2	-
CN-56	AMP	14	Cluster	776273-2	-
CN-59N	AMP	34	MCU (Machine control unit)	4-1437290-1	-
CN-59M	AMP	34	MCU (Machine control unit)	4-1437290-0	-
CN-65	KET	1	Back buzzer	ST730018-3	ST750036-3
CN-66	DEUTSCH	2	Pressure auto regen valve	DT06-2S	-
CN-74	KET	2	Alternator	MG640188-4	-
CN-74	KET	-	Alternator (B+)	S820-308000	-
CN-90E	MOLEX	80	Engine control unit	34566-1903	-
CN-91V	MOLEX	80	Engine control unit	34566-0803	-
CN-96	AMP	4	Fuel warmer	2-967325-3	-
CN-97	KET	2	Fuel feed pump	MG610043	-
CN-113	KET	2	OPSS buzzer	MG610320	-
CN-122	DEUTSCH	2	Forward solenoid 1	DT06-2S	-
CN-123	DEUTSCH	2	Reverse solenoid 1	DT06-2S	-
CN-124	AMP	6	Accelerator pedal	174262-2	-
CN-125	AMP	6	RMCU	-	174262-2
CN-130	AMP	2	Cut-off solenoid 1 (Tilt)	174352-2	174354-2
CN-131	AMP	2	Cut-off solenoid 2 (Lift)	174352-2	174354-2
CN-132	DEUTSCH	2	Forward solenoid 2	DT06-2S	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-133	DEUTSCH	2	Reverse solenoid 2	DT06-2S	-
CN-134	KET	20	Diagnosis port	MG652863	-
CN-138	KET	3	DC/DC converter	MG610045	MG620044
CN-139	DEUTSCH	3	Load sensor harness	DTM06-3S	-
CN-140	KET	3	MCU update	MG610327	-
CN-157	AMP	4	CAN (service port)	174257-2	174259-2
CN-249	AMP	4	Rear view camera	174257-2	174259-2
Switch					
CS-2	KET	2	Start switch	MG610281	MG620282
CS-3	CARLING	10	Wiper/Washer switch	21HN-56300	-
CS-5	RING TERM	-	Horn switch	S810-105000	-
CS-11	DEUTSCH	6	Gear selector switch	DT06-6S	-
CS-12	DEUTSCH	6	Combination switch	DT06-6S-P012	-
CS-13	KET	2	Tilt lever switch	MG610320	MG642552
CS-17	KET	3	Parking switch	MG610045	-
CS-21	CARLING	10	Rear work lamp switch	21HN-56300	-
CS-23	CARLING	10	Beacon lamp switch	21HN-56300	-
CS-41	CARLING	10	Hazard switch	21HN-56300	-
CS-73	DEUTSCH	6	Seat switch	DT06-6S	-
CS-74	CARLING	10	Fuel warmer switch	21HN-56300	-
Lamp					
CL-3	KET	2	Head lamp	MG652520	-
CL-7	DEUTSCH	2	Beacon lamp	DT06-2S	DT04-2P
CL-14	AMP	3	Front turn lamp-RH	936187-3	-
CL-15	DAEDONG	6	R/Combination lamp-LH	110-6PR	-
CL-16	DAEDONG	6	R/Combination lamp-RH	110-6PR	-
CL-17	AMP	1	Front turn lamp-LH	936187-3	-
Relay					
CR-5	OMRON	5	Neutral relay	21FV-55510	-
CR-11	KET	3	Flasher unit relay	S810-003702	-
CR-12	OMRON	5	Auto level relay	21FV-55510	-
CR-13	OMRON	5	Head lamp relay	21FV-55510	-
CR-23	KET	4	Start relay	MG610047	-
CR-24	KET	2	Heater relay	MG610043	-
CR-43	OMRON	5	ECU (B+) relay	21FV-55510	-
CR-45	OMRON	5	ECU (IG) relay	21FV-55510	-
CR-50	OMRON	5	Travel cut relay	21FV-55510	-
CR-51	OMRON	5	Attach cut relay	21FV-55510	-
CR-52	OMRON	5	Brake lamp relay	21FV-55510	-
CR-57	OMRON	5	Auto shift relay	21FV-55510	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
Sensor and pressure switch					
CD-2	KET	3	Fuel sendor	MG610327	-
CD-4	DEUTSCH	4	Oil pressure sensor	DT06-4S	-
CD-5	DEUTSCH	4	Hyd temperature sensor	DT06-4S	-
CD-6	DEUTSCH	4	G sensor	DT06-4S	-
CD-10	KET	1	Air cleaner switch	ST730057-2	-
CD-29	DEUTSCH	4	T/M temperature sensor	DT06-4S	-
CD-35	DEUTSCH	2	Water in fuel switch	DT06-2S	-
CD-50	DEUTSCH	3	Load sensor	DTM06-3S	-
CD-59	KET	2	Brake oil level	MG610320	-
CD-64	SUMITOMO	5	Air-flow sensor	6189-1046	-
CD-73	KET	3	Speed sensor	MG610327	-
DO-01	-	-	Diode	F15890030	-
DO-02	-	-	Diode	F15890030	-
DO-03	-	-	Diode	21EA-50550	-
DO-04	-	-	Diode	21EA-50550	-

GROUP 5 TROUBLESHOOTING

Trouble symptom	Probable cause	Remedy
Lamps dimming even at maximum engine speed.	<ul style="list-style-type: none"> Faulty wiring. 	<ul style="list-style-type: none"> Check for loose terminal and disconnected wire.
Lamps flicker during engine operation.	<ul style="list-style-type: none"> Improper belt tension. 	<ul style="list-style-type: none"> Adjust belt tension.
Charge lamp does not light during normal engine operation.	<ul style="list-style-type: none"> Charge lamp defective. Faulty wiring. 	<ul style="list-style-type: none"> Replace. Check and repair.
Alternator makes abnormal sounds.	<ul style="list-style-type: none"> Alternator defective. 	<ul style="list-style-type: none"> Replace.
Starting motor fails to run.	<ul style="list-style-type: none"> Faulty wiring. Insufficient battery voltage. 	<ul style="list-style-type: none"> Check and repair. Recharge battery.
Starting motor pinion repeats going in and out.	<ul style="list-style-type: none"> Insufficient battery voltage. 	<ul style="list-style-type: none"> Recharge battery.
Excessively low starting motor speed.	<ul style="list-style-type: none"> Insufficient battery voltage. Starting motor defective. 	<ul style="list-style-type: none"> Recharge battery. Replace
Starting motor comes to a stop before engine starts up.	<ul style="list-style-type: none"> Faulty wiring. Insufficient battery voltage. 	<ul style="list-style-type: none"> Recharge battery. Replace
Heater signal does not become red.	<ul style="list-style-type: none"> Faulty wiring. Glow plug damaged. 	<ul style="list-style-type: none"> Check and repair. Replace
Engine oil pressure caution lamp does not light when engine is stopped (with starting switch left in "ON" position).	<ul style="list-style-type: none"> Caution lamp defective. Caution lamp switch defective. 	<ul style="list-style-type: none"> Replace Replace

