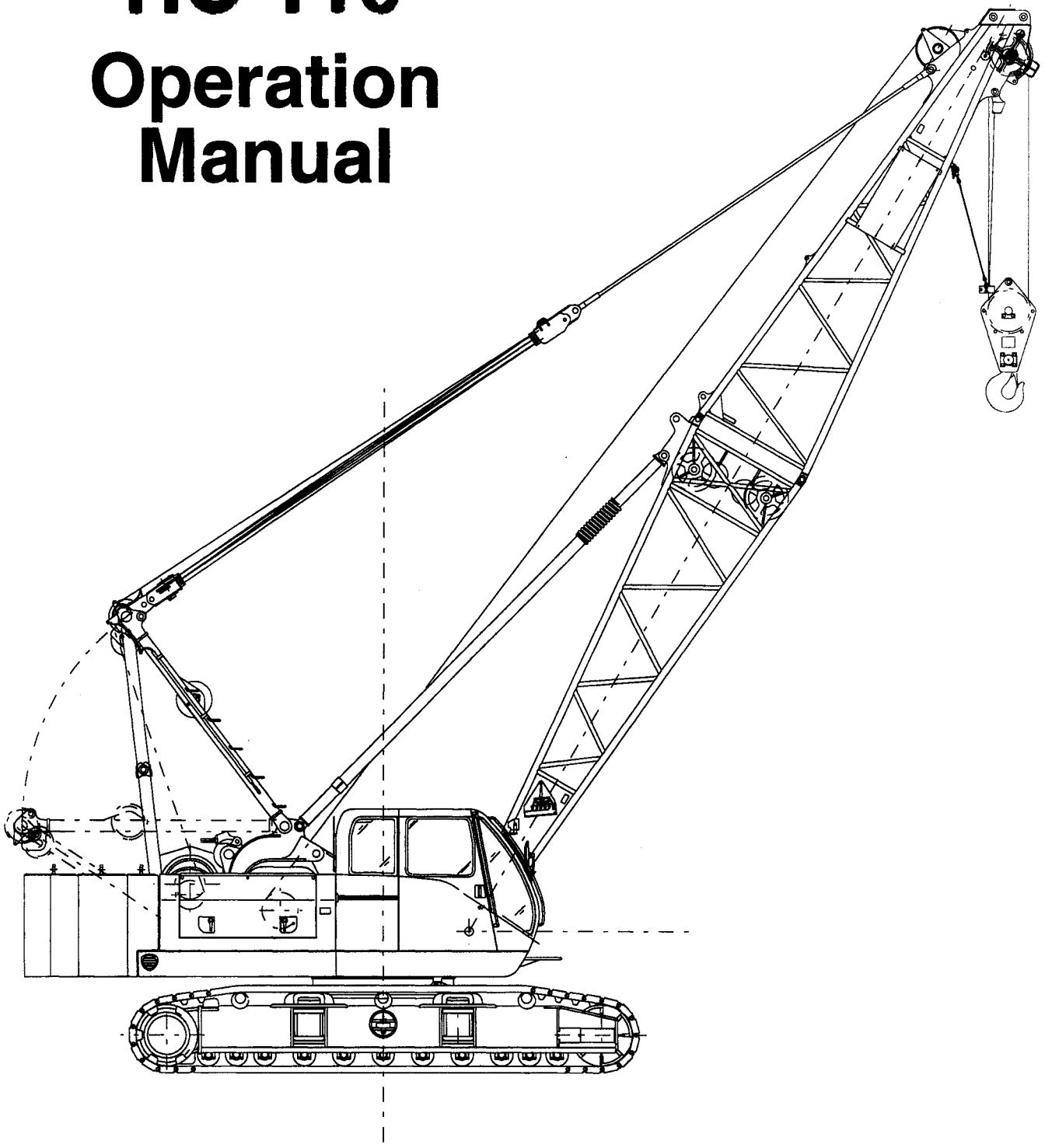
TEREX | AMERICAN

HC 110

Operation Manual



American Crane Corporation
Wilmington, North Carolina

AMERICAN CRANE WARNINGS

American Crane has developed Accident Prevention Signs and Labels that are used throughout the Crane and Operator Manual. It is very important that the user understands these warnings, as they alert the user to potential hazards which can result in personal injury or death.

SIGNAL WORDS

Signal words such as **DANGER, WARNING** and **CAUTION** are used to identify levels of hazard seriousness.

WARNING COLOR

The Warning or Hazard Alert colors (red, orange and yellow) function as a visual code to reinforce the meaning of the Signal Word. They also serve as a strong color accent which at a glance alerts the user to the severity of the hazard at hand.

RED

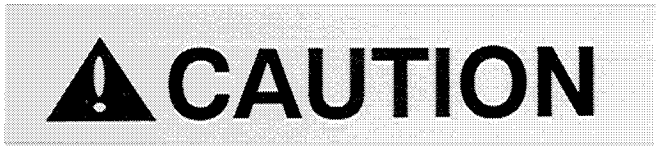
DANGER - Immediate hazards which WILL result in severe personal injury or death.

This will appear in some warnings which use the signal word "DANGER", indicating the highest degree of risk. When red is used in the signal word panel, white letters are used for the word "DANGER". If a safety alert symbol is used along with the signal word such as an exclamation mark inside of a triangle, the triangle will be solid white and the exclamation mark will be red.

ORANGE

WARNING - Hazards or unsafe practices which COULD result in severe personal injury or death.

This will appear in some warnings which use the signal word "WARNING". When orange is used in the signal word panel, black letters are used for the word "WARNING". If a safety alert symbol is used along with the signal word, such as an exclamation mark inside of a triangle, the triangle will be solid black and the exclamation mark will be orange.



YELLOW

CAUTION - Hazards or unsafe practices which COULD result in minor personal injury or product or property damage.

This will appear in some warnings which use the signal word "CAUTION". When yellow is used in the signal word panel, black letters are used for the word "CAUTION". If a safety alert symbol is used along with the signal word, such as an exclamation mark inside of a triangle, the triangle will be solid black and the exclamation mark will be yellow.

Our Products Safety Signs comply with ANSI Z535.4

INTRODUCTION

Owners, Users, and Operators:

Terex Cranes appreciates your choice of our machine for your application. Our number one priority is user safety, which is best achieved by our joint efforts. We feel that you make a major contribution to safety if you as the equipment users and operators:

1. **Comply** with OSHA, Federal, State, and Local Regulations.

2. **Read, Understand, and Follow** the instructions in this and other manuals supplied with this machine.

3. **Use Good, Safe Work Practices** in a common sense way.

4. **Only have trained operators** – directed by informed and knowledgeable supervision – running the machine.

NOTE: OSHA prohibits the alteration or modification of this crane without written manufacturers approval. Use only factory approved parts to service or repair this unit.

If there is anything in this manual that is not clear or which you believe should be added, please send your comments to Manager of Publication, Terex Cranes, P.O. Box 260002 / Highway 501 East, Conway, South Carolina 29526; or contact us by telephone at (843) 349-6900.

Thank you!

THIS SYMBOL MEANS YOUR SAFETY IS INVOLVED! READ, UNDERSTAND, AND FOLLOW ALL DANGER, WARNING, AND CAUTION DECALS ON YOUR MACHINE.

INTRODUCTION

Many aspects of crane operation, inspection and testing are discussed in standards published by the American National Standards Institute. These Standards are updated on an annual basis with addendas, which are sent by ASME to the original purchasers of the standard. Terex recommends that you purchase and refer to the following standards.

ANSI/ASME B30.5 - Mobile & Locomotive Crane (Latest Version)

These standards can be purchased from:

American Society of Mechanical Engineers
United Engineering Center
345 East 47th Street
New York, NY 10017

SYMBOLS

The symbols below are used to inform the operator of important information concerning the operation of this unit.

DANGER – Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

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

CAUTION – Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

ATTENTION – Indicates a situation which, if not avoided, may result in property or equipment damage.

SAFETY

WARNING

These are general safety rules, which must be followed. You are also required to read and understand the Operators Manual as there are instructions, which are more detailed specific to this machine.

HANDLING PERSONNEL

1. Cranes can only be used to lift people when it is the least hazardous way to do the job. (See OSHA 1926.550g, and ASME / ANSI B30.23.)

TRAINING AND KNOWLEDGE

1. Safety must always be the operators most important concern.
2. Do not operate this crane until you have been trained in its operation. This crane must only be operated by trained personnel, who have demonstrated their ability to do so safely.
3. Comply with the requirements of current Occupational Safety and Health Administration (OSHA) standards, the current American National Standards Institute (ANSI) B30.5 latest edition.
4. Read and Understand all Decals and Warnings.
5. Read and Understand the Rating Chart.
6. Know that the crane can safely lift each load before attempting to lift.

7. Operator must understand crane signals and take signals only from designated signal people; except the operator must obey the stop signal from anyone.

⚠ OPERATOR'S RESPONSIBILITIES

1. Read and understand the Operator's Manual.

2. Make sure the machine is in proper order and that all operational aids and warning signals are functional before operating.

3. Keep the machine clean, including all instrumentation, windows, lights and other glazed surfaces.

4. Remove all oil, grease, mud, ice and snow from walking surfaces.

5. Store tools and other necessary items in the tool box.

6. Never lift a load without a Rating Chart Manual in the cab.

7. Know the load to be lifted.

8. Be alert, physically fit and free from the influences of alcohol, drugs or medications that might affect the operators eyesight, hearing, or reactions.

9. Keep people, equipment and material out of the work area.

10. Signal person must be used when the operators vision is blocked or working in hazardous areas such as power lines or people.

11. Keep a fully charged fire extinguisher and first aid kit in the cab at all times, and be familiar with how to use these items.

12. Know about movements of other machinery, trucks and personnel at the jobsite.

13. Never permit people on the machine platform while the machine is working.

14. Make sure everyone is in a safe place before moving the hook, boom, load or outriggers.

15. Start and stop movements smoothly and swing at speeds that will keep the load under control.

16. Keep at least two full wraps of wire rope on drum when operating.

17. Feet must be kept on the pedals while foot pedal brake locks are in use.

18. Use tag lines to keep loads under control.

19. Keep load close to ground.

20. Use shortest boom possible.

21. Never leave a running machine unattended or load suspended.

22. Always use outriggers in accordance with requirements of Load Rating Chart and operators manuals.

⚠ SIGNAL PERSON'S RESPONSIBILITY

1. Standard crane signals must be used, and understood.

2. Assist the operator in safe and efficient operation, without endangering people or property.

3. Have a clear understanding of the work to be done.

4. Signal people must place themselves where they can be clearly seen and where they can safely observe the entire operation.

RESPONSIBILITIES OF ALL CREW MEMBERS

1. Unsafe conditions or practices must be corrected.
2. Obey all warning signs.
3. Watch out for your safety and the safety of others.
4. Know and understand proper machine erection and rigging procedures.
5. Alert operator and signal person of dangers, such as power lines, unstable ground etc.

MANAGEMENT RESPONSIBILITY

1. Operator must be competent, physically fit and if required licensed.
2. Operator, signal people and riggers must be trained in correct crane operation and use.
3. Operator and Signal people must know standard crane signals.
4. Have a supervisor at job site to be responsible for job safety.
5. Crew members given specific safety responsibilities and instructed to report any unsafe conditions to supervisor.
6. Supply the weight on the load to be lifted to the operator.
7. Verify that all crew members are familiar with OSHA, ANSI B30.5 requirements as well as instructions in manuals.

PLANNING THE JOB

1. Have a clear understanding of work to be done.
2. Consider all dangers at jobsite.
3. Know what crew members are needed.
4. Assign responsibilities.
5. Know the weight of load to be lifted.
6. Determine lift radius, boom angle, and the rated lifting capacity of crane.
7. Establish how signal people will communicate with operator.
8. Utilize equipment which will do job safety.
9. Establish how equipment can be safety transported to job site.
10. Determine where gas lines, power lines, or structures are which must be moved.
11. Ensure that surface is strong enough to support machine and load.
12. Determine how load will be rigged.
13. Establish special safety precautions, if necessary.
14. Consider weather conditions.
15. Keep unnecessary people and equipment away from work place.
16. Position machine to use shortest boom and radius possible.

OPERATOR'S SAFETY CHECK

1. Safety related items must be in place.
2. Check machine log book, to see if periodic maintenance and inspections have been performed.
3. Ensure that necessary repairs have been completed.
4. Inspect wire rope for damage (kinks, broken wires etc.)
5. Be sure no unauthorized field modifications have been made.
6. Check for air and hydraulic oil leaks.
7. Check control positions before starting engine.
8. After starting engine, check all gauges and indicators for proper readings.
9. Test all controls.
10. Check brakes and clutches.
11. Check load brakes by lifting a load a few inches off the ground and holding it.

OPERATOR AIDS CHECK

Ensure that the listed items are in place and operational.

1. Boom hoist upper angle limit switch. (Lattice Boom).
2. Boom angle indicator.
3. Backup Alarms.
4. Anti-Two Block devices.
5. Overload Protection, Load Indicators, Rated Capacity Limiters.

⚠ OPERATION OVERLOAD PREVENTION

1. Know the weight of the load.

2. Load radius will increase when the load is lifted. Reduce radius at start of lift to allow for this.

3. Know the weight of hook, and rigging.

4. Know boom length, jib length, parts of line and operating area.

5. Use next lower rated capacity when working at boom lengths or radius between the figures on the rated lifting capacity chart.

6. Never lift a load without knowing whether it is within the rated capacity.

7. Never operate with anything other than recommended counterweight.

ATTENTION

Unauthorized reduction or additions of counterweight constitute a safety hazard.

8. Do not lift loads if winds create a hazard. Lower the boom if necessary. See the Rating Chart Manual for possible restrictions.

9. Avoid side loading.

10. Never let the load or any other object strike the boom.

11. Release load slowly, be sure boom never tightens against back stops. (Lattice Boom).

12. Place the boom point directly above the load when lifting.

13. Be sure loads are freely suspended.

OPERATION SETUP

1. Be sure the load bearing surface is strong enough to support the machine and load.

2. Be sure cranes are level, check frequently and relevel when necessary.

3. Stay away from rotating cranes, erect barricades to keep people away. Make sure these areas are clear before swinging.

POWER LINE SAFETY

1. Determine whether there are power lines in the area before starting any job. Only operate around power lines in accordance with Federal, State and Local Regulations as well as ANSI B30.5 latest edition.

2. Never remove materials from under powerlines with a crane if the boom or machine is capable of contacting them.

3. No part of crane or load must come in contact with, or violate the minimum allowable clearance required for operation of crane near electrical lines.

4. Should contact occur stay on crane until the boom is cleared or until the current is turned off.

5. If in contact keep all personnel off the crane. If you must leave the crane, JUMP, DO NOT STEP OFF, leave area by jumping with feet together.

6. Use a signal person when working around power lines.

SLIP AND FALL PREVENTION

1. Always wait until machine has stopped before getting on and off equipment. Do not jump on or off.
2. Do not use controls and steering wheel as hand holds.
3. Keep the machine clean and dry.
4. Replace all broken ladders.
5. Keep non-slip surfaces in good condition.

TRAVEL

1. Care must be taken when cranes are driven (traveled) whether on or off the job site.
2. Watch for people, power lines, low or narrow clearance, bridge or road load limits, steep hills or uneven terrain.
3. Position boom in line with the direction of travel.
4. Inflate tires to specified pressure.
5. Travel slowly and avoid sudden stops and starts.
6. It is recommended that the seat belt be used during transit and travel.
7. Make sure travel surface can support weight of machine and load.
8. Always set parking brakes when parking machine.

AVOID SERIOUS BODILY INJURY OR PROPERTY DAMAGE. DO NOT ATTEMPT TO START OR OPERATE THIS MACHINE WITHOUT THOROUGHLY READING AND UNDERSTANDING THE INSTRUCTIONS PROVIDED IN THIS OPERATOR'S MANUAL.

Printed in U.S.A.
12/00

PREFACE

This Operating and Maintenance Manual is designed to familiarize owners and operators with the many advantages built into AMERICAN equipment in order to maximize performance. Maintenance and repair sections are provided with procedures which are periodically necessary to keep your equipment in top operating condition.

This manual is intended for use by persons skilled in operation and maintenance of crawler cranes. American Crane Corporation is not responsible for qualifying these personnel.

We have also provided lubrication and inspection checklists which recommend intervals and procedures necessary to help insure that your equipment receives the basic care required for continued operation. Our recommendations are based on the highest standards in the industry and reflect many years of experience. Use these checklists to establish your own program of adjustments, maintenance and lubrication.

Regular inspections will often detect potential problems before failures occur and save on untimely delays.

⚠ WARNING

ANY MODIFICATION TO THIS CRANE NOT APPROVED BY THE FACTORY IS PROHIBITED. THIS INCLUDES THE USE OF REPLACEMENT PARTS, ACCESSORIES OR COMPONENTS NOT AUTHORIZED BY THE FACTORY.

For proven dependability and performance,

USE ONLY GENUINE AMERICAN® PARTS

When ordering parts for your equipment, always refer to the serial number of the machine. This is located on a plate on the front of the machine under the operator's cab window.

For all engine information, please refer to the manufacturers' manuals found in the parts books provided with the original crane order. These manuals are not provided in the reordered parts books.

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12/00

IMPORTANT SAFETY, RATING CHART AND WARRANTY INFORMATION

⚠ WARNING

TO ALL USERS OF AMERICAN CRANE CORPORATION CRANES

AMERICAN CRANE CORPORATION has been made aware of attempts to duplicate and or repair certain types of American Crane booms. These booms may not be built or repaired to the rigid standards which control the manufacturing and repair of American Crane booms. These proprietary standards were developed from years of manufacturing experience in high strength boom fabrication and testing. They are far more stringent than any general manufacturing standards in use today. Extensive fixturing and inspection techniques are required to develop the full potential of American Crane boom designs. Further, to fully comply with the requirements of ANSI/ASME B30.5, American Crane booms have undergone extensive electronic strain gauge testing to verify the design and manufacturing procedures utilized in their production. Without the proper manufacturing controls even adequate materials cannot produce booms which will meet specified strength margins. For these reasons, American Crane Corporation must emphasize the following:

⚠ WARNING

THE USE OF ANY BOOM SECTIONS OTHER THAN THOSE SUPPLIED BY AMERICAN CRANE CORPORATION MAY CAUSE CATASTROPHIC FAILURE RESULTING IN PROPERTY DAMAGE, INJURY AND DEATH.

⚠ WARNING

THE USE OF ANY BOOM SECTIONS OTHER THAN THOSE SUPPLIED BY AMERICAN CRANE CORPORATION INVALIDATES THE CRANE'S RATING CHARTS.

⚠ WARNING

THE USE OF ANY BOOM SECTIONS OTHER THAN THOSE SUPPLIED BY AMERICAN CRANE CORPORATION MAY AFFECT ANY WARRANTIES ASSOCIATED WITH THE CRANE.

Printed in U.S.A.
12/91

IMPORTANT LOAD LIFTING RESTRICTIONS AND REGULATIONS

Crawlers and Truck Cranes

⚠ WARNING

**Study the following carefully.
Failure to observe any of the following limitations may result in serious structural or mechanical failure or accidents.**

Ratings have been established by American Crane on the basis of sound engineering methods and testing procedures. The machine complies with applicable U. S. Industry standards for stability and material strength factors. These standards require operation within rated capacities and in accordance with good operating practice, including the limitations shown on these pages.

DO NOT EXCEED THE RATING OF THE MACHINE. Lifting loads greater than those shown on the rating chart or operation at positions not shown CAN CAUSE STRUCTURAL FAILURE, TIPPING OR COLLAPSE OF THE BOOM OR CRANE.

1. All ratings apply only to machines as originally manufactured and equipped but include machines on which repairs or replacements have been made in accordance with original specifications. American Crane shall have no responsibility for machines or components on which replacements have been made with parts or spares not manufactured by American Crane, or on which any unauthorized changes have been made, or which are operated after damage which has not been repaired. The safe handling of loads with a crane depends on ground conditions, boom length and radius. These factors as well as many others must be taken into consideration by the operator.

2. Ratings are based on the machine standing level on a firm, uniformly supporting surface. Level should be within 1/2% of true level and the supporting surface must be sufficiently firm to maintain this level under load. If the operating surface is not level, the crane should be removed and the foundation leveled before making a lift. If the operating surface is not sufficiently firm and stable, crane mats should be used to reduce soil loadings. If operation is necessary under adverse conditions, contact American Crane for further information before attempting operation.

3. For operation of land-based cranes (truck, crawler or wagon mounted) from a barge or other floating platform the above listed level requirements must be maintained throughout the lift cycle. In addition, other factors such as securing the crane to the platform must be considered by the user. Contact American Crane for further information.

4. Under certain conditions cranes can be overturned without a load. This can be prevented by observing the rating chart and avoiding boom positions which show no load ratings.

5. The rating charts apply up to maximum wind speeds as indicated in the table on Page 3499.1. This table lists the maximum wind velocity for which ratings apply. These wind speeds refer to steady winds or gusts where the maximum wind speeds reached are the magnitudes stated. Velocities must be measured at a point equivalent to the highest boom or jib elevation and should be taken at some location in close proximity to the crane. **No account is taken of the wind force on the load.** This effect, which is substantial for loads with large surface areas, must be considered by the user and ratings reduced accordingly. For more information contact American Crane.

WIND SPEED LIMITATIONS

Boom Size	Boom or Boom Plus Jib	Operation	No operation. Lower boom to 50-60 degrees. Position rear of crane into wind.	Lower or secure boom
37"	0-140' (0-42.3m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
37"	Over 140' (0-42.3m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
46"-47"	0-170' (0-51.8m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
46"-47"	Over 170' (51.8m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
1K 1400	0-170' (0-51.8m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
1K 1400	Over 170' (51.8m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
58"-59"	0-220' (0-67.1m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
58"-59"	Over 220' (67.1m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
77"	0-290' (0-88.4m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
77"	Over 290' (88.4m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
92"-94"-118"	0-360' (0-109.8m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
92"-94"-118"	Over 360' (109.8m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)
130"	0-400' (0-122m)	0-30 mph (0-13.4 mps)	30-50 mph (13.4-22 mps)	Over 50 mph (22.4 mps)
130'	Over 400' (122m)	0-20 mph (0-8.9 mps)	20-30 mph (8.9-13.4 mps)	Over 30 mph (13.4 mps)

6. Crawler sideframes and truck or wagon crane outriggers must be fully extended and set to maximum width to obtain ratings listed for such on the chart. When operating in the "FREE" condition without outriggers on a truck or wagon crane, the boom must never be operated at radii for which no ratings are shown in the "Outriggers Free-Over The Side" area of the chart. Tires must be in good condition and properly inflated for operation. For truck cranes equipped with a front outrigger jack, the ratings designated "Outriggers Set-Over Side" can be used for 360 degree rotation.

7. Do not lift over the front of a truck crane either with or without outriggers. See diagrams on next page for definition of working areas with various types of cranes. If such a lift is unavoidable, consult American Crane for special instructions and suitably reduced ratings.

8. NEVER SIDELOAD THE BOOM. Such sideloading can cause structural failure or collapse. Always keep the boom point directly over the load to avoid sideloading. Operating the crane while out of level or in high winds as well as dragging a load sideways by swinging or pulling on a load while it is partially or fully attached to a structure are all causes of sideloading and must be avoided.

9. The A-Frame must be in the fully raised position for lifting all rated loads. (Sky Horse operation is an exception). Do not operate with the A-Frame in any intermediate (partially raised) position.

10. Check brakes, clutches, and rigging daily and before any heavy lifts. Brakes and clutches must be dry, well adjusted and free from oil. Do not lift load or bucket after the machine has been standing during damp weather without first riding the brakes to evaporate moisture. All wire rope should be checked for wear and stranding and should be replaced if it is defective.

11. Switch Operation Lock Switch to "LOCK" before leaving machine.

12. Never lift or release a load when the boom is solid against the boom stops.

13. Do not leave the operator's seat with the bucket or load suspended. Cooling of the brakes and brake drum may release the brake bands allowing the load to fall. Avoid traveling with a suspended load. When such travel is necessary, keep the load from swinging. Keep feet on the brake pedals while propelling the machine. Jarring of the load may cause the brakes to slip. When the machine is equipped with spring-set, air-released auxiliary brake chambers, the control valve should be placed in the "Brake Set" position so the brakes are engaged by the springs when holding the load or traveling. Reduced ratings must be used when traveling on grades to compensate for changes in stability, load radius, and sideloading of the boom. When traveling uphill, lower the boom to prevent it from falling backward.

14. Lowering against the torque converter (whereby the load runs the machinery backwards) should only be used for inching down loads. Place the sprag clutch flipper valve in the "Sprag Out, Dog In" position and disconnect the tailshaft governor cable at the torque converter on machines so equipped. Excessive lowering speed must be controlled by increasing engine RPM. In extreme cases, it is possible to stall the engine and cause the load to free fall. Keep a foot on the hoist brake pedal and be prepared to apply the brake quickly and smoothly. Be sure to reconnect tailshaft governor cable for duty cycle operation.

15. Detailed instructions for operating and maintenance are given elsewhere in this manual. Read and study the operating instructions carefully.

16. Cranes can self-erect all boom or boom-jib combinations shown on the rating chart unless specifically stated otherwise. During erection the A-Frame must be fully raised and all load-carrying devices must be on the ground. On truck cranes the outriggers must be fully extended and set and the boom erected over the rear of the carrier to achieve maximum capability. On a crawler crane the boom must be erected directly over the idler end of the crawler sideframes with the idler tumblers securely blocked to achieve maximum capability. When erecting over the side of a crawler the sideframes must be fully extended.

17. When two cranes are making a lift together, both cranes must be level. The rigging must be designed so that each crane is lifting a share of the load which is well within its rating. The swing brakes of both machines must be released so that the boom points are free to remain directly over their load attachment points at all times. This can be a dangerous procedure and should be attempted only after substantial planning.

18. PERSONNEL LIFTING

⚠ WARNING

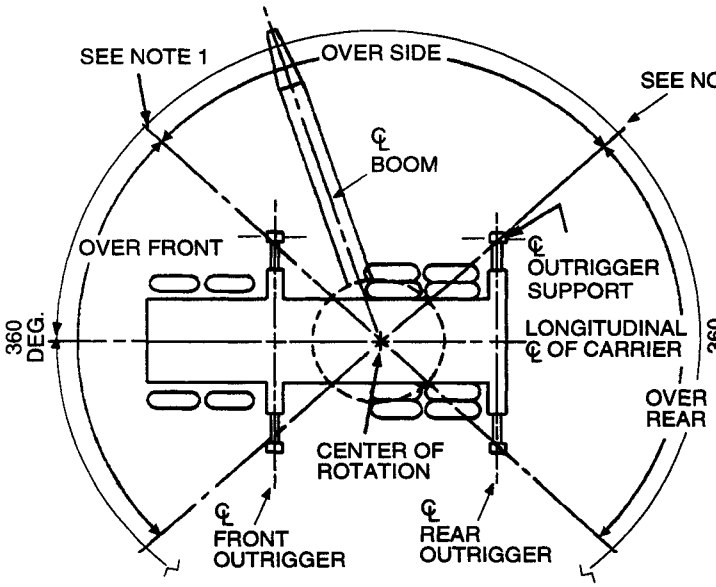
THIS MACHINE IS NOT INTENDED TO BE USED AS A PERSONNEL HOIST! IF SUCH USE IS ALLOWED BY LOCAL, STATE OR FEDERAL REGULATIONS, THE OWNER OR USER IS RESPONSIBLE FOR COMPLYING WITH SUCH REGULATIONS AND ANY OTHER APPLICABLE REQUIREMENTS.

TO THE BEST OF OUR KNOWLEDGE, THIS WOULD REQUIRE THE CRANE TO BE EQUIPPED AS FOLLOWS TO MEET THE CURRENT ANSI/ASME B30.5-1982 OR LATEST REVISION.

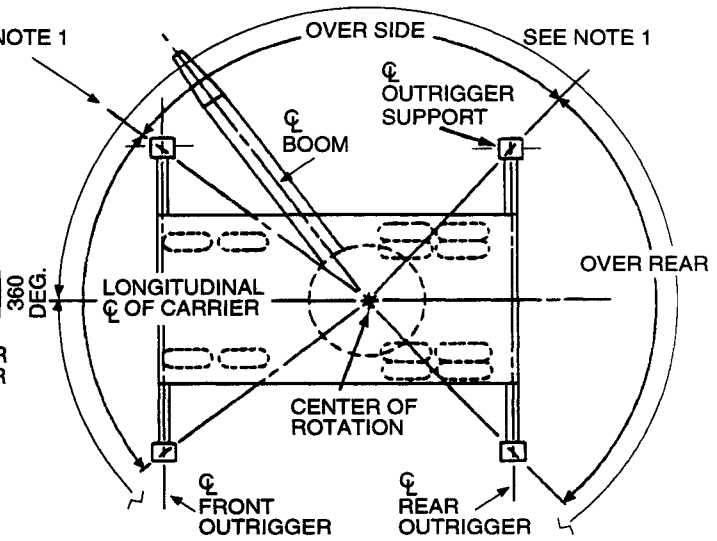
1. **OVERHOISTING DEVICE TO PREVENT THE LOAD BLOCK/OVERHAUL BALL FROM HITTING THE BOOM POINT.**
2. **SINGLE LEVER CONTROL TO PREVENT ANY POSSIBILITY OF FREEFALL.**
3. **CONTROLLED LOAD LOWERING ON THE HOIST BEING UTILIZED TO LOWER THE MAN BASKET.**
4. **PERSONNEL SHALL NOT BE PERMITTED TO RIDE THE BARE HOOK OR LOAD SUSPENDED FROM THE HOOK.**

IMPORTANT: THE TOTAL WEIGHT OF THE LIFTED LOAD (INCLUDING PERSONNEL) SHALL NOT EXCEED 50% OF THE CRANE RATING WITH MACHINE EQUIPPED AS ABOVE; IT IS THE RESPONSIBILITY OF USER OF THIS CRANE TO ASSURE THAT THE FOOTING UNDER ALL THE OUTRIGGERS/CRAWLERS IS ADEQUATE TO SUPPORT THE CRANE AS ANY POSSIBILITY OF FREEFALLING THE LOAD HAS BEEN ELIMINATED.

19. BE SAFE. For any clarification or answers to additional questions contact American Crane before attempting operation.

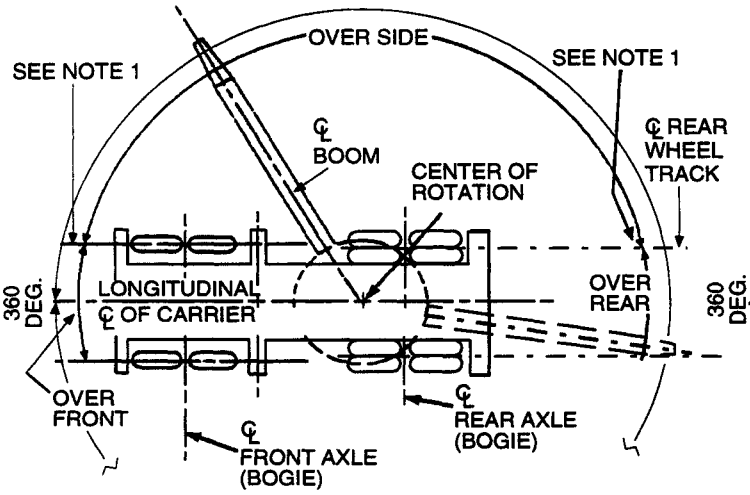


FRONT OUTRIGGER BEHIND FRONT WHEELS

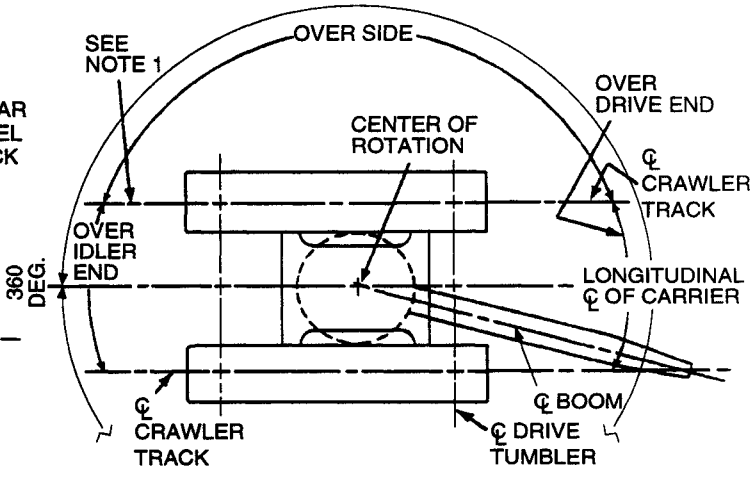


FRONT OUTRIGGER AHEAD OF FRONT WHEELS

CARRIERS ON OUTRIGGERS



CARRIER ON TIRES



CRAWLER TYPE LOWER

WORKING AREA DEFINITIONS

NOTE 1
These lines determine the limiting position of any load for operation within working areas indicated.

CALCULATING TOTAL LOAD WEIGHT

Crane's Lifted Load on Main Fall Includes:

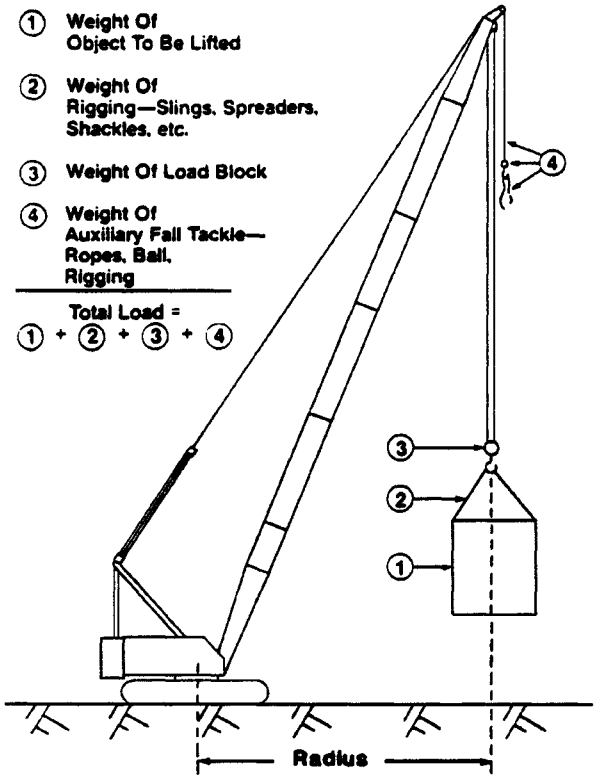
① Weight Of Object To Be Lifted

② Weight Of Rigging—Slings, Spreaders, Shackles, etc.

③ Weight Of Load Block

④ Weight Of Auxiliary Fall Tackle—Ropes, Ball, Rigging

Total Load = ① + ② + ③ + ④



Crane's Lifted Load on Main Fall Must Also Include Jib and Jib Tackle:

① Weight Of Object To Be Lifted

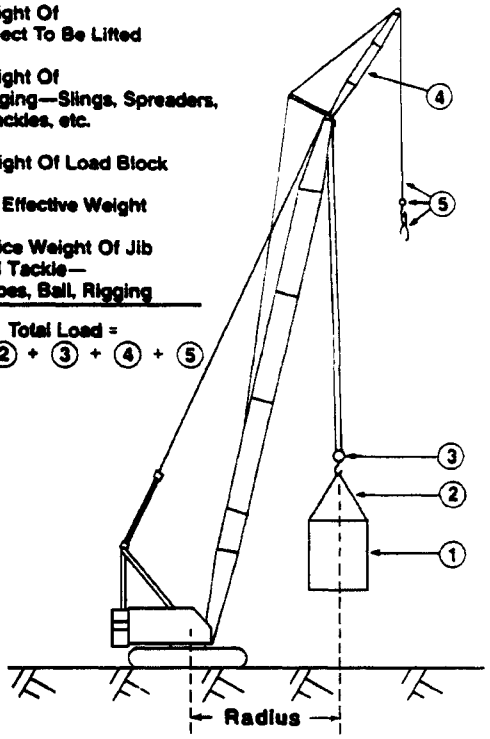
② Weight Of Rigging—Slings, Spreaders, Shackles, etc.

③ Weight Of Load Block

④ Jib Effective Weight

⑤ Twice Weight Of Jib Fall Tackle—Ropes, Ball, Rigging

Total Load = ① + ② + ③ + ④ + ⑤



Crane's Lifted Load on Jib Fall Includes:

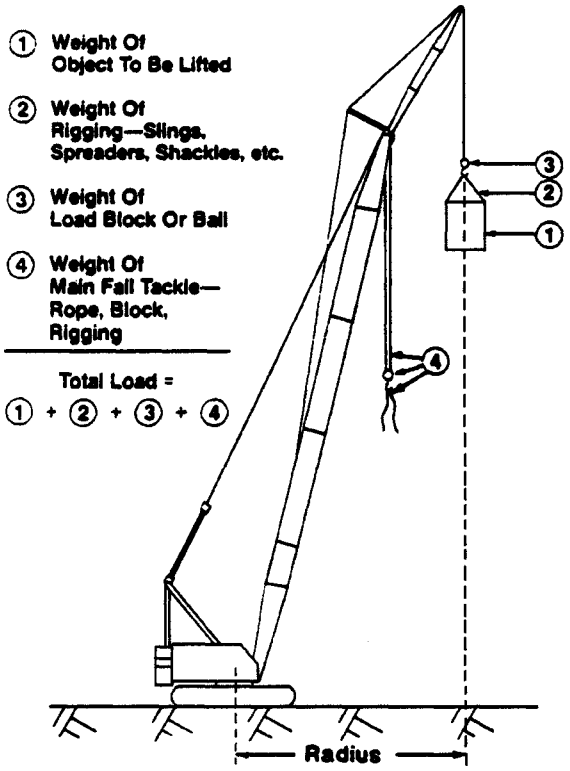
① Weight Of Object To Be Lifted

② Weight Of Rigging—Slings, Spreaders, Shackles, etc.

③ Weight Of Load Block Or Ball

④ Weight Of Main Fall Tackle—Rope, Block, Rigging

Total Load = ① + ② + ③ + ④



NOTE: The weight of the minimum parts of line required to lift the rated load has already been considered in this chart. It need not be added to the load. This applies only to the load fall being used. If additional parts of line are reeved beyond the minimum required to handle a rated load, or if a second fall is in place but not used, the weight of these ropes should be added to the weight lifted. Refer to the Crane Rating Chart and the Rope Weight Table on the back of this page for rope weight reference data.

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ROPE WEIGHT PER GIVEN LENGTH

Use the data in the table below when the total weight of the load being lifted is calculated according to one of the Total Load Formulas in Appendix "A", on the front side of this page.

For IPS, EIPS, or EEIPS Wire Ropes. For other ropes, consult specific chart or the rope manufacturer's own reference data or user's manual.

ROPE DIAMETER		WEIGHT OF ONE FOOT (OR ONE METER) OF ROPE	
IN MILLIMETERS	IN INCHES	LBS./FT.	Kg/M
12.7	1/2	.46	.68
15.9	5/8	.72	1.07
19.1	3/4	1.04	1.55
22.2	7/8	1.42	2.11
25.4	1	1.85	2.75
28.6	1-1/8	2.34	3.48
31.8	1-1/4	2.89	4.30
34.9	1-3/8	3.50	5.21
38.1	1-1/2	4.16	6.19
41.3	1-5/8	4.88	7.26
44.5	1-3/4	5.67	8.44
47.6	1-7/8	6.50	9.67
50.8	2	7.39	11.00
54.0	2-1/8	8.35	12.42
57.2	2-1/4	9.36	13.93
63.5	2-1/2	11.60	17.26
69.9	2-3/4	14.00	20.83

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Service Bulletin

Fuels for Cummins Engines

Introduction

This bulletin covers information about Fuels for Cummins Engines. The purpose of this bulletin is to help the user understand proper fuel selection, and problems associated with fuel.

Diesel Fuel

Diesel fuel performs three major functions in a Cummins® diesel engine.

1. It supplies all the energy for the engine.
2. It cools and lubricates the precision parts of the engine's fuel pump and injectors.
3. It enables emissions controlled engines to meet regulated emissions levels.

Premium Diesel Fuel

Cummins® diesel engines will run on a great variety of fuels, but some fuels will give better performance, higher efficiency, improved reliability, or lower maintenance costs than others. Fuel **must** be selected based on overall operating costs, **not** just on the purchase price. Cummins Inc. recommends the use of premium fuels meeting the requirements of Category 1 through 4 as outlined in the Worldwide Fuel Charter (**www.engine-manufacturers.org/about/guidelines.cfm**). Operators **must** select fuels from these categories to optimize performance and emissions.

Category 1:

Markets with no or minimal requirements for emission controls.

Category 2:

Markets with stringent requirements for emission controls that requires the use of low sulfur fuel, for example, vehicles meeting United States and European on-highway standards. The maximum is 0.05 percent sulfur.

Category 3:

Markets with advanced requirements for emission controls that require ultra low sulfur fuel (less than 50 ppm) for after-treatment devices.

Category 4:

Markets with further advanced requirements for emission control to enable sophisticated NOx and PM after-treatment technologies. This normally requires no detectable sulfur in fuel.

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Markets with further advanced requirements for emission control to enable sophisticated NOx and PM after-treatment technologies. This normally requires no detectable sulfur in fuel.

Required Diesel Fuel Specifications

This section presents the Cummins Inc. required fuel specifications.

Fuels meeting national and international specifications can be used if they observe the specifications listed in Table 1: Required Diesel Fuel Specifications. Cummins® engines will operate satisfactorily on fuels meeting all the properties listed in Table 1; however, fuels meeting **only** the required specifications will **not** give the same level of performance, efficiency, reliability or maintenance costs as premium fuels.

Table 1: Required Diesel Fuel Specifications	
Viscosity	1.3 to 5.8 centistokes (1.3 to 5.8 mm per second) at 40° C [104° F]
Cetane Number	42 minimum above 0° C [32° F]; 45 minimum below 0° C [32° F]
Sulfur Content	**Not** to exceed 0.5 mass-percent [1]
Active Sulfur	Copper Strip Corrosion **not** to exceed Number 2 rating after 3 hours at 50° C [122° F]
Water Sediment	**Not** to exceed 0.05 volume-percent
Carbon Residue	**Not** to exceed 0.35 mass-percent on 10 volume-percent residuum
Density	0.816 to 0.876 grams per cubic centimeter (g/cc) at 15° C [60° F]
Cloud Point	6° C [10° F] below lowest ambient temperature at which the fuel is expected to operate
Ash	**Not** to exceed 0.02 mass-percent (0.05 mass-percent with lubricating oil blending)
Distillation	The distillation curve **must** be smooth and continuous
Lubricity SLBOCLE, or HFRR	3100 grams or greater SLBOCLE, or 0.45 mm maximum: Wear Scar Diameter (WSD) at 60° C [140° F] HFRR

1. Regional, national, or international regulations can require a lower sulfur content than 0.5 percent. Consult all applicable regulations before selecting a fuel for a given engine application. Fuel with sulfur higher than 0.5 percent is **not** allowed without Cummins Inc. prior approval. Fuel system corrosion, heightened emissions, and reduced oil drain intervals are just some of the possible adverse effects of fuels with very high sulfur. Fuel **must** observe proper flash point requirements to satisfy local safety regulations.