SECTION 8 MAST

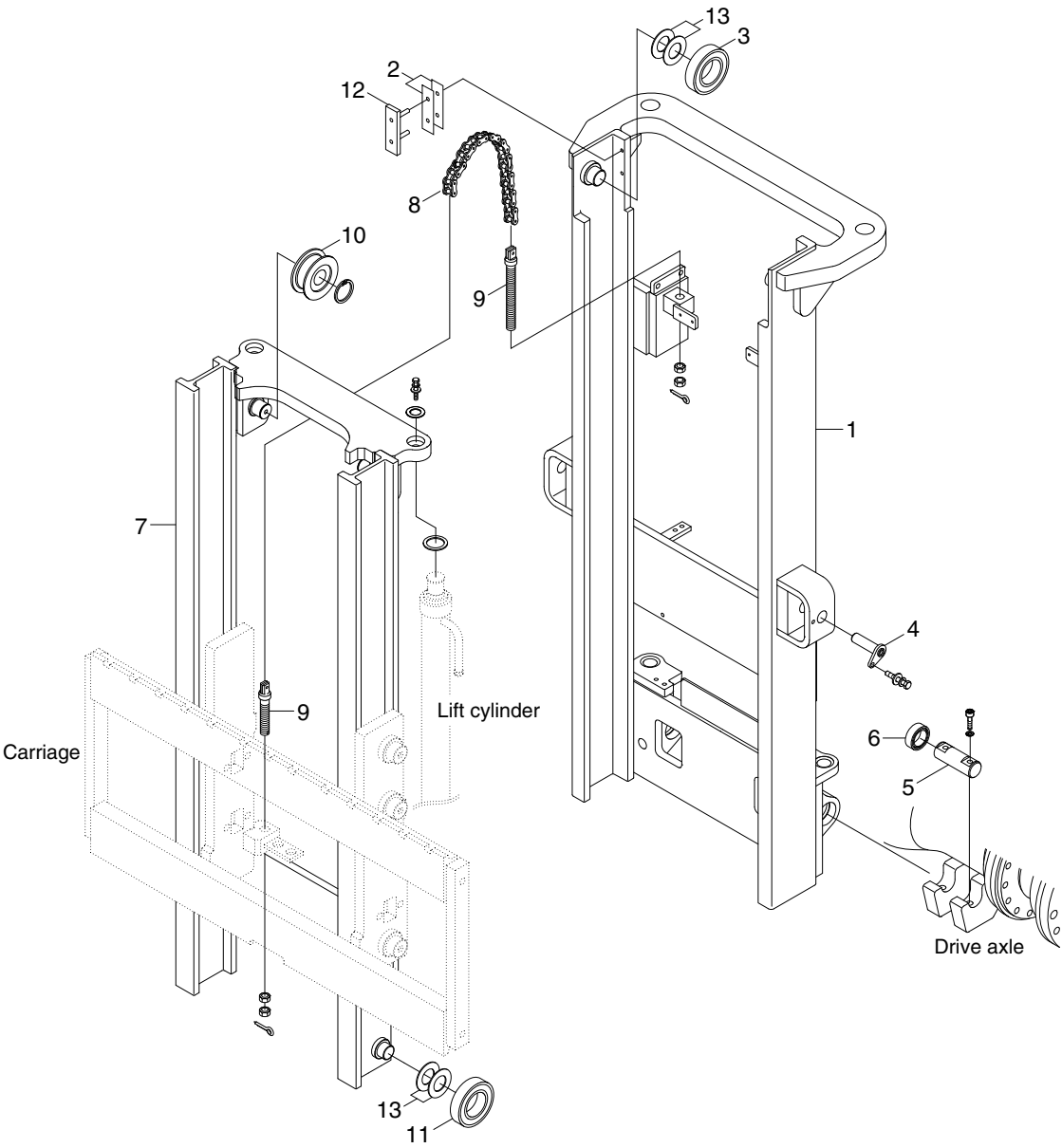


Group 1 Structure	8-1
Group 2 Operational Checks and troubleshooting	8-5
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SECTION 8 MAST

GROUP 1 STRUCTURE

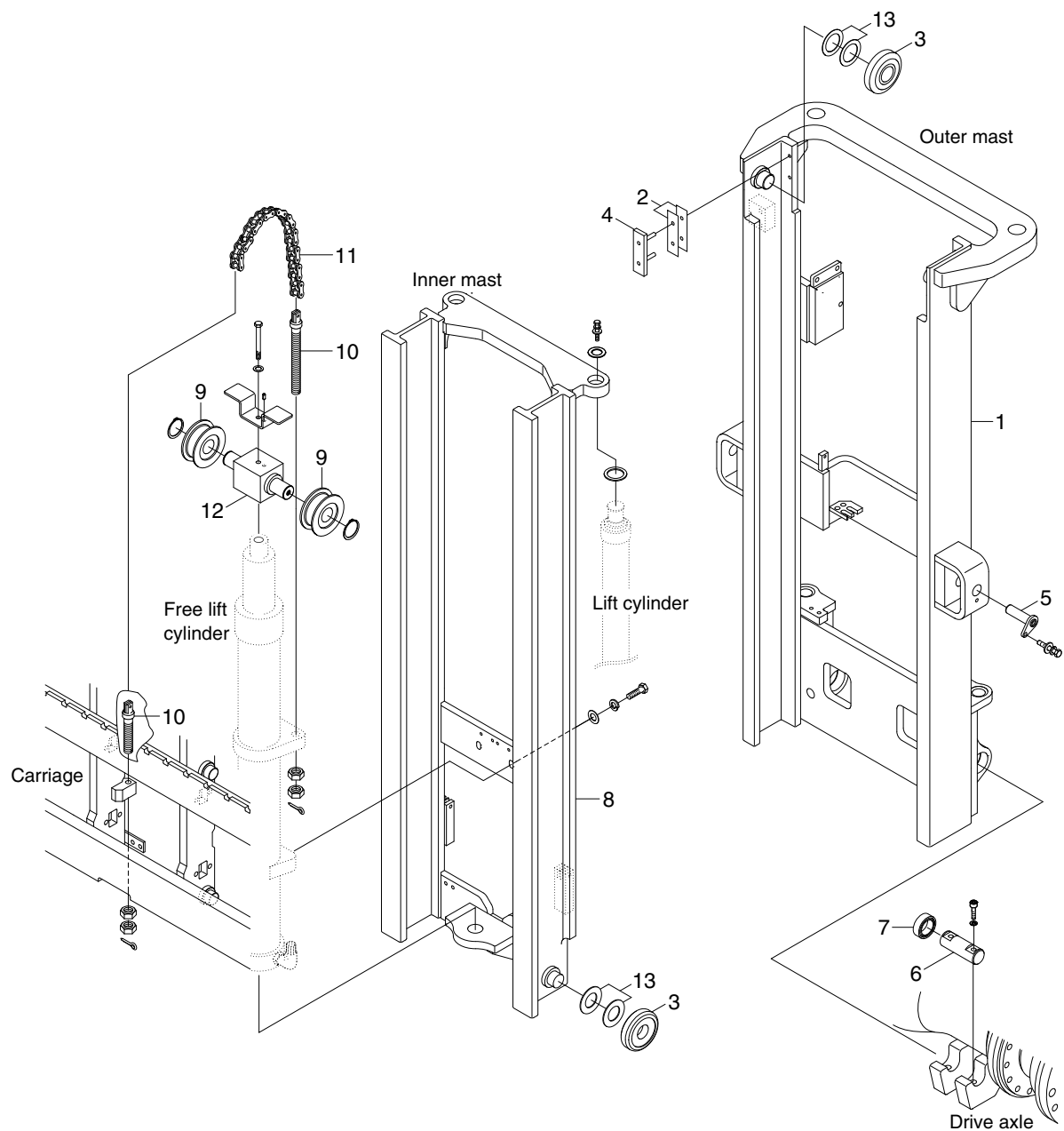
1. 2 STAGE MAST (V MAST)



35D9AMS01

- | | | | | | |
|---|-------------------|----|----------------------|----|------------------|
| 1 | Outer mast | 6 | Bearing | 11 | Roller bearing |
| 2 | Shim (0.5, 1.0t) | 7 | Inner mast | 12 | Back up liner |
| 3 | Roller bearing | 8 | Lift chain | 13 | Shim (0.5, 1.0t) |
| 4 | Tilt cylinder pin | 9 | Anchor bolt | | |
| 5 | Mast mounting pin | 10 | Chain sheave bearing | | |

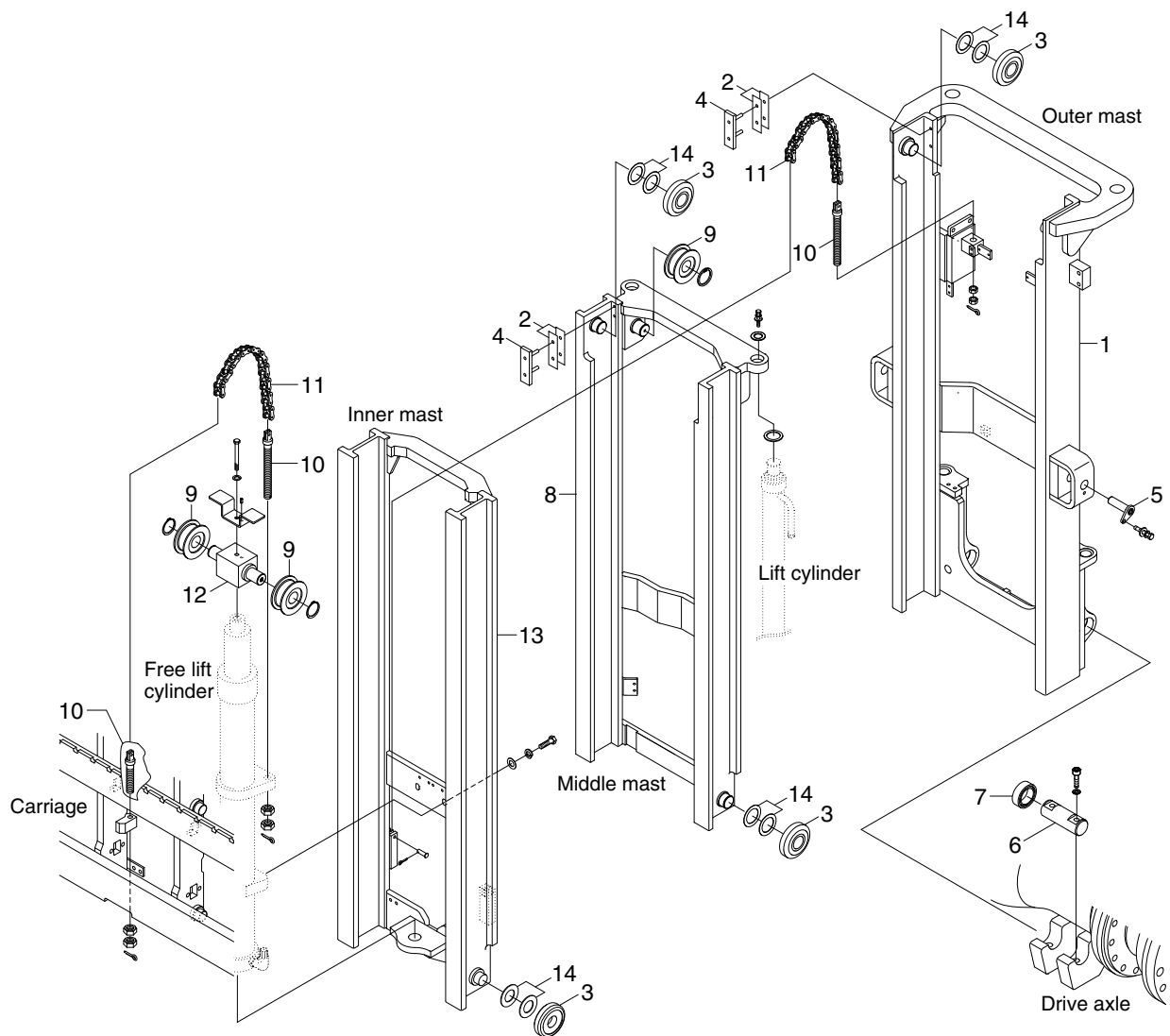
2. 2 STAGE MAST(VF MAST)