Diesel Fuel Properties

- Viscosity
  - General Description - Proper viscosity provides adequate pumping and lubricating characteristics to fuel system components.
  - Test Method - ASTM D445, ISO 3104

- Cetane Number
  - General Description - Cetane number is a measure of the starting and warm-up characteristics of a fuel. In cold weather or in service with prolonged low loads, a higher cetane number is desirable.
  - Test Method - ASTM D613, ISO 5165
  - Fuel with a cetane number greater than 55 can cause increased torque peak smoke. Reference ASTM D613, ISO 5165.

- Sulfur Content
  - General Description - Diesel fuels contain varying amounts of various sulfur compounds. Fuel sulfur contributes to acid formation and exhaust particulates. Reduced sulfur is required to meet particulate emissions and to avoid poisoning after-treatment devices. Higher sulfur fuel also needs higher total base number (TBN) lubricants to compensate for acid corrosion.

    NOTE: Catalyst failures caused by the use of fuels with higher than recommended sulfur levels are not warrantable. High sulfur fuel will also shorten the life of certain components in the exhaust system, including the oxidation catalyst.

  - Test Method - ASTM D2622, ISO 4260

- Active Sulfur
  - General Description - Some sulfur compounds in fuel are actively corrosive.
  - Test Method - ASTM D130, ISO 2160

- Water and Sediment

    - General Description - The amount of water and solid debris in the fuel is generally classified as water and sediment. It is good practice to filter fuel while it is being put into the fuel tank. More water vapor condenses in partially filled tanks due to tank breathing caused by temperature changes. Filter elements, fuel screens in the fuel pump, and fuel inlet connections on injectors **must** be cleaned or replaced whenever they become dirty. These screens and filters, in performing their intended function, become clogged when using a poor or dirty fuel and will need to be changed more often.
    - Test Method - ASTM DI796

- Carbon Residue
    - General Description - The tendency of a diesel fuel to form carbon deposits in an engine can be estimated by determining the Ramsbottom or Conradson carbon residue of the fuel after 90 percent of the fuel has been evaporated.
    - Test Method - ASTM D524, ASTM D189, ISO 10370

- Density
    - General Description - Density is an indication of the energy content of the fuel. Higher density indicates more thermal energy and better fuel economy.
    - Test Method - ASTM D287, D4052, ISO 3675

- Cloud Point
    - General Description - The cloud point of the fuel is the temperature at which crystals of paraffin wax first appear. Crystals can be detected by the cloudiness of the fuel.
    - Test Method - ASTM D97, ISO 3015

- Cold Filter Plugging Point
    - General Description - The cold filter plugging point of the fuel is the lowest temperature at which fuel can still flow through a 45 micron wire mesh. This test method can be directly related to a fuel's tendency to plug fuel filters at reduced temperatures due to the formation of paraffin wax crystals.
    - Test Method - ASTM D6371

- Ash
    - General Description - The small amount of noncombustible metallic material found in almost all petroleum products commonly is called ash.
    - Test Method - ASTM D482, ISO 6245

- Distillation

  - General Description - At least 90 percent of the fuel **must** evaporate at less than 360°C [680°F]. All of the fuel **must** evaporate at less than 385°C [725°F].
  - Test Method - ASTM D86, ISO 3405

- Lubricity (ball on cylinder evaluator) BOCLE
  - General Description - Lubricity is the ability of a liquid to provide hydrodynamic and boundary lubrication to prevent wear between moving parts. Fuel with lower sulfur and viscosity tends to have lower lubricity. It can be measured by either one of two procedures.
  - Test Method: ASTM D6078, Scuffing Load Ball On Cylinder Evaluator (SLBOCLE), or ASTM D6079, ISO 12156, High Frequency Reciprocating Rig (HFRR)

Contingency Diesel Fuel Specifications

This section presents the specifications for fuels which are **only** to be used when fuel meeting the required specifications are **not** available. In the case that fuels meeting the Required Specifications in Table 1 are **not** available, Cummins Inc. has prepared contingency specifications to aid the user in choosing the most acceptable contingency fuel.

CAUTION

Fuels outside the recommended fuel specifications, but within the contingency specifications, are only meant to be used for short periods of time when no other fuels are available. Use of contingency fuels can have an adverse effect on engine performance and durability. Cummins assumes no warranty responsibility for repairs or increased costs of operation resulting from the use of fuels that do not conform to the specifications listed in Table 1.

Guidelines for The Use of Contingency Fuels

1. A calibration change of the fuel pump or injectors is **not** recommended when changing to a contingency fuel that meets all the specifications shown in Contingency Diesel Fuel Specifications, although changing to a contingency fuel can cause a slight power loss and can result in higher than normal wear of certain components. See the sections in this bulletin on Power Loss and Component Wear and Durability for additional information.

2. Although it is **not** anticipated that smoke levels will increase when fuels meeting the contingency fuel specifications are used for short periods of time, the user **must** make sure that the use of such fuels does **not** result in a smoke level which exceeds legal limits applied to the owner or operator. Continued use of fuels meeting the contingency fuel specifications can result in increased smoke levels.
3. Some jet fuel lubricities can be too low to provide the necessary lubrication for the fuel system components. If (based on the fuel supplier's specifications) a fuel does **not** have the minimum lubricity listed for contingency fuels in Contingency Diesel Fuel Specifications, a fuel additive **must** be added to the fuel to increase the lubricity and specially enhanced fuel system components **must** be used. Go to the section in this bulletin on fuel additives. Consult Cummins Inc. for available hardware options.

WARNING

Some contingency fuels, such as jet fuels and kerosene, are much more flammable than normal diesel fuel. Use extreme care to keep cigarettes, flames, pilot lights, sparks, arcing equipment and switches, and other sources of ignition away and out of areas sharing ventilation.

Additional maintenance can be required when using contingency fuels. Those using contingency fuels **must** consult with their fuel supplier to determine any problems which can result from using fuels meeting Contingency Diesel Fuel Specifications. If there is still a question, data on the fuel's physical properties **must** be submitted to Cummins Service Engineering Department for review before use in Cummins® engines.

Table 2: Contingency Diesel Fuel Specifications [1]	
Viscosity	1.3 to 13.1 centistokes
Cetane Number	35 minimum above 0° C [32° F]; 40 minimum below 0° C [32° F]
Sulfur Content	Less than 2.0 mass−percent. Catalyst equipped engines will **not** be able to use high sulfur fuel even for a short period of time without permanent damage to the catalyst.
Active Sulfur	Copper Strip Corrosion **not** to exceed Number 2

Table 2: Contingency Diesel Fuel Specifications [1]	
Water and Sediment	**Not** to exceed 0.5 volume-percent
Carbon Residue	**Not** to exceed 5.0 mass-percent on 10 volume-percent residuum
Density	0.750 to 0.965 g/cc at 15° C
Cloud Point	Lowest temperature at which fuel can be maintained without forming paraffin wax crystals.
Pour Point	Lowest temperature at which fuel can still flow.
Ash	**Not** to exceed 0.05 mass-percent
Distillation	90 volume-percent at 395° C [743° F]
Lubricity (ball on cylinder evaluator) SLBOCLE	Minimum of 2300 grams SLBOCLE, maximum of 0.6 mm Wear Scar Diameter WSD at 60° C [140° F] HFRR
Vanadium	5 ppm, maximum
Aluminum	1 ppm, maximum
Silicon	1 ppm, maximum
Sodium	10 ppm, maximum

1. Reference test methods in Diesel Fuel Properties

Effects of Contingency Diesel Fuels on Engine Operation

- Viscosity
  - Low viscosity causes rapid wear of fuel pump and injectors. High viscosity causes hard starting, white smoke when cold, injector cup cracking, and injector train failures. Governor wear on rotary fuel pumps can cause loss of regulation.

- Cetane Number
  - A cetane number below 42 can cause poor starting, excessive white smoke, and poor idling. A cetane number above 55 can increase smoke at peak torque conditions.

- Sulfur Content
  - High sulfur content increases wear in injectors, piston rings, and bearings. Use of fuels with sulfur content above 0.5 mass-percent requires the use of higher total base number (TBN) lubricants (TBN greater than 10) and shorter oil drain intervals.

NOTE: Catalyst failures caused by the use of fuels with higher than recommended sulfur levels are not warrantable. High sulfur fuel will also shorten the life of certain components in the exhaust system, including the oxidation catalyst.

- Active Sulfur
  - Excessive active sulfur increases the corrosive attack on the fuel pump, injectors, and other fuel system components.

- Water and Sediment
  - Contaminated fuels reduce filter life, fuel system life, and cause on-road failures.

- Carbon Residue
  - High carbon residue causes increased combustion chamber carbon deposits, more exhaust smoke, and higher soot contamination of the lubricating oil.

- Density
  - Lighter fuels contain less thermal energy per gallon and result in somewhat lower fuel economy. A fuel with a density of 0.876 g/cc contains about 3.5 percent more energy per gallon than a fuel with a density of 0.815 g/cc.

- Cloud Point
  - Operating below the cloud point temperature can cause the fuel filter to clog with wax crystals, restrict fuel flow, and cause loss of power. It is suggested that if fuels with cloud points above the expected ambient temperatures are purchased, the consumer **must** consult the fuel supplier and Cummins Inc. concerning fuel handling techniques. For more information, go to Common Issues With Winter Fuel.

- Pour Point
  - Operating near or below the pour point will cause start-up issues. It is doubtful that most fuel pumps can operate at the pour point. In fact, it is recommended that systems be operated at 10 to 15 degrees F above the pour point of a fuel.

- Cold Filter Plugging Point
  - Operating below the cold filter plugging point temperature will cause the fuel filter to clog with wax crystals, restrict fuel flow, and cause loss of power. If is suggested that if fuels with cold filter plugging points above the expected ambient temperatures are purchased, the consumer **must** consult the fuel supplier and

Cummins Inc. concerning fuel handling techniques. For more information, go to Common Issues with Winter Fuel.

- Ash
  - High ash content causes deposits of noncombustible metallic material in the combustion chamber and on the exhaust valves.

- Distillation, Maximum
  - Fuels with high distillation temperature can leave gummy deposits in the fuel system and result in poor fuel combustion.

- Lubricity
  - Fuels with low lubricity can cause increased wear or seizure of fuel system components.

- Vanadium
  - Fuels with high vanadium content can cause valve burning.

- Aluminum
  - Fuels with high levels of aluminum can cause premature ring and liner wear which can lead to excessive oil consumption.

- Silicon
  - Fuels with high levels of silicon can cause premature ring and liner wear which can lead to excessive oil consumption.

- Sodium
  - Fuels with high levels of sodium can cause premature ring and liner wear which can lead to excessive oil consumption. Sodium can combine with vanadium, if present, and catalyze, causing valve burning.

- Zinc
  - Fuels with high levels of zinc can cause injector spray hole carboning. Do **not** use galvanized pipe or fittings in the fuel system plumbing. Diesel fuel will leach zinc galvanized material.

Power Loss

This section gives guidelines on power loss to be expected when using recommended or contingency fuels, or fuels that are above normal temperature.

NOTE: The values given concerning power loss due to the use of contingency fuels are intended only to help estimate power loss. Power loss can vary greatly, depending on operating conditions, engine type, fuel

system type, fuel composition, and other factors. These guidelines can not be used to precisely calculate engine power loss.

The use of contingency fuels can cause a decrease in the power output of the engine due to differences in fuel density and viscosity. In addition, changes in fuel temperature also affect engine power output because temperature affects both viscosity and density.

Density

All engines will have a predictable variation in power output depending on the density of the fuel used. Engines using fuels with a high density will produce more power than those using fuels with a lower density because the thermal energy content of the fuel is higher. Since fuel is marketed by volume, lower density fuel carrying less thermal energy results in a proportional decrease in fuel economy or power output.

Viscosity

In general, lower viscosity results in lower power due to increased internal leakage in the fuel system. Also, lower viscosity fuels generally have lower thermal energy content. The effect viscosity has on power depends on the type of fuel system used.

Temperature

Temperature causes changes in engine power because it affects both viscosity and density. An increase in fuel temperature will cause a decrease in viscosity, which will reduce power due to internal leakage in the fuel system as described above. The maximum recommended fuel pump inlet temperature for Cummins® engines is 70°C [158°F].

An increase in fuel temperature will also cause a decrease in fuel density (increase in API gravity), which will reduce power due to lower energy content of the fuel. On Cummins® engines using the PT®, Quantum, or HPI fuel systems, the power loss due to increasing temperature is less than that on engines using the in-line, distributor, or CELECT™ systems (less than 1 percent per 5°C [10°F]), due to the inherent viscosity compensating characteristics of these systems.

Component Wear and Durability

This section shows the effects of contingency fuels on wear and durability of fuel systems components.

The use of contingency fuels can affect the wear and durability of both fuel pump and injector components within the fuel system. Many of these fuels are low in

viscosity and lubricity as measured in the Ball On Cylinder Lubricity Evaluator (BOCLE) tests. Fuels with lubricity values below 2300 grams are considered to have poor lubricity and can cause failure of fuel system components. Other factors that affect wear and durability are sulfur, water, and sediment content. High sulfur content increases wear of the fuel system components. Abnormal quantities of water and sediment in the fuel will also cause excessive wear, as well as other engine problems.

Fuel Blending

This section presents the effects of blending fuels with used and new lube oil, other fuels, and with gasoline, gasohol, or alcohol.

There are two different types of fuel blending processes referred to in this section. The first is the blending of used engine lubricating oil to reduce fuel costs and to aid in disposing of used engine oil. This section also discusses the blending of fuel and engine oil in on-highway applications. The second is the blending of heavier fuels with lighter fuels to lower the wax content, cloud point, and pour point, and thus improve cold weather operation. In addition, the effects and hazards of mixing alcohol with diesel fuel are discussed.

Blending Fuel and Lubricating Oil for On-Highway Applications

WARNING

Some state and federal agencies have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. If not reused, dispose of in accordance with local environmental regulations.

CAUTION

Engines equipped with an oxidation catalyst must not use fuel blended with lubricating oil. The lubricating oil causes deposits in the catalyst which will plug the catalyst and possibly cause higher emission levels and reduced engine performance.

CAUTION

Do not blend more than 5 percent used lubricating oil with the fuel. Do not blend other used oils with fuel, such as transmission fluid, gear case oil, and so forth.

Used engine lubricating oil can be blended with fuel using the Cummins Lube Oil Blender, Part Number 3376317 (110 volt, 60 Hz) or Part Number 3376362 (220 volt, 50 Hz). This process can be used to supplement fuel supply as well as provide a means of disposing of used lubricating oil.

To blend used engine oil with fuel, follow the instructions provided with the Cummins Lube Oil Blender.

Two rulings by the United States Environmental Protection Agency (EPA) affect the practice of blending lubricating oil with diesel fuel in the United States. First, on September 10, 1992, the Office of Solid Waste of the United States Environmental Protection Agency determined that used lubricating oil was **not** classified as hazardous waste. In addition, the blending of used lubricating oil with diesel fuel for burning in diesel powered vehicles was determined to be an acceptable method for disposing of used lubricating oil (57 Federal Register, R 41583, September 10, 1992). Second, beginning October 1, 1993, diesel fuel used in motor vehicles, as defined by the EPA, in on-highway applications **must** contain less than 0.055 percent sulfur by weight (Mandated in Section 211 of the 1990 Clean Air Amendments; 57 Federal Register, P. 19535, May 7,1992). Fuel blended with lubricating oil **must** also meet this specification.

Cummins Inc. allows the blending of lubricating oil with fuel used in their engines, except those equipped with an oxidation catalyst, often referred to as a catalytic converter (such as 1994 M11's and 1994 C8.3's used in urban transit buses, and 1994 B5.9's and C8.3's used in automotive applications). Cummins Inc. permits a maximum of 5 percent used lubricating oil to be blended with fuel. This helps to reduce operating costs and aids in the disposal of used engine oil. The blending of new lubricating oil to raise viscosity is also permissible. This helps to increase the viscosity of lighter fuels to acceptable levels. Cummins Inc. recommendations for the blending of lubricating oil with fuel used in its engines have **not** changed; however, if blended fuel used in motor vehicles, as defined by the EPA, in on-highway applications exceeds the maximum sulfur content, United States federal law has been violated and penalties can be assessed. To be sure that blended fuel complies with the law, the following procedure **must** be followed. Both the diesel fuel and lubricating oil **must** have their sulfur content measured by a qualified laboratory using the testing method specified in ASTM D2622 (American Society of Testing and Materials Standard, or ISO 4260). Once the correct blend factor has been determined, multiply this by the volume of fuel to be blended. The result is the amount of this oil that can be blended with this fuel

and remain within legal limits. Similar restrictions and processes **must** be followed worldwide where regional or national regulations can impose such sulfur limits.

As an example, consider 50,000 gallons of fuel with a sulfur content of 0.04 percent by weight and lubricating oil with a sulfur content of 0.5 percent by weight. Of this oil, 450 gallons can be blended with 50,000 gallons of this fuel and remain within legal limits for sulfur content in the United States. Margins **must** be allowed for measurement errors.

Blending Fuel with Fuel

Cummins Inc. recommends the use of a premium diesel fuel during winter (ambient conditions at -7°C [20°F] or below) operating conditions. See Additives section of this bulletin.

In cold-weather operation, the most common method of preventing fuel waxing problems is to dilute heavier, higher wax content fuels such as U.S. Number 2-D diesel fuel with lighter, lower wax content fuels such as Number 1-D diesel or jet fuel. This reduces the concentration of wax, and thereby reduces both the cloud point and pour point. Blended fuels of this nature are more expensive to use both because they cost more and because they have a lower thermal energy content. A typical blended fuel contains 30 to 60 volume-percent light distillate fuel, usually yielding a 3 to 7°C [5 to 12°F] drop in cloud point, and a 5 to 11°C [9 to 20°F] drop in pour point. Lower wax content fuels **must** be added BEFORE wax forms to be effective.

Blending Fuel with Gasoline, Gasohol, and Alcohol

WARNING

Under no circumstances must gasoline or alcohol be used to dilute diesel fuel. This practice creates an extreme fire hazard and under certain circumstances an explosive hazard. Gasoline dilution is not an effective way to lower cloud point (20 volume-percent gasoline only lowers cloud point 4° C [7° F] and it lowers the fuel viscosity, cetane number, and flash-point). Alcohol dilution will increase the cloud point.

Additives

This section gives information on the use of fuel additives in Cummins® engines including the use of bio-diesel and water emulsifiers.

Cummins Inc. neither approves nor disapproves of the use of any fuel additive, fuel extender, fuel system modification, or the use of any device **not** manufactured or sold by Cummins Inc. or its subsidiaries. Engine damage, service issues, or performance problems that occur due to the use of these products are **not** considered a defect in workmanship or material as supplied by Cummins Inc. and can **not** be compensated under the Cummins® warranty.

Fuel Additives

Cummins Inc. engines are designed, developed, rated, and built to operate on commercially available diesel fuel as listed in Required Diesel Fuel Specifications; therefore, it is **not** our policy to recommend fuel additives.

In extreme situations, when available fuels are of poor quality or problems exist which are peculiar to certain operations, additives can be used. However, Cummins Inc. recommends consultation with the fuel supplier or Cummins Service Engineering Department prior to use of fuel additives.

Among the situations where additives can prove useful are the following:

1. A cetane improver additive can be used with low cetane fuels.
2. A pour point depressant or flow improver additive can help with high pour point fuels.
3. A wax crystal modifier can help with fuels with high cold filter plugging points (CFPP).
4. An anti-icer can help prevent ice formation in wet fuel during cold weather.
5. An anti-oxidant or storage stability additive can help with fuel system deposits and poor storage stability.
6. A lubricity enhancer can be used to increase the lubricity of fuels so that they meet the requirements given in Table 1.
7. A biocide or fungicide can help when fuels are prone to contamination with bacteria or fungus. Although other additives can provide some performance benefits, Fleet-tech™ Microbicide (quart - CC2661 and gallon - CC2662) and Microbicide SP (pint - CC2671, quart - CC2672 and gallon - CC2673) are the **only** products recommended by Cummins Inc. to treat fuels with biological contamination problems.
8. Fleetguard's Fleet-tech™ Turbo Diesel All Season Fuel Additive (pint - CC2588) can be used with low cetane fuels to boost cetane values. Although other additives are available that will boost the cetane number, Fleetguard's Fleet-tech™ All Season Fuel Additive is the **only** diesel fuel additive recommended by Cummins Inc. for cetane number improvement.
9. Fleetguard's Fleet-tech™ Asphaltene Conditioner (quart - CC2597 and 2.5 gallon CC2596) or Fleetguard's Fleet-tech™ Turbo Diesel All Season Fuel

Additive (pint -CC2588) can be used to clean carbon deposits from injectors and improve lubricity in fuels that fall below the recommended lubricity specification in Table 1. Although other additives can provide some performance benefits, Fleet-tech™ Asphaltene Conditioner, and Turbo Diesel All Season Fuel Additive are the **only** diesel fuel additives recommended by Cummins Inc. for use with fuels that do **not** meet the lubricity specification in Table 1.

10. Fleetguard's Fleet-tech™ Winter Conditioner (pint - CC2591, quart - CC2592, 2.5 gallon - CC2595, 5 gallons - CC2593, 55 gallons - CC2594, and bulk - CC2590) and Turbo Diesel All Season Fuel Additive (pint - CC2588) can be used to improve the pour point and cold filter plugging point of diesel fuels in addition to preventing ice formation in wet fuels during cold storage. Although other additives are available that can provide some winter performance benefits, Fleet-tech™ Winter Conditioner and Turbo Diesel All Season Fuel Additive are the **only** diesel fuel additives recommended by Cummins Inc. for winter performance improvements.
11. Fleetguard's FS20000 lubricity enhancing fuel filter can also be used to improve the lubricity of fuels that fall below the recommended lubricity specification given in Table 1. The FS20000 is required for Tier 2 QSB engines running Jet A or JP8 Fuels.

Premium diesel fuels can possibly contain several additives that can accomplish the same as buying additives and adding them to lower quality diesel fuel. A premium diesel fuel is defined by the Worldwide Fuel Charter as described on page 1.

Cummins Inc. recommends the use of a premium diesel fuel during winter (ambient conditions at -7°C [20°F] or below) operating conditions.

Great care **must** be exercised in the choice and use of additives. Some fuel additives can be harmful to the engine. Fuel additives containing ash forming materials will cause combustion chamber deposits. Most legitimate fuel additives perform **only** one function. Multifunctional fuel additives are mixtures of several additives. All fuel additives perform differently in different fuels; therefore, the additive used **must** be one to which the fuel will respond. There are no known additives that increase the power or improve the efficiency of a properly maintained engine.

NOTE: Cummins Inc. accepts no liability for engine damage resulting from the use of fuel additives which are not specifically recommended.

Bio-Diesel Fuel

With increased interest in emissions and reducing the use of petroleum distillate based fuels, many governments and regulating bodies encourage the use of bio-fuels. Bio-diesel fuels **must** be considered experimental at this time.

Bio-diesel fuels are methyl/ethyl ester-based oxygenates derived from a broad variety of renewable sources such as vegetable oils, animal fats, and cooking oils. Their properties are similar to diesel fuel, as opposed to gasoline or gaseous fuels, and thus are capable of being used in compression ignition engines. Soy Methyl Ester (SME) or some SME Diesel is the most common bio-diesel in the United States and is derived from soybean oil. Soy Diesel is a bio-diesel or petro-diesel blend based on SME. Rape Methyl Ester (RME) Diesel is the most common bio-diesel in Europe and is derived from rapeseed oil. These fuels are collectively known as Fatty Acid Methyl Esters (FAME).

Cummins Inc. test data on the operating effects of bio-diesel fuels indicates that typically smoke, power, and fuel economy are all reduced. However, as there are no firm industry standards on the content and properties for bio-fuels, consistency and predictability of bio-diesel operation is **not** well documented. There are provisional specifications for FAME issued in Germany under DIN V 51 606 and also recently through ASTM as PS121; however, these standards are under development and are subject to change.

Cummins Inc. certifies its engines using the prescribed EPA and European Certification Fuels. Cummins Inc. does **not** certify engines on any other fuel. It is the user's responsibility to use the correct fuel as recommended by the manufacturer and allowed by EPA or other local regulatory agencies. In the United States, the EPA allows use of **only** registered fuels for on-highway applications. The EPA has additional alternative fuel information at: **http://www.epa.gov/otaq/consumer/fuels/altfuels/altfuels.htm**.

It is the responsibility of the user to obtain the proper local, regional, or national exemptions required for the use of bio-diesel in any emissions regulated Cummins® engine.

Warranty and the Use of Bio-Diesel Fuel in Cummins Engines

Cummins Inc. neither approves nor disapproves of the use of bio-diesel fuel blends. There is a major difference between operating on pure (100 percent concentration) bio-diesel fuels and bio-diesel or petro-diesel fuel blends. Cummins Inc. is **not** in a position to evaluate the many variations of bio-diesel fuels, and the long-term effects on performance, durability or emissions compliance of Cummins® products. The use of bio-diesel fuel does **not** affect Cummins Inc. materials and workmanship warranty. Failures caused by the use of bio-diesel fuels or other fuel additives are **not** defects of Cummins Inc. parts or workmanship and therefore will **not** be covered by Cummins Inc. warranty.

Given the current industry understanding of bio-fuels and blending with quality diesel fuel, it can be expected that blending up to a 5 percent volume-concentration will **not** cause serious problems. This is consistent with the position taken by worldwide fuel system manufacturers.

For customers intent on blending bio-fuels above a 5 percent volume-concentration, the following concerns represent what is currently known in the industry. Concentrations beyond 5 percent by volume can have an adverse affect on the engine's performance and the fuel system integrity or durability. The affects are more serious with increasing concentration levels. Areas of concern when operating with bio-diesel fuels include low temperature operability (fuel gelation, filter plugging), heat content (poor fuel economy), and storage and thermal stability (filter plugging, injector deposits). In addition, from our fuel systems suppliers, the following issues are also noted:

- Swelling and hardening or cracking of some elastomer seals within the fuel system or engine
- Corrosion of fuel system and engine hardware, especially aluminum and zinc
- Solid particle blockage of fuel nozzles and passages
- Filter plugging
- Injector coking
- Higher injection pressures due to physical flow properties, reduced fuel system life
- Added stress and heat to injection components, especially rotary fuel pumps
- Increased pump seizures and early life failures
- Poor fuel spray atomization, reduced fuel economy
- Poor lubricity, reduced service life of fuel pump and fuel system.

Pure bio-diesel fuel is **not** stable and its acid content increases over time which can damage powdered metal components.

Operational Factors to Consider:

- The oil change interval can be affected by the use of bio-diesel fuel. End users are advised to use oil sampling to monitor the engine oil condition and to determine the optimum oil change interval. Pure bio-diesel fuel can cause a chemical reaction with lube oil resulting in oil sludging.
- Bio-diesel provides approximately five to seven percent less energy per gallon of fuel when compared to distillate fuels. To avoid engine problems when the engine is converted back to 100 percent distillate diesel fuel, do **not** change the engine rating to compensate for the power loss when operated with bio-diesel fuels.

- Elastomer compatibility with bio-diesel is still being monitored. The condition of seals, hoses, gaskets, and wire coatings **must** be monitored regularly.
- Bio-diesel fuels can pose low ambient temperature problems for both storage and operation. At low ambient temperatures, fuel can possibly need to be stored in a heated building or a heated storage tank. The fuel system can require heated fuel lines, filters, and tanks. Filters can plug and fuel in the tank can solidify at low ambient temperatures if precautions are **not** taken. Consult your bio-diesel supplier for assistance in the blending and attainment of the proper cloud point fuel.
- Bio-diesel has poor oxidation stability which can result in long term storage problems. The poor oxidation stability qualities can accelerate fuel oxidation in the fuel system. This is especially true in engines with electronic fuel systems because they operate at higher temperatures. Consult the fuel supplier for oxidation stability additives.
- Bio-diesel fuel is an excellent medium for microbial growth. Microbes cause fuel system corrosion and premature filter plugging. The effectiveness of conventional anti-microbial additives, when used in bio-diesel, is **not** known. Consult your fuel and additive supplier for assistance.
- Care **must** be taken to remove water from fuel tanks. Water accelerates microbial growth. Water is naturally more prevalent in bio-diesel fuels than in distillate fuels.

Water-Emulsions

Fuel Characteristics - Water-emulsified diesel fuel is an alternative fuel that is made by blending water and other additives (e.g. detergents) into diesel fuel.

Emissions - Water-emulsified diesel fuels have been verified by EPA and some state agencies as an emissions reduction technology.

Cummins Inc. does **not** certify engines with water-emulsified fuels. Cummins Inc. does **not** warranty any emissions improvements with the use of water-emulsified fuels.

Performance Issues - Water emulsified fuels have lower energy content than Number 2 diesel fuel. Customers **must** expect at least a 15 percent power reduction and a 15 percent fuel consumption increase when water-emulsified fuels are used. Because of the lower energy content in water-emulsified diesel fuels, engines running on water-emulsified diesel fuels can require idle governor adjustments to prevent engine stalling.

Durability Issues - Many fuel system components in Cummins® engines are made of materials that are susceptible to corrosion from water in fuel. Prolonged exposure to water in fuel can result in fuel system component failures from corrosion.

Vehicle System Issues - Some water-emulsified diesel fuel suppliers recommend the removal of the fuel water separator from the vehicle's fuel system. Removal of the fuel-water separator violates Cummins Inc. engine installation requirements.

Since water is a significant component of water-emulsified diesel fuels, conductivity sensors that detect water in fuel will **not** function properly with water-emulsified diesel fuels.

Some water-emulsified diesel fuels use a surfactant in the emulsifier. Surfactants can strip the fuel tank and fuel lines of deposits, resulting in fuel filter plugging. Fuel filters **must** be monitored closely during the initial use of water-emulsified diesel fuels.

Water-emulsified diesel fuels can **not** remain static for more than a month in storage or in vehicle fuel tanks. Most water-emulsified diesel fuel storage facilities are required to have circulation pumps for daily or weekly agitation. Engines operating on water-emulsified diesel fuel **must** be operating for a least 15 minutes every 30 days to avoid fuel-water separation in the vehicle fuel tank and in the engine fuel system.

Cummins Inc. Engine Warranty - Cummins Inc. Engine Warranty covers failures that are a result of defects in material or factory workmanship. Engine damage, service issues, and/or performance issues determined by Cummins Inc. to be caused by the use of water-emulsified diesel fuel are **not** considered to be defects in material or workmanship and are **not** covered under Cummins Inc. engine warranty.

Some water-emulsified fuel suppliers provide a comprehensive warranty for fuel system failures caused by the use of water-emulsified diesel fuel. Customers are encouraged to contact the water-emulsified diesel fuel supplier to determine the warranty provisions.

Oxy-Diesel or E-Diesel

WARNING

Do not mix gasoline, alcohol, or gasohol with diesel fuel. This mixture can cause an explosion.

WARNING

Under no circumstances must gasoline or alcohol be used to dilute diesel fuel. This practice creates an extreme fire hazard and under certain circumstances an explosive hazard. Gasoline dilution is not an effective way to lower cloud point (20 volume−percent gasoline only lowers cloud point 4° C [7° F] and it lowers the fuel viscosity, cetane number, and flash−point). Alcohol dilution will increase the cloud point.

Alcohol is considered a renewable energy source. Some suppliers integrate up to 15 percent alcohol in diesel fuel to form oxy-diesel or e-diesel. While the use of special additives addresses some of the problems with alcohol blending in diesel fuel, Cummins Inc. recommends against the use of such blends due to safety reasons. This kind of fuel is considered experimental and is **not** covered by warranty. Engine damage, service issues or performance problems that occur due to the use of these products are **not** considered a defect in workmanship or material as supplied by Cummins Inc. and can **not** be compensated under the Cummins® warranty.

Fuel Filters

This section explains the types of fuel filters and their uses.

Fuel filters are standard equipment on all Cummins Inc. engines. They are designed to remove water and harmful particles from the fuel before they damage the fuel pump and other engine components.

Effective September 1, 1991, Cummins Inc. requires a fuel-water separator or fuel filter and water separator combination be installed in the fuel supply system. This requirement applies to all 1991 and later automotive certified engines and all future automotive engines. In addition to this requirement, Cummins Inc. recommends that a fuel-water separator or fuel filter and water separator combination be installed in the fuel supply system on all Cummins Inc. engines regardless of application.

NOTE: It is strongly recommended that the "N" and "L" series engines, built with CELECT™ and STC prior to September 1, 1991, be up-fitted with a fuel-water separator.

Water can be introduced to a diesel engine's fuel system in two ways. Water can be present in the fuel and enter the engine's supply tank at fill-up or water that is normally in the air above the fuel can condense on the walls of the fuel tank.

Water in diesel fuel is normally present as both free and emulsified water. Free water settles to the fuel tank bottom where it can be drained. Emulsified water

stays in suspension where it can enter the fuel lines, fuel pump, and injectors. Once this suspended water is in the fuel system, it can cause corrosion and failure of key fuel system components.

Throw Away Canister

The standard fuel filter is the spin-on element. These filters contain a porous, pleated, chemically treated paper element that will pass fuel freely but trap impurities and sediment.

When the element is serviced, it is simply detached from the fuel filter head assembly, discarded, and replaced with a new element. The element **must** be tightened to the manufacturer's specifications.

NOTE: Do not pour fuel from an old fuel filter into a new filter in an effort to prime the fuel system. Use only clean fuel to prime the fuel system. It is not necessary to add fuel to a new fuel filter if the engine is equipped with an electric fuel transfer pump. Fuel systems on these engines can be primed by turning the vehicle keyswitch on and off several times to activate the fuel transfer pump.

CAUTION

Overtightening will distort the filter cartridge or crack the filter head. Do not use a filter element that has been dented or damaged prior to, or during, installation.

Replaceable Element Type

Another type of fuel filter used on Cummins® engines has a replaceable pleated paper element.

Pre-Filters

Midrange B and C series engines require the use of a fuel pre-filter (150 micron maximum).

Fuel-Water Separators

Free and emulsified water can be removed from the fuel. Integral fuel filter and water separators are available that remove both free and emulsified water with varying degrees of efficiency. The standard fuel filter (FF105, FF202, FF213, FF5052) does remove some free and emulsified water, but with low efficiency.

Due to the above facts and the requirement that a fuel-water separator or fuel filter and water separator be installed in the fuel supply system, Cummins Inc. has increased the requirements for free water and emulsified water removal. For engines with CELECT™ fuel systems, the fuel-water separator or fuel filter and water separator combination **must** remove a minimum of 95 percent of free water (per SAE J1839) and 95 percent of emulsified water (per SAE J1488). Fuel-water separator filters produced by Fleetguard® and most other major filter manufacturers meet or exceed these requirements.

Cummins® engines with CELECT™ fuel systems are factory fit with Fleetguard® fuel-water separators that utilize StrataPore™ filter media. These StrataPore™ filters provide high efficiency removal of harmful particles and both free and emulsified water.

The fuel-water separator requires daily draining. See Owner's Manual or Operation and Maintenance Manual for other regular service intervals of fuel filters.

NOTE: The drained fluids (mixture of water and fuel) must be properly disposed of according to regulations.

Table 1 lists the Cummins® and Fleetguard® fuel filters that are available from Cummins Inc. Distributors and Dealers. Change or clean the fuel pre-filter, if so equipped.

Fuel Filter Maintenance

Fuel filters **must** be changed periodically to prevent restriction of fuel flow from the fuel tank to the fuel pump. Change fuel filters as recommended by the appropriate Cummins Engine Operation and Maintenance Manual.

Check the fuel restriction when operating under severe conditions in order to determine if additional fuel filter changes are needed. These measurements **must** be taken at full load and peak power on engines with PT® and in-line fuel pumps or high idle with no load on Celect™ model engines. After checking the restriction a few times, a maintenance schedule for fuel filter changes can be established for each type of operation.

Table 3: Fuel Filter Part Numbers				
Fleetguard® Model Number	Cummins® Part Number	Length mm [in]	Outside Diameter mm [in]	Used On
FF-104	3315846*	107	94 [3.7]	L10, NT, Small Vee,

Table 3: Fuel Filter Part Numbers				
Fleetguard® Model Number	Cummins® Part Number	Length mm [in]	Outside Diameter mm [in]	Used On
		[4.2]		Medium Vee, K19 fuel filter
FF-105	3315844*	137 [5.4]	94 [3.7]	L10, NT, Small Vee, Medium Vee, K19 fuel filter
FF-105-D (with drain)	3315847*	152 [6.0]	94 [3.7]	L10, NT, Small Vee, Medium Vee, K19 fuel filter
FF-202	3313306*	286 [11.3]	118 [4.7]	V28, K38, K50 fuel filter
FF-213	3300901*	174 [6.9]	94 [3.7]	NT fuel filter
FF-5052	3931063*	116 [4.6]	77 [3.0]	Midrange fuel filter
FS-1280	3930942	162 [6.4]	94 [3.7]	Midrange fuel-water separator
FS-1212	3315843	174 [6.9]	94 [3.7]	L10, NT, and K19 and QSK19 fuel-water separator
FS-1216	3313304	308 [12.1]	118 [4.7]	V28 and KV fuel-water separator
FS-1251	3286503	141 [5.6]	77 [3.0]	Midrange fuel-water separator
FS-1232	3834656	115 [4.5]	77 [3.0]	Fuel-water separator for B-Series in pre-1994 Dodge Ram (distributor fuel pumps **only**)
FS-1232V	3912104	170 [6.7]	77 [3.0]	Fuel water separator for B-Series in pre-1994 Dodge Ram (distributor

Table 3: Fuel Filter Part Numbers				
Fleetguard® Model Number	Cummins® Part Number	Length mm [in]	Outside Diameter mm [in]	Used On
				fuel pumps **only**)
FS-1253	3923108	118 [4.6]	94 [3.7]	Fuel-water separator for B-Series in 1994 through 1996 Dodge Ram
FS-1253V	3865402	173 [6.8]	94 [3.7]	Fuel-water separator for B-Series in 1994 through 1996 Dodge Ram
FS-1000	3329289**	249 [9.8]	94 [3.7]	Fuel-water separator for M11, N14, ISM/QSM, and K19/QSK
FS-1001	3413084**	203 [8.0]	94 [3.7]	Short version of FS-1000
FS-1003	3406889**	250 [9.8]	94 [3.7]	ISM/QSM fuel-water separator
FS-1006	3089916**	310 [12.2]	120 [4.7]	QSK45/60/78 fuel-water separator
FS-1007	4010650**	298 [11.7]	119 [4.7]	ISX/QSX fuel-water separator
FS-1022	3800394**	238 [9.4]	94 [3.7]	ISC/QSC fuel-water separator
FS-1040	4010651**	298 [11.7]	119 [4.7]	ISX/QSX fuel-water separator
FS-19519	3942533**	148 [5.8]	94 [3.7]	ISB/QSB fuel-water separator
FS-19519V	3894519**	148 [5.8]	94 [3.7]	ISB/QSB fuel-water separator
FS-19528	3931476	110	105 [4.1]	Fuel-water separator for

Table 3: Fuel Filter Part Numbers				
Fleetguard® Model Number	Cummins® Part Number	Length mm [in]	Outside Diameter mm [in]	Used On
		[4.4]		B-Series in 1997 through 1999 Dodge Ram
FS-19579	3945213**	103 [4.1]	87 [3.4]	Fuel-water separator for 1996 through current midrange (2000 and 2001 Dodge Ram)
* These filters are recommended **only** when using a standalone water separator.				
** These filter utilize StrataPore™ filter media.				

Fuel restriction can be checked as follows. Go to the appropriate troubleshooting and repair manual for more detailed instructions.

1. On the PT® fuel system, measure the restriction at the suction side (inlet) of the fuel gear pump. Change the filter element if the restriction is above 203 mm Hg [8 in Hg].
2. On in-line or distributor fuel systems, measure the restriction at the inlet of the fuel lift pump. Also measure the pressure drop across the fuel filter and the pressure at the inlet to the fuel injection pump. Change the filter element if the pressure drop across the filter is more than 34 kPa [5 psi].
3. On the CELECT™ system, measure the restriction at the suction side (inlet) of the fuel gear pump. Change the filter element if the restriction is above 254 mm Hg [10 in Hg].
4. On the HPI-TP system (ISX/QSX/Signature) there are different test locations and limits depending on the engine option. See the engine Troubleshooting and Repair Manual for specific instructions.
5. On the CAPS system, measure the restriction at the inlet of the fuel gear pump. Change filter if restriction is above 254 mm Hg [10 in Hg].

6. On the Quantum system, there are different test locations and limits depending on the engine option. See the engine troubleshooting and repair manual for specific instructions.

NOTE: If the restriction exceeds these limits, the fuel flow to the pump will be reduced and engine power will decrease.

Hot Restarts

This section shows how contingency fuels affect the ability of the engine to restart while still hot.

On Cummins® engines which use a distributor type fuel system, the use of contingency fuels can cause difficulty restarting the engine while it is still hot. In addition, if excessive wear exists in the fuel pump, the same difficulty can occur even when using fuels within the range listed in Required Diesel Fuel Specifications. The problem is caused by excessive leakage of fuel around the internal components of the fuel pump. Fuel leakage becomes excessive due to the high temperatures and low viscosity of the fuel. Excessive wear of the fuel pump components will make the problem worse. The leakage can become so great that the pump will **not** produce the fuel rate necessary to restart the engine. If this problem is encountered, it can be corrected by using fuel which meets the specifications in the Required Diesel Fuel Specifications section of this bulletin. If this does **not** correct the problem, repair or replacement of worn fuel pump components is necessary.

Alternate or contingency fuels can cause difficulty restarting a hot engine. The hot restart complaint can be caused by fuel burning prematurely during the first compression stroke. Lighter alternate or contingency fuels can enter the cylinder through an open injector caused by the thermal expansion that occurs during the heat soak after engine shut down. The burning fuels increase the starting cylinder pressure and increase the amount of torque needed to start the engine. Lighter alternate or contingency fuels with lower flash points increase the probability of fuel entering and burning in the cylinder. This issue can, on occasion, occur when using fuels that meet the required properties listed in Table 1. Various Hot Restart kits (sometimes referred to as a Hot Start Knock kit) have been released by Cummins Inc. to address this issue.

If this complaint is encountered, it can be corrected by using fuels which meet the requirements in the Required Diesel Fuel Specifications section of this bulletin.

Common Issues With Winter Fuel

This section presents the various winter fuel issues and methods of dealing with them.