35D9AMS02

- | | | | | | |
|---|-------------------|----|----------------------|----|------------------|
| 1 | Outer mast | 6 | Mast mounting pin | 11 | Chain |
| 2 | Shim (0.5, 1.0t) | 7 | Bearing | 12 | Sheave bracket |
| 3 | Roller bearing | 8 | Inner mast | 13 | Shim (0.5, 1.0t) |
| 4 | Backup liner | 9 | Chain sheave bearing | | |
| 5 | Tilt cylinder pin | 10 | Anchor bolt | | |

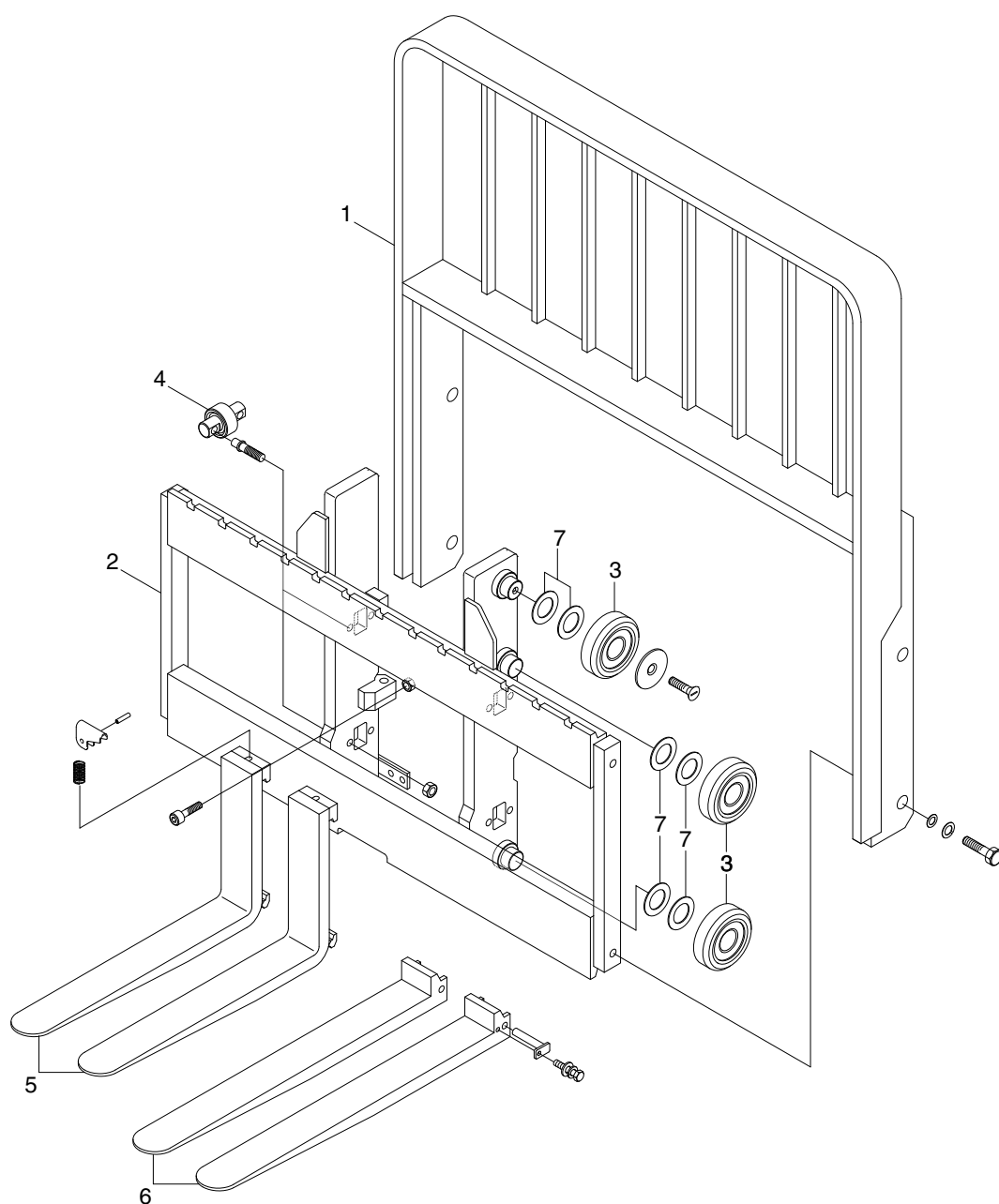
3. 3 STAGE MAST(TF MAST)



35D9AMS03

- | | | | | | |
|---|-------------------|----|----------------------|----|------------------|
| 1 | Outer mast | 6 | Mast mounting pin | 11 | Chain |
| 2 | Shim (0.5, 1.0t) | 7 | Bearing | 12 | Sheave bracket |
| 3 | Roller bearing | 8 | Middle mast | 13 | Inner mast |
| 4 | Backup liner | 9 | Chain sheave bearing | 14 | Shim (0.5, 1.0t) |
| 5 | Tilt cylinder pin | 10 | Anchor bolt | | |

3. CARRIAGE, BACKREST AND FORK



35D7EMS04

- 1 Backrest
- 2 Carriage
- 3 Roller
- 4 Side roller

- 5 Fork
- 6 Extension fork
- 7 Shim (0.5, 1.0t)

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

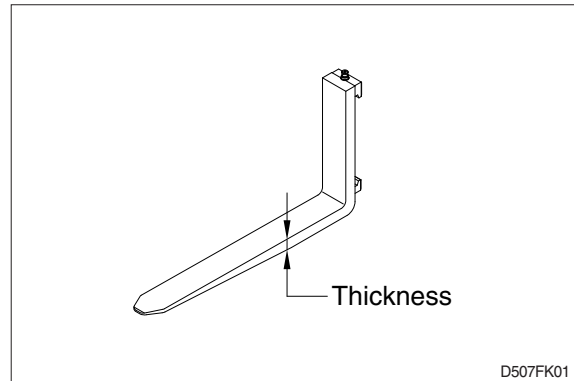
1. OPERATIONAL CHECKS

1) FORKS

- (1) Measure thickness of root of forks and check that it is more than specified value.

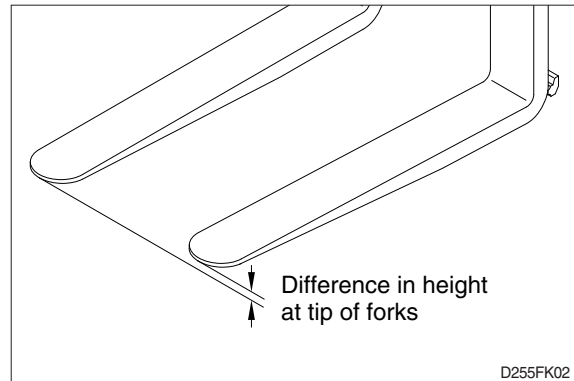
EX : $l = 1200 \text{ mm (47 in)}$ mm (in)

STD Fork assy	Applicable model	Standard	Limit
S173896-02	35D-9K	50 (2.0)	45 (1.7)
F13710020	40D-9K	50 (2.0)	45 (1.7)
F13710020	45D-9K	50 (2.0)	45 (1.7)
F14710011	50DA-9K	60 (2.4)	54 (2.1)



- (2) Set forks in middle and measure out of parallel and difference in height at the top of forks.

Model	Fork length	Height difference
35D/40D/45D-9K	equal or below 1500	3 mm
50DA-9K	above 1500	4 mm



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

2. MAST

- 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-to-right 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)
- Check that there is an oil groove in bushing at mast support.
- Set mast vertical, raise forks about 10 cm 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.
- 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.	<ul style="list-style-type: none"> Deformed mast or carriage. 	<ul style="list-style-type: none"> Disassemble, repair or replace.
Fork fails to elevate	<ul style="list-style-type: none"> Faulty hydraulic equipment. Deformed mast assembly. 	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> Faulty hydraulic equipment. Deformed mast assembly. 	<ul style="list-style-type: none"> See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system. Disassemble mast and replace damaged parts or replace complete mast assembly.
Mast fails to lift smoothly.	<ul style="list-style-type: none"> Deformed masts or carriage. Faulty hydraulic equipment. Damaged load and side rollers. Unequal chain tension between LH & RH sides. LH & RH mast inclination angles are unequal. (Mast assembly is twisted when tilted) 	<ul style="list-style-type: none"> Disassembly, repair or replace. See Troubleshooting Hydraulic Cylinders, pump and control valve in section 6, hydraulic system. Replace. Adjust chains. Adjust tilt cylinder rods.
Abnormal noise is produced when mast is lifted and lowered.	<ul style="list-style-type: none"> Broken load roller bearings. Broken side roller bearings. Deformed masts. Bent lift cylinder rod. Deformed carriage. Broken sheave bearing. 	<ul style="list-style-type: none"> Replace. Replace. Disassemble, repair or replace. Replace. Replace. Replace.
Abnormal noise is produced during tilting operation.	<ul style="list-style-type: none"> Insufficient lubrication of anchor pin, or worn bushing and pin. Bent tilt cylinder rod. 	<ul style="list-style-type: none"> Lubricate or replace. Replace.

2) FORKS

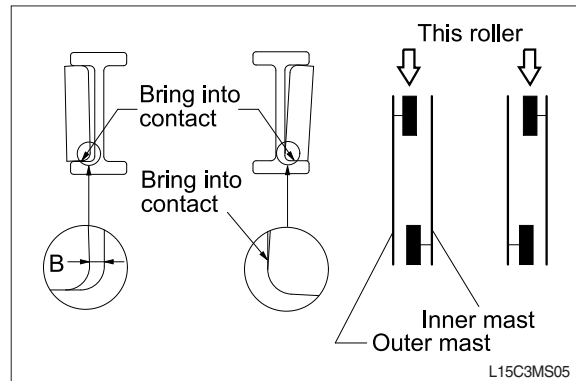
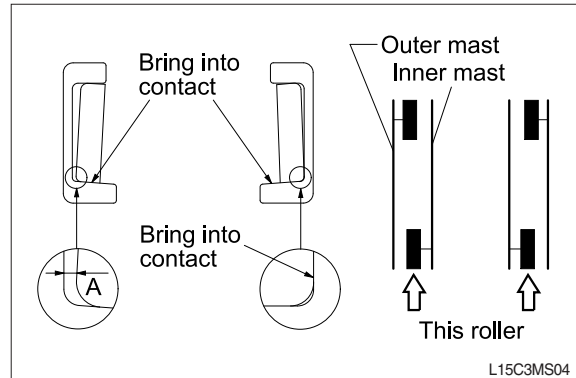
Problem	Cause	Remedy								
Abrasion	<p>Long-time operations causes the fork to wear and reduces the thickness of the fork.</p> <p>Inspection for thickness is needed.</p> <ul style="list-style-type: none"> Wear limit : Must be 90% of fork thickness 	If the measured value is below the wear limit, replace fork.								
Distortion	<p>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.</p> <ul style="list-style-type: none"> Difference in fork tip height <table border="1"> <thead> <tr> <th>Model</th><th>Fork length</th><th>Height difference</th></tr> </thead> <tbody> <tr> <td rowspan="2">35D/40D/45D-9K 50DA-9K</td><td>equal or below 1500</td><td>3 mm</td></tr> <tr> <td>above 1500</td><td>4 mm</td></tr> </tbody> </table>	Model	Fork length	Height difference	35D/40D/45D-9K 50DA-9K	equal or below 1500	3 mm	above 1500	4 mm	If the measured value exceeds the allowance, replace fork.
Model	Fork length	Height difference								
35D/40D/45D-9K 50DA-9K	equal or below 1500	3 mm								
	above 1500	4 mm								
Fatigue	<p>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.</p> <ul style="list-style-type: none"> Crack on the fork heel. Crack on the fork weldments. 	<p>Repair fork by expert.</p> <p>In case of excessive distortion, replace fork.</p>								

GROUP 3 ADJUSTMENT

1. MAST LOAD ROLLER (V, VF MAST)

1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

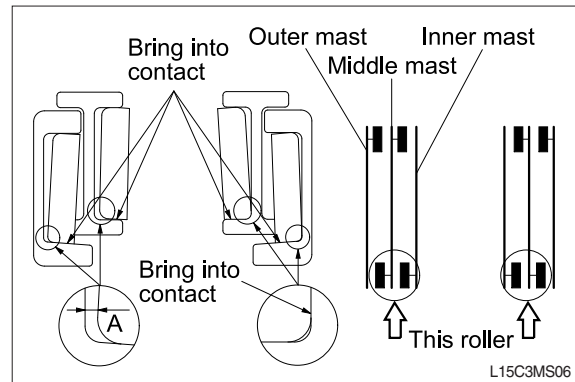
- (1) Measure the clearance with the mast overlap at near 480 mm.
- (2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner/outer mast roller shim.
 - Standard clearance A, B = 0~0.6 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)

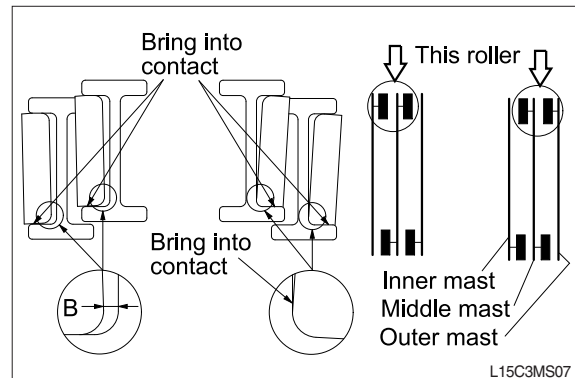
1) INNER AND MIDDLE MAST ROLLER CLEARANCE ADJUSTMENT

- (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.
 - Standard clearance A = 0~0.6 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.