Two winter fuel handling issues, wax and ice, have annoyed diesel operators for years. There is no solution to either of these problems that is ideal for all situations, but the better one understands the problem, the less difficult the process of finding a solution becomes. Determining whether a low power complaint is due to fuel filter plugging complaint is fairly simple: replace the fuel filter with a new filter. If this allows the vehicle to operate normally even for a short period of time, then obviously something in the fuel is plugging the filter and causing the complaint. A simple way of determining whether the filter plugging is caused by wax or ice is to bring the plugged filter into a warm shop, drain out the liquid fuel, place the filter upside down on a piece of paper or in a shallow pan, and allow the filter to warm to room temperature. If there is ice in the filter, it will melt and run out of the filter and the water on the paper or in the pan will be obvious. Most petroleum wax, on the other hand, will **not** melt at room temperature. To speed the analysis process, the filter can be cut open and spread out. Once the cause of the low power complaint is determined, then a logical solution can be chosen.

Fuel Wax

All middle (or intermediate) distillate fuels, such as jet fuels, heating fuels, and diesel fuels, contain paraffin wax. Paraffin wax is a solid, crystalline mixture of straight-chain or normal hydrocarbons melting in the approximate range of 40 to 60°C [104 to 140°F]. This paraffin wax occurs naturally in the crude oil from which fuel oils are distilled. The wax content of a distillate fuel varies greatly, depending on the crude oil from which the fuel is produced and in the processing of the fuel. Generally, higher boiling distillate fuels, such as U.S. Number 2-D diesel fuel, have a higher concentration of paraffin wax than lower boiling distillate fuels, such as jet fuel.

Because of the strong relationship between temperature and solubility of wax, wax separation is a problem in handling and using diesel fuel during cold weather. As fuel cools, a temperature is reached at which the soluble paraffin wax in the fuel begins to come out of solution (Cloud Point); any further cooling will cause wax to separate out of solution. The temperature at which a certain fuel will become saturated with wax and causes filter plugging problems is termed the Cold Filter Plugging Point (ASTM D 6371). The temperature at which fuel will no longer flow is the Pour Point (ASTM D-97). At the pour point, most of the fuel is still liquid oil although it is very thick or viscous and trapped in a honeycomb-lick network of wax crystals.

Since diesel powered equipment is frequently used at temperatures low enough to cause wax to separate, a number of techniques have been devised to prevent the wax from causing problems by plugging fuel screens, lines, filter, and so on, and preventing fuel flow to the engine. Vehicles designed to operate at very low temperatures have provisions for heated fuel tanks, insulated fuel lines, heated fuel filters and other mechanisms to warm the fuel so that the wax does **not**

separate. These more elaborate systems are usually **not** practical in more temperate climates where they are needed **only** a few days a year.

Fuel Filters

Fuel filters have already been discussed in detail in the Fuel Filters section of this bulletin. The **only** additional consideration in terms of common issues with winter fuels is that using a large filter or multiple filters in parallel will allow more fuel wax to be filtered before a power loss occurs. Also, relocating the fuel lines and filter out of the wind-stream and wheel splash and into the engine compartment near the engine block will help keep them warm.

Engine Idling

CAUTION

Do not idle the engine for excessively long periods of time. Long periods of idling (more than 10 minutes) can damage an engine because combustion chamber temperatures drop so low the fuel can not burn completely. This will cause carbon to form in the injector spray holes and on the piston rings and can result in stuck valves.

Additives

There are a number of fuel additives available which reduce the pour point and cold filter plugging point (CFPP) of diesel fuel. These are commonly referred to as pour point depressant additives, cold flow improver additives, wax crystal modifiers, or fluidity improver additives (and can be collectively termed “Winter Additives”). Certain additives can reduce the Pour Point by as much as 70°F and the CFPP by as much as 30°F. A survey of winter blend fuels by the Bureau of Mines (now a part of the Energy Research and Development Administration) revealed that a large percentage of the commercially marketed diesel fuels had been treated with a winter additive. Before purchasing such an additive to treat fuel, ask the fuel supplier whether the fuel already contains a winter additive. Depending on the amount and type of additive already in the fuel, additional additives will or will **not** be necessary.

These additives alter the size and shape of wax crystals allowing pumping of fuel at lower temperatures. Although certain additives can be very effective, they are **not** a cure all. Their performance varies depending on the paraffin type and content of the fuel treated. Severe weather applications can require fuel warmers in addition to additives. Although other additives are available that can provide some benefits, Fleetguard's Fleet-tech™ Winter Conditioner and Turbo Diesel All

Season Fuel Additive are the **only** fuel additives recommended by Cummins Inc. to help prevent filter gelling in cold weather applications.

Fuel Warmers

Warming diesel fuel just prior to filtration is an excellent method of preventing fuel filter plugging. If cold fuel is warmed sufficiently, the wax crystals will dissolve in the fuel. The dissolving requires warming to a temperature of approximately 11 to 22°C [20 to 40°F] above the fuel's cold filter plugging point.

In order for a fuel warmer to reliably prevent fuel filter plugging due to wax, it **must** be capable of supplying enough heat to the fuel at the maximum fuel flow (**not** just fuel consumption) rate to raise the fuel temperature from the lowest expected fuel temperature (probably the lowest expected ambient temperature) to 11 to 22°C [20 to 40°F] above the fuel's cold filter plugging point. There are four different fuel warmers presently offered by Fleetguard® to raise the temperature of the inlet fuel.

1. Fuel Filter Heater - The Fleetguard® Positive Temperature Coefficient (PTC) fuel filter heats the fuel before the fuel flows into the fuel filter. The heater is installed on the fuel filter head. Most complaints of fuel waxing occur in the fuel filter. The heater uses ceramic discs that sense the fuel temperature and heats the fuel to a temperature just above the cloud point.

The PTC heater is self-regulating. Depending on battery voltage, the heaters use from 6 to 25 amps at maximum output. When no heat is required, the heater uses less than 0.5 amp. The heater can be left on during engine operation or it can be turned off with the cab switch. The heater reaches full heating capacity in about two minutes. The PTC heater kit is available (see Table 4).

Table 4: Fuel Filter Heaters	
Watts	Fleetguard® Part Number
300	3836029-S

A Fleetguard® kit, Part Number 3837317-S, adapts the heater to most fuel filter heads with 1 in-14 threads. Use to the following fuel filter list to identify fuel filter heads with 1 in-14 threads. The heater adds about one inch in height to the fuel filter head assembly.

Fuel Filter List with 1 in -14 Threads	
FF-104	FF-213
FF-105	FF-105C

FS-1242(B)	FS-1001
FS-1000	FS-1212
FF-105D	FS-1003

The Fleetguard® kit, Part Number 3832054-S, adapts to FS-1251 filter.

2. Recirculating Fuel Warmer - Part Number 3305782, can be used to warm inlet fuel for flow up to 9.5 l/pm [2.5 gpm]. The unit circulates engine coolant around the inlet fuel to warm the fuel. The unit is most effective when immersion or tank heaters are used to warm the coolant. An optional thermostat, Part Number 3305783, can be used to bypass fuel when 27°C [80°F] is reached. Use Table 5 to determine the performance capability of this fuel warmer for different operating conditions.

Table 5: Recirculating Fuel Warmer, Part Number 3305782 - Performance Data

Temperature Rise Chart			
Inlet Fuel Temperature (° F)	Outlet Fuel Temperature (° F) Fuel Flow Rate		
	2-1/2 GPM	1-1/2 GPM	1/2 GPM
-30	32	38	52
-10	39	45	55
10	47	53	59
30	60	62	67
50	71	74	77
70	85	87	88

3. Thermo Blend - The Fleetguard® Thermo Blend fuel warmer recirculates warm deaerated drain fuel from the engine to the filter and injection system, rather than allowing it to return to the tank. A 10 to 15 minute engine-running warm up period is usually necessary to provide successful operation. A built-in thermostat automatically bypasses fuel at 43°C [110°F]. Part Number 3310200 **must** be used for all Midrange and Heavy Duty diesel engines. Part Number 3308750 **must** be used for all heavy duty off-highway equipment (such as 12 and 16 cylinder engines).
4. Thermo Blend FM, Part Number 3310630 - The Fleetguard® Thermo Blend FM fuel warmer combines the return fuel heating principle with a special filter head. When used with Cummins® Part Number 3315843 (Fleetguard® Part Number FS-1212) fuel-water separator, it provides fuel dewaxing, water removal, and filtration. A built-in thermostat automatically

bypasses fuel at 21°C [70°F]. When using fuel warmers, do **not** overheat the fuel. The maximum fuel temperature at the inlet to the fuel pump is 70°C [158°F]. Alterations of heating devices **must** be reversible, or have some means to turn them off during warm weather operation. The fuel tank is heated by the injector return (drain) fuel from the engine. On typical installations, the cooling effect of the tank maintains fuel temperatures at an acceptable level.

On some installations, such as acoustically enclosed units, little cooling of the tank occurs because of the design. On these installations, a fuel oil cooler can be used to limit the temperature of the fuel at the fuel pump inlet to 70°C [158°F] or less.

Depending on the particular engine model involved, the engine horsepower will begin to decrease slightly above fuel inlet temperatures of 46°C [115°F]. The percent of power loss is **not** as great on engines with the Cummins PT® and HPI fuel system (less than 1 percent per 5°C [9°F]), due to the inherent viscosity compensating characteristics (see Power Loss section in this bulletin). Operation above 70°C [158°F] is **not** recommended due to the loss of the lubricating quality of the fuel with resultant wear to the fuel system components which depend on fuel for lubrication. A fuel warmer will **not** help if the fuel is below the pour point and can **not** be pumped to the warmer; therefore, in extremely cold conditions, fuel can be treated with light distillate fuel or treated with a pour point depressant to reduce the pour point, or it can be necessary to heat the fuel to allow it to flow.

When using fuel warmers that use engine coolant as a source of heat, some form of coolant heating during shutoff will allow the heater to become effective much more quickly after start-up. These fuel warmers **must** also be checked for leaks. Since the fuel warmer is on the suction side of the fuel pump and the cooling system is pressurized, any small leak will allow coolant to enter the fuel system.

Other Considerations

Wax in the fuel will deposit in any restriction or sharp bend in the fuel plumbing system. If fuel starvation occurs during cold-weather operation and plugged fuel filters are **not** found, look for plugging of tank pick-up screens, sharp bends in the fuel lines, fittings, and so forth.

Water Contamination

Free water (non-dissolved) in the fuel can freeze at low temperatures and the resulting ice crystals can plug fuel filters causing fuel starvation. Care **must** be taken to keep fuel storage tanks dry. Tanks can be “stuck” often with water detecting paste (usually obtainable from fuel suppliers) to be sure they are dry. If water is detected, it **must** be pumped out.

Keeping bulk fuel storage tanks dry has already been mentioned; however, if this is a persistent issue, a dryer (fuel-water separator) can be installed on the bulk fuel dispensing system.

Condensation in the vehicle fuel tank(s) occurs when the air in the fuel tank(s) cools down during a shutdown period. This moisture can be reduced by filling the vehicle fuel tank before engine shutdown to reduce the air space above the fuel.

Dissolved water comes out of solution as fuel cools. As fuel cools from 4 to -29°C, [40 to -20°F] the solubility of water in the fuel reduces 70 percent. Therefore, fuel pumped from a relatively warm underground tank into a vehicle which sits overnight in sub-zero temperatures can cause some free water to separate. However, this source of free water is almost negligible, because even at high temperatures fuel will dissolve very little water (0.1 mass-percent at 71°C) [160°F]).

Additives can be used to prevent fuel line freeze up. These additives work by lowering the freeze point of water so that it will **not** freeze and cause lines and filters to plug. Although other additives can provide some benefits, Fleetguard's Fleet-tech™ Winter Conditioner and Turbo Diesel All Season Fuel Additive are the **only** additives recommended by Cummins Inc. for this application.

NOTE: More cold weather engine operation recommendations are in Service Bulletin Number 3379009 and in the engine operation and maintenance manual.

Microbial Contamination of Fuel

WARNING

Although most of the microbes that will live in fuel tanks are common organisms to which humans are constantly exposed, contact with microbes or fungi from a fuel tank must be avoided. When a fuel system is contaminated and cleaning is necessary, workers must be protected. Remember that the fungi produce reproductive spores and when dry these can easily become airborne, so breathing protection must be provided or the microorganisms must be kept wet. Dispose of the water and sludge removed from fuel tanks properly. Never place these materials in sanitary sewer system since they can kill bacteria used in sewage treatment. Never place them in storm sewers or surface water streams since they can kill fish and other aquatic animals.

WARNING

The most common problem associated with exposure to these microbes is dermatitis which in some people can be quite serious. Any exposed skin must be thoroughly washed with warm, soapy water.

WARNING

Avoid eating, drinking and smoking while working with these microbes. Any ingestion of the microbes or exposure to broken skin must be considered serious. It is recommended that if this happens the worker be taken to a doctor, along with a sample of the microbes.

WARNING

Biocides are generally only mildly toxic to humans and animals but must still be handled carefully. In cases of ingestion or contact with the eye, follow manufacturer's recommendations. Seek medical attention.

This section covers the recognition of and solutions to microbial contamination of diesel fuel.

To protect against fuel shortages, many users have been storing fuel and, as a result, the frequency of microbial contamination has increased. Microbial contamination of fuel, though **not** a new concern, is more common in metalworking industries which use water- soluble oils as cutting fluids or in long-term storage of hydrocarbon fuels than it is in diesel fleet operations. All hydrocarbon fuels are essentially sterilized by the high temperatures encountered in the refining process; however, they can become contaminated soon after leaving the refinery by microorganisms. These microorganisms, primarily bacteria and fungi, exist rather harmlessly in moisture-free fuel, passing through fuel systems without having any negative effects.

However, in the presence of water, these microorganisms begin to grow and reproduce. The rate of growth depends on how well the environment suits the particular microorganism's needs.

The growth of a large colony of microorganisms in a fuel system can cause several issues. The first and usually most obvious is fuel filter plugging with a greenish-black or brown slime, frequently accompanied by a foul odor. This slimy, string-like colony can also plug sharp bends in fuel lines, fuel meters and other restrictions. The second issue these microorganisms can cause is corrosion due to the acid by-products some of them produce. It is also possible, if the microorganisms pass through the fuel filter, that they will form deposits and cause damage in the fuel pump and injectors.

Some indicators of microbial contamination are:

1. Slime deposits on tank walls, piping, or other surfaces which are exposed to fuel. These deposits are usually greenish-black or brown and are slick to the touch.
2. Black or brown "stringy" material suspended in tank water bottoms.
3. Swelling or blistering of any rubber surface (washers, hoses, connectors, and so forth) that comes in contact with fuel.
4. Sludge or slime deposits on filter surfaces.
5. Foul odor resembling that of rotten eggs (hydrogen sulfide).

A more conclusive approach is to routinely check the fuel by means of one of the several available test kits which are listed below. These can detect microorganisms long before there is any visible evidence of contamination.

The following list shows test kits of which we are aware. Listing of a kit can **not** be construed as a recommendation or approval; and, the fact that a kit is **not** listed **only** means we are unaware of it. Cummins Inc. has **not** tested any of these kits, but has **only** reviewed the manufacturer's literature. Users **must** evaluate the kits available to them and select one based on their own judgment.

1. Total Count Sampler, Catalog Number MTOO 000 25 for package of 25, from Millipore Corporation, Bedford, MA 01730, 1-800-645-5476. The Total Count Sampler contains a nutrient media specifically designed to encourage bacterial growth; however, many fungi will grow on it. Millipore recommends incubation at 35°C [95°F] for 24 hours; however, they can be incubated at room temperature for 36 to 48 hours. If the results on the Total Count Sampler are low and is still suspected, re-sample using Millipore's Yeast and Mold Sampler (Catalog Number MYOO 000 25 for package of 25). This sampler contains a nutrient media which suppresses the growth of most bacteria, but is rich in nutrients for fungi. For best results, use both samplers each time water bottoms are tested. These Millipore samplers are probably the most sensitive of those listed, and in

fact, can lead one to overtreat a fuel system. Millipore samplers are also available from Millipore in Australia, Belgium, Brazil, Canada, Denmark, England, Finland, France, Italy, Japan, Mexico, Norway, Spain, Sweden, Switzerland, and West Germany. Inquiries from other countries can be directed to Millipore Intertech, Inc., P.O. Box 255, Bedford, MA 01730 U.S.A.

2. Microbe Monitor Test Kit (From Air BP) British Petroleum Cleveland-Hopkins International Airport Cleveland, OH 44135 1-800-533-2340. One sample per kit. Incubates at room temperature.

When it has been established that microbial contamination is present and action **must** be taken, there are several approaches. The most obvious solution is prevention. Most of the bacteria and fungi involved are soil organisms which can become airborne or waterborne. Prevention of the entrance of microorganisms is **not** possible because these organisms can enter the fuel through many different routes.

Growth of these microorganisms can be prevented. Since all metabolic processes of an organism are conducted in water, denying the microorganism access to water will prevent growth, thus preventing the development of large, troublesome colonies. Therefore, the first and most important step in prevention is to keep fuel systems dry. Keeping a fuel system entirely dry is impossible. In cases where microbial contamination is a recurring issue, a microbicide can be used to chemically treat the fuel or the water.

There are three general classes of biocides: water-soluble, fuel-soluble, and universally soluble. Fuel-soluble biocides are best suited for treating fuels which are to pass through several storage steps in the distribution process. A fuel-soluble biocide injected into the fuel early in the distribution system is carried with the fuel through the entire downstream system, effectively sterilizing the fuel until usage. Fuel-soluble biocides are easier to add to the fuel system since the exact amount needed to treat a volume of fuel is easily determined and they have a low toxicity to human and other life forms. The obvious disadvantage to fuel-soluble biocides is cost; each batch of new fuel added to the system **must** be treated since the biocide is consumed as the fuel is consumed.

Water-soluble biocides are more economical for use in treating one step in a fuel distribution system, such as the end-user's storage tank. The water-soluble biocides, since they are insoluble in fuel, stay where they are placed until the water bottoms are pumped from the tank; therefore, the total amount of biocide purchased is less. There are a number of disadvantages to water soluble biocides. Since no biocide is carried downstream by the fuel, each successive tank in the system **must** be individually treated. There is some difficulty in determining how much biocide to place in a tank since that depends on how much water is in the tank. The biocide can **not** be thoroughly mixed with the water in the bottom of a tank. Water-soluble biocides are much more easily taken

in by humans and other life forms: and therefore, **must** be disposed of properly when water bottoms are pumped from a tank. Water bottoms containing a water-soluble biocide **must not** be placed in a sanitary sewer system because the biocide can destroy the bacteria used by sewage treatment plants. These water bottoms **must** be treated as an acidic, industrial oily waste.

Universally soluble biocides are soluble in both water and diesel fuel. They allow you to treat the entire downstream system. However, each subsequent load of fuel does **not** need to be treated. The biocide will remain in any water that has collected at the bottom of the storage tank and continue to inhibit microbial growth. With certain types of biocides, the interval between treatments can be as long as six months. Like water-soluble biocides, universally soluble biocides are more easily taken up by humans and other forms of life. They also tend to be more expensive than the other types of biocides.

Treating a fuel tank that is infested with a large population of microorganisms will kill the microorganisms, but it will **not** eliminate the filter plugging they can be causing. The water and sludge containing the microorganisms **must** be removed from the fuel systems. First, clean the fuel system thoroughly. Next, a fuel-soluble or universally-soluble biocide **must** be added to the next few batches of fuel to kill any remaining microorganisms. Finally, the addition of a water-soluble or universally-soluble biocide can be continued for at least several months to be sure the microorganisms are all dead. If microbial contamination is a recurring issue, it is recommended that use of the water-soluble or universally-soluble biocide be continued permanently since this will be the most cost effective solution to the problem. This can be done by determining the amount of water that accumulates in tank bottoms between pump outs and adding about double or triple the amount of water-soluble biocide recommended to treat that volume of water. For example: you normally pump out approximately 379 liters [100 gallons] of water bottoms. In this case, after pumping the bottoms, immediately add to the fuel tank two or three times the amount of biocide normally used to treat 379 liters [100 gallons] of water. Since the biocide is more dense than fuel, it will settle to the bottom of the tank and will dissolve in the water as it accumulates. After refilling a fuel tank, the biocide **must** be allowed to settle before drawing fuel from it to keep from pumping the biocide out with the fuel.

Although other products can provide some benefits, the **only** biocide recommended by Cummins Inc. is Fleetguard's Fleet-tech™ Microbiocide. It is a universally soluble biocide. For specific treatment recommendations, contact Fleetguard and Microbiocide SP Service Engineering department at 1-800-22FILTER.

Natural Gas (NG)

WARNING

Compressed natural gas is normally treated with an odor producing chemical so that users will be able to smell gas leaks. Always be alert for the smell of gas. If you enter a room or approach a vehicle and a smell of gas is present, immediately shut off all engines and ignition sources. Avoid sparks, arcing switches and equipment, cigarettes, pilot lights, flames, and other sources of ignition in the area and in areas with common ventilation. Provide extra ventilation to the area and do not start the equipment or nearby equipment until the leak is corrected and the area is ventilated. Avoid leaving natural gas fueled equipment in unventilated rooms overnight or for extended periods. Store and service natural gas fueled equipment in large well-ventilated areas or outside.

WARNING

If natural gas leaks are present, do not store the vehicle inside or in any area that is covered. Severe personal injury can result from asphyxiation or explosion.

WARNING

Natural gas is highly flammable. Keep all cigarettes, sparks, arcing switches and equipment, pilot lights, flames and other sources of ignition out of the work area and areas sharing ventilation.

WARNING

Not all types of Natural Gas are treated with an orderant. Gas leaks from a non-refined source, such as Landfill Gas, Biogas, Coal Bed Gas or Wellhead Gas, can not always be detected by smell.

WARNING

Do not troubleshoot or repair gas leaks while the engine is running.

CAUTION

Natural gas is lighter than air and can accumulate under the hood and awnings.

CAUTION

Always torque fasteners and fuel connections to the required specifications. Overtightening or under tightening can allow leakage. These connections are critical to the fuel and air systems.

CAUTION

Always test for fuel leaks as instructed, as odorant can fade.

CAUTION

Close the manual fuel valves prior to performing maintenance and repairs, and when storing the vehicle inside.

Specifications

This section presents the specifications for natural gas engines.

Cummins® spark-ignited engines that use natural gas as a fuel source provide a low emission alternative for various applications. In order for the engines to continually provide extremely low emission levels and provide the best durability and reliability, Cummins Inc. has developed several fuel standards. Cummins Engineering Standard (CES) 20067, Natural Gas Fuel; CES 14604, Natural Gas Fuel; and CES 14608 Wide Range Natural Gas Fuel define some of the natural gas specifications. Depending on the type of engine (rich-burn, lean-burn, or alternative fuel) and application (automotive, industrial, or generator), go to the

appropriate engine's operation and maintenance manual for the correct fuel specification. Operators of Cummins® natural gas engines **must** refer the standard or specification to the potential fuel suppliers and request confirmation as to local availability.

These specifications apply to fuel as it is delivered to the engine, regardless of whether its origin was liquid or gaseous. These specifications are **not** intended to cover certification requirements. Landfill gas and gas with chlorine additives are **not** permitted in standard rich-burn or lean-burn natural gas engines. **Only** engine that have been specifically designed, built, and approved by Cummins Inc. for use with alternative fuels (including Landfill and Biogas) can be operated with low energy or aggressive fuels. The fuel **must not** contain water, dust, sand, dirt, oils, or any other substance or component in an amount that is detrimental to the operation of the engine. More specifications and test methods are detailed in these standards. For alternative fuels information, contact a local Cummins Authorized Repair Location for assistance.

For CES 20067, the basic chemical composition for natural gas is detailed in Table 6: CES 20067 Chemical Composition. The Wobbe index **must** be between 1300 and 1377 as measured by ASTM D 3588. The Wobbe index is a calculated value. Go to CES 20067 for more information.

Table 6: CES 20067 Chemical Composition

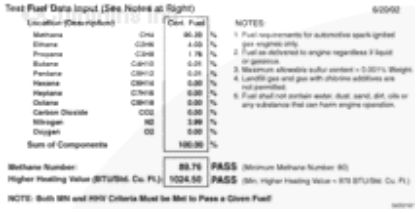
Constituents	Requirements	Test Method
Methane (CH_4)	90.0 percent volume minimum	ASTM D 1945
Ethane (C_2H_6)	4.0 percent volume maximum	ASTM D 1945
Propane (C_3H_8)	1.7 percent volume maximum	ASTM D 1945
Butane and Heavier ($C_4H_{10}+$)	0.7 percent volume maximum	ASTM D 1945
Carbon Dioxide and Nitrogen ($CO_2 + N_2$)	3.0 percent volume maximum	ASTM D 1945
Hydrogen (H_2)	0.1 percent volume maximum	ASTM D 2650
Carbon Monoxide (CO)	0.1 percent volume maximum	ASTM D 2650
Oxygen (O_2)	0.5 percent volume	ASTM D 1945

Table 6: CES 20067 Chemical Composition		
Constituents	Requirements	Test Method
	maximum	
Sulfur (S)	0.001 percent weight maximum	Title 17 CCR Section 94112 Method 16

For CES 14604, the methane number based on SAE 922359 **must not** be below 80 and the higher heating value **must not** be below 975 BTU/Standard Cubic Feet.

“Plus Technology” engines include knock sensing and control and Cummins® CORE hardware based control architecture (currently CM556B ECM). For approved ratings, CES 14608 can be used. The methane number based on SAE 922359 **must not** be below 65 and the lower heating value **must not** be below 16,100 BTU/lbm.

Contact a local Cummins Authorized Repair Location for information regarding calculating methane number, higher heating value, and lower heating values. The following is an example using CES 14604 to determine if the fuel is compliant.



Liquid natural gas (LNG) is an acceptable fuel provided the on-board fuel storage and supply system delivers proper pressure, temperature, and complete vaporization to the engine fuel system inlet.

Cummins Inc. natural gas engines are designed and adjusted to meet performance and emissions specifications with fuel meeting these specifications. The engine can operate on a wide range of fuel properties, but performance and emissions will be affected, and in extreme cases, fuel with characteristics out of these specifications can cause engine reliability or durability issues. Cummins Inc. assumes no responsibility for the use of fuels that do **not** meet this specification.

Engine damage caused by fuel **not** meeting this specification is **not** covered under warranty.

Operators **must** be alert for sudden changes in engine operation, power levels, or pre-ignition. Each of these can be a sign of substandard fuel. If you suspect an issue related to fuel quality, ask your fuel supplier to sample and analyze the fuel in the vehicle or the fuel being supplied to the engine in stationary applications, or contact a local Cummins Authorized Repair Location for assistance.

Fuel Filters

CAUTION

Gas is extremely flammable. Contents under pressure. Vent gas from the filter by opening the drain on the filter.

CAUTION

Overtightening will distort the filter cartridge, damage the filter seal, or crack the filter head. Do not use a filter element that has been dented or damaged prior to, or during, installation.

CAUTION

Oil getting inside of the gas mass flow sensor or on the screen pack will cause poor performance.

Fuel filters are required equipment on all Cummins® natural gas engines. They are designed to remove oil and harmful particles from the fuel before they damage the fuel system or other engine components. These filters are a coalescent type filter that will capture oil contaminants and moisture typically found in natural gas.

Oil can be introduced into a natural gas engine's fuel system in several ways. The most common is from the fueling station compressor. The oil can also be present in the station tank from the refining process. Oil in the fuel will cause the gas mass flow sensor and the heated oxygen sensor to read incorrectly. Engine performance will be affected.

The fuel filter, Fleetguard® NG 5900, needs to be drained as part of the daily or refueling maintenance check. The interval period for draining the fuel filter is dependent on the fueling station and varies for each location. The drain interval **must** be adjusted to the time required to accumulate no more than 30 milliliters [1 ounce] of oil in the fuel filter or daily, whichever occurs first.

Go to the engine operation and maintenance manual for fuel filter replacement intervals.

Liquefied Petroleum Gas (LPG)

WARNING

Liquefied Petroleum Gas (LPG) is normally treated with an odor producing chemical so that users will be able to smell gas leaks. Always be alert for the smell of gas. If you enter a room or approach a vehicle and a smell of gas is present, immediately shut off all engines and ignition sources. Avoid sparks, arcing switches and equipment, cigarettes, pilot lights, flames, and other sources of ignition in the area and in areas with common ventilation. Provide extra ventilation to the area and do not start the equipment or nearby equipment until the leak is corrected and the area is ventilated. Avoid leaving liquefied petroleum gas (LPG) fueled equipment in unventilated rooms overnight or for extended periods. Store and service liquefied petroleum gas (LPG) fueled equipment in large well-ventilated areas or outside.

WARNING

Do not troubleshoot or repair gas leaks while the engine is running.

CAUTION

Liquefied Petroleum Gas (LPG) is heavier than air and can accumulate near the floor, in sumps, and in low-lying areas.

CAUTION

Always torque fasteners and fuel connections to the required specifications. Overtightening or under tightening can allow leakage. These connections are critical to the fuel and air systems.

CAUTION

Always test for fuel leaks as instructed, as odorant can fade.

CAUTION

Close the manual fuel valves prior to performing maintenance and repairs and when storing the vehicle inside.

Specifications

This section presents the specifications for liquefied petroleum gas engines.

Liquefied Petroleum Gas (LPG) has been used as an engine fuel for many years. Modern technology and compliance with various emissions standards now mandate that certified engines be tuned to precise standards and operated on a more restrictive fuel specification for optimum performance and emissions control. Cummins Engineering Standard (CES) 20068 has been developed as a specification for liquefied petroleum gas (LPG) fueled engines. Depending on the type of engine and application (automotive, industrial, or generator), go to the appropriate engine's operation and maintenance manual for the correct fuel specification. Operators of Cummins® liquefied petroleum gas (LPG) engines **must** refer the standard/specification to the potential fuel suppliers and request confirmation as to local availability.

CES 20068 covers liquefied petroleum gas (LPG) fuel for use in automotive spark-ignited liquefied petroleum gas (LPG) engines. The requirements apply to fuel as it is delivered to the engine. This specification is **not** intended to cover certification requirements. The fuel **must not** contain water, dust, sand, dirt, oils, or any other substance or component in an amount that is detrimental to the operation of the engine. More specifications and testing methods are detailed in the standard.

Basic chemical composition is detailed in Table 7: CES 20068 Chemical Composition.

Table 7: CES 20068 Chemical Composition		
Constituents	Requirements	Test Method
Propane (C_3H_8)	90.0 percent volume minimum	ASTM D 2163
Propylene (C_3H_6)	5.0 percent volume maximum	ASTM D 2163
Butane and Heavier (C_4H_{10}+)	2.5 percent volume maximum	ASTM D 2163
Hydrogen Sulfide (H_2S)	Pass	ASTM D 2420
Sulfur (S)	123 ppmw	ASTM D 2784
Oxygen (O_2)	0.5 percent weight maximum	ASTM D 1945
Carbon Dioxide and Nitrogen ($CO_2 + N_2$)	3.0 percent volume maximum	ASTM D 1945

Cummins® liquefied petroleum gas (LPG) engines are designed and adjusted to meet performance and emissions specifications with fuel meeting these specifications. The engine can possibly operate on a wide range of fuel properties, but performance and emissions will be affected, and in extreme cases, fuel with characteristics out of these specifications can cause engine reliability or durability issues. Cummins Inc. assumes no responsibility for the use of fuels that do **not** meet this specification. Engine damage caused by fuel **not** meeting this specification is **not** covered under warranty.

Operators **must** be alert for sudden changes in engine operation, power levels, or pre-ignition. Each of these can be a sign of substandard fuel. If you suspect an issue related to fuel quality, ask your fuel supplier to sample and analyze the fuel in the vehicle, or contact a local Cummins Authorized Repair Location for assistance.

Fuel Filters

CAUTION

Gas is extremely flammable. Contents are under pressure. Vent gas from the filter by opening the drain on the filter.

CAUTION

Overtightening will distort the filter cartridge, damage the filter seal, or crack the filter head. Do not use a filter element that has been dented or damaged prior to, or during, installation.

CAUTION

Oil getting inside of the gas mass flow sensor or on the screen pack will cause poor performance.

Fuel filters are required equipment on all Cummins® natural gas engines. They are designed to remove oil and harmful particles from the fuel before they damage the fuel system or other engine components.

Oil can be introduced to a liquefied petroleum gas (LPG) engine's fuel system in several ways. The most common is from the fueling station compressor. Oil in the fuel will cause the gas mass flow sensor and the heated oxygen sensor to read incorrectly. Engine performance will be affected.

The fuel filter, Fleetguard® NG5900, needs to be drained as part of the daily or refueling maintenance checks. The interval period for draining the fuel filter is dependent on the fueling station and varies for each location. The drain interval **must** be adjusted to the time required to accumulate no more than 30 milliliters [1 ounce] of oil in the fuel filter or daily, whichever occurs first.

A liquid magnetic in-line filter is required on the liquefied petroleum gas (LPG) fueled engines between the liquefied petroleum gas (LPG) fuel tank(s) and the fuel inlet on the engine. The liquid magnetic in-line filter is **not** Cummins Inc. supplied and has a 5-micron requirement.

Go to the engine operation and maintenance manual for fuel filter replacement intervals.

Fuel Supply Hoses

The vehicle supply hose to the engine **must** be approved for use with liquid phase propane (CGA Type III Approved). Engine damage, service issues, or performance issues that occur due to the use of other products are **not** considered a defect in workmanship or material as supplied by Cummins Inc. and can **not** be compensated under the Cummins Inc. warranty.

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Section 1
OPERATION

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Section 2
DISASSEMBLY, ASSEMBLY AND TRANSPORTATION

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Section 3
MAINTENANCE

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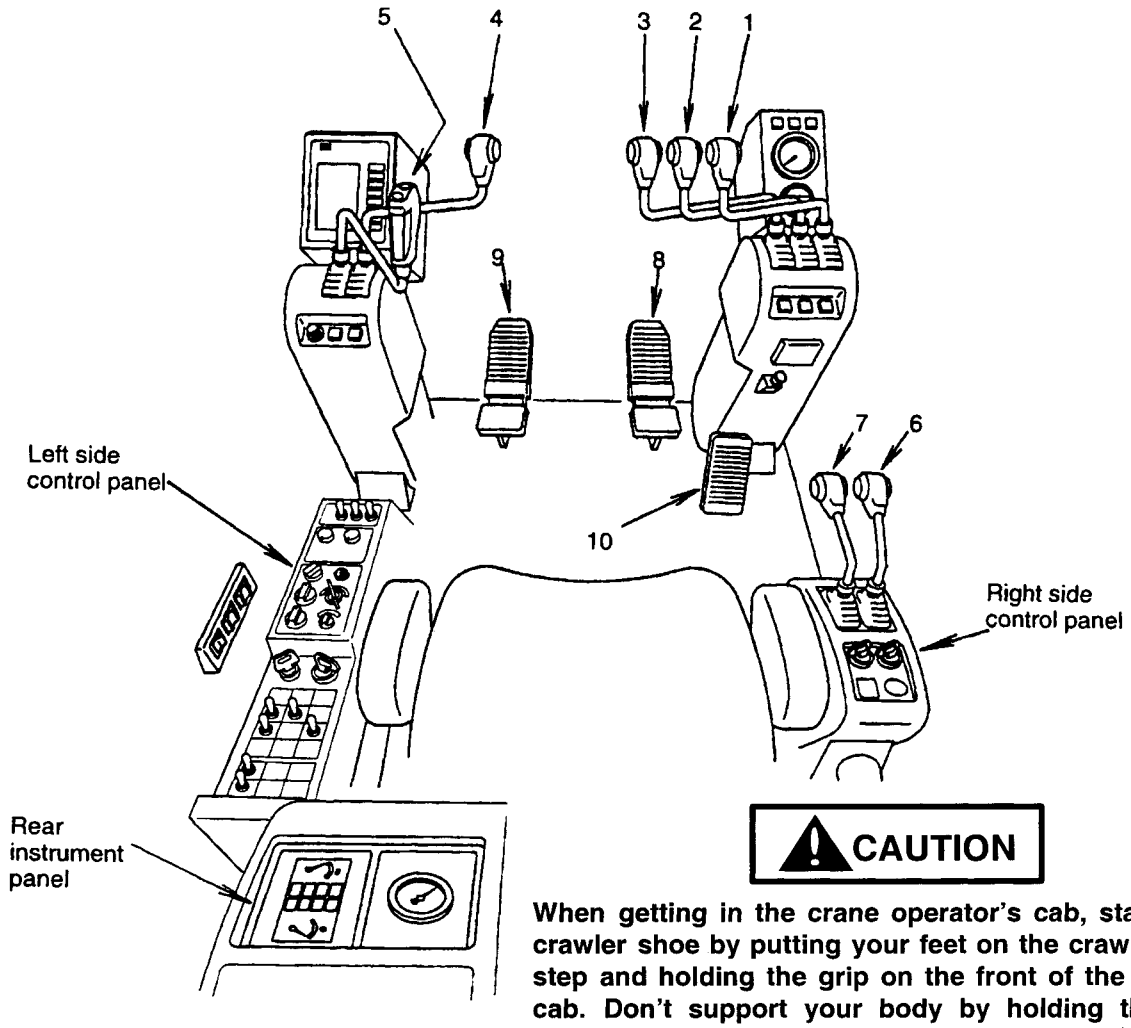
Section 1

OPERATION

Printed in U.S.A.
5/01

1. ARRANGEMENT AND USAGE OF OPERATING EQUIPMENT

1-1 Arrangement of control levers and pedals



CAUTION

When getting in the crane operator's cab, stand on the crawler shoe by putting your feet on the crawler frame's step and holding the grip on the front of the operator's cab. Don't support your body by holding the control levers when getting in or out of the operator's cab. If the operation lock switch is at the release side, the crane function will move by moving the lever.

No.	Name	No.	Name
1.	Boom hoist lever	6.	Right travel lever
2.	Main winch lever	7.	Left travel lever
3.	Auxiliary winch lever	8.	Main winch brake pedal
4.	Power take off or 3rd drum lever	9.	Auxiliary winch brake pedal
5.	Swing Lever	10.	Engine throttle pedal

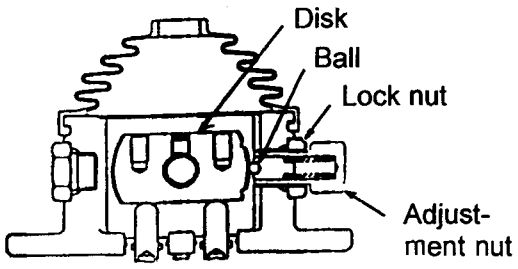
1-2 Outline of control levers

All operations are remotely controlled by manipulating the main control valve from the remote control valve.

*Except for the swing lever, each lever is provided with a lever holding device (detent) at the stroke end.

The strength of the detent is adjustable by turning the adjustment nut with the lock nut loosened. (See the figure at right.)

When tightening the nut, the detent stiffens, and it weakens when loosening the nut.



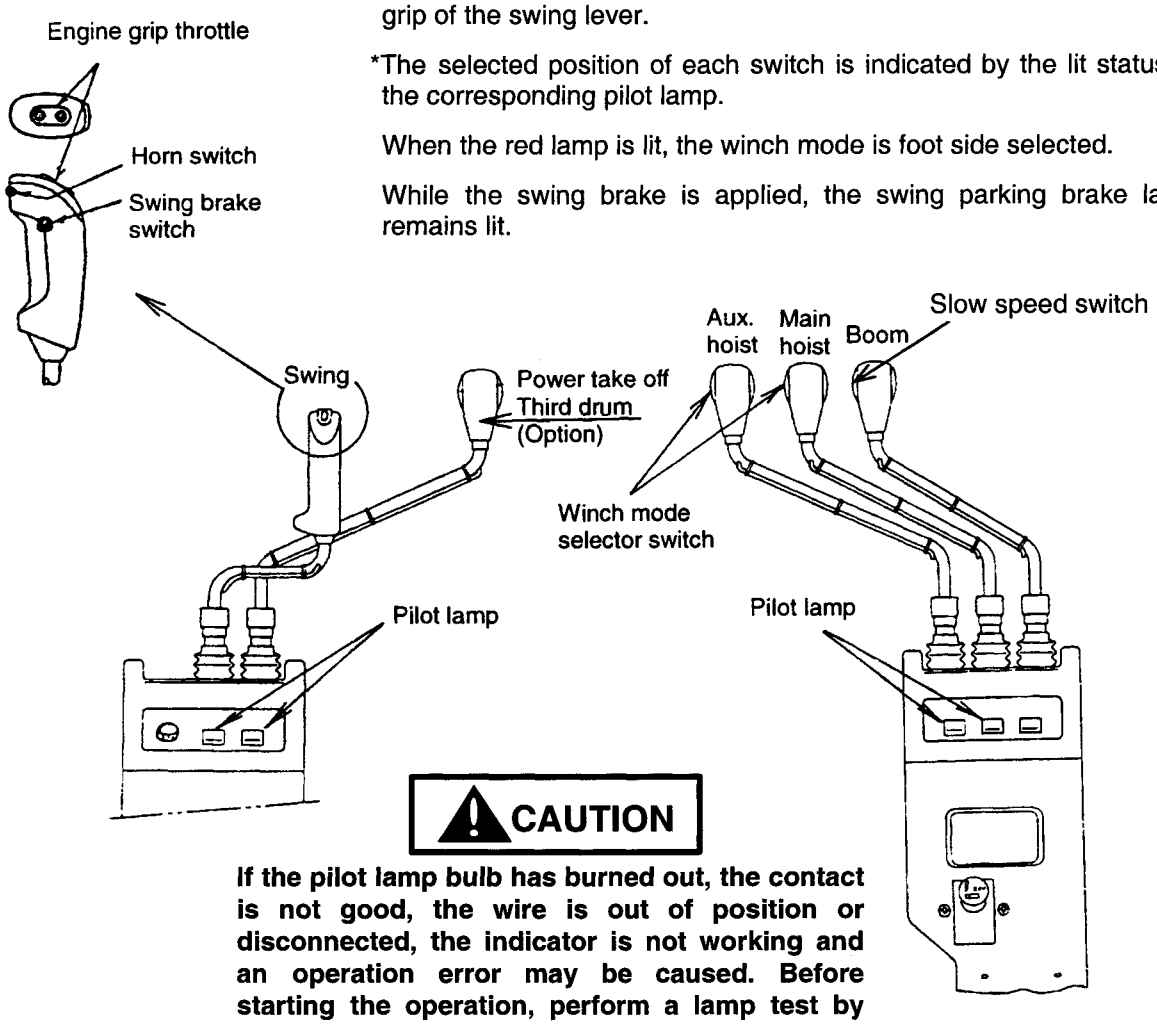
A grip switch for selection of the winch mode is located on the left side of the grip for the main and auxiliary winch levers. The automatic side and foot side are alternately selectable by pressing the grip switch when the winch mode selector switch on the right side control panel is set in the foot side.

Engine throttle, swing brake and horn switches are equipped on the grip of the swing lever.