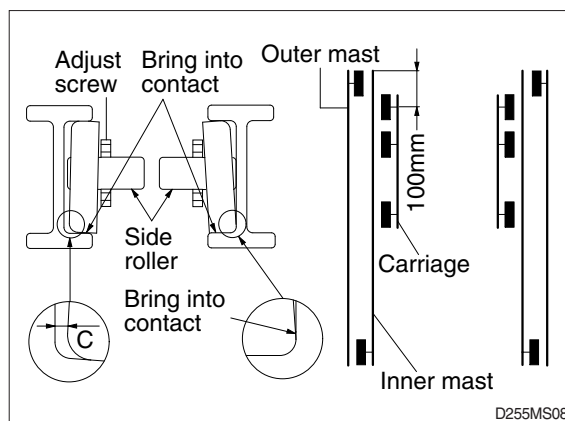
2) OUTER AND MIDDLE MAST UPPER ROLLER CLEARANCE ADJUSTMENT.

- (1) Measure the clearance with the mast overlap at near 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 outer and middle mast roller shim, respectively.
 - Standard clearance B = 0~0.6 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.



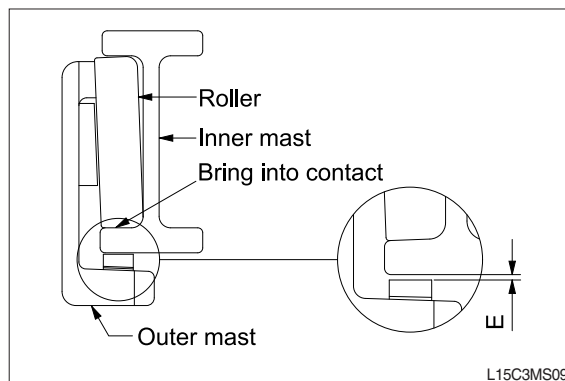
3) CARRIAGE LOAD ROLLER

- (1) Measure the clearance when the center of the carriage upper roller is 100 mm from the top of the inner mast.
- (2) Measure the clearance at upper, middle and 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 $C = 0 \sim 0.6$ mm
 - Shim thickness 0.5, 1.0 mm
- (3) Distribute the shim thickness equally to the left and right roller. Refer to Carriage assembly.
- (4) After the adjustment, the carriage should move smoothly along the overall mast length.



4) MAST BACK UP LINER

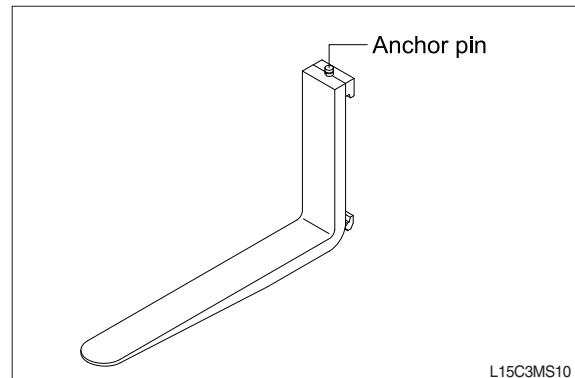
- (1) Measure the clearance with the middle mast at the bottom position.
- (2) With the middle mast in contact with the outer mast roller, adjust the clearance between the mast back up liner and middle mast to the following value by inserting the back up liner shim.
 - Standard clearance $E = 0.2 \sim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



GROUP 4 REMOVAL AND INSTALLATION

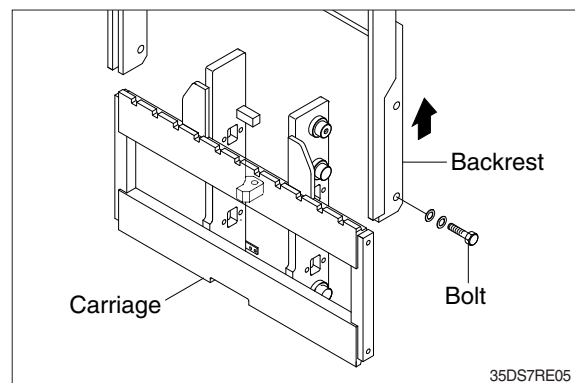
1. FORKS

- 1) Lower the fork carriage until the forks are approximately 25 mm (1 in) from the floor.
- 2) Release fork anchor pins 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

- 1) 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.

▲ 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 parts.
- (6) Reverse the above steps to reinstall.

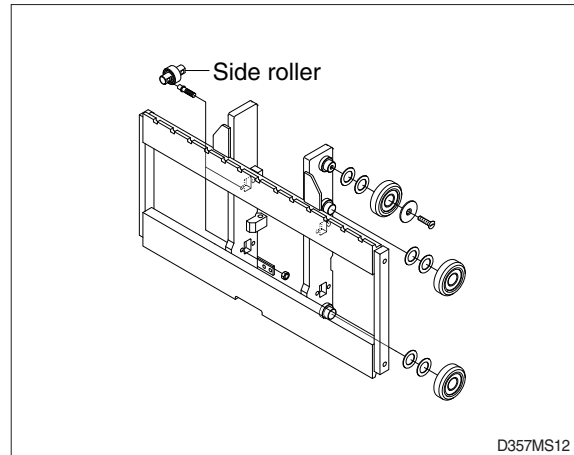
▲ Replace the split pin of chain anchor with new one.

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 plate.
- (3) Thoroughly clean, inspect and replace all worn or damaged parts.
- (4) Reverse the above procedure to assembly.