*The selected position of each switch is indicated by the lit status of the corresponding pilot lamp.

When the red lamp is lit, the winch mode is foot side selected.

While the swing brake is applied, the swing parking brake lamp remains lit.



CAUTION

If the pilot lamp bulb has burned out, the contact is not good, the wire is out of position or disconnected, the indicator is not working and an operation error may be caused. Before starting the operation, perform a lamp test by turning the ignition switch to the "ON" position.

1-3 Function and releasing method of the operation lock device

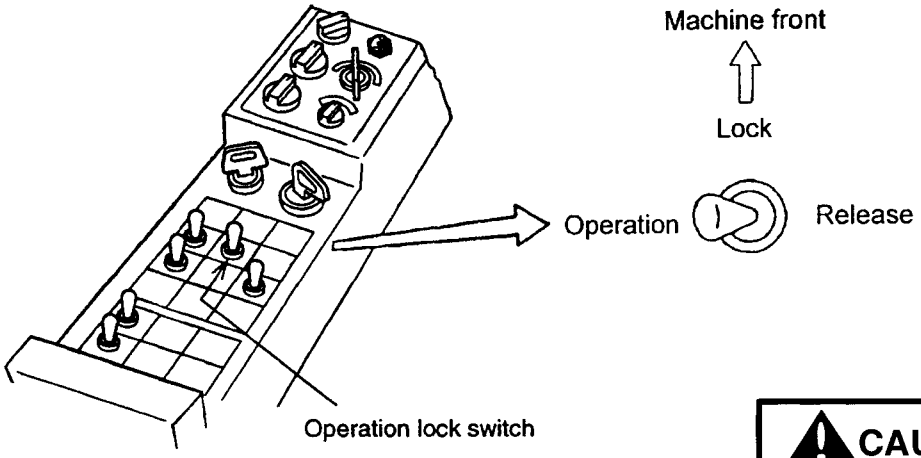
1. When turning the operation lock switch to the lock position, the operator cannot operate the machine even if sitting on the operator seat.

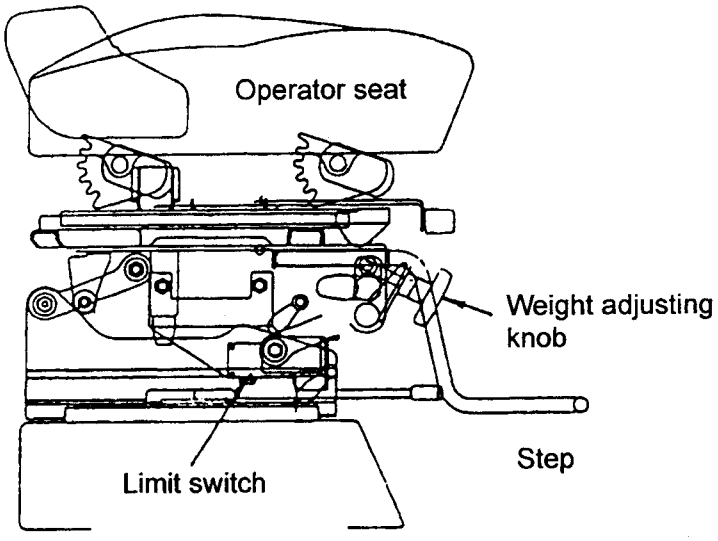
   When turning the switch to the release position, the operator can operate the machine even if he is not sitting on the seat.

   In the released position, the operator aid does not work. Be very careful.

   When the switch is at the operation position and the operator sits on the operator seat, the seat moves down, the limit switch works, the oil pressure is supplied to the remote control valves and the machine can be operated by using the levers. If the operator leaves the seat when the operation lock switch is in the operation position, the control oil pressure is cut to all the hydraulic remote controls and, after approximately 1.5 seconds, it is impossible to operate the machine even if actuating the lever.

2. If the operator has to stand up to operate the machine, he must get on the step. Always set the switch to the operation position for safety. Only use the release position in very extreme conditions.





⚠ CAUTION

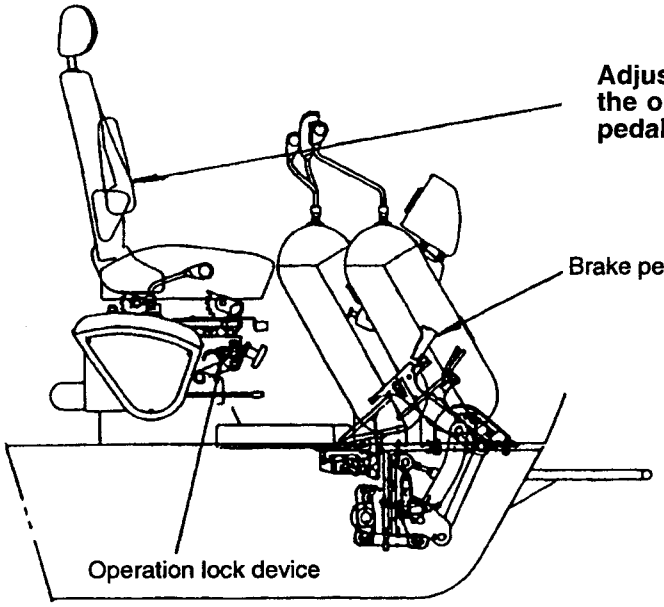
Before operation, make adjustment to operate the limit switch. Make adjustment so that the limit switch may operate at the value less than the operator's weight. Turn the knob for adjustment (see illustration.) The timer is set at 1.5 seconds. It is impossible to operate the levers 1.5 seconds after leaving the seat.

⚠ CAUTION

1. **This device does not function when the operation lock switch of the left operation console is turned to the released position. For safety this switch must be set to the operation position.**
2. **The machine can travel even if the operation lock switch is in the lock position.**

NOTICE

Adjust the operator seat so that the operator can depress the brake pedal securely.



CAUTION

1. **When the operation lock switch is set to "RELEASE" on the left-side control box, this device does not operate. Normally, set the switch to "OPERATION".**
2. **Even if the switch is at "OPERATION" or "LOCK", it is possible to let the machine travel.**
3. **Make sure that each control lever is at "NEUTRAL" and then change the operation lock switch. Don't change the switch to "LOCK" during operation. The machine will stop suddenly.**
4. **When you leave the operator's cab, stop the engine and set the operation lock switch to "LOCK". When operating the machine again, change the switch to "OPERATION".**

1-4 Arrangement and operating method of switches, meters, etc.

Left side operation box

Key No.	Name	Reference Page
1	Main drum winch lock switch	1-7, 1-33
2	Auxiliary drum winch lock switch	1-7, 1-33
3	Boom drum lock switch	1-7, 1-45
4	- -	- -
5	Main drum winch speed selector switch	1-7, 1-24
6	Auxiliary drum winch speed selector switch	1-7, 1-24
7	- -	- -
8	- -	- -
9	Engine air heater lamp	1-8
10	Engine starting switch	1-8
11	Engine throttle mode selector switch	1-8, 1-21
12	Engine throttle dial	1-8, 1-21
13	Pump control dial	1-9, 1-23
14	Travel speed selector switch	1-9
15	Overload prevention device switch	1-9
16	Bypass switch	1-9
17	- -	- -
18	- -	- -
19	- -	- -
20	Pump control switch (manual)	1-10, 1-23
21	Operation lock switch	1-3, 1-10
22	- -	-- -
23	Travel alarm switch	1-10
24	- -	- -
25	Slow down select switch (Gentle stop)	1-10
26	- -	- -
27	- -	- -
28	- -	- -
29	Crawler extension/retraction switch	1-11
30	A-frame extension/retraction switch	1-11
31	- -	- -
32	- -	- -
33	- -	- -

Operation panel on the left side of the cab

Key No.	Name	Reference Page
34	Front wiper switch	1-12
35	Roof wiper switch	1-12
36	Working lamp switch	1-12

Rear instrument panel

Key No.	Name	Reference Page
37	OK monitor	1-26
38	Control circuit oil pressure gauge	1-12

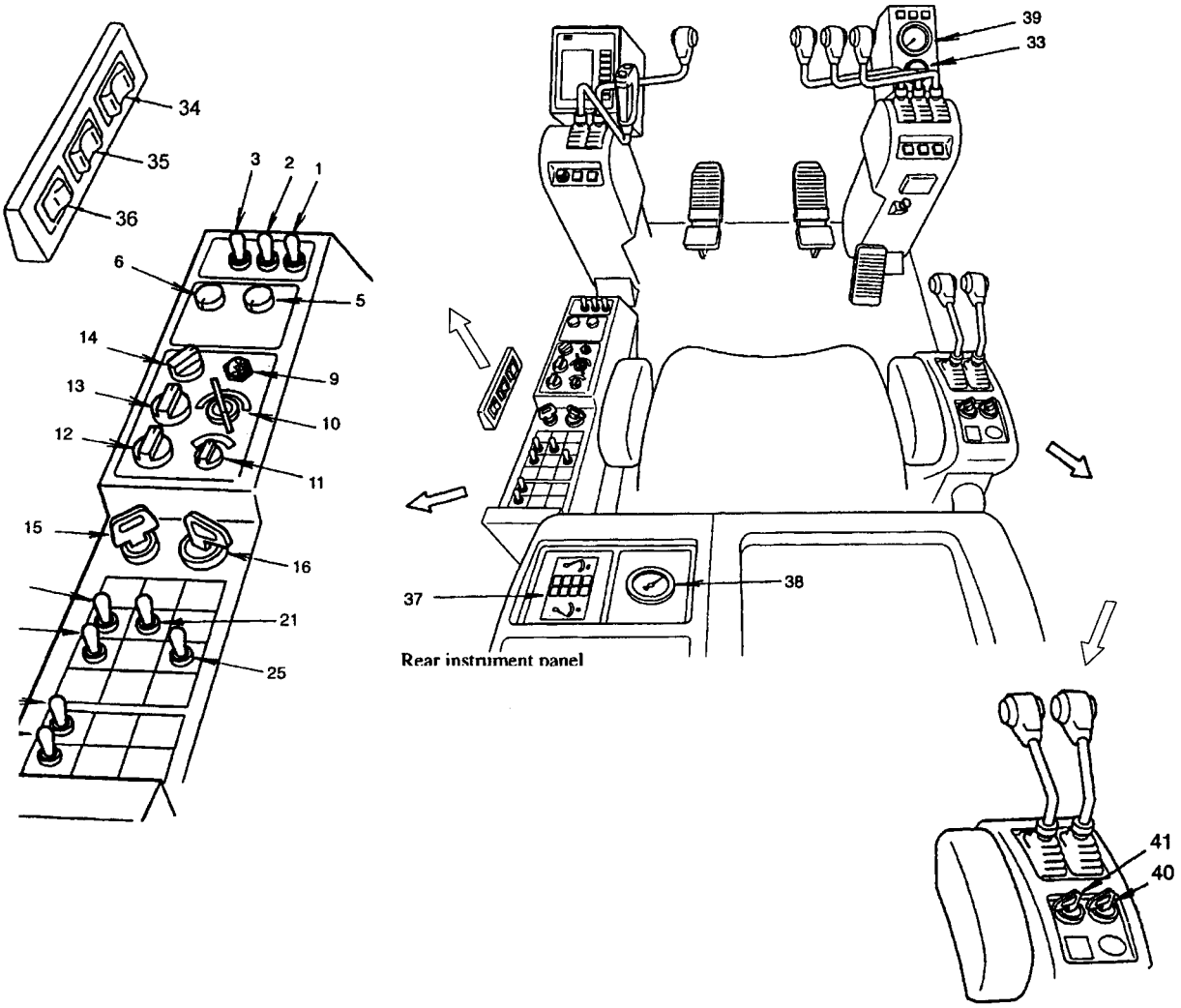
Right side lever stand

Key No.	Name	Reference Page
33	Engine hour meter	1-11
39	Engine tachometer	1-13

Right operation box

Key No.	Name	Reference Page
40	Main hoist winch mode selector switch	1-13, 1-24, 1-31
41	Auxiliary hoist winch mode selector switch	1-13, 1-24, 1-31
42	- -	- -
43	- -	- -
44	Hook overhoist prevention device release switch	1-14
45	Clutch maintenance switch	1-14, 1-15

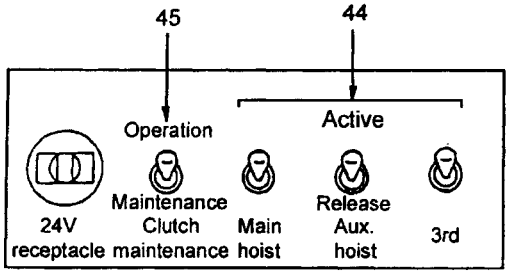
Set the working conditions of the overload prevention device (Moment Limiter) correctly as referring to the setting method. See pages 1-70 to 132.



Rear instrument panel

Set the switch of the winch to be used to "ACTIVE". If not, the overhoist prevention device will not work. Set the switch of the unused winch to "RELEASE". The switches are positioned above the control panel behind the operator's cab.

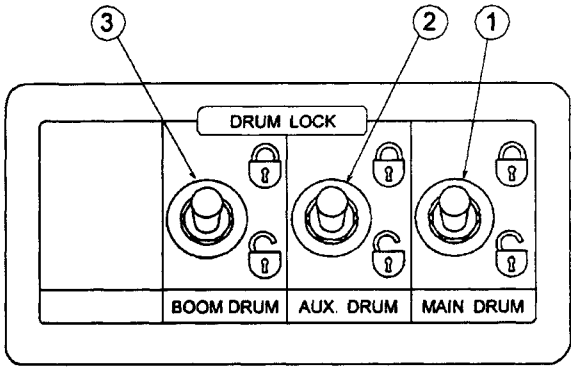
Refer to page 1-14 for the hook overhoist prevention device release switch and others.



Installed above the control panel.

Left side operation panel

Drum lock switches



(1) Main winch drum lock switch

(2) Auxiliary winch drum lock switch

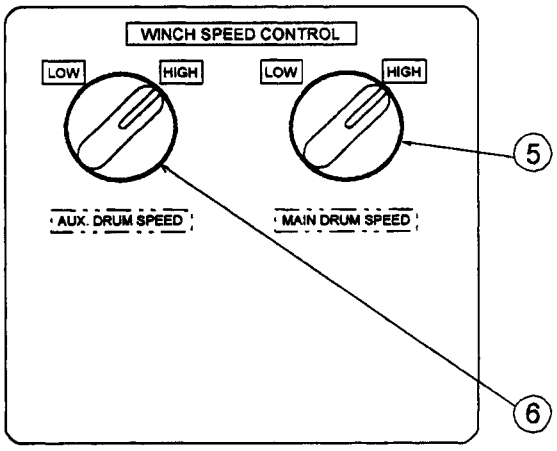
(3) Boom drum lock switch

These are the drum lock switches for main hoist, auxiliary hoist and boom hoist. Set the switch to the key release position, and the drum is unlocked. Hoist the drum a little if it is difficult to unlock the drum. Force is removed from the pawl and the drum is unlocked.

CAUTION

Do not move the switch to the lock position when the drum is rotating in lowering. If so, the pawl or drum may be damaged and shock load the crane.

Winch drum speed selector switches



(5) Main winch drum speed selector switch

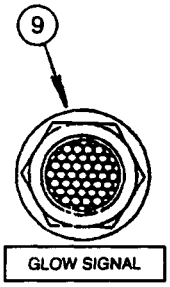
(6) Auxiliary winch drum speed selector switch

Set the switch to "LOW" , and the load hoist drum rotation is decelerated. Set it to "HIGH", and the load hoist drum rotation is accelerated. Don't change the hoisting speed during hoisting or lowering. Stop the load and apply the brake securely before changing the speed.

When the pump control dial (13) is set to the "DECREASE" position while the engine speed is low, hunting sometimes occurs during lowering if this speed selector switch is set to the high speed position. This is not a problem.

(9) Engine air heater lamp

This signal shows the engine preheating condition.



(10) Engine starting switch

OFF: Engine stop position

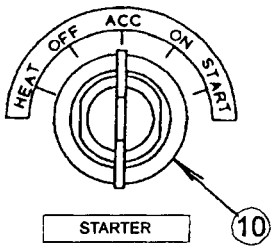
The key can be inserted or removed. The complete electric circuit of the crane is "OFF".

START: Engine start position

Do not operate the starter for more than 15 seconds at a time.

The use time of "START" is 15 seconds or less. Wait for 20 seconds before reusing the "START" position. Release the key at this position, and the switch returns to "ON" automatically.

NOTE: The engine cannot start if the main or auxiliary winch mode selector switch is not at the automatic position. In such a case, the interlock red lamp is lit above the engine tachometer when the key is turned to the "START" position.



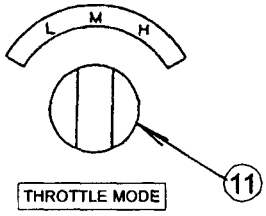
ON: Engine run position

Don't move the switch to other positions except "ON" during operation to protect the electric components.

HEAT: Air heater position

In a cold climate, set the switch to "HEAT" to heat the suction air and to start easily. Approximately 60 seconds are necessary for preheating until the heater lamp glows. The preheating time is changed according to the battery capacity.

ACC: Used when listening to the radio, etc. when the engine is not running.

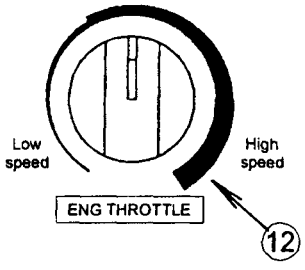


(11) Throttle mode selector switch

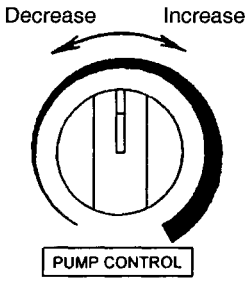
This switch is used to select the engine's acceleration speed. When the operator accelerates the engine, the switch selects the time required to reach the selected speed. The time is longer at "L" and shorter at "H".

(12) Throttle dial

The operator can control the engine speed manually with this switch. Determine the minimum speed needed with this switch, and for higher speeds override this dial by using the hand throttle or foot throttle.



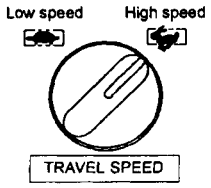
(13) Pump flow control dial



This dial is used to change the flow delivery of the hydraulic pump manually when the switch (20) is at "MANUAL". The delivery is not changed when the switch (20) is at "AUTO". The engine may stall if this dial is fully turned to the "INCREASE" position when the engine speed is low. Be careful.

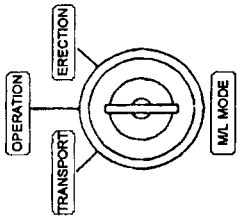
When this dial is set at "DECREASE" while the engine speed is low, hunting sometimes occurs during lowering if the speed selector switch is set at the high speed position. It is not a problem.

(14) Travel speed selector switch



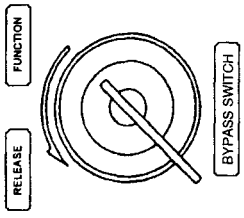
This switch is used to select the travel speed. The high speed is selected at the rabbit position and the low speed is selected at the tortoise position. Stop traveling and then change the speed.

(15) Overload prevention device (moment limiter) mode switch



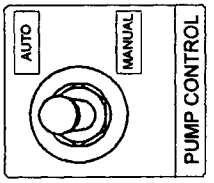
Position this switch to "OPERATION" during the crane operation. Position it to "ERECTION" when disassembling or assembling the attachment. The display unit of the overload prevention device blinks at "ERECTION" and at the same time the function of the device is canceled except "Boom Overhoist Prevention". Even at "ERECTION" it is possible to hoist or lower the boom but you must be careful because the overload prevention device does not work. One of the three-colored alarm lamps (the red one) is lit at "ERECTION". The electric power is "OFF" when the switch is at "TRANSPORT". You can remove the key at "OPERATION". Don't switch to "TRANSPORT" and "ERECTION" during the crane operation.

(16) Bypass switch (reset switch)



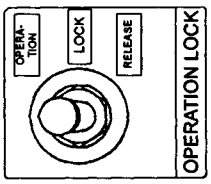
This switch can release the automatic stop condition. Even when the machine stops automatically, you can operate it by positioning this switch to "RELEASE". Don't operate the crane under dangerous conditions, or an accident may occur. Refer to pages 5-8 and 5-9 for how to release the stop condition with the reset switch. Position the switch to "FUNCTION" and remove the key for safety. When the hook overhoist prevention device operates, the reset switch cannot release the condition.

(20) Pump control selector (manual control) switch



When this switch is at "AUTO", the pump delivery is automatically changed according to the change of the engine speed. When it is at "MANUAL", the delivery is set with the dial (13). Set this switch to "MANUAL" before operating the dial (13).

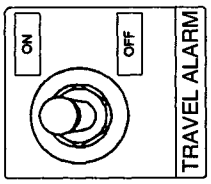
(21) Operation lock switch



This is an operator aid which locks the machine to prevent actuating the levers accidentally. Position this switch to "LOCK" when leaving the operator's cab.

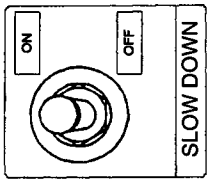
- The operation lock does not function when this switch is at "RELEASE".
- The machine does not function even if actuating the lever at "LOCK".
- At "OPERATION", the operator can operate the machine by actuating the lever only when sitting on the operator seat.
- It is possible to travel the machine even if the switch is at "LOCK" or "OPERATION".

(23) Travel alarm switch



This switch is used to sound an alarm when the crane travels. Position this switch to "ON", and an alarm will sound continuously while the crane is traveling.

(25) Slow down (Gentle Stop) switch



A shock occurs when the crane stops at the load ratio of 100%. A function is provided to reduce such a shock. The function decreases the hoisting speed beforehand when the moment limiter indicates that the load ratio is 90% or when the boom angle reaches the upper or lower limit. "GENTLE STOP" can be released by using this switch. If "GENTLE STOP" is released, a shock occurs when the crane stops. Refer to the description of the overload prevention device for the angles at which the hoisting speed of the boom is to be decreased. (See Pages 1-77 & 1-78 "Setting of Gentle Stop"). If "GENTLE STOP" is necessary, set this switch to "ON". When the crane is working in "SLOW DOWN OPERATION" condition, the slow speed lamp is lit above the engine tachometer.

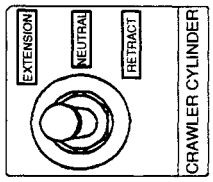
(29) Crawler extension/retraction switch

This switch is used to change the crawler width.

When this switch is at "EXTENSION", the crawler width is extended.

When it is at "RETRACT", the crawler width is retracted. Release this switch, and it returns to "NEUTRAL" automatically.

Refer to Section 2 "DISASSEMBLY, ASSEMBLY AND TRANSPORTATION" for the details of operation.

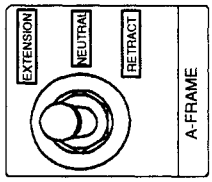


(30) A-frame switch

This switch is used to operate the A-frame.

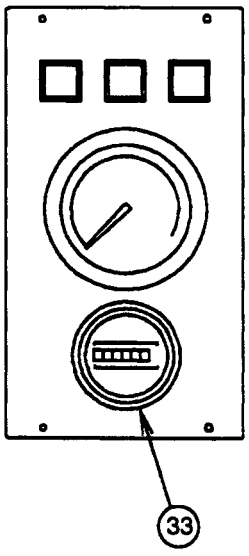
When this switch is at "EXTENSION", the A-frame is extended.

When it is at "RETRACT", the A-frame is retracted. Release this switch, and it returns to "NEUTRAL" automatically.



(33) Engine hour meter

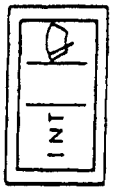
The 6 digit numeral indicates the accumulated operation time. The operation time should be a standard for maintenance of the machine.



Operation panel on the upper left side of the cab

(34) Front wiper switch

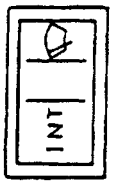
The intermittent or continuous operation can be selected. Press the "INT" side to select the intermittent operation. If switch is pushed while in this position, window washer liquid will come out.



Front wiper

(35) Roof wiper switch

The intermittent or continuous operation can be selected. Press the "INT" side to select the intermittent operation. If switch is pushed while in this position, window washer liquid will come out.



Roof wiper

(36) Working lamp switch

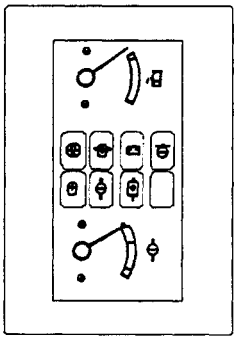
This is the cab head lamp switch. Press the picture side, and the lamp is lit.


Working lamp

Rear instrument panel

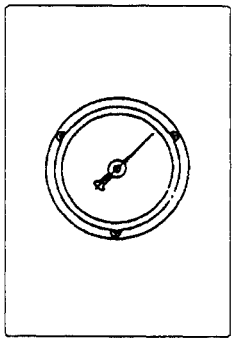
(37) OK Monitor

Refer to Page 1-26 for the details of the OK monitor.



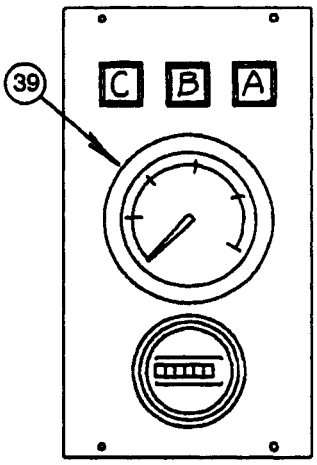
(38) Control circuit oil pressure gauge

Make sure that the pointer is within the green zone. The green zone shows the normal condition. The alarm buzzer sounds when the pressure is lowered to 710 psi or less.


Green: 850 to 1280 psi
Red: 0 to 850 psi
1280 to 2130 psi

Right side lever stand

(39) Engine tachometer



The pointer indicates the engine speed (RPM).

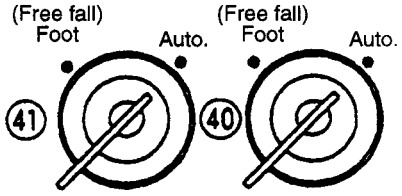
The pilot lamps above the tachometer indicate as follows:

[A] Indicates an engine start interlock. The engine will not start if this light is lit. The main and auxiliary drum winch mode selector key switches must be set in the "AUTOMATIC" position. (See Page 1-19 for additional information). If the selector is set to "FOOT" position, the engine will not start and the light "A" will be lit.

[B] This is the slow speed indicator lamp. Press the switch at the head of the boom hoist lever, and the slow speed operation starts. This lamp is lit when the slow speed operation starts. At the same time, the winch and boom drum operate at the slow speed and traveling is also done at the slow speed. The green lamp is lit during gentle stop operation.

[C] This lamp is lit when the swing brake is applied.

Right side operation panel



(40) Main hoist winch mode selector switch (Automatic brake/free fall foot brake)

(41) Auxiliary hoist winch mode selector switch (Automatic brake/free fall foot brake)

These switches are used to set the main and auxiliary winch drum operation to "AUTOMATIC" (brake operation) or "FOOT" (brake pedal operation).

The selection is linked with the grip switches of the main/auxiliary levers. Refer to P. 1-31 and after for details.

When the main and auxiliary drum winch mode selector switches are not at "AUTOMATIC", the engine cannot start.

Right side panel Winch mode selector switches	Winch mode is selected by the grip button switches on the levers.
Automatic	Automatic position is always set regardless of the grip switch.
Foot	Automatic and foot position are selected in response to the grip switch.

⚠ CAUTION

Winch must be stopped when selecting winch mode. (Auxiliary winch is stopped when the foot pedal is fully depressed).

(44) Hook overhoist prevention device switches (Anti two blocking)

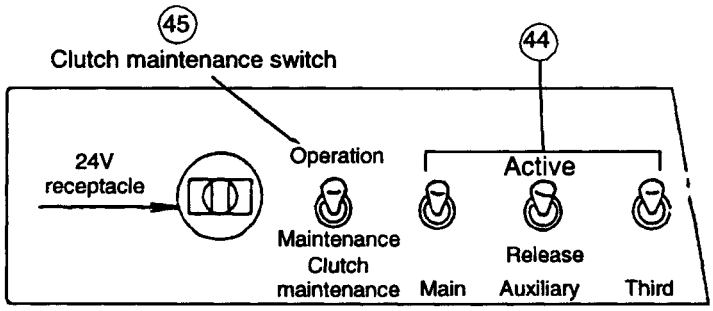
The switches are installed above the control panel.

Work	Switch Position	
	Main Hoist	Auxiliary Hoist
Crane, clamshell and other operations	Set the switch of the main hoist or auxiliary hoist winch which is used to "Active".	

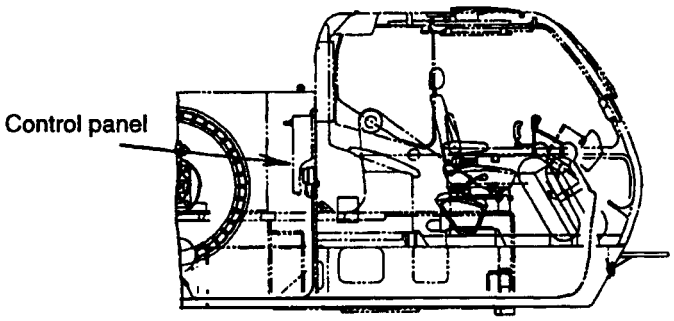
Set the switches of the main and auxiliary winches to "Release" when disassembling or assembling. When starting crane operation after assembling, set the above switches to "Active". In clamshell or other operations, set them to "Active" if necessary.

⚠ WARNING

Set the overhoist prevention device switches to "Active" before operating the crane. If not, the overhoist prevention devices do not function and an accident such as overhoisting of the hook may occur.



Above the control panel

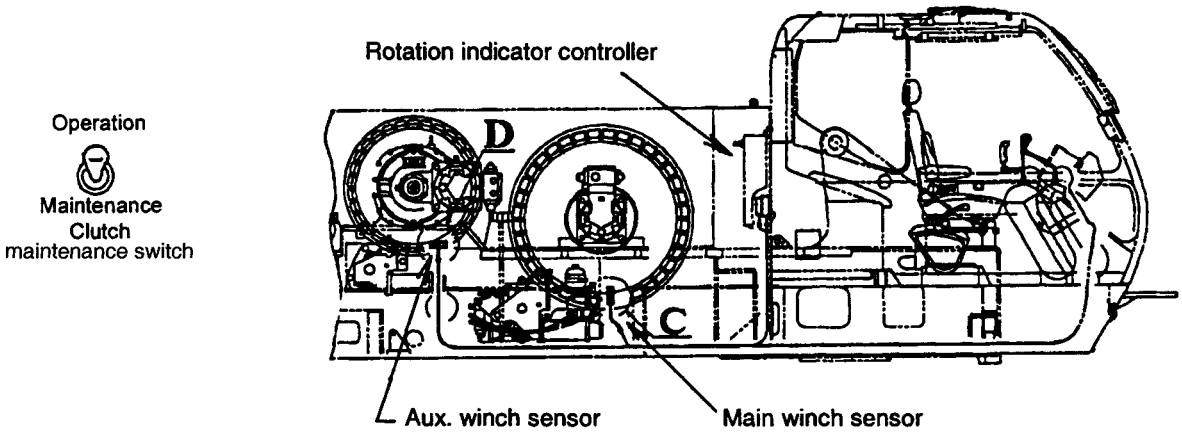


(45) Clutch maintenance switch

⚠ CAUTION

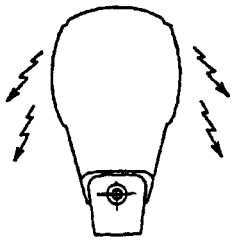
Clutch must not be rotated until you are assured that all personnel are away from rotating or moving parts

When it is necessary to release the main and auxiliary clutches for adjustment or repair, position the clutch switch to "Maintenance" while the winch mode is at "Foot". The main and auxiliary clutches are released at the same time. When checking or repairing the clutch, one person must sit in the operator's seat and turn the clutch to the proper position for maintenance.



1-5 Drum rotation indicator (Optional specification)

This device vibrates the hoist lever grip when the main or auxiliary winch drum rotates and so indicates the drum rotation for the operator. The vibration stops when the drum rotation reaches the specified or higher value.

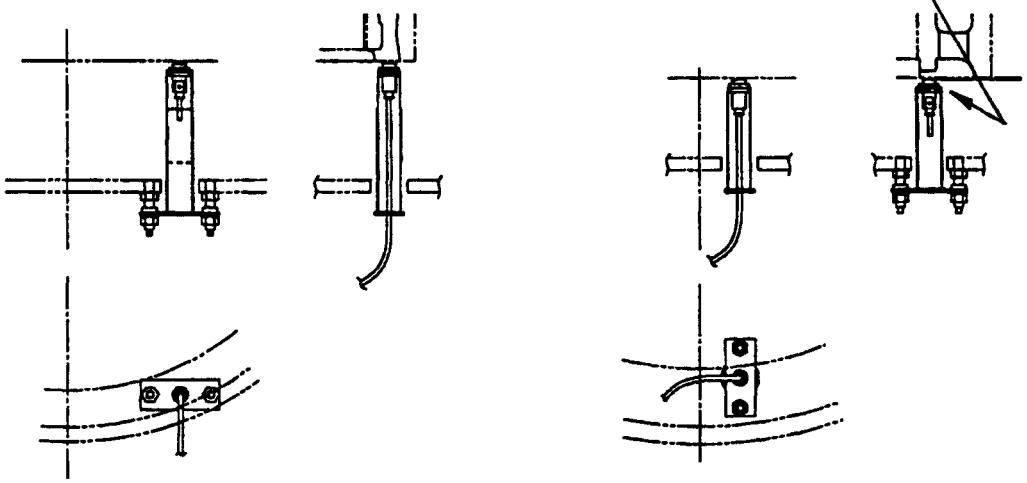


Contact lever grip

- The operation power supply is constantly "ON".

  The power supply is connected when the engine key is "ON"

The clearance between drum and a sensor is adjusted to 0.102"



2. PREOPERATIONAL CHECK

2-1 Operational aids

⚠ WARNING

Check the operator aids according to the regulations before operation. If an operator aid malfunctions, the crane may tip or boom may collapse. Check the overhoisting prevention device in a very slow speed to stop the device if necessary.

1. **Operate the overhoisting prevention device and make sure that it operates smoothly. Make sure that the hook or boom stops automatically when hoisting it slowly in a low speed.**
2. **Operate the overload prevention device and make sure that it operates smoothly. Lower the boom with no load, and make sure that the buzzer sounds continuously, the boom stops automatically and the load ratio "100%" is displayed when it reaches the boom lower limit angle.**

⚠ WARNING

2-2 Inspection of wire rope

1. **If the boom hoist rope is damaged or cut, a serious accident such as the boom falling down may be caused. It is an obligation to check the boom hoist rope before operation. If the rope reaches the allowable limit, replace it at once.**
2. **If the suspension pendant rope for boom is damaged or cut, a serious accident such as the boom falling down may be caused. It is an obligation to check the pendant rope before operation. Check carefully the joint of the wire rope to the pin connecting socket. Any signs of corrosion or broken wires at this joint must be thoroughly evaluated before using. If the rope is damaged or any problem is found in the pin connecting socket, replace the part at once.**
3. **Check the wire rope for lifting load, too. Refer to "Chapter 3 MAINTENANCE" for the standard of wire rope replacement.**

⚠ WARNING

If a lifting tool such as a sling wire rope is cut, a person may be injured by the dropped load. Check the lifting tools before operation. If there is a problem, replace the tool at once.

Replacement criteria for sling wire rope (reference)

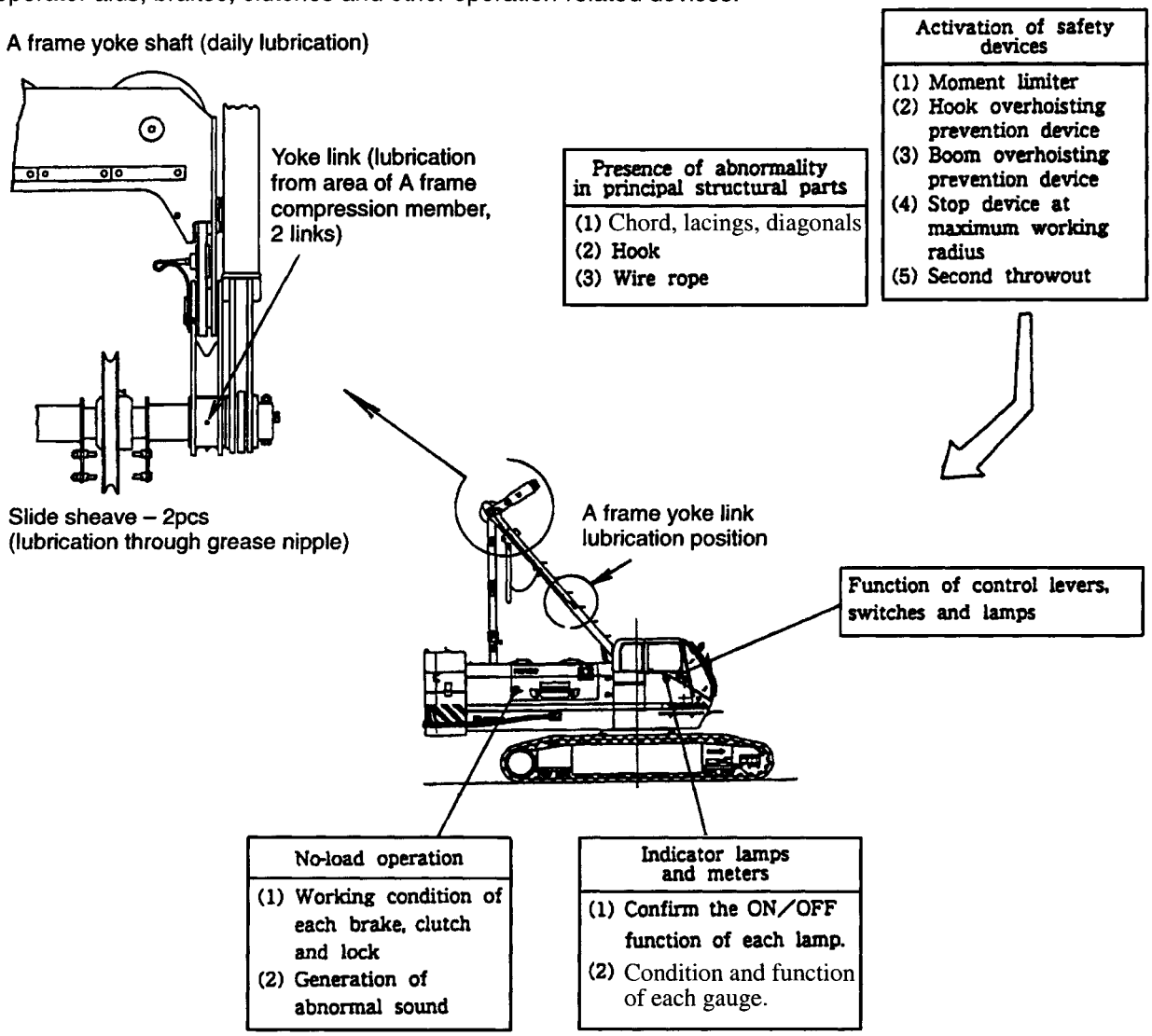
a. **The diameter is reduced by 7% or more than the nominal diameter.**
b. **10% or more wires (except fillers) are broken within one lay of the rope.**
c. **The rope is kinked.**
d. **The rope is extremely deformed or corroded.**

Refer to ANSI/ASME B30.9 Safety Standard for cableways, cranes, derricks, hoists, hooks, jacks and slings.

2-3 Check points

The preoperational check must be performed.

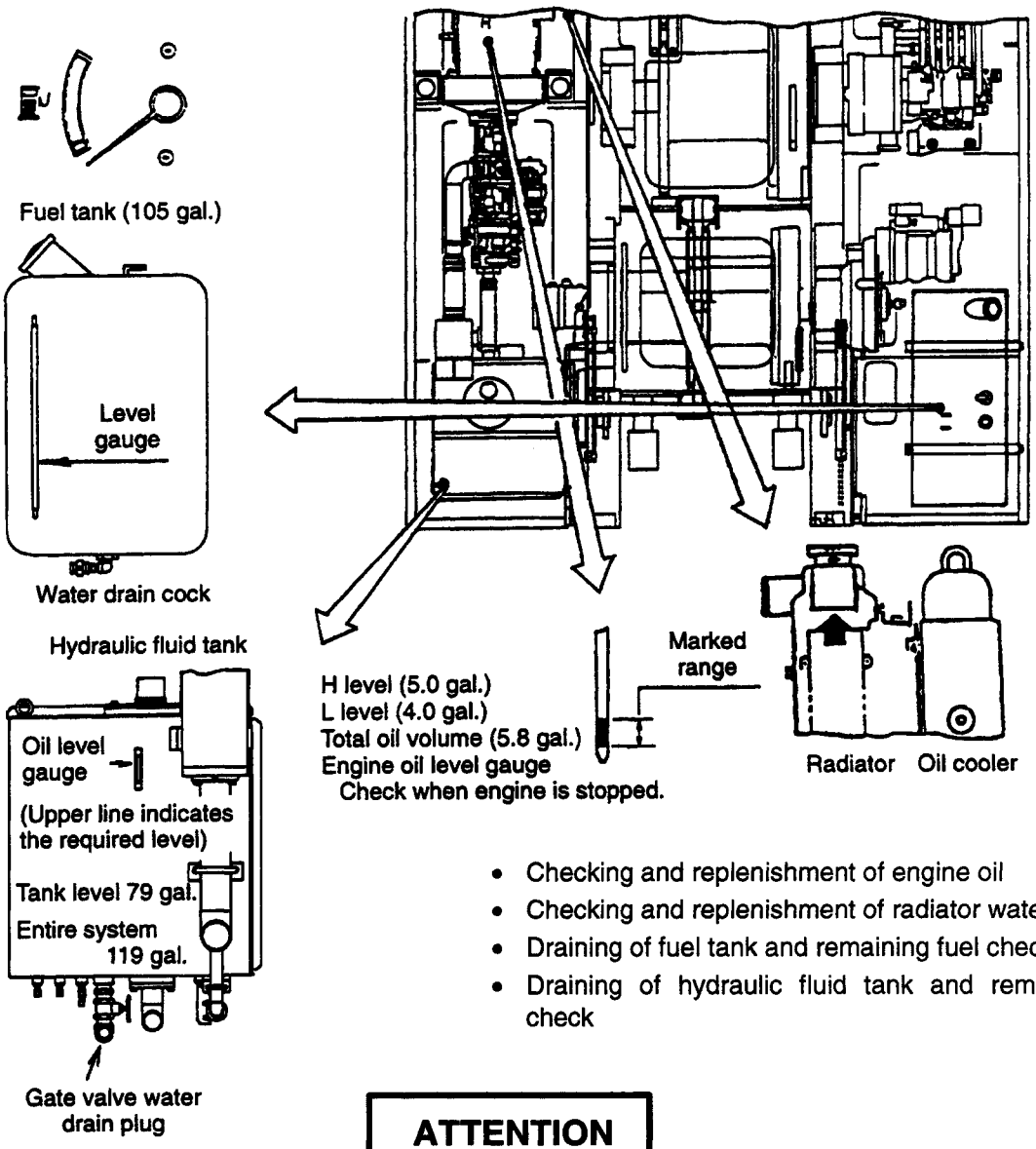
Carry out functional checking on the overhoisting prevention device, overload prevention device, other operator aids, brakes, clutches and other operation-related devices.



CAUTION

1. **Actually operate each operator aid to confirm smooth operation.**
2. **If an abnormality is found, it must be properly repaired or replaced before using.**
3. **When the engine is rotating, checking on the engine side calls for extreme caution and attention to safety. Keep body parts away from and clear of rotating and moving parts. Adequate attention should also be paid to safety when the machine is operated for checking.**
4. **Make sure that the winch mode changes correctly.**

Fuel gauge (on rear panel of operator's cab)



- Checking and replenishment of engine oil
- Checking and replenishment of radiator water (LLC)
- Draining of fuel tank and remaining fuel check
- Draining of hydraulic fluid tank and remaining oil check

ATTENTION

1. **The fuel tank and hydraulic fluid tank should be drained before starting the engine because moisture has gathered at the bottom of each tank. After slight draining, check if water is mixed. If not mixed, the fuel or oil is normal. If mixed, complete draining is required. Water drain is performed once a month.**
2. **After starting the engine, perform adequate warming-up of the engine and hydraulic system. Warming-up takes at least 5 minutes. During the warming-up period, gauges and meters should be checked.**

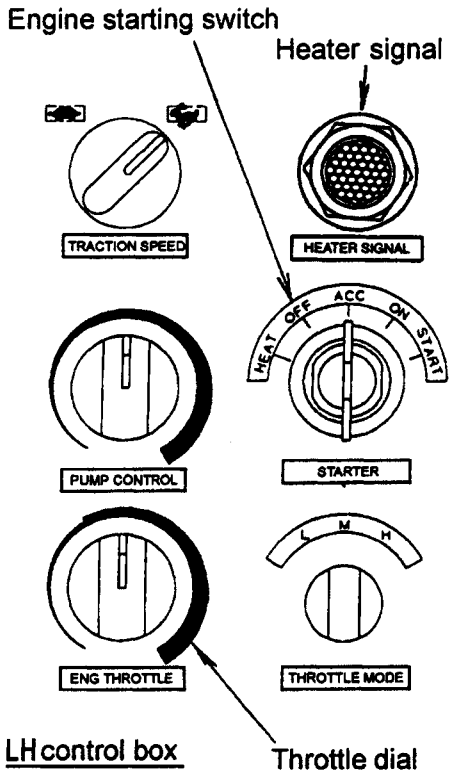
   There may be cases where no-load operation, short-interval relief operation or the like is required for raising the temperature of the hydraulic fluid. In winter or a cold area, a longer warm-up period may be required.
3. **Level of hydraulic oil has a regular upper limit level in the state of crawler retraction and A-frame folding. In the working state for crawler extension and A-frame raising, the oil level is below about 0.4" (10mm) from upper limit level.**

3. ENGINE STARTING & USAGE OF ENGINE THROTTLE & EACH SWITCH

3-1 Engine starting

⚠ CAUTION

1. **The engine cannot be started unless both of the main and auxiliary winch mode selector switches (40) and (41) on the right-side operation console are set at the automatic position. In such a case, the interlock lamp above the engine tachometer is lit when the starting switch is at "START" position. If the winch mode selector switch is set to the "FOOT" (free fall) position, the engine will not start.**
2. **Turn the winch mode selector switches to the automatic mode and depress all the brake pedals. In addition, make sure that each control lever is set at neutral.**
3. **Before starting the engine, sound the horn or turn on the voice alarm switch to inform personnel of engine start. Do not start engine until you are sure all personnel are clear.**



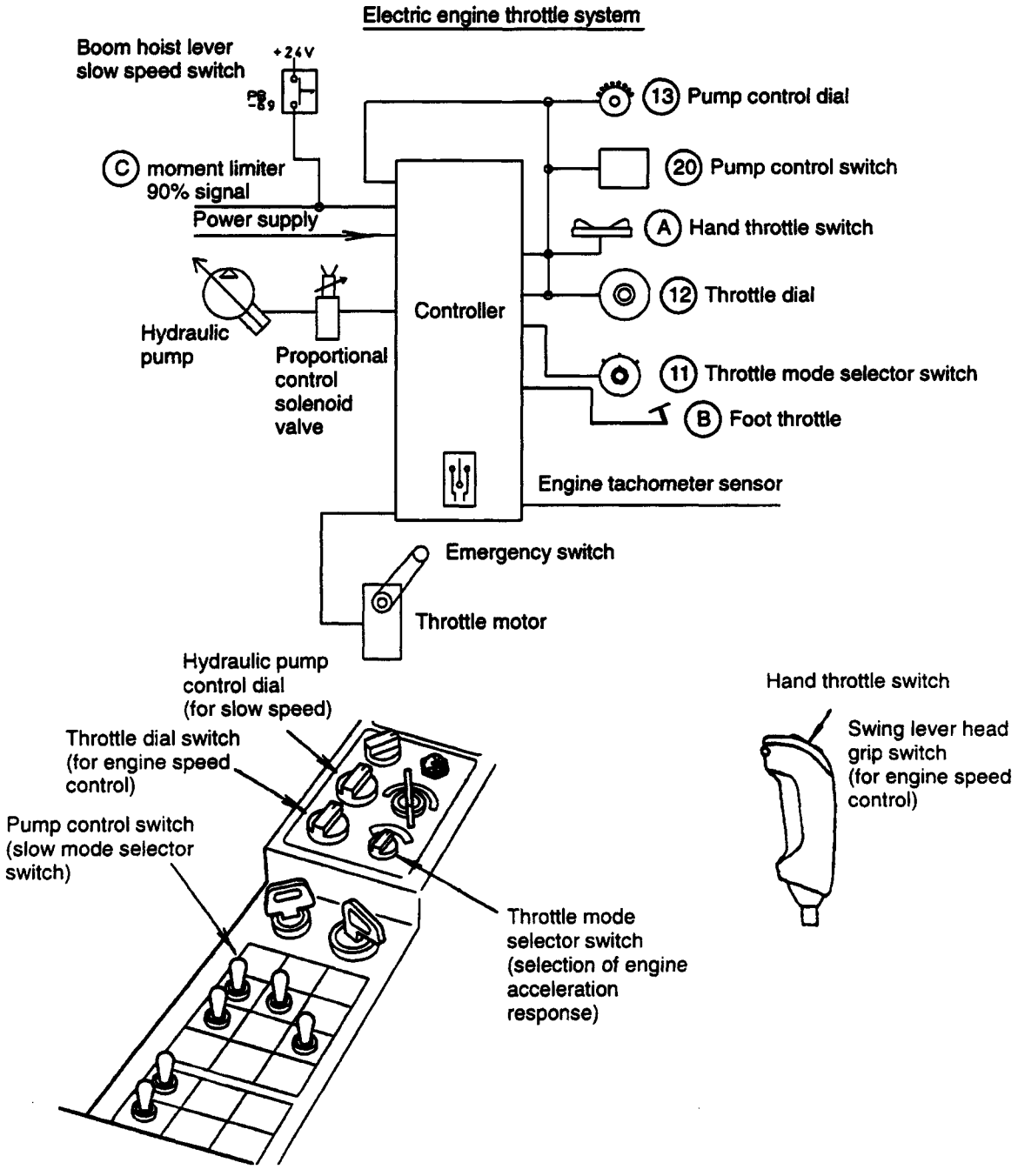
1. Turn "ON" the engine starting switch, and the battery relay will work to connect with the power supply.
2. Turn the throttle dial to the medium speed position.
3. Turn the key switch to the "START" position, and the engine will start.
4. If the key switch is released the moment the engine starts, it will return to the "ON" position automatically.
5. Return the throttle dial to the low speed position and carry out idling to warm up the engine.

ATTENTION

1. **Preheat the engine before starting in winter or a cold area.**
2. **Refer to Page 1-8 for handling the starter switch and heater signal.**
3. **While the engine is rotating, don't turn the starting switch to other positions except "ON".**
4. **Check the "OK" monitor and control circuit oil pressure gauge during warm-up running.**

3-2 Handling of engine throttle

1. This is an electrical engine throttle dependant on a DC motor drive.
2. This is a remote control system. The rotation of throttle motor is increased or decreased by the command voltage from the throttle controller.
3. A proportional control solenoid valve is incorporated with the hydraulic mechanism. The delivery of hydraulic pump is controlled and engine stall is prevented by the command voltage from the throttle controller electrically.



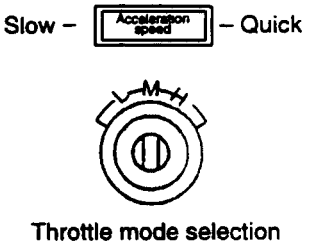
3-3 Method of operation

(11) Throttle mode selector switch

A high mode number shows quick acceleration to full rotation.

Select a proper mode for each crane operation.

Mode	1	2	4
Speed	Approx. 6 sec.	Approx. 5 sec.	Approx. 2 sec.



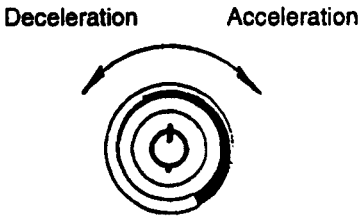
Throttle mode selection

(12). Throttle dial

Turn the throttle dial to the desired engine speed.

Set the engine minimum speed.

A lower engine speed cannot be set by other switches when the minimum speed is already selected by this dial. If it is necessary to change the engine speed frequently during operation, set the speed at a slightly lower value with the throttle dial. Then, adjust the engine speed with the hand or foot throttle during operation. It is convenient for operation. Turn the dial clockwise to increase the speed. Turn it counterclockwise to decrease the speed.



Throttle dial

[A] Hand throttles switch (mounted at the top of the swing lever)

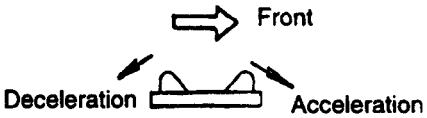
This switch controls the rotational speed, from the speed set by the above dial to full rotation.

Turning forward: acceleration

Turning backward: deceleration

Released: neutral (rotation is fixed)

The hand throttle is useful to accelerate or decelerate the engine during operation. By releasing the hand throttle, the engine speed is kept constant.

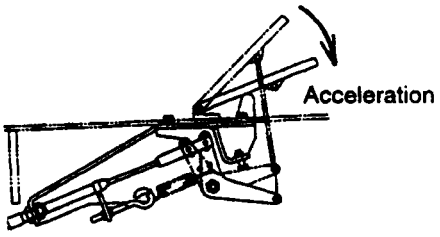


Natural by releasing
(rotation is fixed)

Hand throttle

[B] Foot throttle

The control range of the foot throttle is from the higher speed selected by the throttle dial or hand throttle to full rotational speed.



Foot throttle pedal

ATTENTION

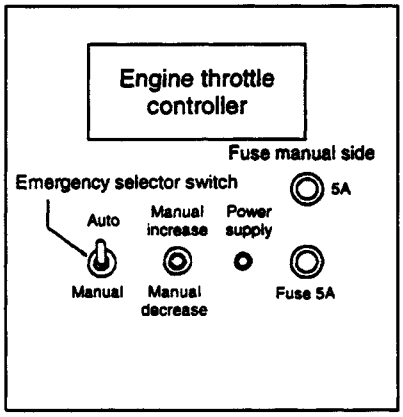
If the engine acceleration speed is too high, a shock or disturbance will be given to the crane or its load. If the speed is too slow, quick operation cannot be done. Select a throttle mode applicable to work.

[C] Deceleration signal by the overload prevention device (gentle stop device)

When the throttle controller receives a deceleration signal from the moment limiter, it sends a signal to the proportional control solenoid valve in order to reduce the pump delivery gradually. Consequently, the pump delivery is reduced to operate the crane slowly. The deceleration signal is outputted at the optional boom upper or lower limit angle or when the load ratio is 90%.

Select the operation of this device with the gentle stop release switch. Turn OFF the switch if this device is not necessary. It is possible to set the deceleration start angle for the gentle stop device 1°~15° before the stop angle optionally. Set this angle by operating the display unit of the overload prevention device. Refer to the description of how to set the working conditions for the overload prevention device.

[D] Emergency selector switch (Engine throttle controller)



If a problem occurs in the control system, turn the auto/manual selector switch of controller to the "Manual" position. Then, the engine speed can be increased or decreased by the manual increase/decrease switch.

- The emergency selector switch on the front of the engine throttle controller should normally be turned to the "AUTO" position.

  If the throttle dial or throttle controller malfunctions, turn the selector switch to the "Manual" position and then perform the operation manually.

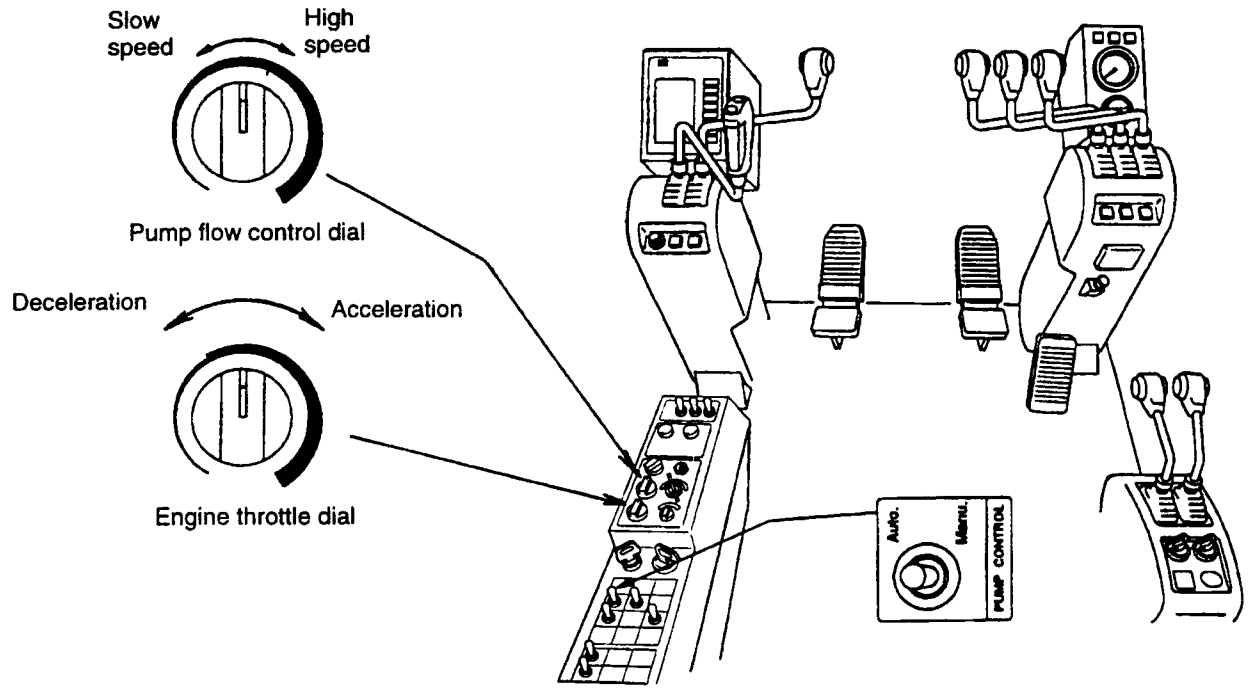
ATTENTION

1. **Don't start engine at a high speed. Warm up the engine at the medium or low speed until the lubricating oil is fully supplied to each unit of the engine, turbocharger, etc.**
2. **Running-in operation of engine**

   If full load operation is done without running-in operation, seizure or scratching may occur and so the life of the engine may be adversely affected. Carry out running-in operation fully. When a new machine is delivered or when the machine is overhauled, output no more than 80% of full load until the first 50 hours have passed.
3. **Cooling operation required after the engine has completed work**

   This is an engine with a turbocharger. If the engine is stopped suddenly without cooling operation, the lubricating unit is dried by heat and the turbocharger may malfunction. Carry out cooling operation by running the engine at a low speed for approximately 5 minutes.

3-4 Pump flow control (Manual control)



1. When normal operation is done:

   Pump control switch to the "AUTO" position. Adjust the engine rotational speed directly by the engine throttle dial.

2. When the speed is adjusted with the pump flow control dial:

   Set the pump control selector switch to "MANUAL".

   Turn the pump flow control dial to change the delivery of the 1st and 2nd pumps and carry out slow speed operation, etc. The speed can be changed infinitely by turning the dial. The speed for main/auxiliary hoisting, boom hoisting and travelling can be adjusted until it reaches "SLOW SPEED".

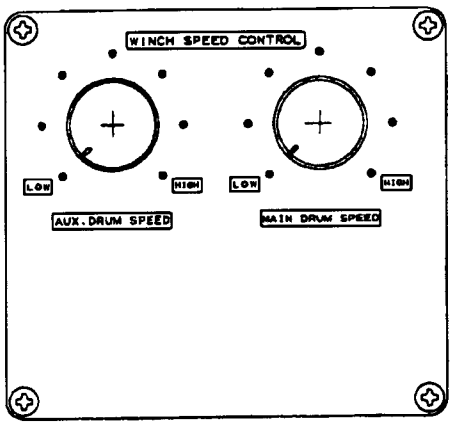
ATTENTION

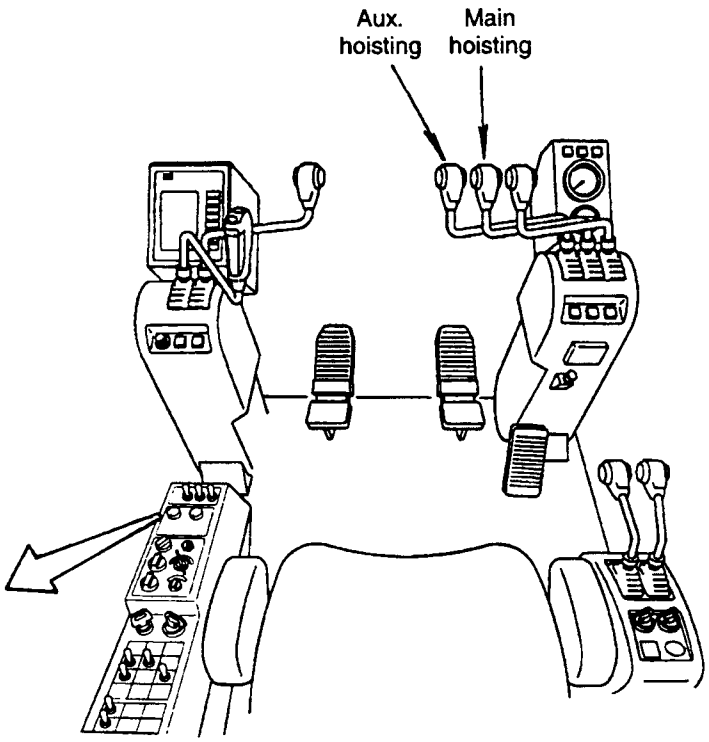
1. **Don't change the pump control selector switch during operation because the speed is decreased or increased rapidly. Stop the machine, make sure of safety and then change the switch.**
2. **The slow speed switch is provided on the boom hoist lever. Press this switch, and slow speed is set. At this time the green lamp is lit above the engine tachometer. This slow speed is set by a system which is not the same as the above-mentioned dial control.**

3-5 Main/auxiliary/winch speed adjustment switch

The winch speed is changed by changing the capacity of the main/auxiliary hoist hydraulic motor with the speed adjusting switch.

The winch speed will be fast if switch is turned to the "HIGH" direction. The winch speed will be slow if the switch is turned to the "LOW" direction.





ATTENTION

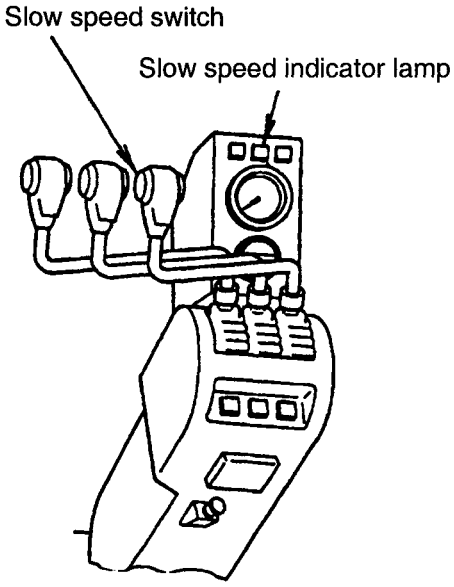
1. Before speed adjustment, check the hoisting and lowering speed and operational condition with no load or with a load near the ground.
2. Don't adjust the speed during hoisting or lowering because the operation speed is rapidly changed.
3. Adjust the speed while the hoisting control lever is in "NEUTRAL".

3-6 Slow speed switch

Press the slow speed switch on the head of the boom hoist lever, and the slow speed operation is possible.

During the slow speed operation, the green slow speed indicator lamp is lit above the engine tachometer. Press the switch again, and the slow speed operation is released and the lamp is turned off.

When the slow speed operation is selected, the speed of main/auxiliary hoisting and travelling is set to "slow speed".



Right side lever stand

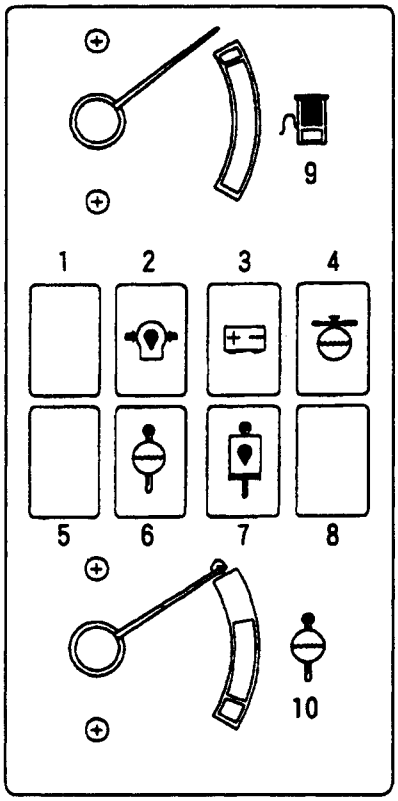
4. OK MONITOR

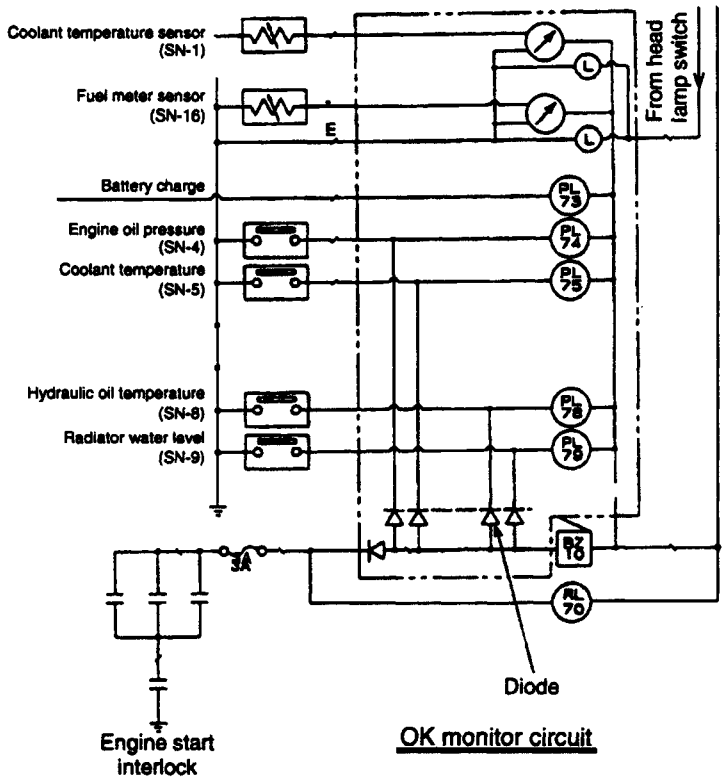
(37) Details of OK monitor

When the engine starting switch is at "ON", all the monitor lamps are lit. After the engine starts, check the monitor lamps. Start the work when all the lamps are turned off and the symbol marks disappear in the display units.

ATTENTION

If there is a problem in one of the following display units, the monitor "red" lamp is lit. When the buzzer sounds and the red lamp is lit before or during operation, stop the operation, stop the engine and repair the part causing the trouble.



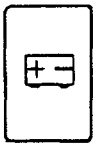


Key No.	Name	Key No.	Name
1	- - -	6	Coolant temperature
2	Engine oil pressure	7	Hydraulic oil temperature
3	Battery charge	8	---
4	Radiator coolant level	9	Fuel gauge
5	- - -	10	Engine coolant temperature

Operation of monitor lamp and buzzer

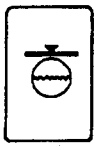
2. Engine oil pressure

   When the pressure exceeds 8psi the lamp will lite and the buzzer sounds. When the pressure is lowered abnormally, the lamp will lite and the buzzer sounds.



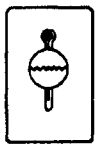
3. Battery charge

   When the battery is not normally charged, the lamp will lite and the buzzer sounds. (Excessive discharge or insufficient charge).



4. Radiator coolant level

   When the radiator coolant is not full, the lamp will lite and the buzzer sounds. Supply the coolant from the sub tank.



6. Coolant temperature

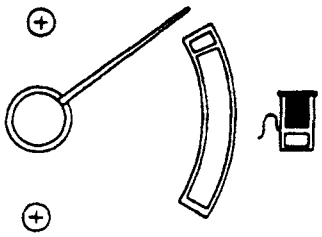
   When the coolant temperature is 210°F or higher, the lamp will lite and the buzzer sounds. Set the engine at idle speed and run the engine until the temperature lowers. Then, stop the engine, search for and fix the cause.

7. Hydraulic oil temperature

   When the hydraulic oil temperature is 195°F or higher, the lamp will lite and the buzzer sounds. If the high temperature continues, stop the operation and decrease the engine speed to lower the oil temperature.

ATTENTION

1. **When the monitor lamp is lit and the buzzer sounds, stop crane operation, check the machine and remove the cause of the error indication.**
2. **Don't resume crane operation after lowering the coolant or oil temperature without removing the cause of the error indication.**

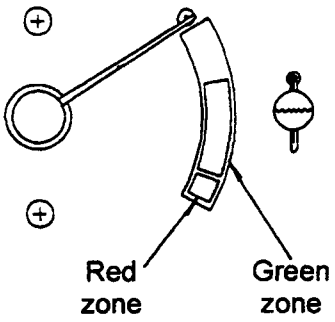


9. Fuel meter

   F: Fuel tank full side

   E: Fuel tank empty side

   Water drops can easily be generated as the space is larger in the fuel tank. Being careful to supply fuel more frequently will help not to make a space.



10. Coolant temperature gauge

    Make sure that the pointer shows the green zone. When the pointer shows the red zone, the symbol mark is lit and the buzzer sounds.

ATTENTION

The OK monitor does not always show the machine condition correctly. As referring to the indication of the monitor, carry out the daily or periodical check and repair.

1. **Check visually the remaining quantity or contamination of the engine oil, coolant, fuel tank and the hydraulic oil tank.**
2. **Check the lamps, connectors and wires periodically for the operation.**
3. **Replace the filter element when it has reached the replacing time regardless of the alarm indication. The element cannot always be used until the alarm lamp lights.**
4. **When the engine oil temperature is low, the oil pressure is high and so the lamp may be lit. The lamp is turned off by warm-up. If the lamp is not turned off after warm-up, it is an abnormal condition and it is necessary to check and repair.**

5. BASIC OPERATION

5-1 Safety precautions for crane operation

1. Prohibition of overload

⚠ DANGER

Unless the following items are observed, the machine may tip over or boom may be damaged to cause an accident resulting in injury or death.

1. **Don't lift a load over the allowable limit (rated load).**
2. **Don't perform the crane work if the overload prevention device switch is at other positions except "OPERATION".**
3. **Don't operate a crane while the reset switch remains released.**
4. **Don't continue to operate the crane by overriding an operator aid which stops the crane automatically.**

2. Maintenance of firm level ground

⚠ WARNING

A mobile crane can demonstrate its ability on firm, level ground. It may tip over on soft ground. Use the following procedure:

1. **Examine the ground supporting force where a crane is to be set beforehand.**
2. **Calculate the load applied to the crawler when the rated load is applied to the crane.**
3. **Make the ground sufficiently firm and level to support the applied load. Use mats if necessary.**

3. Prevention of contact during operation

⚠ WARNING

If a boom contacts with a building or other object, the boom may collapse and cause a serious accident. It is very dangerous when lifting a heavy load.

1. **Understand the working environment fully beforehand and make a safe working plan.**
2. **Place a watchman. Operate the crane carefully not to contact with buildings or other obstructions.**

⚠ WARNING

If a load collides with a boom or building, the boom may collapse or the building may be damaged. Take a countermeasure to prevent collision.

1. **Use a tagline rope to prevent sway or rotation of the load.**
2. **Make a working radius as large as possible.**
3. **When operating the machine near a building or other obstructions, place a watchman to prevent collision.**

4. Countermeasure against jamming

⚠ WARNING

When operating the machine near the broadcasting (TV or radio) high output electric wave source, an induced current is generated in the hook, wire rope, crane structure, etc. and the worker could be injured. The moment limiter may malfunction or a fall accident may occur when operation is done in a high place.

1. **The worker must wear rubber or leather shoes and gloves to prevent an electric shock when operating the machine near an electric wave source.**
2. **Avoid the electric wave path if possible when positioning a crane. Make the influence of the electric wave as small as possible.**
3. **Don't turn off the moment limiter because of the electric wave.**

5. Precautions for handling the control levers

CAUTION

If handling the lever rapidly, swing, travel or hoisting is started or stopped rapidly. In addition, an excessive force is applied to the boom. Observe the following items for safe operation:

1. **Move the control lever slowly and gently. Return it to the neutral position slowly and gently.**
2. **If moving the lever rapidly, the crane may not show a desirable action. Operate the lever slightly and check the machine motion. Then, carry out the normal lever operation. Do not start or stop swinging sharply.**

CAUTION

If operating the lever erroneously, unexpected or rapid crane action could cause a load collision, etc. Set the engine to a low speed, operate the lever gently and check the crane motion. Then, carry out the normal crane operation. Operate the levers gently even after the machine motion has been checked.

CAUTION

6. Prohibition of inapplicable use

Don't perform lateral side pulling or side lifting by a crane. The boom may be damaged or the crane may tip over.

1. **Lift a load vertically according to an applicable signal.**
2. **Don't perform a lifting operation if the working radius is increased or if a horizontal load (side load) is applied to the boom.**

CAUTION

Don't use a crane for other purposes except the proper ones or an accident may occur. Wrong operations are stated below:

1. **Pulling operation by letting out the wire rope from the winch, which is different from the normal lifting operation.**
2. **Lifting a worker, transporting a worker, using the boom for a ladder or footing, etc.**

ATTENTION

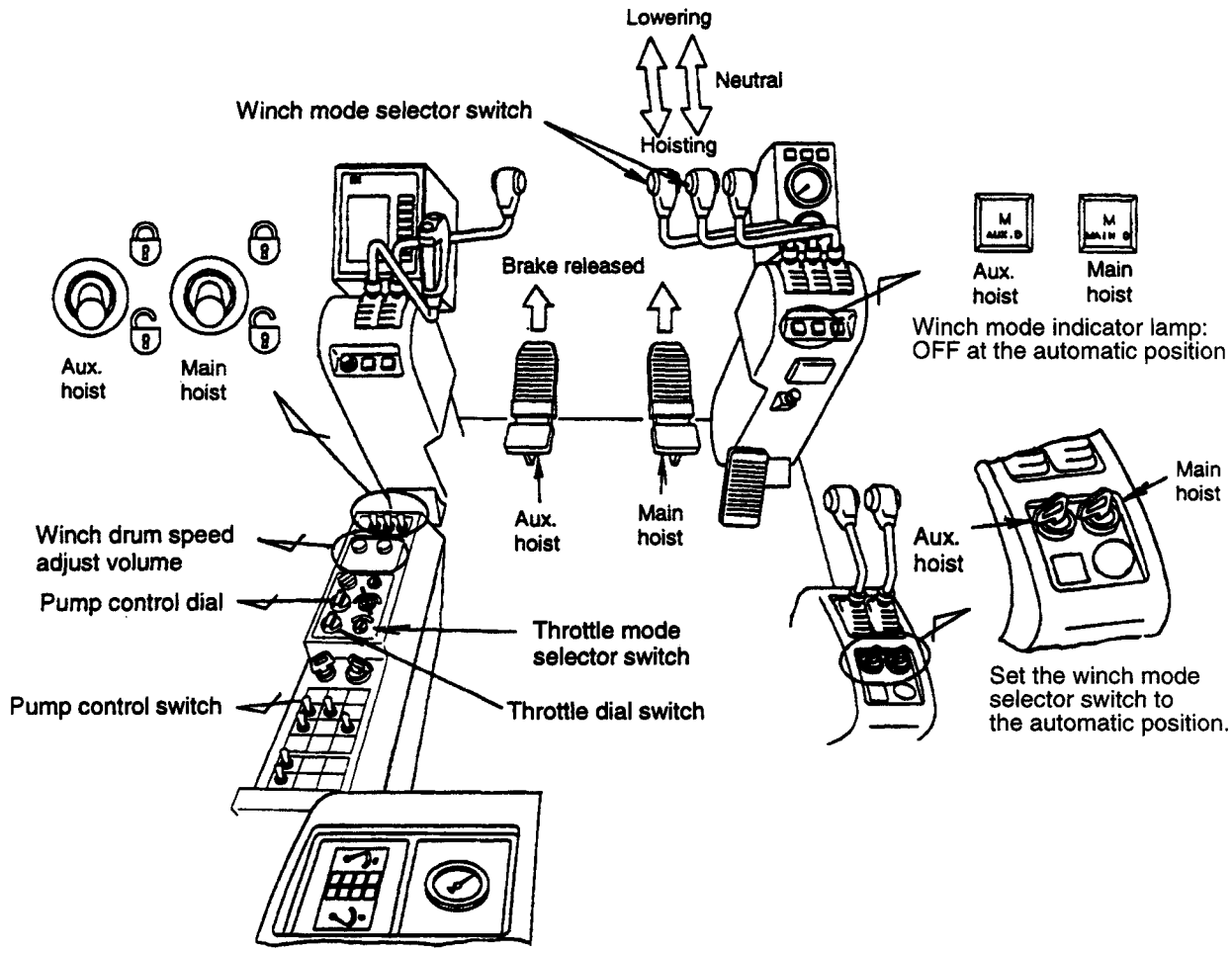
If the auxiliary hoisting is set at the 2nd speed while the main hoisting is at the 1st speed, the main hoisting stops. Keep this fact in mind when operating the machine.

In addition to the above, there are precautions for each operation. Observe them in the same way.

There are also safety precautions in the chapters of "DISASSEMBLY, ASSEMBLY AND TRANSPORTATION" and "MAINTENANCE". You must observe them.

5-2 Load hoisting and lowering with automatic brake (free fall of load disabled)

Explanation is given assuming that the engine is already started.



Operating Procedure

1. Determine either the main drum or auxiliary drum to be used.
2. Then, with the brake pedal depressed, turn the winch mode selector switch of the main or auxiliary winch on the right side box to the "AUTOMATIC" position. Make sure that the mode indicator lamp at the foot of the lever is turned off. When the lamp is off, the winch mode is at the automatic position.
3. Turn the hoisting speed selector switch to the "HIGH" or "LOW" position. When the load is heavy, "LOW" speed is recommended for ensuring safety.
4. Determine the engine speed changing rate by the throttle mode switch, and minimum engine speed by the throttle dial switch. Engine speed beyond the minimum speed is controllable by the grip throttle of the swing lever, or foot throttle.
5. Release the winch drum lock. Tilt the toggle switch in the direction of the "key released" figure.

Operating Procedure (continued)

6. Raise the brake pedal to release the corresponding brake. The pedal must always be kept in the "release" status during hoisting and lowering operations. When turning the winch lever to neutral, the brake is automatically applied.
7. For hoisting a load, pull the main or auxiliary winch lever backward. When returning the lever to neutral, hoisting stops. For lowering the load, push the lever forward. When returning the lever to neutral, lowering stops.

   The lever should be returned gradually to neutral in order to slow the movement of the load, thereby avoiding shock on stopping of the load.

   Each of the main and auxiliary winch levers is provided with a detent between the neutral position and stroke end. The detent position corresponds to the first speed, and the stroke end to the second speed.

⚠ CAUTION

1. **The hoisting speed selector switch must not be moved during the course of hoisting or lowering. Be sure to stop the load before changing the switch position.**
2. **When the winch mode is selected to the "automatic" position, the foot brake pedal must be kept released at the top. Perform the operation as you are ready to depress the pedal.**
3. **Never turn the drum lock switch to the lock position while the load is lowered. Otherwise, the drum or its locking pawl may be damaged.**
4. **Never change the winch mode while any winch is operating. Before changing the winch mode, set the winch lever to neutral and depress the foot brake.**
5. **The overhoisting prevention device switch of the winch to be used must be set at the "active" position without fail. Unless set at the "active" position, the over hoist prevention device does not work.**
6. **Winch must be stopped when selecting winch mode. (Auxiliary winch is stopped when the foot pedal is depressed setting the brake).**

8. For the rated load, follow the rated overall load table and indications given by the overload prevention device. Note, however, that the following relation between the load and hook part of line must be observed.

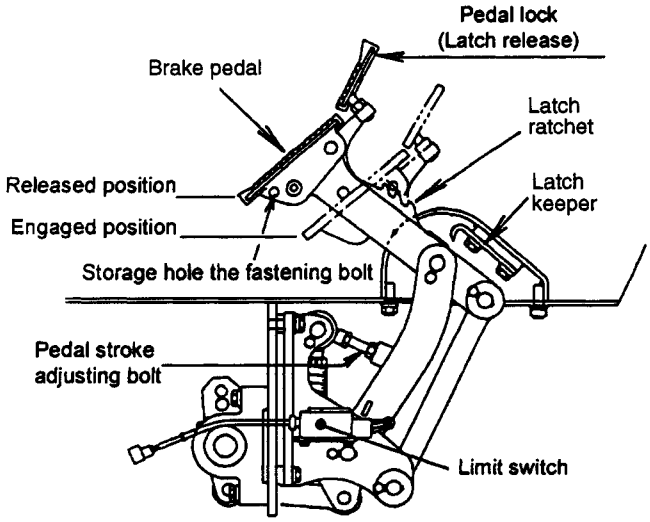
Up to 29,500 lbs. ·····	1-part of line	Up to 147,700 lbs. ·····	5-part of line
Up to 59,050 lbs. ·····	2-part of line	Up to 177,250 lbs. ·····	6-part of line
Up to 88,600 lbs. ·····	3-part of line	Up to 206,800 lbs. ·····	7-part of line
Up to 118,150 lbs. ·····	4-part of line	Up to 220,000 lbs. ·····	8-part of line

Note: Above information is with 1.00" diameter EIPS wire rope. Refer to the crane's Rating Chart for detailed information.

9. Winch mode selector switches should be used in the following combinations. Unless the main and auxiliary winches are set in the foot mode, the grip switch of the winch lever is not capable of selection.

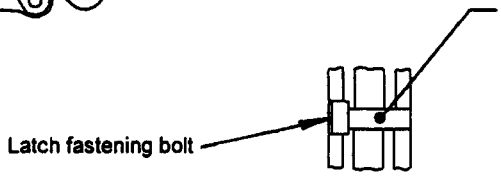
Right side console winch mode selector switches	Winch mode is selected by the grip button switch on control lever.
Automatic position	Automatic position is always set irrespective of grip switch.
Foot position	Automatic and foot positions are selected in response to the grip switch.

- Operation of brake pedal (main drum structure)



For releasing the brake, separate the latch ratchet from the latch keeper by depressing the latch release and allow the pedal to rise. Usually, the pedal is moved up and down while depressing the latch release.

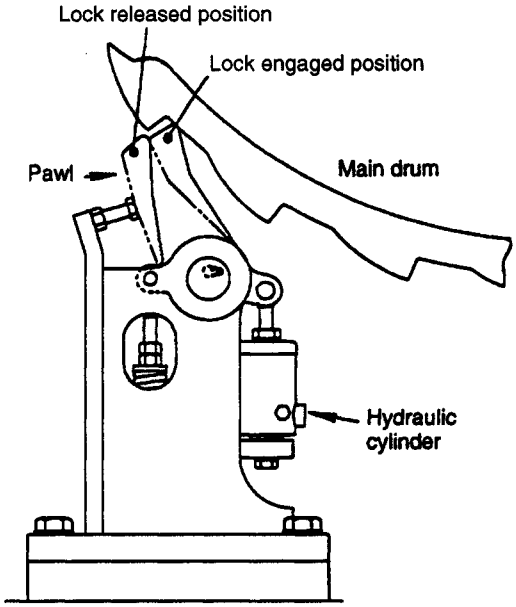
When depressing the pedal and taking your foot off, the pedal should be depressed down to the innermost latch (down to the latch closest to the pedal). If the drum is hot, the pedal should be depressed down to the second latching position.

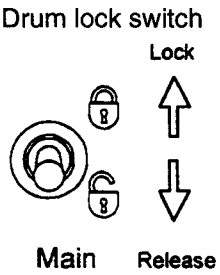


When the ratchet does not need to be engaged in clamshell operation, etc., set the latch release at the release position and mount this bolt.

In normal operation, remove the bolt from its storage position and put it in the storage hole.