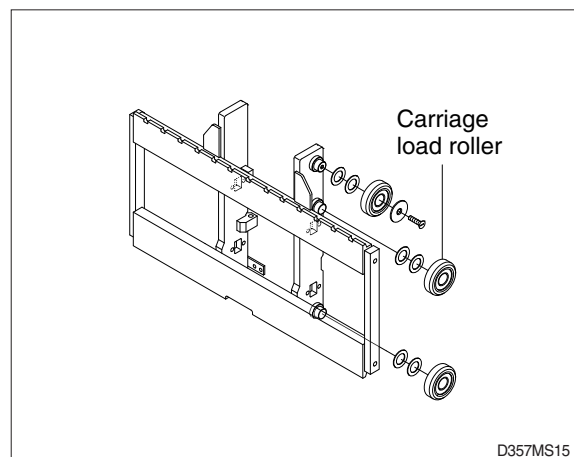
※ Adjustment

- 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

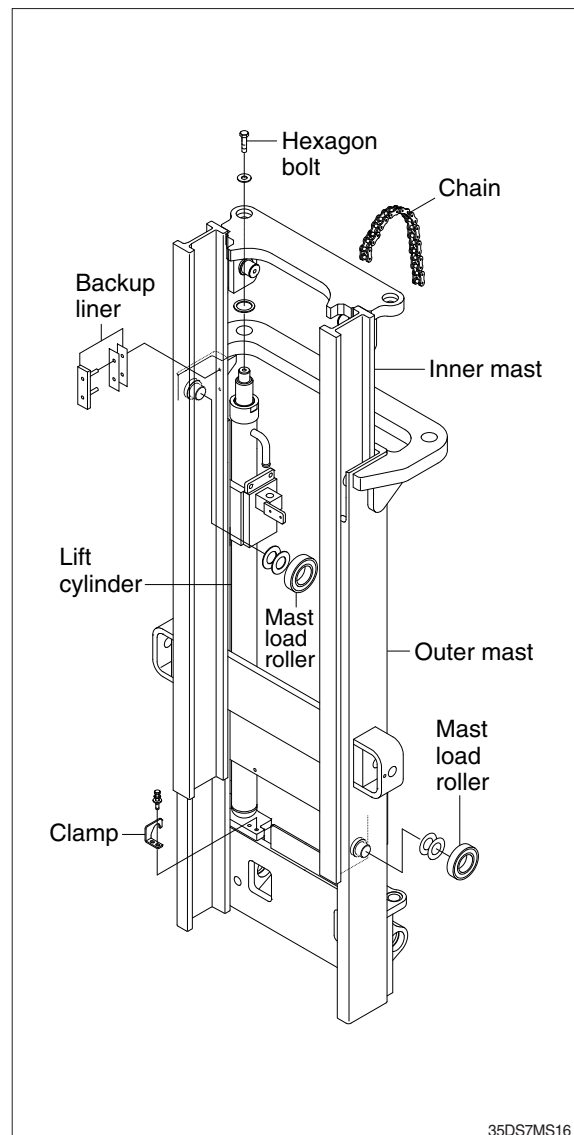
- (1) Remove carriage as outlined in the carriage assembly removal paragraph.
- (2) Loosen and remove flat head bolts and plain washers from top load roller bracket.
- (3) Using a pryer, remove load rollers from load roller bracket.
- (4) Reverse the above procedure to assemble. Refer to MAST ROLLER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



4) MAST LOAD ROLLER AND BACK UP LINER

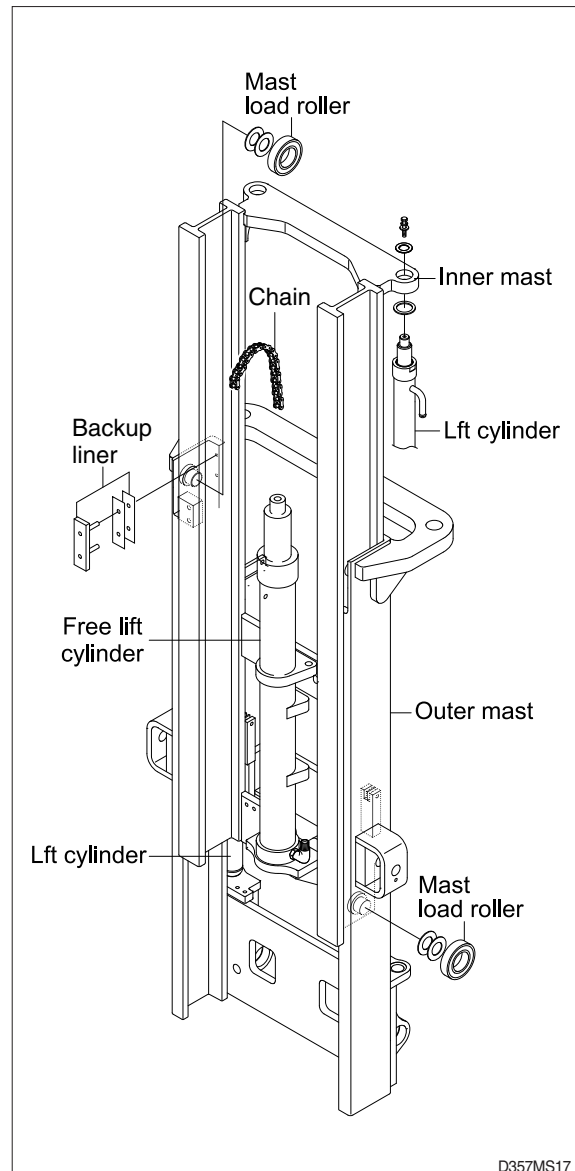
(1) 2 stage mast (V mast)

- ① Remove the carriage assembly and move them to one side.
- ② Loosen and remove hexagon bolts and clamps securing lift cylinders to outer mast.
- ③ Loosen and remove hexagon bolts and washers 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.
- ⑨ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