- Operation of drum lock (main drum lock structure)





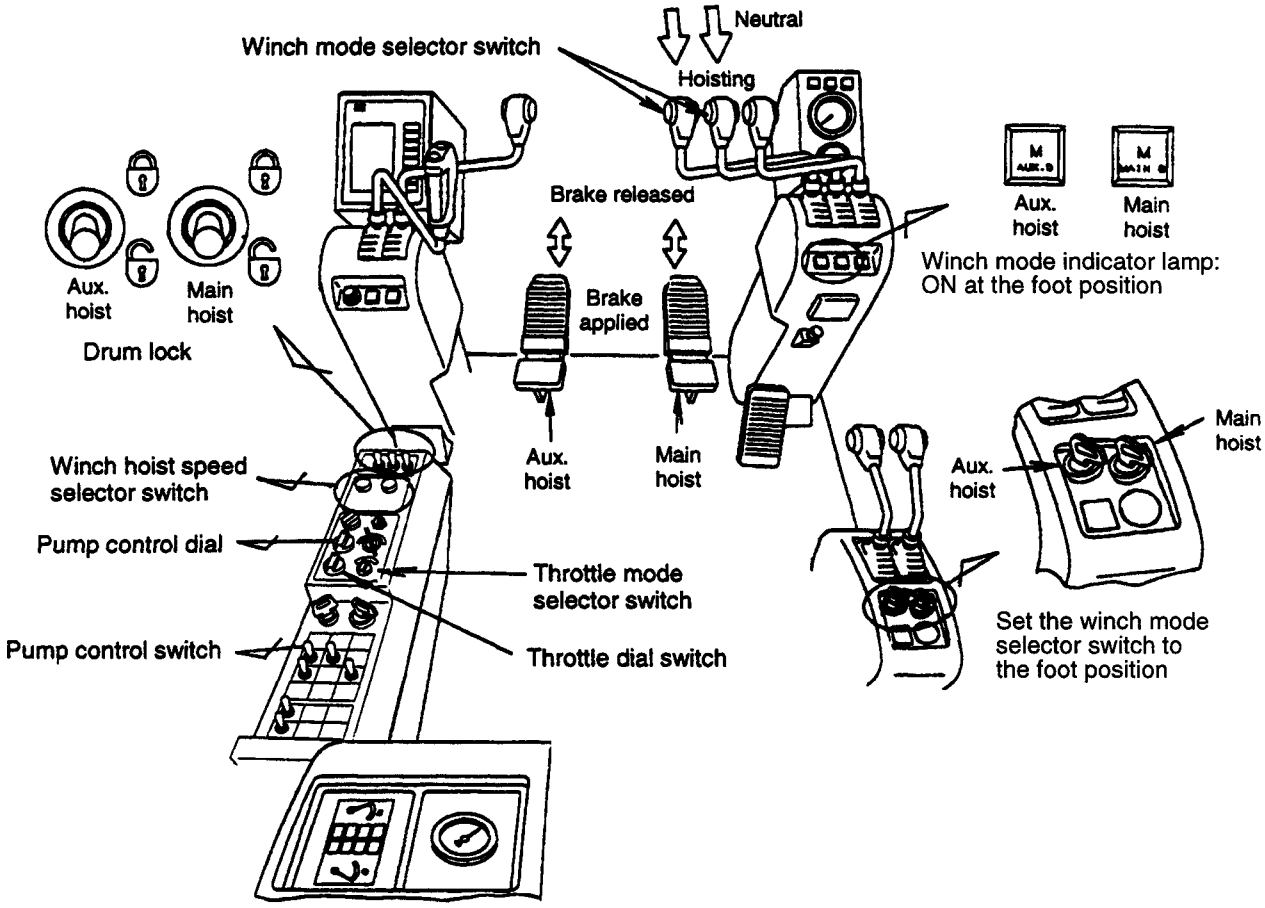
Before hoisting or lowering, the drum lock must be disengaged. When tilting the release position of the lock switch on the left control panel, the relevant drum is unlocked. Upon turning the switch to the release position, oil pressure is sent to the hydraulic cylinder so the pawl is disengaged from the drum.

If the pawl cannot be disengaged because of a force applied by the drum, it is recommended to hoist the drum slightly. The pawl will be disengaged immediately.

If drum lock operation is attempted while the drum is rotating in the lowering direction, the drum or pawl will be damaged due to shock. To prevent this, never try to engage drum lock while lowering.

5-3 Load hoisting and lowering with foot brake (used when free fall of load desired)

Explanation is given assuming that the engine is already started.



Operating Procedure

1. Determine either the main drum or auxiliary drum to be used.
2. Then, with the brake pedal depressed, turn the winch mode selector switch of the main or auxiliary winch on the right side console to the "foot" position. Press the selector switch at the head of the winch lever. Check the selected status through the lighting of the mode indicator lamp at the foot of the lever.
3. Turn the hoisting speed selector switch to the "HIGH" or "LOW" position. When the load is heavy, "LOW" speed is recommended for better control.
4. Determine the engine speed changing rate by the throttle mode switch, and minimum engine speed with the throttle dial switch. Engine speed beyond the minimum speed is controllable by the grip throttle of the swing lever, or foot throttle.
5. Release the winch drum lock. Turn the toggle switch in the direction of the "key released" figure.

Operating Procedure (continued)

6. Gradually move the lever in the hoisting or lowering direction. As soon as the clutch is engaged, release the brake pedal so that it rises up to the top. If the brake is released too early, the lifted load will drop. A heavier load, in particular, will drop by a larger distance. Before actual operation, the timing of brake releasing in combination with lever operation must be learned by practice. If releasing of the brake is delayed, an excessive force will be applied to the brake drum, etc., and the hydraulic system may be adversely affected.
7. In contrast, for stopping the hoisting or lowering operation, the brake pedal should be depressed at a slightly earlier timing, then return the lever to the neutral position immediately. If this timing is lost, the lifted load will drop as in the aforementioned start of hoisting or lowering.

   Hoisting and lowering can select the first or second speed through inclination of the lever.
8. For free fall of the load, set the winch lever at neutral and gradually raise the brake pedal. In response to this operation, the load will fall gradually. If the brake is loosened excessively at one time, the load will fall rapidly. So, the brake must be operated carefully.

⚠ CAUTION

1. **The winch speed selector switch must not be moved during the course of hoisting or lowering. Be sure to lower the load to the ground before changing over the switch position.**
2. **Dropping of the load to the ground or abrupt stopping of a falling load involves great danger. Be careful not to allow the load to free fall until you thoroughly understand the clutch and brake operation timing.**
3. **Never turn the drum lock switch to the lock position while the load is lowered. The drum or its locking pawl may be damaged.**
4. **Never change over the winch mode while any winch is operating. Before changing over the winch mode, set the winch lever at neutral and depress the foot brake.**
5. **When the winch mode is changed to "Foot", make sure that the pilot lamp is lit and then carry out hoisting and lowering without a load to ensure the mode is at "Foot".**
6. **The overhoisting prevention (anti two blocking) device switch of the winch to be used must be set at the "Active" position without fail. Unless set at the "Active" position, the overhoisting prevention device does not work.**
7. **Do not leave from the operator's seat during operation of a winch. When leaving the operator's seat, be sure load is lowered down on the ground and all functions are in neutral and locked.**
8. **Winch must be stopped when selecting winch mode. (Auxiliary winch is stopped when the foot pedal is depressed, setting the brake).**

Operating Procedure (continued)

9. For the rated load, follow the rated overall load table and indications given by the moment limiter.

   Note: The following relation between load and hook parts of line must be observed:

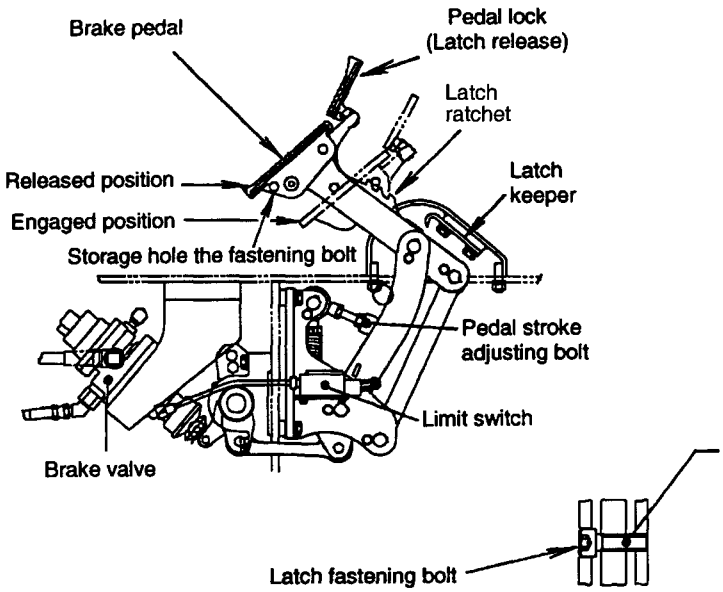
Up to 29,500 lbs.	1-part of line	Up to 147,700 lbs.	5-part of line
Up to 59,050 lbs.	2-part of line	Up to 177,250 lbs.	6-part of line
Up to 88,600 lbs.	3-part of line	Up to 206,800 lbs.	7-part of line
Up to 118,150 lbs.	4-part of line	Up to 220,000 lbs.	8-part of line

   Note: Above information is with 1.00" diameter EIPS wire rope. Refer to the crane's Rating Chart for detailed information.

10. Winch mode selector switches should be used in the following combinations. Unless the main and auxiliary winches are set in the foot mode, the grip switch of the winch lever is not capable of selection.

Right side console winch mode selector switches	Winch mode is selected by the grip button switch on control lever.
Automatic position	Automatic position is always set irrespective of grip switch.
Foot position	Automatic and foot positions are selected in response to the grip switch.

- Operation of brake pedal (auxiliary drum structure)



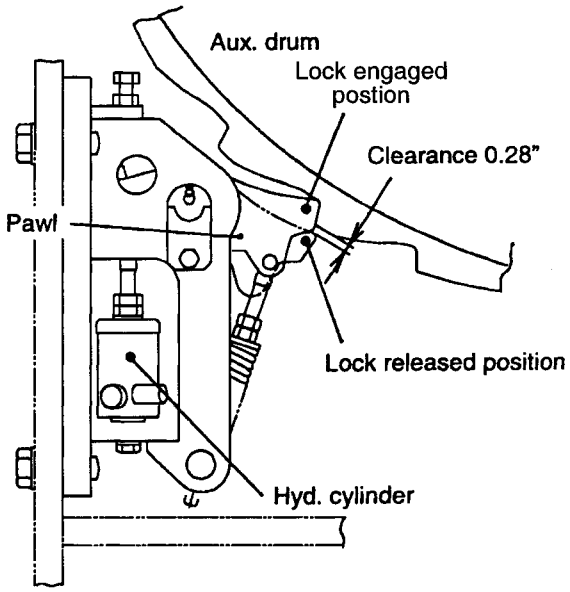
For releasing the brake, separate the latch ratchet from the latch keeper by depressing the latch release and allow the pedal to rise. Usually, the pedal is moved up and down while depressing the latch release.

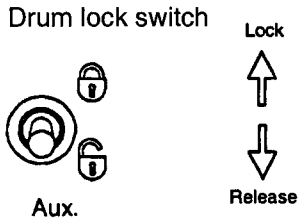
When depressing the pedal and taking your foot off, the pedal should be depressed down to the innermost latch (down to the latch closest to the pedal). If the drum is hot, the pedal should be depressed down to the second latching position.

When the ratchet does not need to be engaged in clamshell operation, etc., set the latch release at the release position and mount this bolt.

In normal operation, remove the bolt and put it in the storage hole.

- Operation of drum lock (auxiliary drum lock structure)





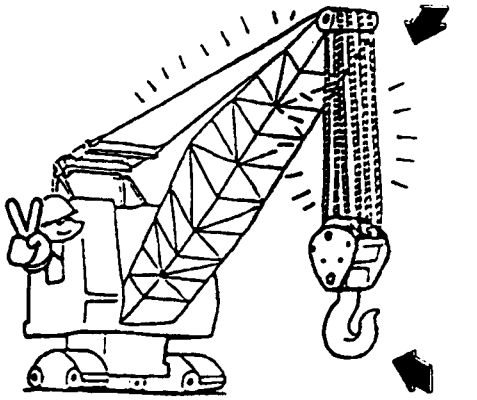
Before hoisting or lowering, the drum lock must be disengaged. When tilting the lock switch on the left control panel to the release position , the relevant drum is unlocked. Upon turning the switch to the release position, oil pressure is sent to the hydraulic cylinder so the pawl is disengaged from the drum.

If the pawl cannot be disengaged because of a force applied by the drum, it is recommended to rotate the drum slightly in the hoisting direction. The pawl will be disengaged immediately.

If drum lock operation is attempted while the drum is rotating in the lowering direction, the drum or pawl will be damaged due to shock. To prevent this, never try to engage drum lock while lowering.

Rated load and hook part of line

Lifting capacity
(capacity per rope line pull x No. of parts line)



Hook
capacity

CAUTION

The lifting capacity of a single rope line is determined.

The hook capacity and rope line parts need to be selected so as to meet the load to be lifted.

1-part of line up to 29,500 lbs.	5-part of line up to 147,700 lbs.
2-part of line up to 59,050 lbs.	6-part of line up to 177,250 lbs.
3-part of line up to 88,600 lbs.	7-part of line up to 206,800 lbs.
4-part of line up to 118,150 lbs.	8-part of line up to 220,000 lbs.

Note: Above information is with 1.00" diameter EIPS wire rope. Refer to the crane's Rating Chart for detailed information.

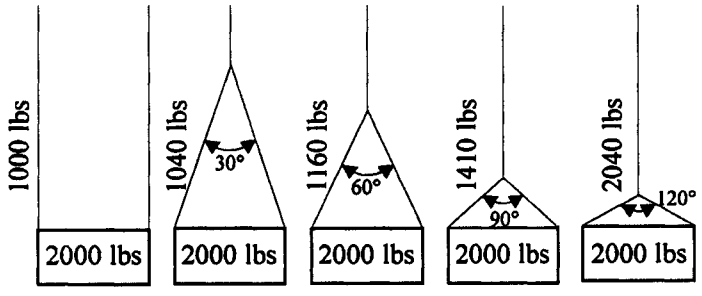
Wire ropes of the same diameter may be different in strength depending on the rope type. Also, the ratio of the sheave pitch circle diameter to the wire rope diameter varies with rope type.

Example when the wire rope diameter is 7/8"

(2,200 lbs = 1 metric ton)

Name	Standard	Breaking strength (Lbs)	Sheave diameter/ rope diameter
Filler 29-rope	6 x Fi (29) IWRC		16 or more
Toughsuper	6XP•Fi (29) IWRC		16 or more
Seal 31-rope	6XP•Fi (29) IWRC		16 or more
Monorope EP	3 x F (40)		20 or more
Toughnuflex	P.S (19) + 39XP.7		20 or more

Secure a safety factor of 6 or more for the sling wire rope.

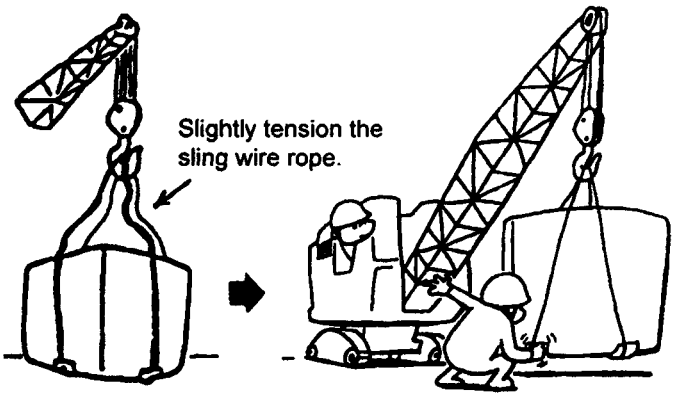


If an angle is formed between ropes as shown above, the safety factor must be multiplied with the determined coefficient. At a rope hooking angle of 60° a coefficient of 1.16 must be used. Also, the safety factor of hoisting chain is specified to 5 or more. Periodic checking and the service limit are also determined for slinging devices. Carry out their periodic check. Never use damaged sling wire rope.

Caution at lifting load just off the ground

⚠ CAUTION

1. **Before lifting a load just off the ground, confirm the position and condition of the sling wire rope.**
2. **After lifting a load just off the ground, stop swaying of the load, check the wire status and then proceed to the hoisting operation.**

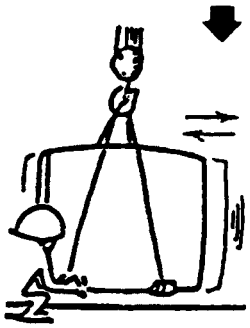


Confirm slinging position.

The sling rope should be tensed gradually while repeating hoisting and stop. Just before the rope is tensed completely, stop hoisting and check the position of rope pads.

Immediately after a load is lifted just off the ground, interrupt lifting and stop swaying of the load. If slinging is improper, lower the load to the ground and perform slinging again. Slinging workers must have their certificate of training completion with them when engaging in slinging work.

Shortly after lifting the load just off the ground, the working radius tends to widen due to expansion of the boom hoist rope, etc. This tendency is conspicuous when hoisting a heavy load or using a longer boom. Therefore, hoisting should be carried out with adequate care. The resulting working radius corresponds to the actual working radius indicated in the rated overall load table.

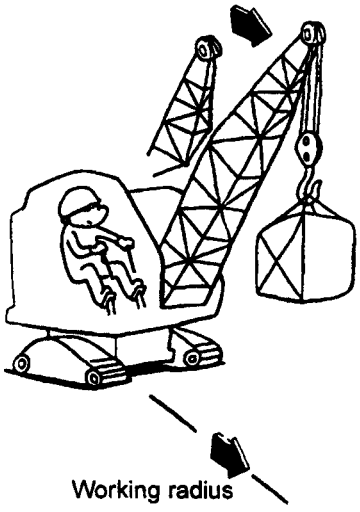


Stop swaying of load.

⚠ CAUTION

Though the sling wire rope is normal, the slinging method, etc., may be improper. In such a case, the wire rope will be cut or come off to drop a load. A qualified person must perform slinging. A crane must be operated safely according to a clear signal.

- **Select a lifting tool having a specified safety ratio in consideration of the lifting angle and tension of the rope.**
- **Use a pad where the rope is liable to be damaged.**
- **Don't lift only one rope. Use a guide rope.**
- **Lift the load just off the ground and check how to apply the wire rope.**

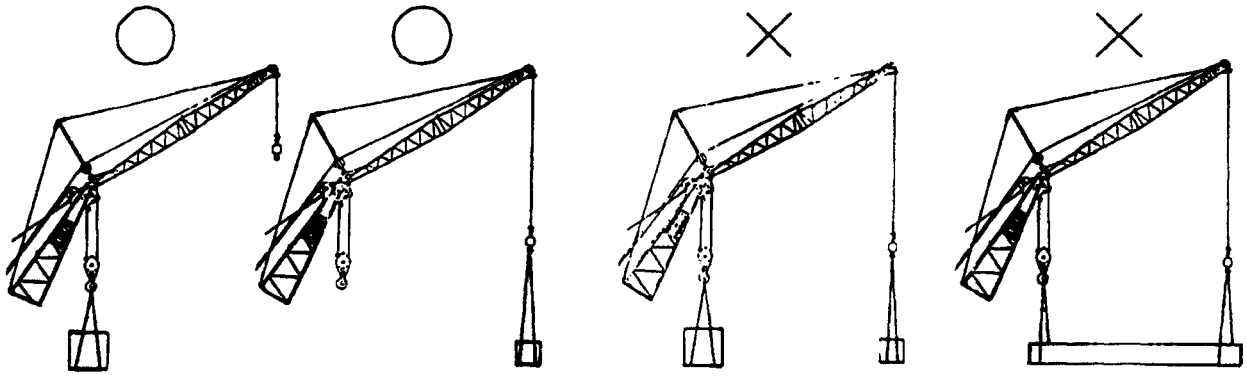


If the load is lowered onto the ground in working at the upper limit boom angle (80°), the automatic boom stopper may be activated. Pay attention!

Don't operate the main and auxiliary winches simultaneously

⚠ CAUTION

1. **It is not permitted in the crane specifications to lift a load by using the main and auxiliary winches simultaneously during crane operation. Carry out the crane operation by using one of main or auxiliary winches.**
2. **Hoist the hook of the unused winch (main or auxiliary) near to the minimum clearance during crane operation. The hook may be swayed and collide with the load or boom.**



⚠ DANGER

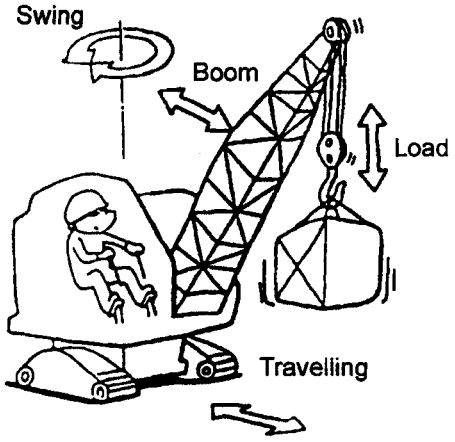
1. **When the lifted load has to be kept stationary for a long time, apply the foot brake and drum lock regardless of the winch mode position.**
2. **Don't leave the operator's cab when the lifted load is stationary in the air. If the operator leaves the operator's cab, lower the load to the ground and apply the foot brake.**

⚠ CAUTION

1. **As a rule, traveling with a lifted load is prohibited. Don't perform traveling with a lifted load if the crane is not specified for such operation.**
2. **If traveling with a lifted load is done, the traveling shock will affect the boom or each mechanical section to cause damage. In addition, the machine life will be shortened.**
3. **The machine may lose stability and tip over during traveling with a load. The machine cannot be quick in action during traveling with a load.**

Precautions for combined operation:

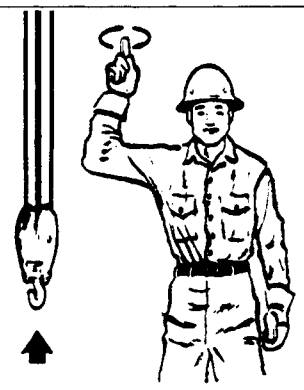
"Combined operation" means the combination of winch hoisting (or lowering), boom hoisting, swing, traveling, etc. If the operator is careful only for one operation, the other is sometimes in dangerous status. Be very careful for both of them.



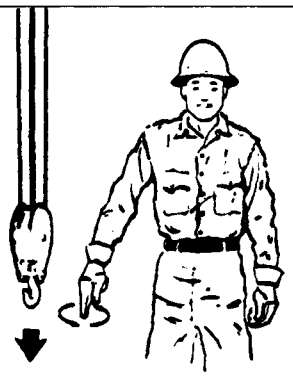
⚠ CAUTION

A combination of three or more operations may cause unexpected danger. Avoid such combination if possible.

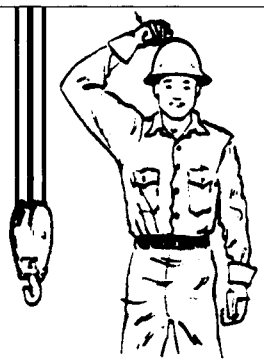
HAND SIGNALS



HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.

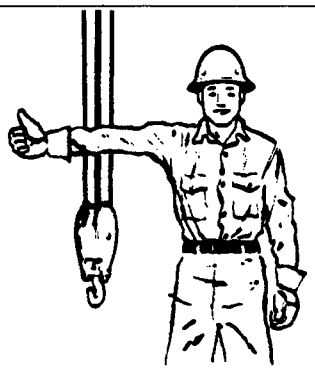


LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circles.

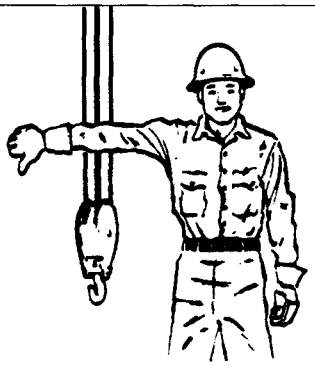


USE MAIN HOIST. Tap fist on head; then use regular signals.

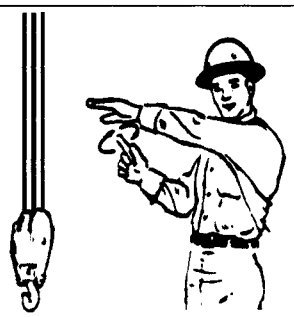
USE WHIPLINE (Auxiliary Hoist). Tap elbow with one hand, then use regular signals.



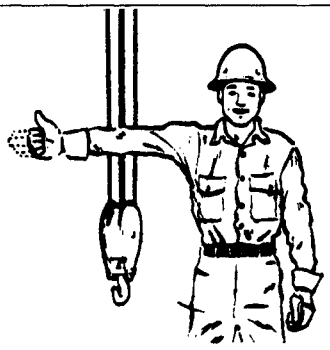
RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.



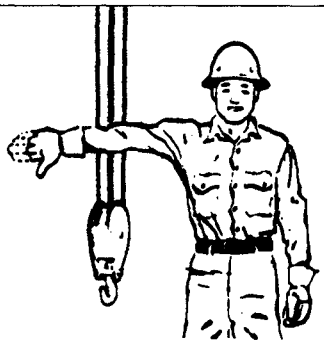
LOWER BOOM. Arm extended fingers closed, thumb pointing downward.



MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist slowly shown as example.)

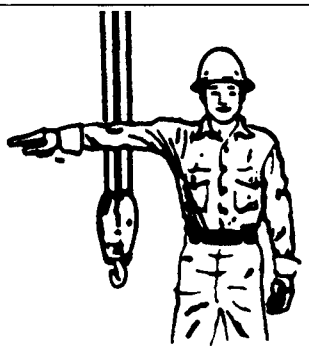


RAISE THE BOOM AND LOWER THE LOAD. With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.

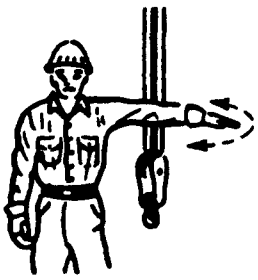


LOWER THE BOOM AND RAISE THE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.

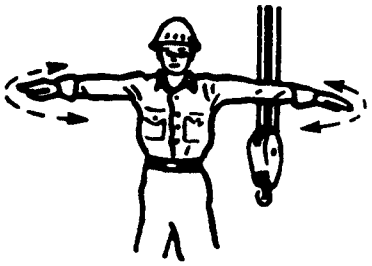
HAND SIGNALS (Continued)



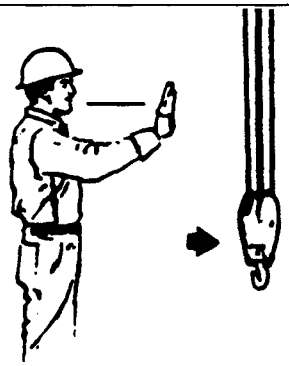
SWING. Arm extended, point with finger in direction of swing of boom.



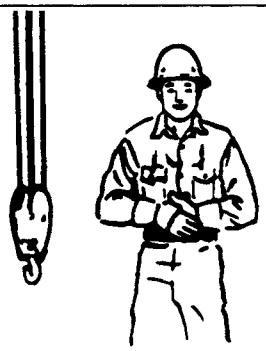
STOP. Arm extended, palm down, move arm back and forth horizontally.



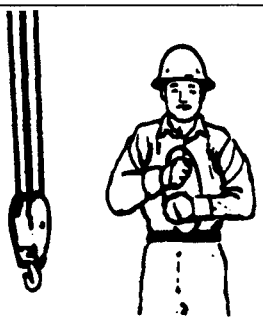
EMERGENCY STOP. Both arms extended, palms down, move arms back and forth horizontally.



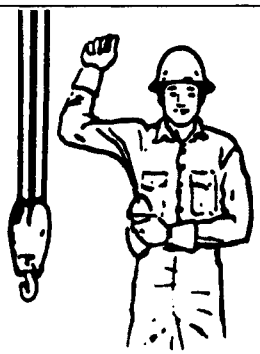
TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.



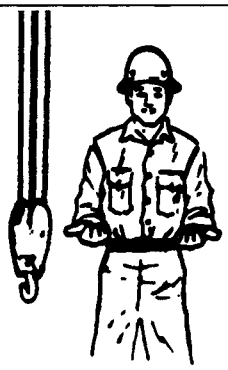
DOG EVERYTHING. Clasp hands in front of body.



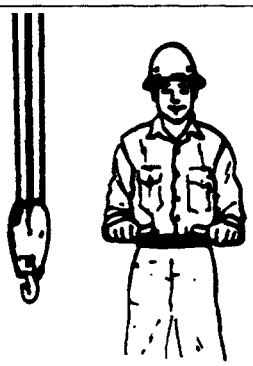
TRAVEL (Both Tracks). Use both fists in front of body, making a circular motion about each other, indicating direction of travel forward or backward. (For land cranes only).



TRAVEL (One Track). Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body. (For land cranes only).



EXTEND BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing outward.



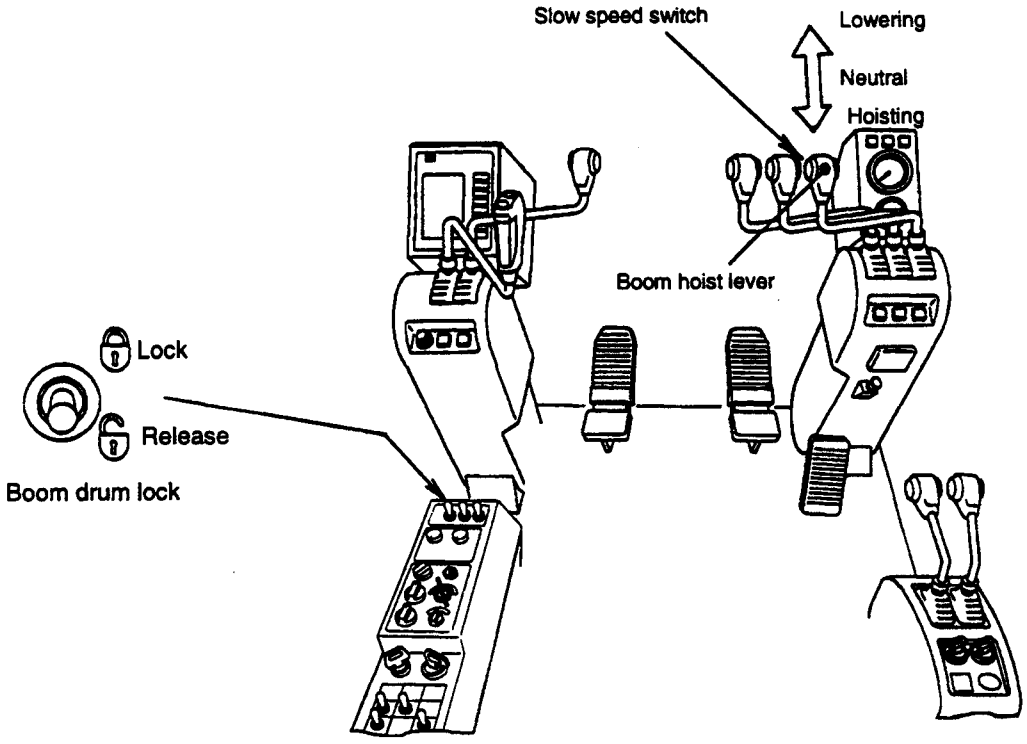
RETRACT BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing toward each other.

Extracted from American National Standard. Safety Code for Crawler, Locomotive and Truck Cranes. B30.5-1968 with the permission of the publisher. The American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.

Safety Rules for Crane Operators

- No one but an authorized person shall enter the crane cab.
- The operator shall recognize signals only from the person supervising the lift, or an authorized signal man.
- If a warning signal is furnished, it shall be sounded each time before travelling, and when load approaches near or over workmen.
- The proper party shall be notified of the need for adjustments and repairs as soon as it becomes known.
- Chains and ropes used for handling the load must be straight and free from twists and kinks. Knots shall not be used to shorten chain or rope.
- The operator shall make sure, either by personal observation or from signals, that the load is well secured and balanced before it is lifted more than a few inches off the ground.
- Sudden starts and stops should be avoided.
- When handling heavy loads, stability and strength shall be checked by hoisting the load a few inches and holding it off the ground with the brake.
- Swing speed shall be controlled so that the load does not swing out beyond the radius at which it can be handled safely.
- Do not drag load sideways by swinging.
- Do not travel with load swinging back and forth as it may cause crane to tip. Use tagline to keep swinging out of load.
- Do not leave crane or shovel with bucket or load suspended in air.
- Do not lift bucket or load after machine has been standing during rainy weather without riding the brakes to evaporate moisture before handling load.
- Do not engage master clutch until you are sure that everything is in the clear and in neutral.
- Do not travel over rough ground with a high boom.
- Do not back up with boom high without first making sure that ground is level and free of obstructions.

5-4 Boom hoisting/lowering



While the boom is hoisted or lowered, the disc brake built into the hydraulic motor is automatically released and the brake is automatically applied to stop and hold the boom when the lever is set at neutral.

Operating Procedure

1. Manipulate the boom lock switch to unlock the boom drum. The drum lock operates on the same principle as that of the main and auxiliary winches. However, if the lock is difficult to release, it is recommended to rotate the drum slightly on the boom hoisting side. The lock will be released easily.
2. When pulling the boom hoist lever, the boom rises, and it lowers when pushing the lever forward. Upon returning the lever to neutral, the boom stops.

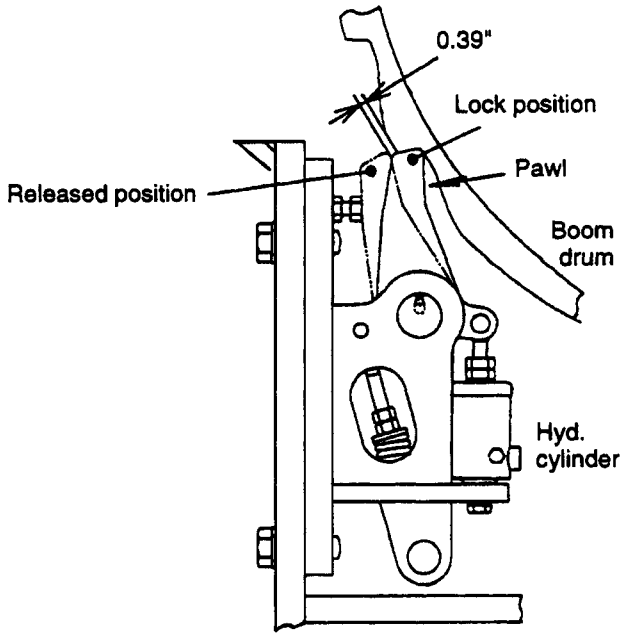
⚠ CAUTION

1. **Make sure that there are no workers or obstacles in the boom hoisting range.**
2. **Hoist or lower the crane boom in the range shown in the crane specifications.**
3. **Don't stop the action suddenly when lowering the boom. Hoist or lower the boom smoothly and slowly so as not to sway the load.**
4. **When lowering the boom, stop lowering temporarily at horizontal, make sure of safety, and then put it on the ground at a low speed.**

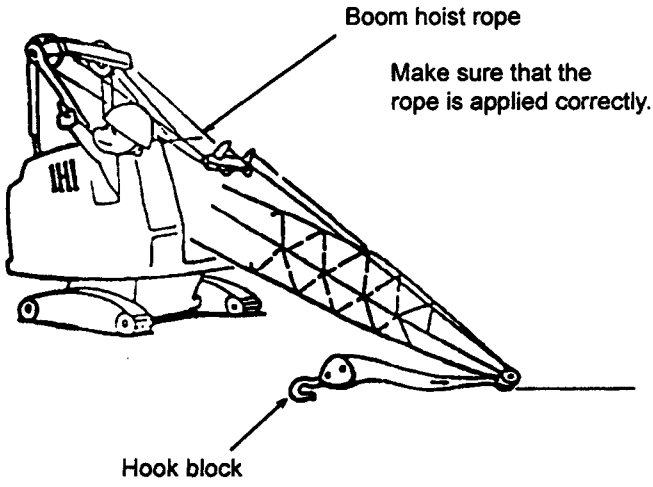
NOTICE

Never attempt to lock the boom drum while the boom is lowered. Otherwise, the drum or pawl will be damaged.

Structure of boom lock



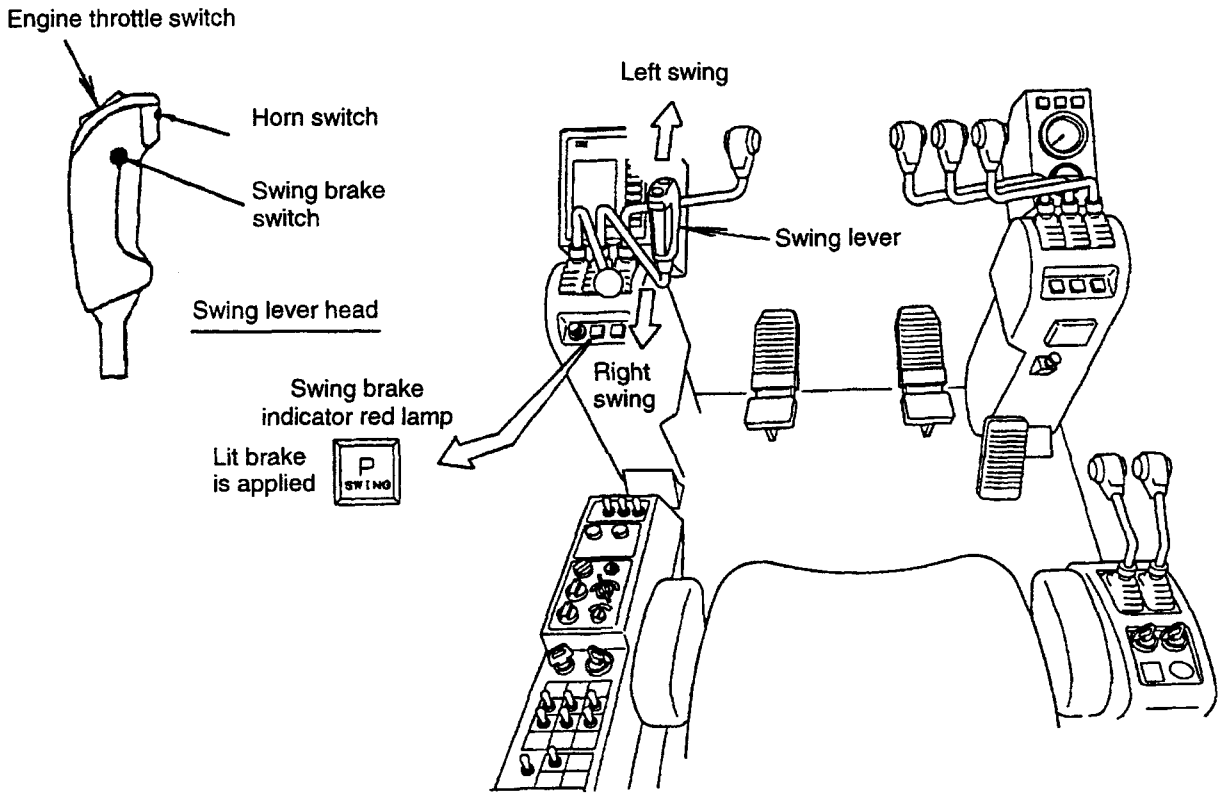
Precautions for hoisting or lowering the boom



CAUTION

1. **When the boom is lifted from or is lowered to the ground, it stops automatically if the overload prevention device switch is in the operation position. Turn the overload prevention device switch to erection position when lifting or lowering the boom from or to the ground. Turn it to operation position as soon as the boom is in working status.**
2. **When the boom is lifted just off the ground or is lowered to the ground, great stress is applied to the boom and boom hoist rope. Hoist or lower the boom slowly and smoothly. If the hoist rope is tensed, stop hoisting temporarily and run the engine in a low speed. Hoist the boom to its angle 20°~30° slowly in a low speed while the hook is put on the ground.**

5-5 Swing operation



Operating Procedure

1. Manipulate the swing lock handle to release the swing lock. The swing lock handle pin which is located on the right hand side boom foot is lifted. The raised handle is turned 90°, and is lowered and locked to a released position. If the lock is difficult to release, it is recommended to swing slightly in the clockwise or counterclockwise direction. The lock will be released the moment the lock pin is separated from the pin receptacle of the car body.
2. Release the swing brake. When pressing the swing brake switch shown in the figure above, the swing brake is released. When pressing the switch again, the swing brake is applied. While the swing brake is applied, the pilot lamp at the root of the lever remains lit. Make sure that the lamp is turned off.
3. For clockwise swing, pull the lever gradually. For counterclockwise swing, push the lever gradually. The swing lever does not have a holding mechanism. Therefore, when releasing the lever, it automatically returns to neutral. Since the swing brake action is unavailable with the lever at neutral, the crane swings due to inertia.

   The swing can be stopped at the desired point by two methods:

   - One method is a swing operation taking the drift of the swing due to inertia into account, and
   - The other method is stopping by slight swing operation in the reverse direction just before the desired point.

WARNING

Before starting the operation, check the following points and take the necessary precautions:

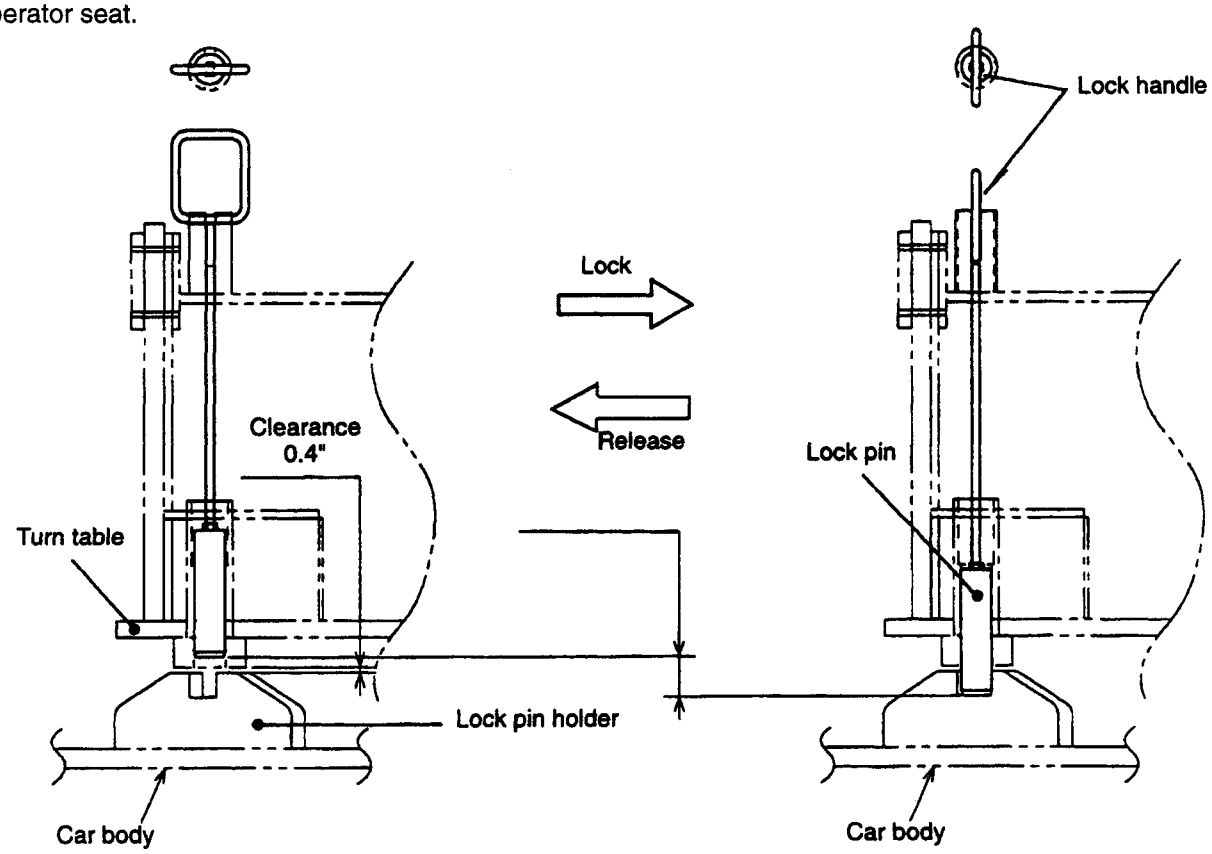
1. **Check ON/OFF of the pilot lamp by pressing the swing brake switch. If the bulb has burned out or if the wiring is disconnected, repair it at once.**
2. **Check how far the operator can check visually in the rear swing radius with a rear mirror, etc. Show "Keep Out" or place a watchman if necessary.**
3. **Don't let a person go into the swing range during operation. If there is a passer-by, withdraw the load and stop the operation. Restart after the passer-by leaves the swing range.**

Be careful not to be caught by the crane or between the crane and other equipment during swing. It will cause an accident resulting in injury or death.

When two or more persons repair the machine, start the engine or perform the swing operation according to the director's instructions and signals. Don't approach the crane when it is operating.

1. **Be careful not to be caught between the superstructure and crawler.**
2. **Be careful not to be caught between the counterweight and other equipment.**

4. Release the swing lock (Structure of swing lock)
   The swing lock is provided on the rear of the right boom foot. It is impossible to operate the swing lock in the operator seat.



Machine front

⚠ DANGER

1. **The swing brake is used not to stop swinging, but to stop the swing drift when on tilted ground or when there is a high wind. If swinging is stopped by the swing brake, the machine will stop abruptly and the lifted load will sway violently. Don't use the swing brake to do so.**
2. **If the swing lock is applied during swinging, the car body or turntable will be damaged. Don't apply the swing lock during swinging. After swinging is stopped, align the lock pin with the pin holder accurately and then apply the lock.**

5. Start and stop swinging slowly

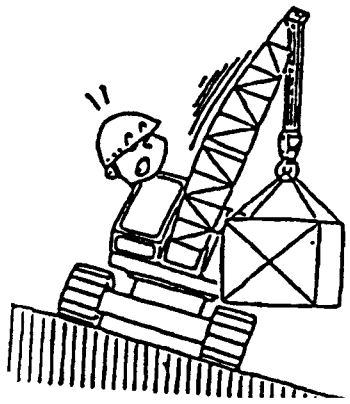
   If swing is done abruptly, a lateral load will be applied to the boom. The machine may tip over because the working radius is increased or the lifted load may collide with others.

6. Avoid operating the crane on tilted ground if possible, because a lateral load is applied to the boom.

⚠ WARNING

When swinging is done downward on tilted ground, an overload is generated by increasing the working radius or by the centrifugal force due to the increased swing speed. The crane may tip over because of the overload. Moreover, the boom may be damaged because a horizontal load is applied.

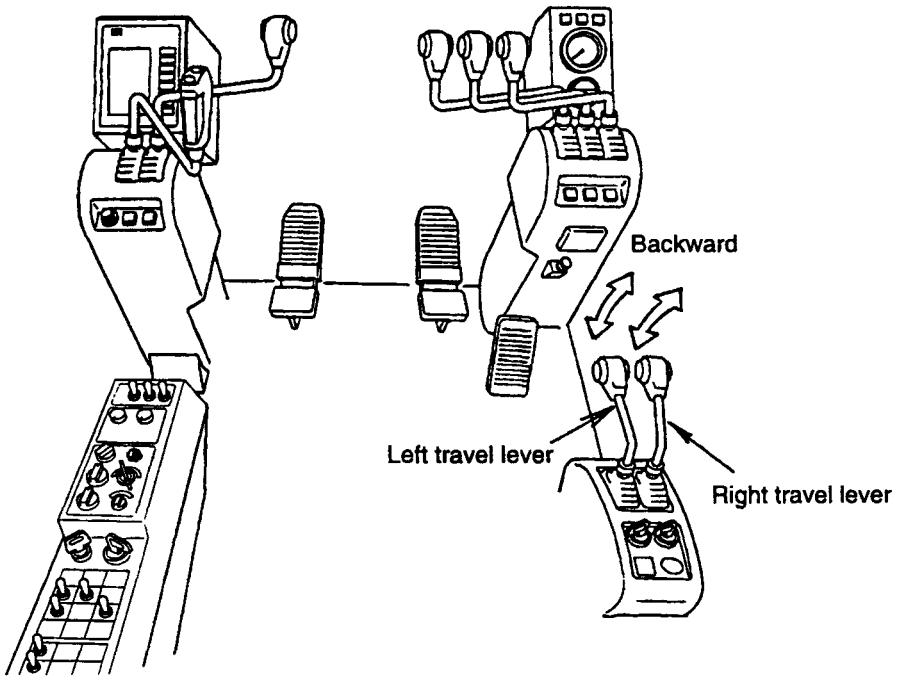
1. **Don't operate the crane on tilted ground. It is prohibited by the Labor Standards Bureau.**
2. **If the crane has to be operated on tilted ground, level the crane by using a footing board, etc.**
3. **There is no specification for the operation on tilted ground.**



7. Handling of swing lock

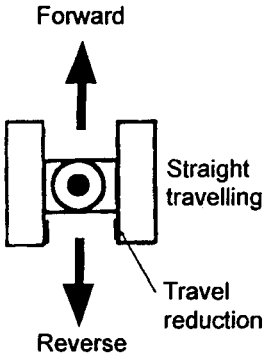
   This is a device to lock the superstructure and undercarriage when the operation is ended, when traveling a long distance, when transported by trailer, when a strong wind is anticipated, etc. Swing the superstructure so that the lock pin may be fit to the pin holder of the car body, and then lower the lock pin.

5-6 Procedures for traveling



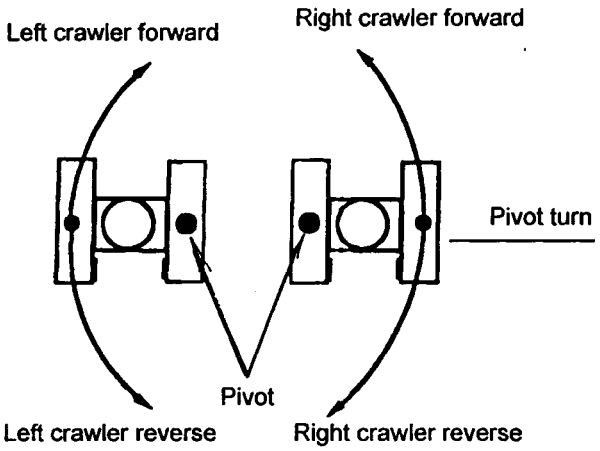
1. Straight traveling

   The left and right levers move the left and right crawler, respectively. The location of the traveling reduction gear corresponds to the rear of the crawlers. Traveling with the traveling reduction gear positioned at the front means reverse traveling actually. This positional relationship remains the same irrespective of the direction in which the superstructure faces. When pushing down both levers, the machine moves forward. When pulling up both levers, the machine reverses. Upon releasing the levers, the brake in the traveling motor automatically functions to stop the machine.



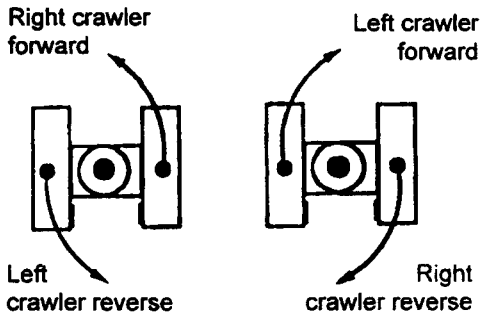
2. Pivot turn (steering with either crawler alone fixed)

   Either crawler alone is fixed for pivot turn. The fixed crawler serves as a pivot (center of steering). Four kinds of pivot turns are possible: 2 kinds each in the forward and reverse directions.



3. Spin turn (steering on the spot)

   Spin turn is caused by moving the two travel levers in different directions. At this time the center of steering is that of the machine.



⚠ CAUTION

Check or observe the following points to prevent an accident during traveling:

1. **Check the environment and make sure that there is no person or obstacle on the traveling path. Place a signal man if necessary.**
2. **Sound the horn to inform personnel nearby that the machine will travel.**
3. **Avoid abrupt steering and carry out forward traveling.**
4. **Be careful about the machine stability when the boom is long, the boom working radius is low or the ground condition is not good.**
5. **Perform traveling at a safe speed applicable to the machine equipment and its path.**
6. **Apply the swing brake and swing lock.**
7. **Don't walk with a lifted load. The boom may be damaged or the machine may tip over.**

⚠ CAUTION

Don't approach a crane unnecessarily during traveling. The crane may run over a person unless the operator notices him/her, even though it is traveling at a low speed. Let the operator notice the person in the distance if necessary. Approach the crane after it stops.

5-7 Procedure for changing crawler width

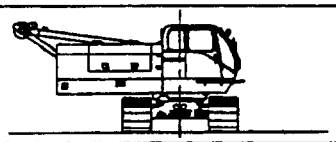
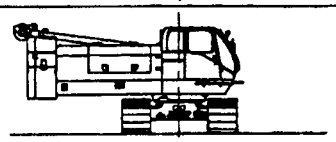
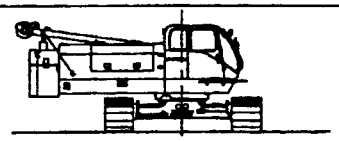
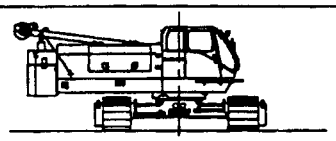
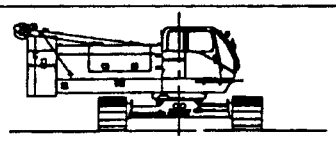
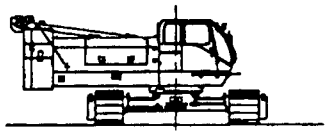
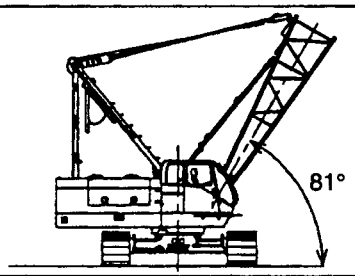
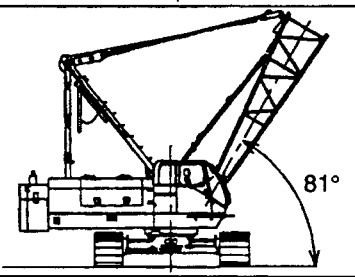
For transporting this machine with a trailer or passing through a narrow place, the crawler width can be reduced. The crawler width can be extended or retracted in the crane posture as shown on the following page.

When changing the crawler width, remove the counterweight and crawler weight beforehand.

When the crawler width is extended as shown on the next page, the machine is stable, But, if the crawler width is retracted under the above stated condition, the machine may tip over.

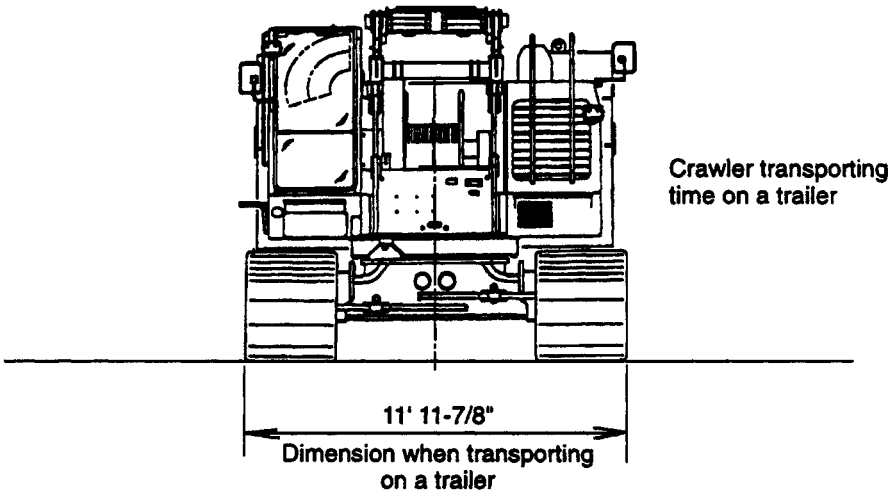
In (1) and (7) among the postures shown on the next page, the crawler width can be changed.

●Crawler width changeable △Changeable with caution ✖Unchangeable

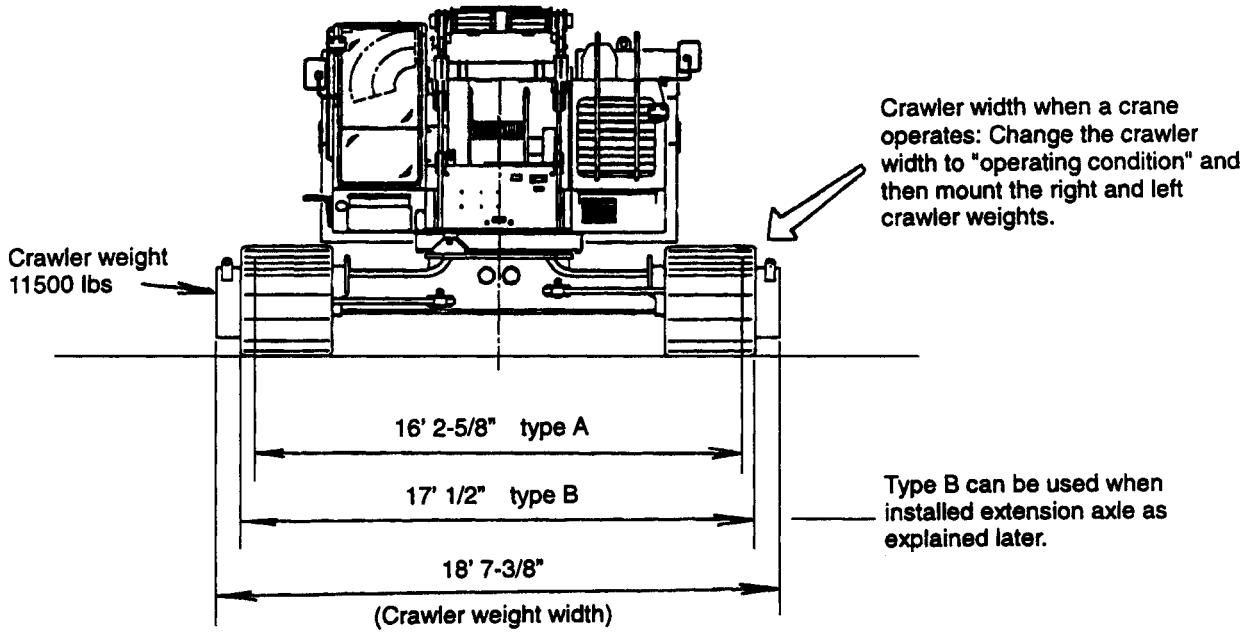
	Machine posture	Possible/ Impossible
①	 Type A, B common Crawler retract Without counterweight Without crawlerweight	●
②	 TypeB Crawler retract With counterweight Without crawlerweight In this posture, the machine will tip over to the counterweight side.	×
③	 Type A Crawler extend With counterweight Without crawlerweight In this posture, the machine may tip over to the counterweight side.	×
④	 Type A Crawler extend With counterweight With crawlerweight In this condition, the rear stability is not full.	△
⑤	 Type B Crawler extend With counterweight Without crawlerweight In this posture, the machine may tip over to the counterweight side.	×
⑥	 Type B Crawler extend With counterweight With crawlerweight In this condition, the rear stability is not full.	△
⑦	 Type A With inner boom Crawler width changeable	●
⑧	 Type A Crawler width extend With inner boom Without counterweight Without crawlerweight	×

5-7-1 Crawler width when transporting on a trailer and when a crane operates

Crawler width when transporting on a trailer

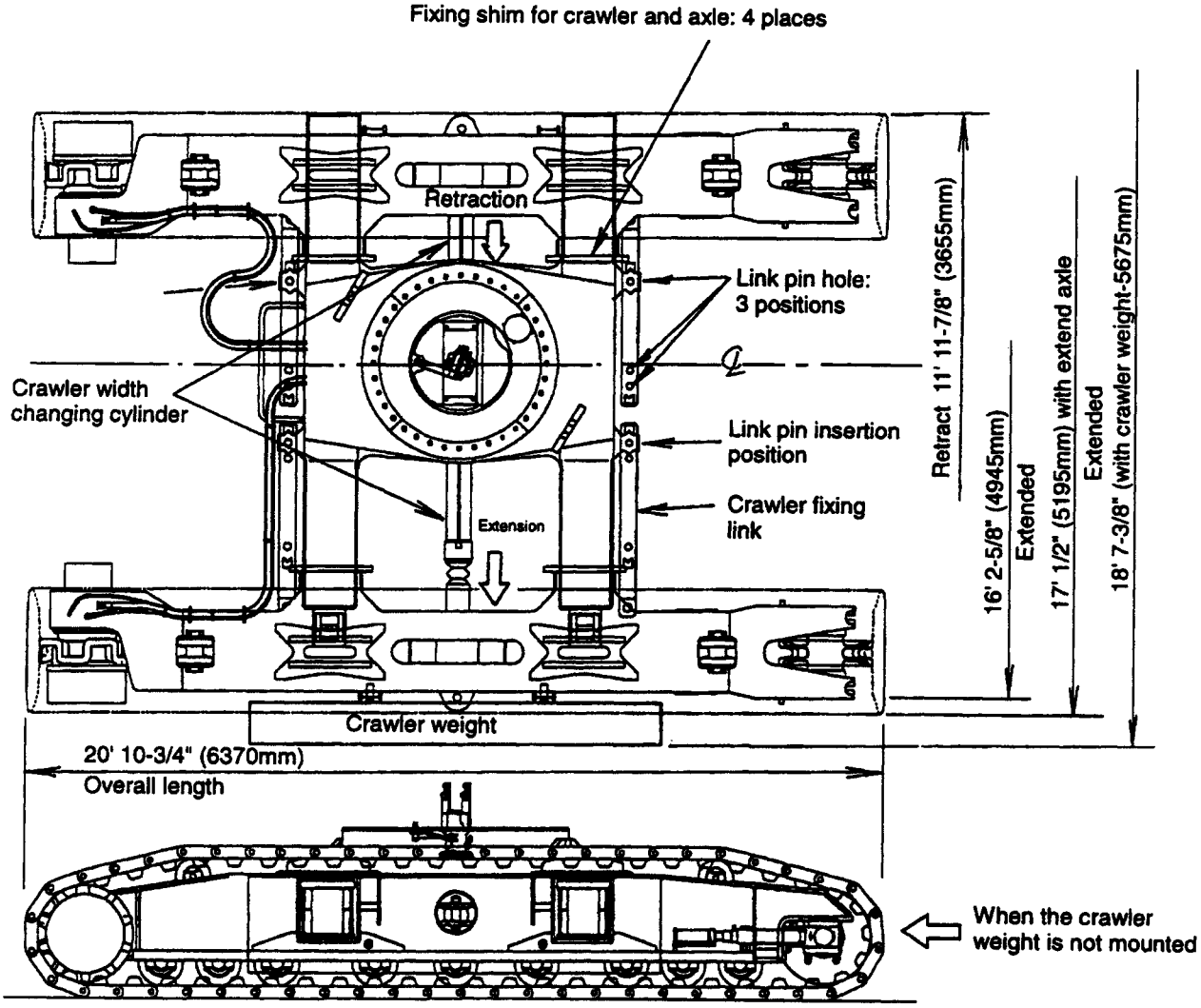


Crawler width in operating condition



5-7-2 How to fix the crawler width, axle and crawler frame

- Transportation: 11' 11-7/8" (3655mm)
- Extended for operation type A: 16' 2-5/8" (4945mm) Middle extended position
- Extended for operation type B: 17'-1/2" (5195mm) Maximum extended position (extension axle is used)



Change the crawler width by extending or retracting the crawler width changing cylinder.

Retract the crawler width fully, and the overall crawler width is 11' 11-7/8" (3655mm).

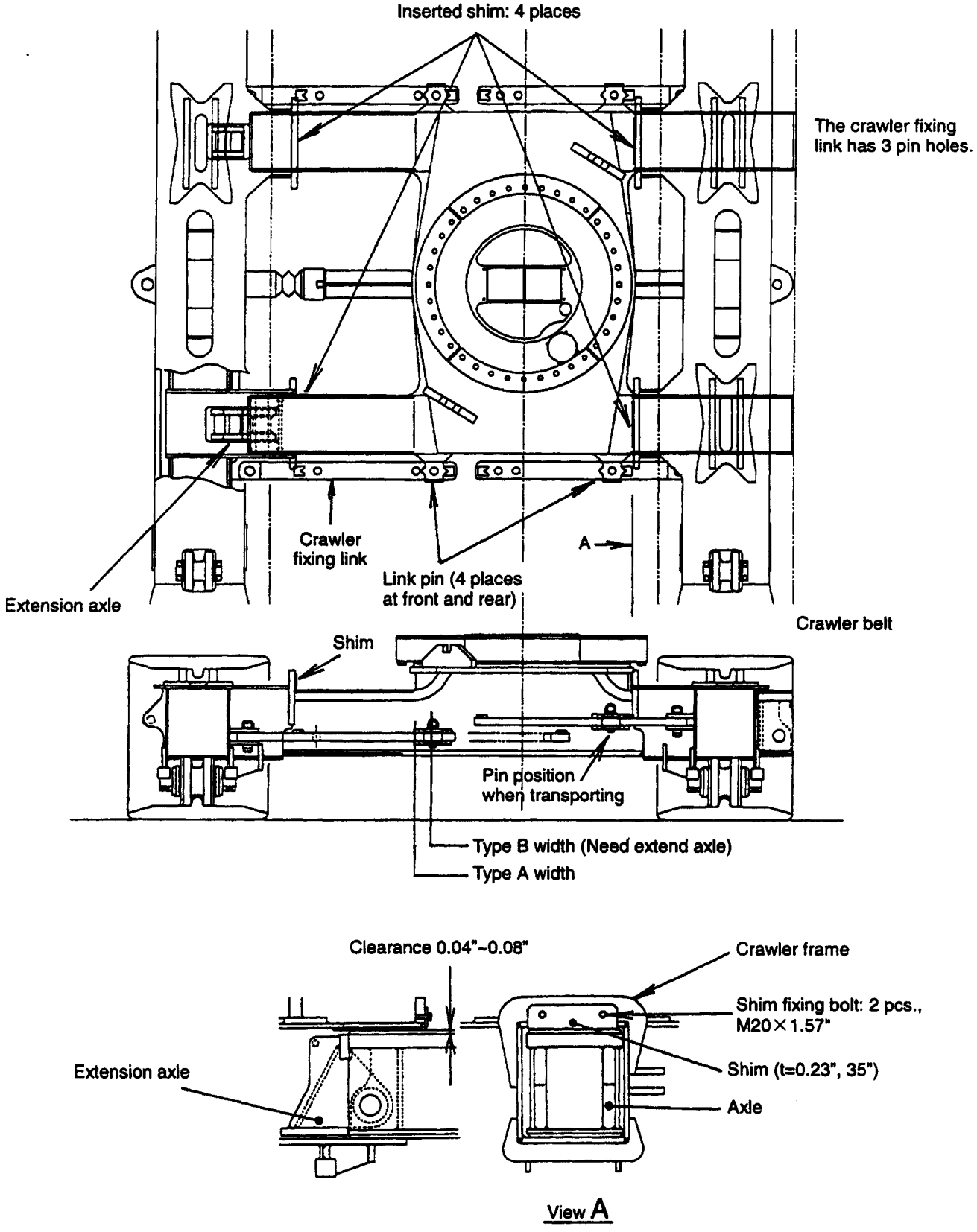
Extend the crawler width to the middle position, and the overall crawler width is 16' 2-5/8" (4945mm).

Set the crawler width to the maximum extension position, and the overall crawler width is 17'-1/2" (5195mm).

When you want to set the crawler width to 17'-1/2" (5195mm), the extension axle must be attached to the axle.

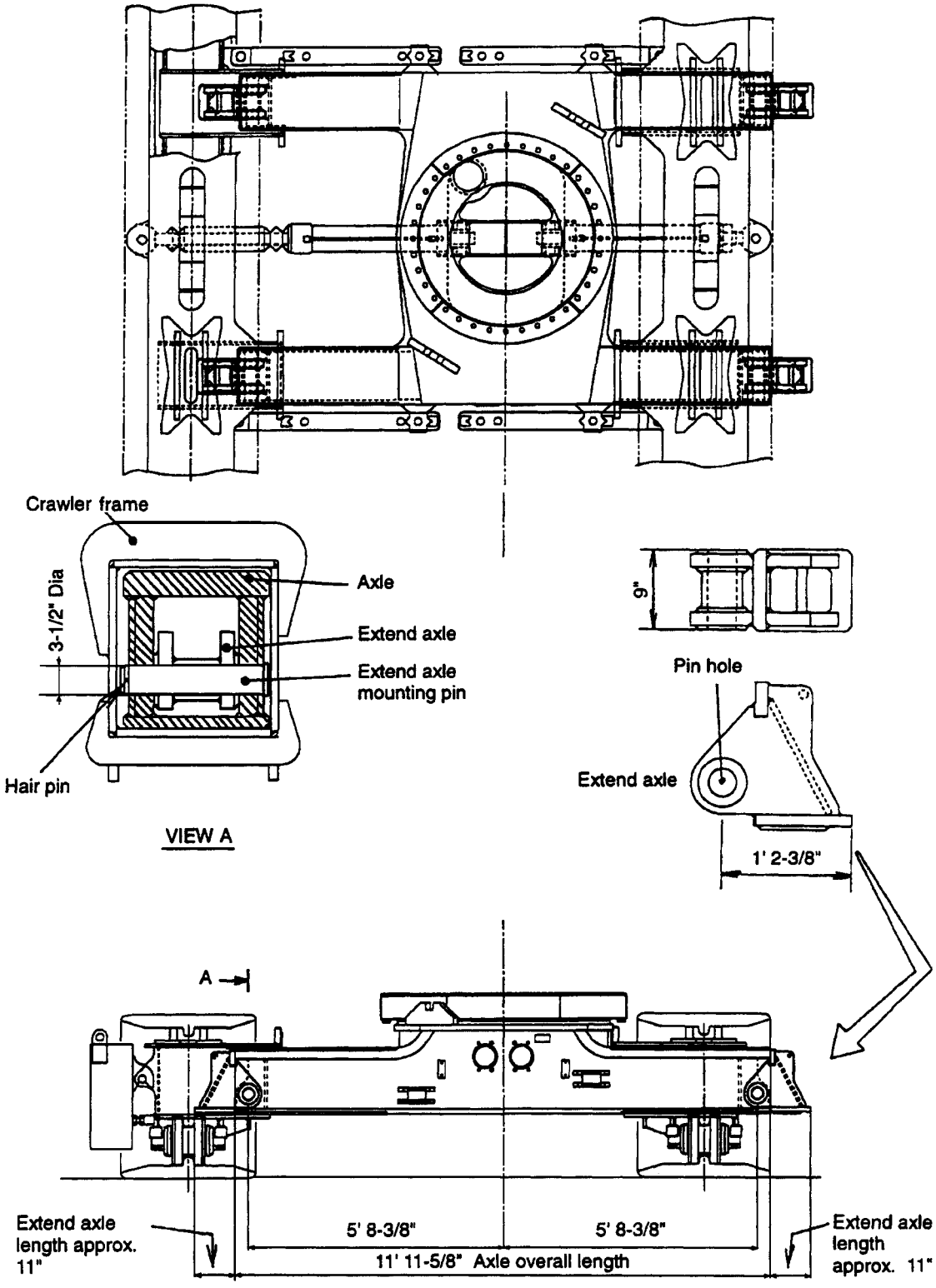
The overall width including the crawler weight width is 18' 7-3/8" (5675mm).

The crawler frame and axle are fixed by the crawler link pins (at 4 places) and shims (at 4 places) inserted between the axle and crawler frame.



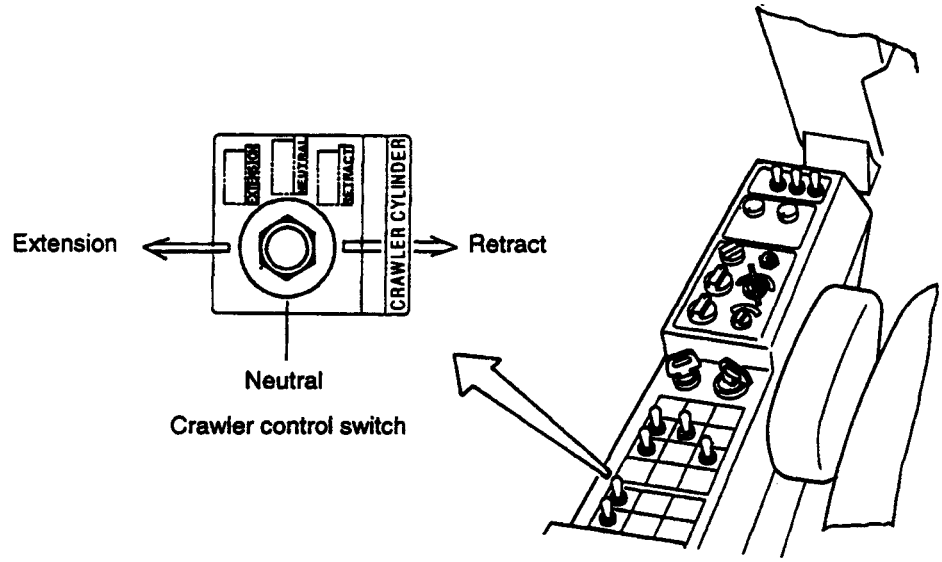
5-7-3 How to mount the extension axle

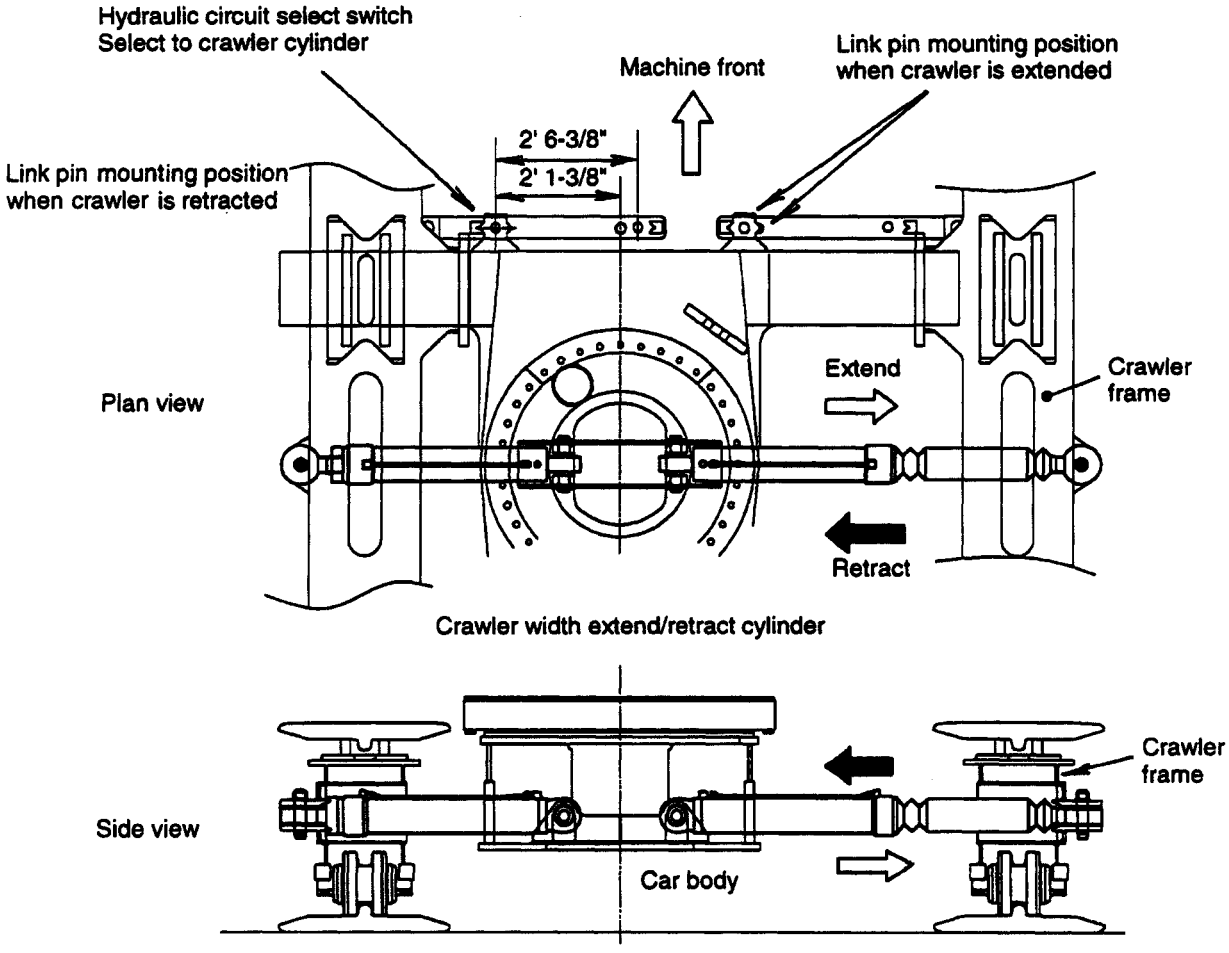
By using the extension axle mounting pins, mount the extension axle on the 4 axle ends. Set a hairpin to the mounting pin to prevent the mounting pin from falling off.



When the extension axle is mounted, one side of the axle is lengthened by approx. 11"

5-7-4 Crawler width control switch



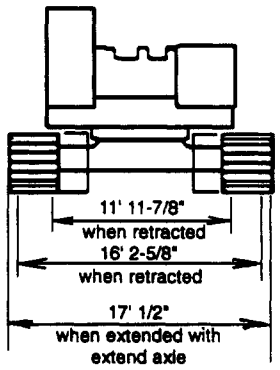


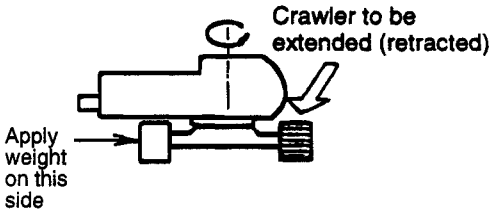
5-7-5 How to change crawler width

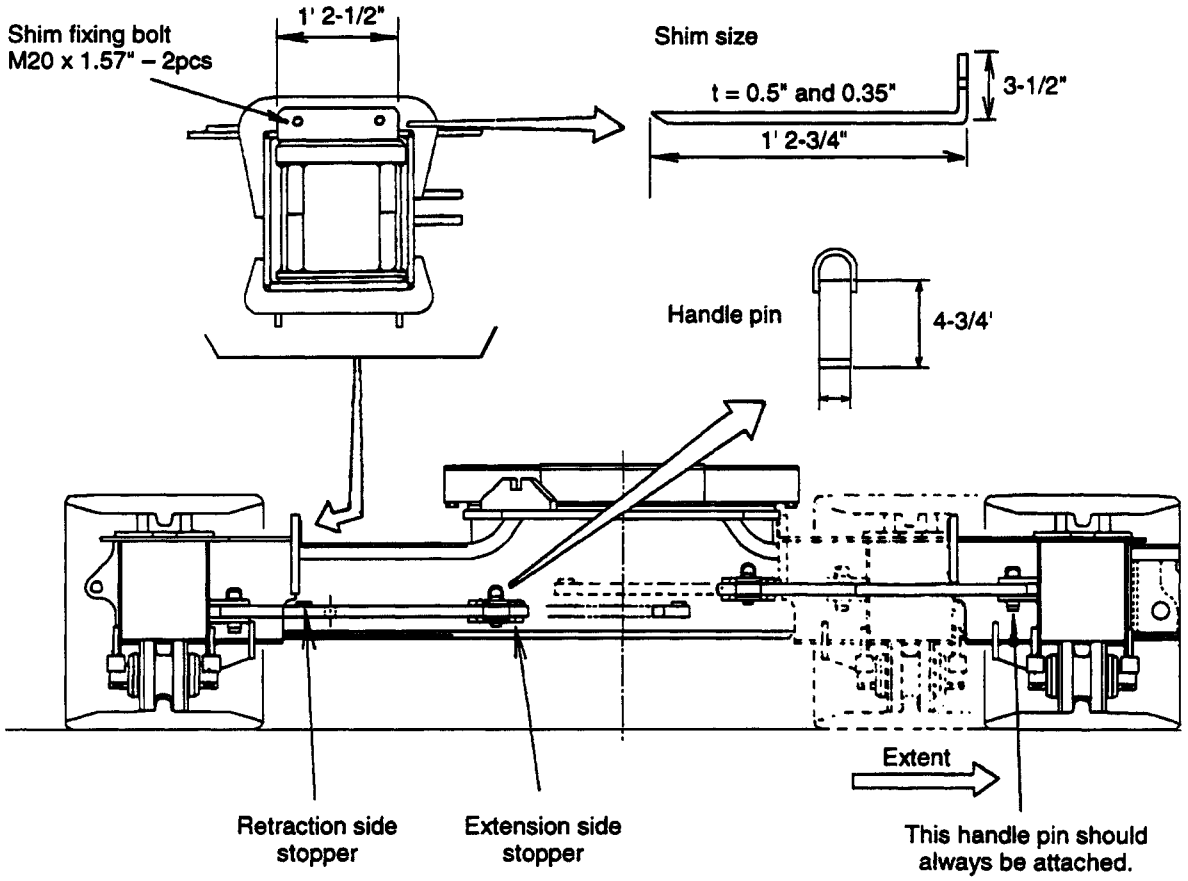
Although the front attachment and counterweight must be removed as a rule, the crawler width is changeable beforehand in the position shown (when unavoidable).

1. Move the crane to level ground. Operation tends to be easier on muddy ground rather than concrete. Each crawler is shiftable by dimension as shown in the figure at right.
2. In order to reduce the weight applied to the crawler to be shifted, swing the superstructure toward the opposite crawler so as to apply the weight of the superstructure, thereby facilitating crawler extension/retraction.

   The superstructure must be swung gradually with utmost care.
3. Check the ground condition so that it does not create a problem in extension or retraction of crawler.
4. Remove the shim fastening bolt and shim at 4 points front and rear to release the fixed status of the crawler frame and axle (or remove the wedge pack).

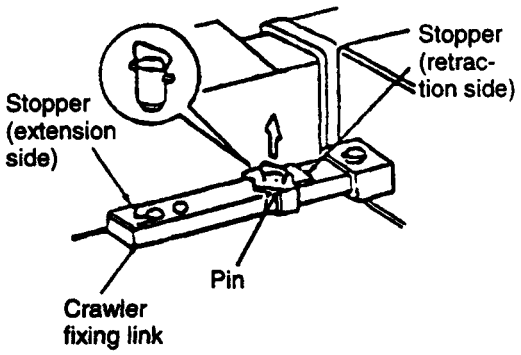






5. Pull out the two crawler fixing link pins at the front and rear (pins of the crawler to be extended or retracted). The crawler fixing link pins of the opposite crawler must be kept inserted.
6. Adjust the engine speed to about 1,200 rpm and increase or decrease the crawler width by manipulating the crawler extend/retract lever.

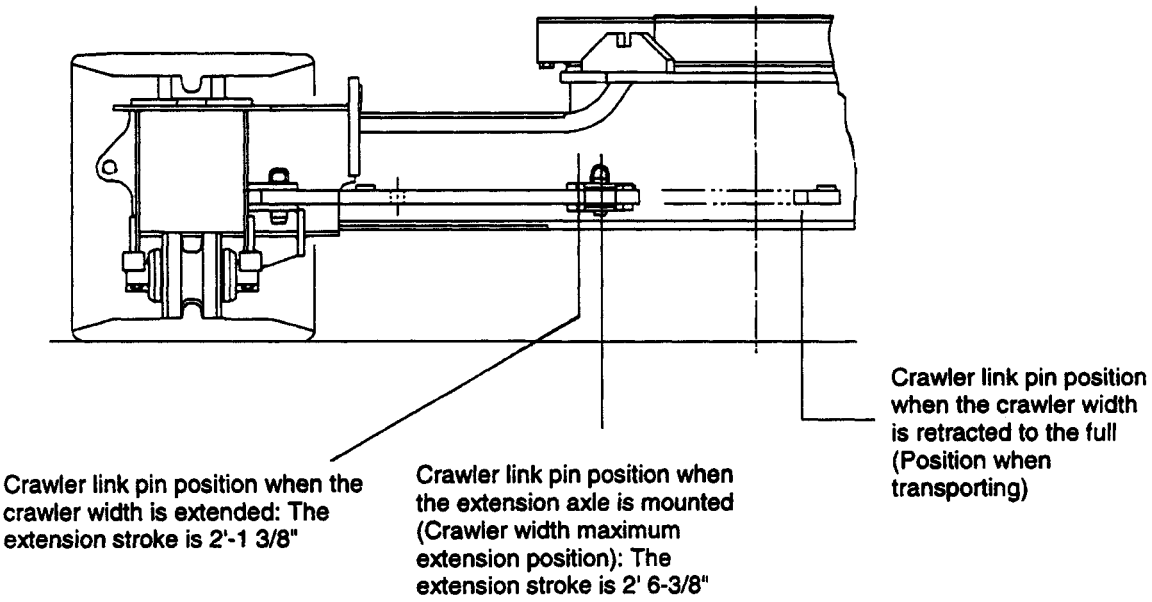
   If the crawler is difficult to shift because of resistance applied on it, the crawler extend/retract lever should be manipulated while driving (travelling) the crawler to be extended or retracted at a very slow speed. This measure may be required particularly for retracting the crawler.
7. After the crawler has been extended or retracted up to the stopper of the crawler link, the pin must be inserted to fix the crawler frame and axle.
8. Insert the shim and tighten the shim fastening bolts, which were removed in previous step (4), in order to fix the crawler frame and axle.
9. Repeat steps (2) through (8) for changing the width of the opposite crawler.



CAUTION

Do not extend to maximum crawler width, when not mounted on extension axle.