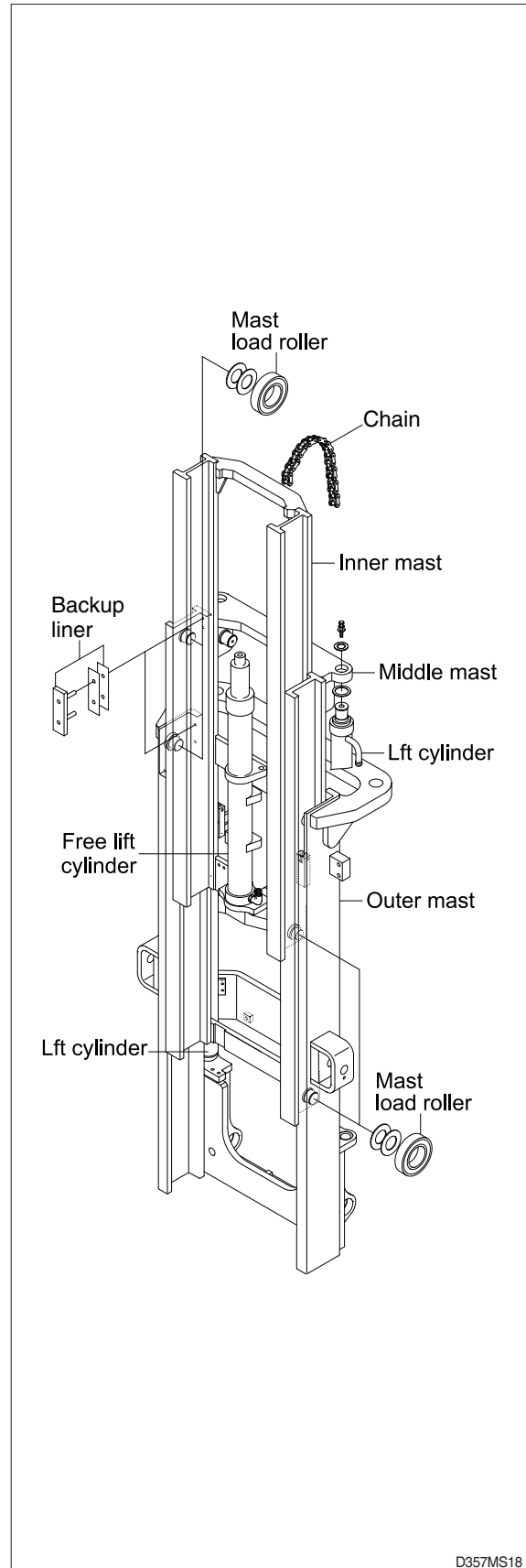
(2) 2 stage mast (VF mast)

- ① Remove free lift chain connected between carriage and free lift cylinder.
- ② Remove the carriage assembly and move them to one side.
- ③ Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.
- ④ Loosen and remove hexagon bolts and nuts securing lift cylinders to inner mast.
- ⑤ 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.
- ⑥ 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.
- ⑦ Using the overhead hoist, lower inner mast until top and bottom rollers and back up liners are exposed.
- ⑧ Using a pry, remove load rollers from load roller bracket. Remove back up liners and shims.
- ⑨ Thoroughly clean, inspect and replace all worn or damaged parts.
- ⑩ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



(3) 3 stage mast (TF mast)

- ① Remove the carriage assembly and move to one side.
- ② Loosen and remove hexagon bolt securing bottom cylinder from outer mast.
- ③ Loosen and remove bolts and special washers securing lift cylinders to middle mast.
- 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 pryer, remove load rollers from load bracket. Remove back up liners and shims.
- ⑨ 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.
- ⑩ Using a player, remove load rollers from load roller bracket.
- ⑪ 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, VF 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.

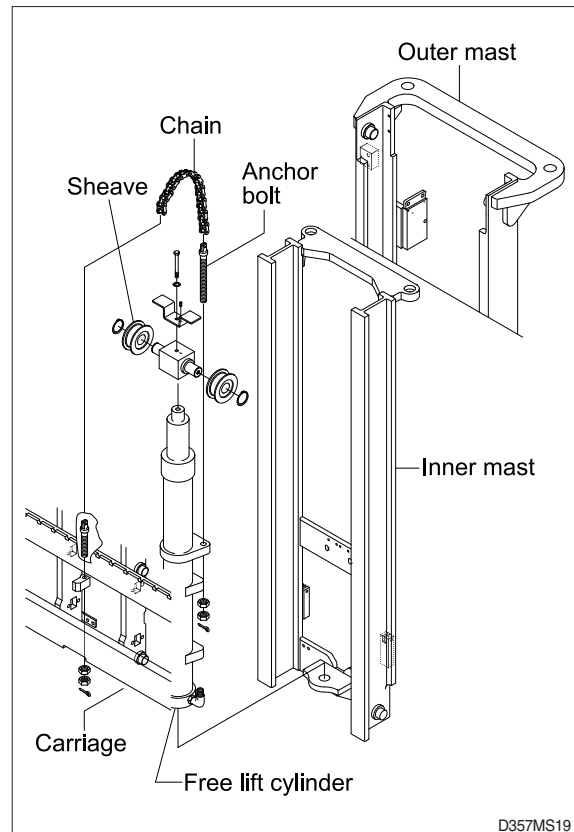
(2) Inner and middle mast (TF mast)

- 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.
- ⑦ Replace upright and reverse above procedure to install. Make all necessary measurements and adjustments.

6) CHAIN

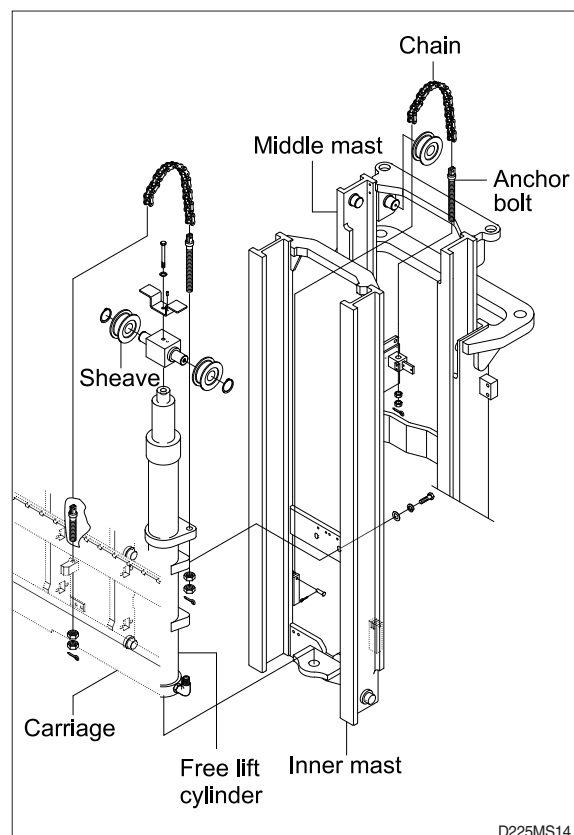
(1) Chain sheave (V, VF mast)

- ① 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.
- ② 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)

- ① 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 developes 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 :

- Bent pins or plates.
- Rusty joints.
- 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.

⑦ 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.

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

▲ 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.
- Proper sequencing of mast.
- Prevent over-stretching of chains.
- Prevent chains from jumping off sheaves if they are too loose.

④ Adjustment procedure

- With mast in its fully collapsed and vertical position, lower the fork to the floor.
- 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.