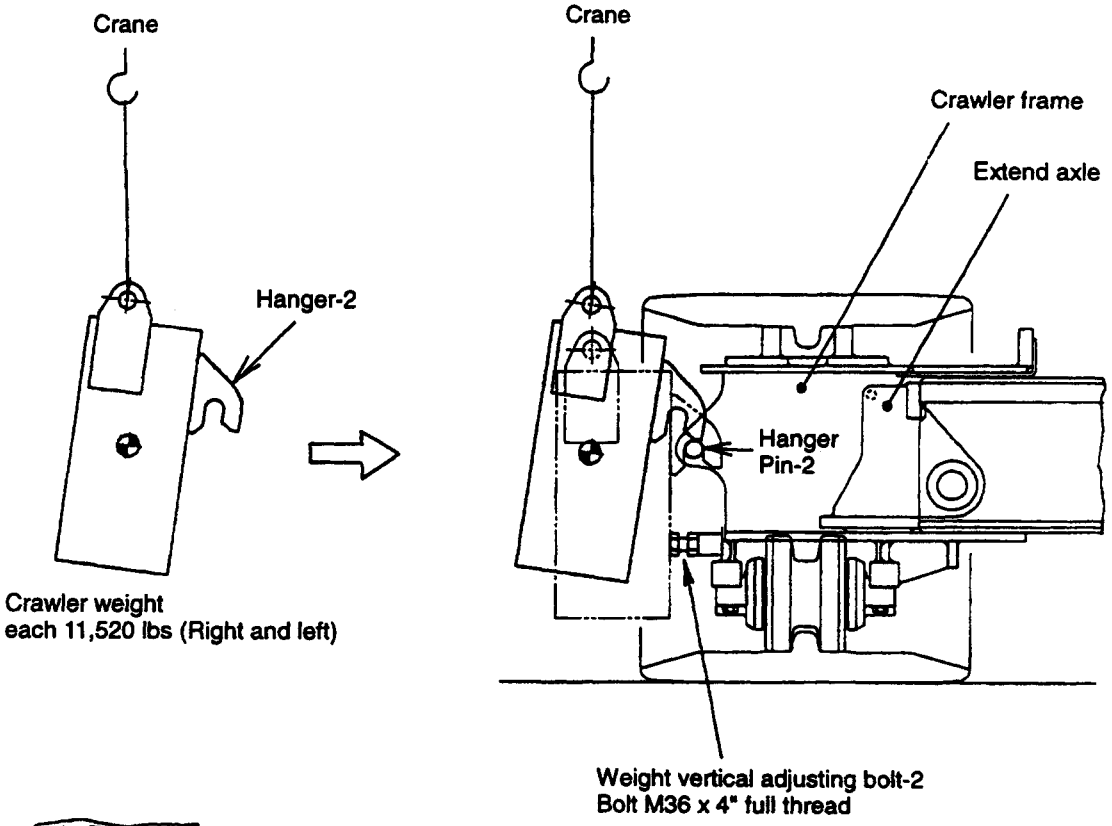
It should be mounted on extension axle before extending to maximum crawler width as shown on next page.

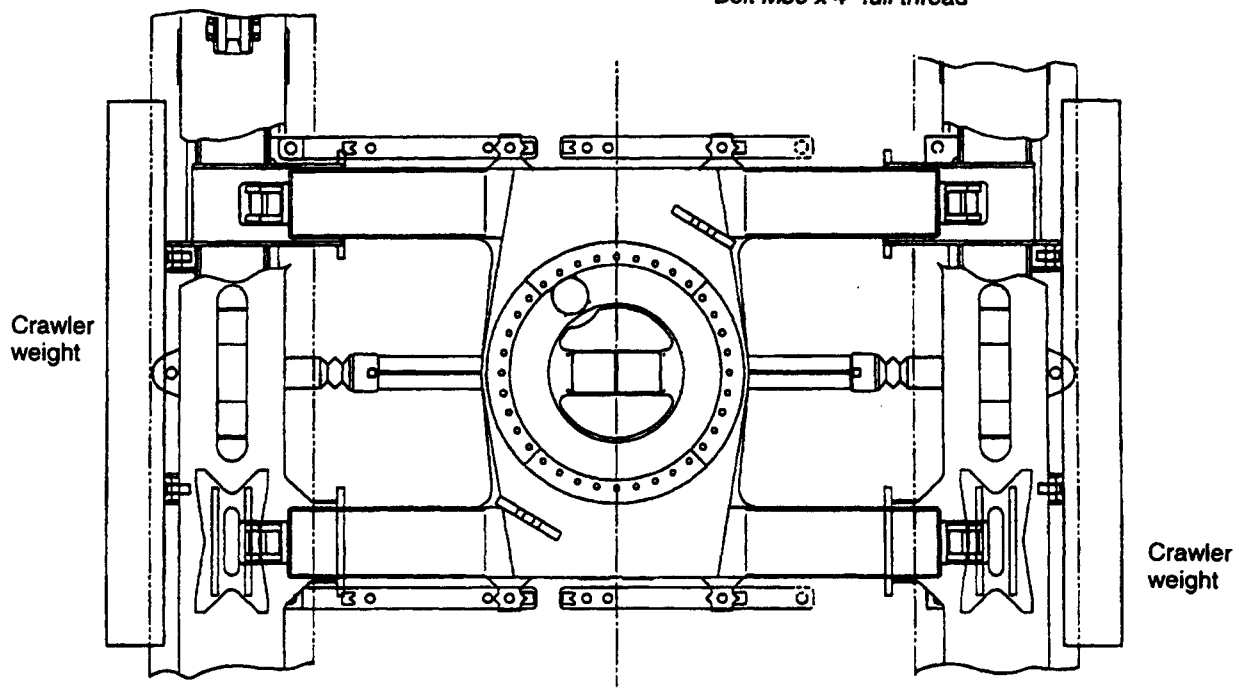


5-7-6 How to mount crawler weight

Lift the weight and put the hanger of the weight on the hanger pin of the crawler frame.

Adjust the perpendicularity of the weight with the adjusting bolt. Mount the crawler weight on the opposite side.





6. USAGE OF OVERLOAD PREVENTION DEVICE (MOMENT LIMITER)

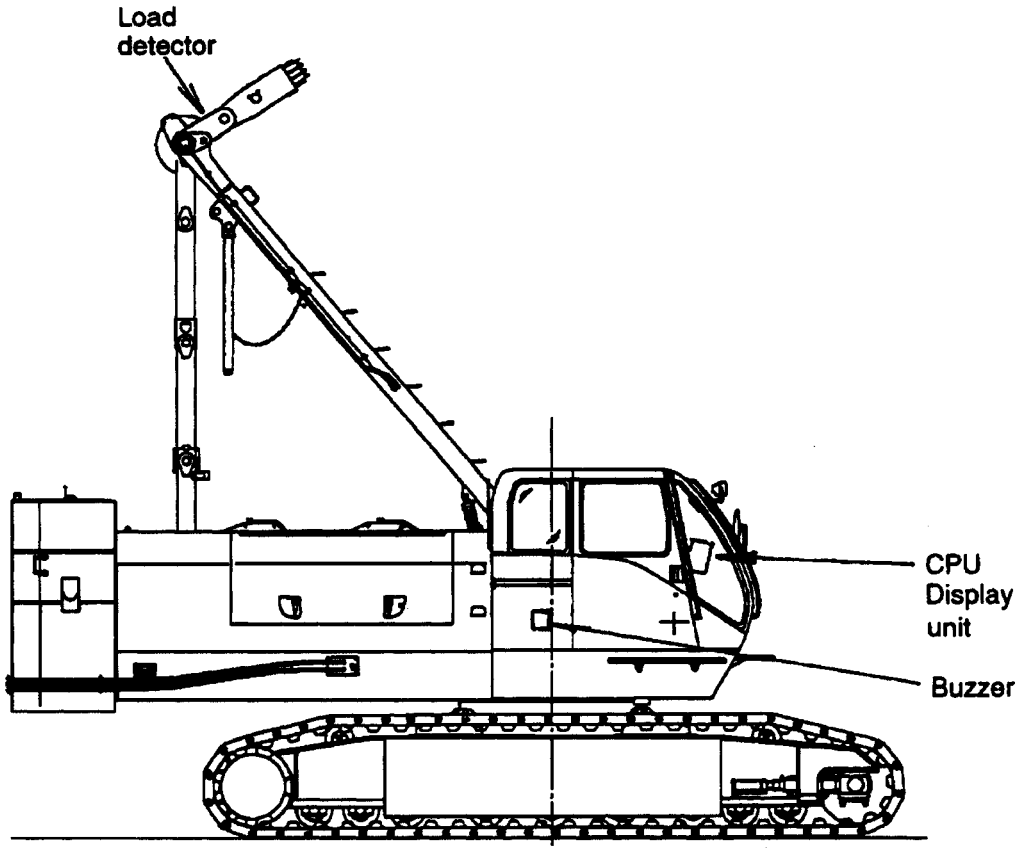
6-1 Outline (ML-D3A automatic stop type)

The moment limiter consists of a CPU unit, a display unit, various sensors such as an angle detector and a load detector, an alarm buzzer, an automatic stop circuit, etc.

When an actual load reaches 90% of the permissible load, the buzzer generates an intermittent sound as an alarm. If the actual load reaches 100% of the permissible load, the buzzer generates a continuous sound. At the same time, load hoisting or boom lowering of the crane is stopped. If alarm mode is selected, automatic stop is not done.

For releasing the automatic stop status, lower the load or hoist the boom until the crane returns to the safe zone, automatic stop is released in about 2 seconds and all the operation can be done. Even in the automatic stop status, load lowering and boom hoisting are allowed. If alarm mode is selected, when the buzzer generates a continuous sound, hoist the boom and lower the load at once.

Arrangement of major components



PRECAUTIONS FOR HANDLING THE MOMENT LIMITERS

⚠ WARNING

If the working conditions of the moment limiter are set incorrectly, the crane may tip over because of overload, etc. Do not perform the operation while the moment limiter is "OFF".

1. **Display the setting screen and make sure the crane status is set to the proper values. If you set to a shorter boom length than what you are using the allowable load is displayed with large letters. (The crane may tip over before the actual load reaches the allowable load).**
2. **Make sure that the crane is set to the values displayed on the screen for every item and then start the operation.**

⚠ CAUTION

The overload prevention device may malfunction because of various causes such as the wrong setting of working conditions, improper electric current in the electric wires, disconnection, wet wires, malfunction of angle indicator, malfunction of load detector, deterioration of components, electric wave jamming, voltage drop, improper ambient temperature, defective IC card, etc.

1. **Check if the working conditions are set correctly, if the electric wiring is correct or if the wiring is wet.**
2. **Move the crane to minimize the electric wave jamming.**
3. **The overload prevention device does not operate normally under extreme high or low temperature. Keep the cab temperature 30°F~120°F by using a room heater or cooler. Don't expose the device to direct sunlight. For other cases, ask the Company or service shop to repair the device.**

⚠ CAUTION

The moment limiter must usually be ready to operate normally. Check the following items:

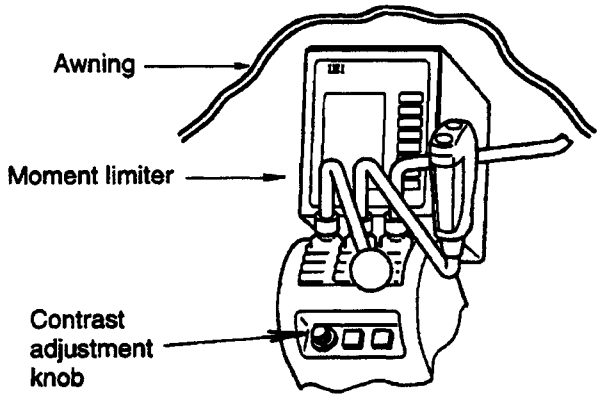
1. **Hoist a load for which actual weight is known. Add the hook weight value to the load value and then compare the value with the displayed load value.**
2. **While only the hook is hoisted, measure the working radius with a tape measure and compare it with the displayed value. If the values are different from the displayed ones, adjustment is necessary. Contact the Company or nearest service shop.**

Precautions on operational environment (temperature, etc.) of moment limiter

Since the moment limiter is a precision electronic product, its operational environment is limited as follows. Avoid operation and preservation over the limit.

1. Operational environment of moment limiter
   - Operational temperature: 30°F~120°F
   - Preservation temperature: -5°F~185°F
   - Preservation ambient humidity: 10% to 95%

   If the display unit is subjected to direct sunlight and heated up, it will result in damage of the moment limiter. When parking the machine, cover it from sunlight to keep a preservation temperature lower than the temperature maximum. It is also required to warm up the temperature when the cab is lower than temperature minimum. If the room temperature is higher than operational temperature maximum, turn off the moment limiter power supply and lower the temperature of the operator's cab and moment limiter, then turn on the power again. If the cab temperature is lower, warm it up to higher than 30°F. If the liquid crystal on the display unit is exposed to direct sunlight for a long time, it is heated up and turns black. In this case, try to keep it away from sunlight and lower the temperature.



Reference:

The contrast adjustment knob enables you to adjust the contrast (shading) of the display unit. Turn the knob into position according to ambient brightness for the most clear display.

2. Prevention of rain water leak in, lightning strike, etc.

   Make sure that the water prevention cap is correctly set at the connected parts of wire harness and waterproof process is properly done, which assures prevention of water leak-in. If water leaks in, you will not be able to use the moment limiter.

   If the moment limiter is struck by lightning, it will be damaged. If lightning is forecasted or observed, keep the moment limiter away from lightning by lowering the boom on the ground or other necessary action. Be careful not to spill any solvent such as gasoline, alcohol etc. over the moment limiter body. In particular, take care that no solvent will be on the display unit.

TEREX AMERICAN MODEL HC 110 MOMENT LIMITER WORK NUMBERS

CRANE EQUIPPED WITH AMERICAN 59"HI OR 59"SI TUBULAR CHORD BOOM AND 9HL TUBULAR CHORD JIB WITH "B" TYPE COUNTERWEIGHT (FULL COUNTERWEIGHT)

ML-D3A MOMENT LIMITER p/n 0881223UA
ROM BOARD INSTALLED IS p/n D59806612
WORK NUMBER DECAL p/n D40599600
CAUTION DECAL p/n D40556812

Note:
Serial Nos. AC3801, AC3802 and AC3803

WORK NO.	WORK MODE	BOOM LENGTH (ft.)		WORK NO.	WORK MODE	BOOM LENGTH (ft.)
11	CRANE	TYPE B HI BOOM 50 ~ 80				
12	CRANE	TYPE B HI BOOM 90 ~ 230				
13	CRANE	TYPE B SI BOOM 50 ~80				
14	CRANE	TYPE B SI BOOM 90~210				

CRANE EQUIPPED WITH EITHER 59"HI OR 59"SI TUBULAR CHORD BOOM AND 9HL TUBULAR CHORD JIB WITH EITHER "B" OR "A" TYPE COUNTERWEIGHT

ML-D3A MOMENT LIMITER p/n 0881223UA
ROM BOARD INSTALLED IS p/n D59806614
WORK NUMBER DECAL p/n D40602900
CAUTION DECAL p/n D40556814

Note:
Serial Nos. AC3818 and higher

WORK NO.	WORK MODE	BOOM LENGTH (ft.)		WORK NO.	WORK MODE	BOOM LENGTH (ft.)
11	CRANE	TYPE B HI BOOM 50 ~ 80		15	CRANE	TYPE A HI BOOM 50 ~ 80
12	CRANE	TYPE B HI BOOM 90 ~ 230		16	CRANE	TYPE A HI BOOM 90 ~ 230
13	CRANE	TYPE B SI BOOM 50 ~ 80		17	CRANE	TYPE A SI BOOM 50 ~ 80
14	CRANE	TYPE B SI BOOM 90 ~ 210		18	CRANE	TYPE A SI BOOM 90 ~ 210
41	FLOATING CRANE	TYPE B HI BOOM 50 ~ 80		21	CRANE	TYPE SPECIAL HI BOOM 60 ~ 80 (HC110.10)
42	FLOATING CRANE	TYPE B HI BOOM 90 ~ 210 (HC110.08)		22	CRANE	TYPE SPECIAL HI BOOM 90 ~ 210 (HC110.10)

PRE-OPERATIONAL CALIBRATION PROCEDURE FOR ML-D3A MOMENT LIMITER (STANDARD CRANE)

IF THIS IS A NEW INSTALLATION, THE FOLLOWING NEEDS TO BE PERFORMED.

> **IMPORTANT** - If the steps are not followed properly and in exact order, the Moment Limiter will **not** function properly.

CRANE NEEDS TO BE LEVEL ON FIRM GROUND

1. Installation
   - A. Install electric angle indicator to the boom inner, if not already installed.
   - B. Connect the cable for the angle indicator to the connector box between the boom feet (see Figure 1).
   - C. Install the anti-two-block switch and cable.
   - D. Turn the "M/L MODE" switch to "OPERATION" position. Start the engine.

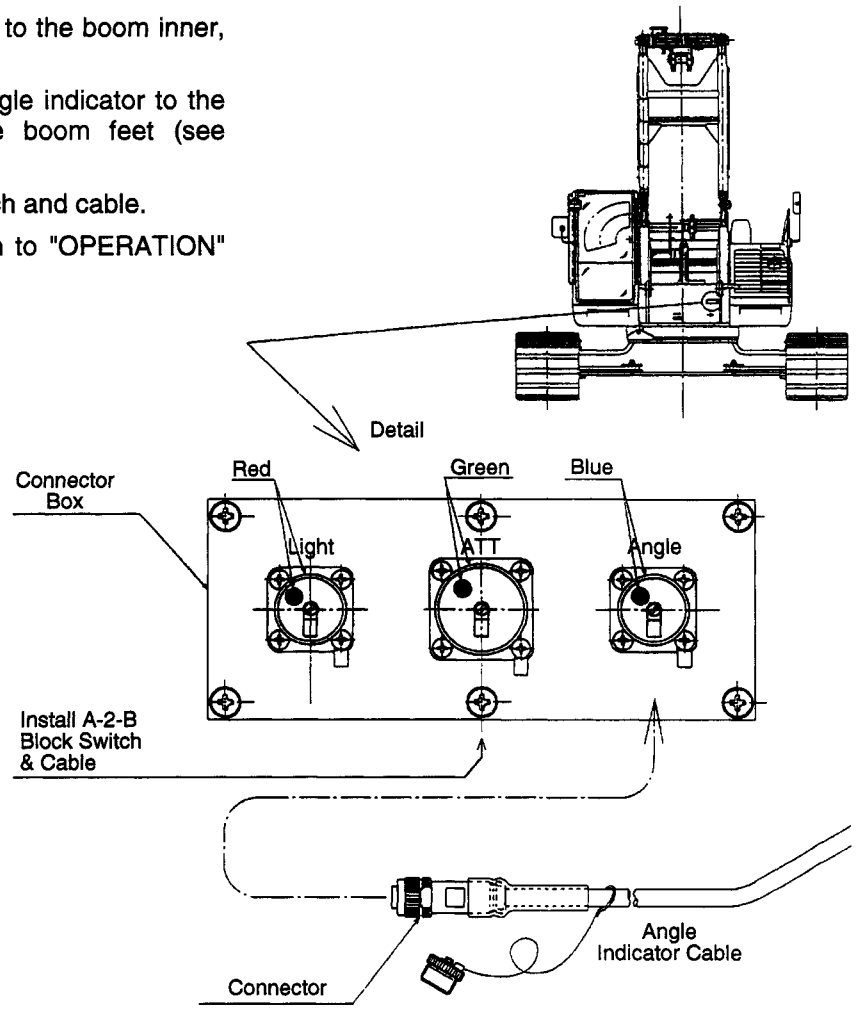


Figure 1

READ OPERATOR'S MANUAL FOR THE MOMENT LIMITER OPERATION

2. Program Moment Limiter for working conditions and crane configuration.

   A. Bring the ATT. SET mode screen up on the Moment Limiter (see Figure 2) by pressing [Func] (Function).

      1.) Enter the WORK NO. from table below.

CRANE EQUIPPED WITH AMERICAN 59"HI OR 59"SI TUBULAR CHORD BOOM AND 9HL TUBULAR CHORD JIB WITH "B" TYPE COUNTERWEIGHT (FULL COUNTERWEIGHT)

ML-D3A MOMENT LIMITER p/n 0881223UA
ROM BOARD INSTALLED IS p/n D59806812
WORK NUMBER DECAL p/n D40599600
CAUTION DECAL p/n D40556812

Note:
Serial Nos. AC3801, AC3802 and AC3803

WORK NO.	WORK MODE	BOOM LENGTH (ft.)		WORK NO.	WORK MODE	BOOM LENGTH (ft.)
11	CRANE	TYPE B HI BOOM 50 ~ 80				
12	CRANE	TYPE B HI BOOM 90 ~ 230				
13	CRANE	TYPE B SI BOOM 50 ~80				
14	CRANE	TYPE B SI BOOM 90~210				

CRANE EQUIPPED WITH EITHER 59"HI OR 59"SI TUBULAR CHORD BOOM AND 9HL TUBULAR CHORD JIB WITH EITHER "B" OR "A" TYPE COUNTERWEIGHT

ML-D3A MOMENT LIMITER p/n 0881223UA
ROM BOARD INSTALLED IS p/n D59806814
WORK NUMBER DECAL p/n D40602900
CAUTION DECAL p/n D40556814

Note:
Serial Nos. AC3818 and higher

WORK NO.	WORK MODE	BOOM LENGTH (ft.)		WORK NO.	WORK MODE	BOOM LENGTH (ft.)
11	CRANE	TYPE B HI BOOM 50 ~ 80		15	CRANE	TYPE A HI BOOM 50 ~ 80
12	CRANE	TYPE B HI BOOM 90 ~ 230		16	CRANE	TYPE A HI BOOM 90 ~ 230
13	CRANE	TYPE B SI BOOM 50 ~ 80		17	CRANE	TYPE A SI BOOM 50 ~ 80
14	CRANE	TYPE B SI BOOM 90 ~ 210		18	CRANE	TYPE A SI BOOM 90 ~ 210

      2.) Enter BOOM LENGTH.

      3.) Enter MAIN HOOK CAPACITY (See capacity plate on load block).

      4.) Enter MAIN HOOK NUMBER OF PARTS OF LINE.

      5.) Enter JIB LENGTH (if no jib, enter 0).

      6.) Enter AUXILIARY HOOK CAPACITY (See capacity plate on overhaul ball). If no jib , enter 0.

      7.) Enter AUXILIARY HOOK PARTS OF LINE (1 only).

      8.) Enter the JIB OFFSET ANGLE. If no jib, enter 0.

      9.) After all information is entered, scroll to END OF SET and press [Enter] once.

ATT SET mode

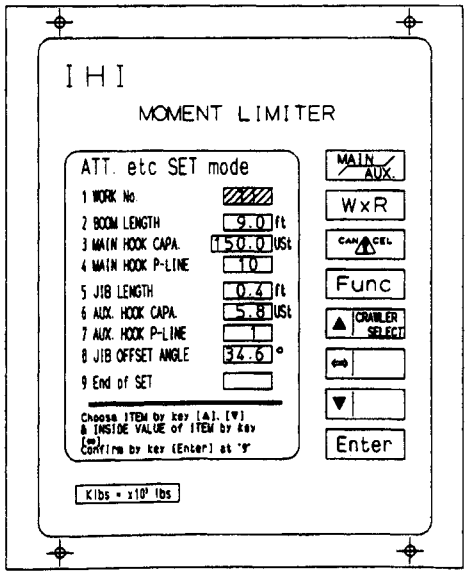


Figure 2

3. Program Moment Limiter for Boom Angle Limits.
   A. Bring the ANGLE SET mode screen up (see Figure 3).
      1.) Enter the maximum boom UPPER LIMIT ANGLE desired.

      Note: Do not set higher than 81°.

      2.) Enter the minimum boom LOWER LIMIT ANGLE (see load chart for minimum boom angle with a load rating for the boom length installed).
      3.) Enter the SLOW DOWN ANGLE (HI). (This slows the boom up speed before it reaches the limit. Standard setting is 2°).
      4.) Enter the SLOW DOWN ANGLE (LO). (This slows the boom down speed before it reaches the limit. Standard setting is 2°).
      Enter by using ▲ or ▼.

ANGLE SETTING MENU

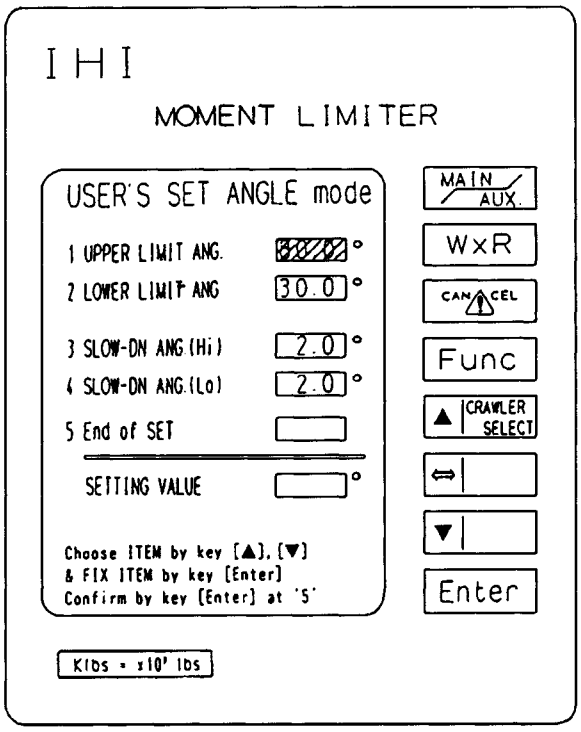


Figure 3

4. Calibration for the Angle Indicators
   A. Set zero adjustment and span of boom angle indicators.
      1.) Level boom to zero by using a plumb bob on the boom inner pins (see Figure 4).
      2.) Adjust the manual boom angle indicator to zero.
      Enter by using ▲ or ▼.

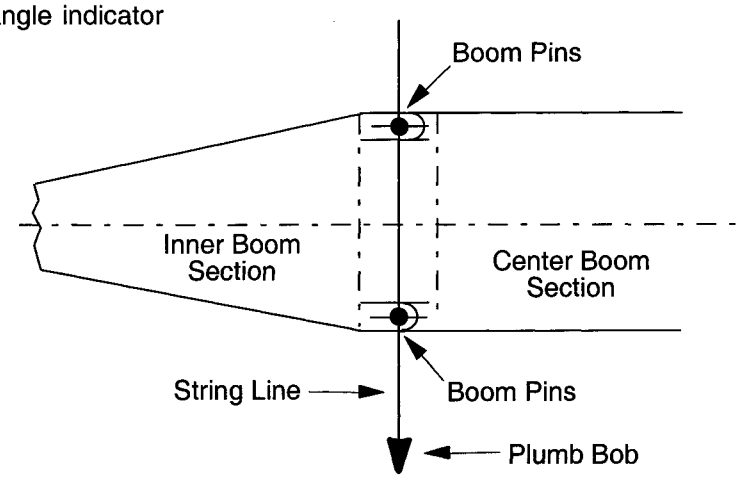


Figure 4

4. Calibration for the Angle Indicators (Continued)
   3.) Bring the ZERO ADJUSTMENT OF ANGLE mode screen up on the Moment Limiter (see Figure 5).
   4.) Input the ANGLE to 0.0°. (Push Enter Key twice slowly) by entering into SETTING VALUE θ.

   Note: Do not be concerned with the COUNT VALUE.
   5.) Raise the boom to 70° and measure the radius from the center of rotation (swivel) to the center of the load block to verify angle. Use the Table below to get the exact radius with the parts of line reeved on the load block. You will have to boom up or down to get the radius exact.

Table is for Boom Angle of 70° and Radii for Boom Lengths of 50 ft. (15.240m) through 230 ft. (70.104m).

ZERO ADJUSTMENT of ANGLE

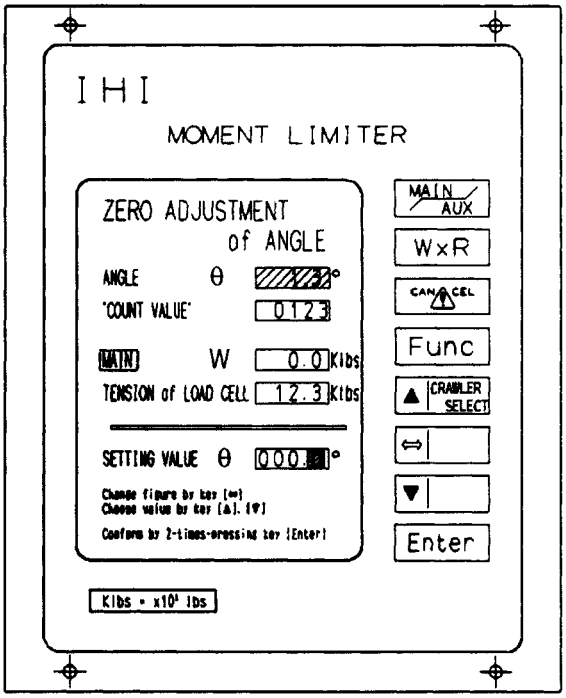


Figure 5

HC110 BOOM ANGLE CALIBRATION - 59HI AND 59SI BOOMS

	Horizontal Distance (in Ft. and m) from Centerline of Rotation to Center of Hook at 70° Boom Angle		
Boom Length in Ft. (m)	**1 Part Line in Ft. (m)**	**2 PartsLine in Ft. (m)**	**3 Parts Line in Ft. (m)**
50 Ft. (15.240m)	22.2 Ft. (6.767m)	20.9 Ft. (6.370m)	21.3 Ft. (6.492m)
60 Ft. (18.288m)	25.6 Ft. (7.803m)	24.4 Ft. (7.437m)	24.7 Ft. (7.529m)
70 Ft. (21.336m)	29.1 Ft. (8.870m)	27.8 Ft. (8.473m)	28.2 Ft. (8.595m)
80 Ft. (24.384m)	32.5 Ft. (99.06mm)	31.2 Ft. (9.510m)	31.6 Ft. (9.632m)
90 Ft. (27.432m)	35.9 Ft. (10.942m)	34.6 Ft. (10.546m)	35.0 Ft. (10.668m)
100 Ft. (30.480m)	39.3 Ft. (11.979m)	38.0 Ft. (11.582m)	38.4 Ft. (11.704m)
110 Ft. (33.528m)	42.7 Ft. (13.015m)	41.5 Ft. (12.649m)	41.8 Ft. (12.741m)
120 Ft. (36.576m)	46.2 Ft. (14.082m)	44.9 Ft. (13.686m)	45.3 Ft. (13.807m)
130 Ft. (39.624m)	49.6 Ft. (15.118m)	48.3 Ft. (14.722m)	48.7 Ft. (14.844m)
140 Ft. (42.672m)	53.0 Ft. (16.154m)	51.7 Ft. (15.758m)	52.1 Ft. (15.880m)
150 Ft. (45.720m)	56.4 Ft. (17.191m)	55.1 Ft. (16.794m)	55.5 Ft. (16.916m)
160 Ft. (48.768m)	59.8 Ft. (18.227m)	58.6 Ft. (17.861m)	58.9 Ft. (17.953m)
170 Ft. (51.816m)	63.3 Ft. (19.294m)	62.0 Ft. (18.898m)	62.4 Ft. (19.020m)
180 Ft. (54.864m)	66.7 Ft. (20.330m)	65.4 Ft. (19.934m)	65.8 Ft. (20.056m)
190 Ft. (57.912m)	70.1 Ft. (21.366m)	68.8 Ft. (20.970m)	69.2 Ft. (21.092m)
200 Ft. (60.960m)	73.5 Ft. (22.403m)	72.2 Ft. (22.007m)	72.6 Ft. (22.128m)
210 Ft. (64.008m)	76.9 Ft. (23.439m)	75.7 Ft. (23.073m)	76.0 Ft. (23.165m)
220 Ft. (67.056m)	80.4 Ft. (24.506m)	79.1 Ft. (24.110m)	79.5 Ft. (24.232m)
230 Ft. (70.104m)	83.3 Ft. (25.390m)	82.5 Ft. (25.146m)	82.9 Ft. (25.268m)

4. Calibration for the Angle Indicators (Continued)

   6.) Bring the SPAN ADJUSTMENT OF ANGLE screen up on the Moment Limiter (see Figure 6).

   7.) Enter the SETTING VALUE of 70.0° (push the Enter Key twice slowly).

SPAN ADJUSTMENT of ANGLE

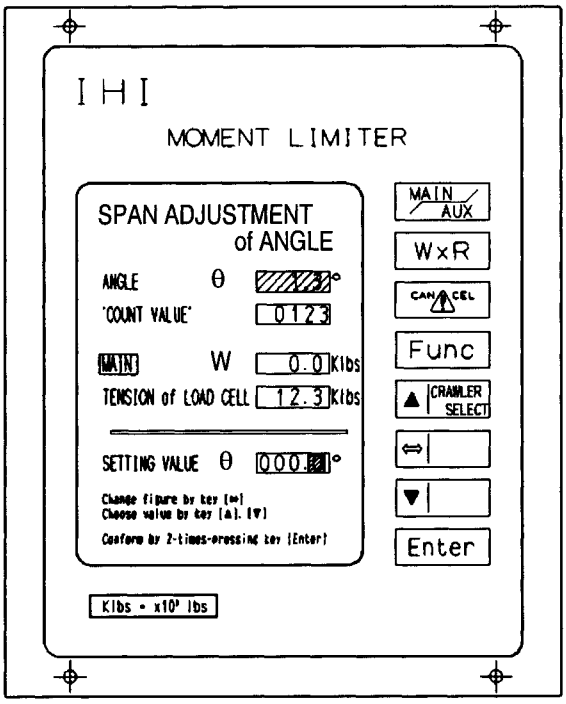


Figure 6

5. Calibration for Load Cell

   A. Zero and Span Adjustment for the load cell at boom angle of 70°.

   Note: Boom angle must be at 70°.

   1.) Bring the ZERO ADJUSTMENT OF LOAD CELL screen up on the Moment Limiter (see Figure 7).

   2.) Hoist the load block or ball (no load on the hook) off the ground.

   3.) Enter the weight of the block or ball (Example: if the block weight is 1,500 lbs. -- enter 1.5 Klbs) into the SETTING VALUE. (Push the Enter Key twice slowly).

   Enter Angle W (0.0 klbs) by using ▲ or ▼.

ZERO ADJUSTMENT of LOAD CELL

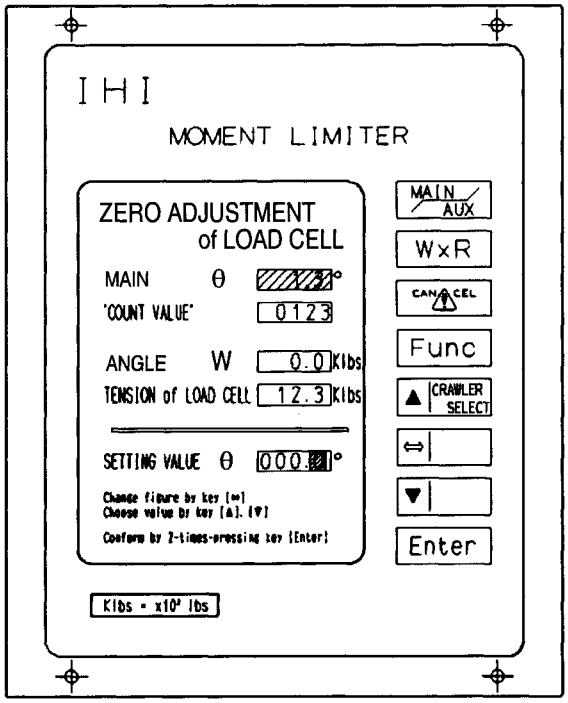


Figure 7

5. Calibration for Load Cell (Continued)

   4.) Bring the ZERO SPAN OF LOAD CELL screen up on the Moment Limiter (see Figure 8).

   5.) Hoist a **known** weight of approximately 20,000 lbs. at 70° boom angle.

CAUTION

USING A SMALLER KNOWN WEIGHT THAN 20,000 LBS. TO SPAN THE LOAD, OR AN INACCURATE ACCOUNT OF THE WEIGHT WILL GIVE AN INCORRECT CALIBRATION OF THE MOMENT LIMITER.

ZERO SPAN of LOAD CELL

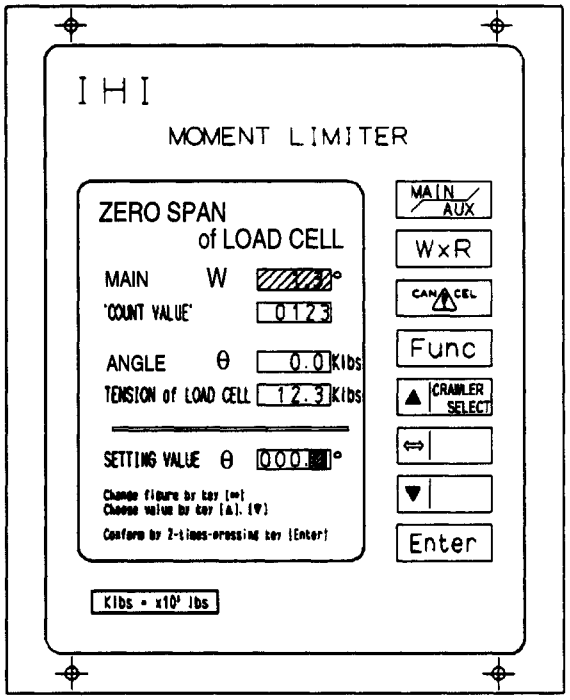


Figure 8

   6.) Enter the known weight and the weight of the load block or ball and rigging into the SETTING VALUE.

   Example: The block weight is 1,500 lbs. (or 1.5 Klbs), and the rigging is 200 lbs (or 0.2 Klbs.) and the known weight is 20,000 lbs. (or 20.0 Klbs). The NUMBER TO ENTER is 21.7 Klb).

   Push the Enter Key twice slowly.

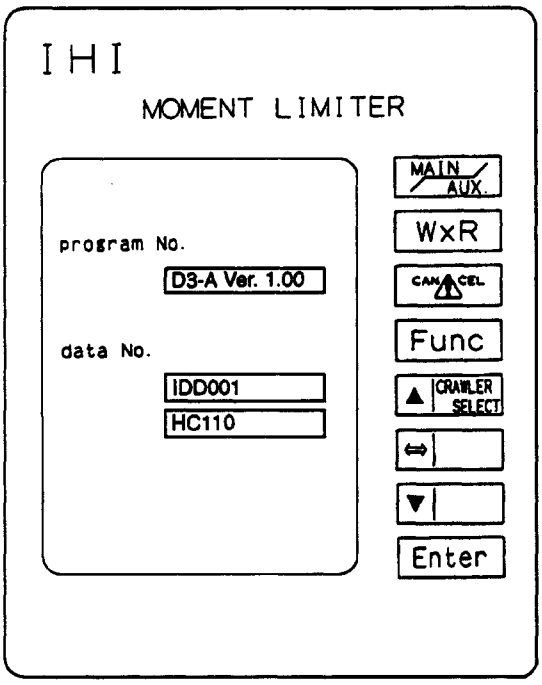
Note: If the crane is using a boom tip extension or a jib, the calibration must be performed on each load block or ball for Zero and Span Adjustments of the Load Cell. Depress the MAIN AUX key once. The Zero or Span screen is displayed to change to AUX. for calibration.

6-2 How to operate the ML-D3A type overload prevention device (Moment Limiter)

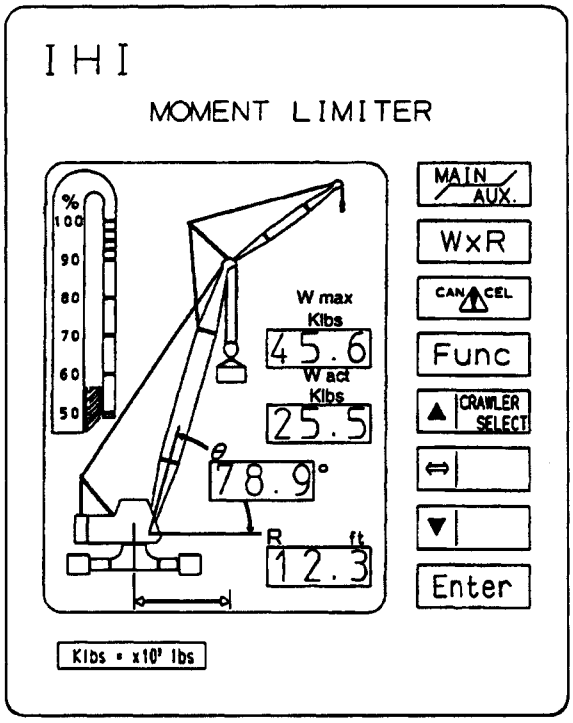
Setting of working conditions - standard crane

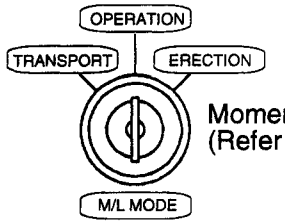
1. Turning on the power and display of the standard menu

Starting menu



Standard menu (boom work)





Moment limiter mode switch
(Refer to Page 1-9)

(1) Make sure that the moment limiter mode switch is at "OPERATION".

(2) Start the engine, and the moment limiter is automatically turned on.

(3) After approximately 5 seconds, the starting menu (as illustrated at left) is displayed. In the starting menu, "Program No.", "Data No." and the model name are displayed. Check the displayed data.

(4) After 5 seconds since the starting menu was displayed, the menu is changed to the standard menu. The standard menu shows the following items:

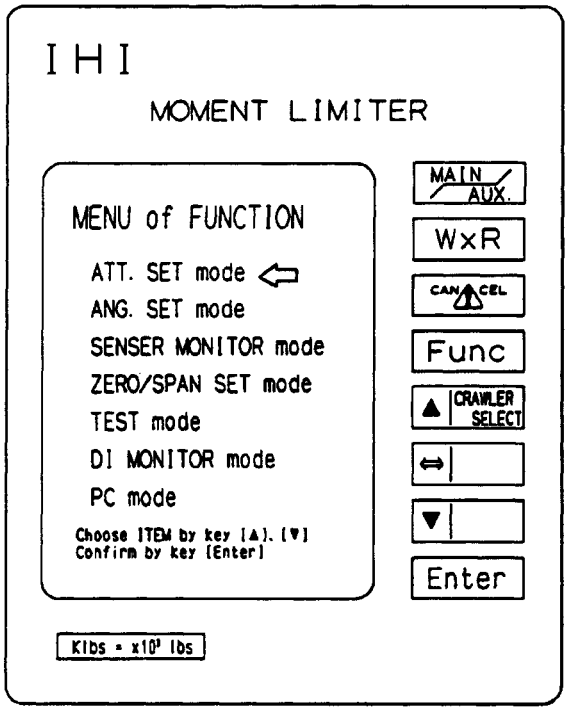
- Load ratio . . . . . %
- Rated overall lifting load . . . . . Klbs (allowable load)
- Actual load. . . . . Klbs
- Boom angle . . . . . °
- Working radius. . . . . Ft.

(5) The standard menu is displayed for "boom lifting". If the operator has to change to "jib lifting", press the MAIN AUX key switch. The load of "boom lifting" as illustrated at left moves to the jib side.

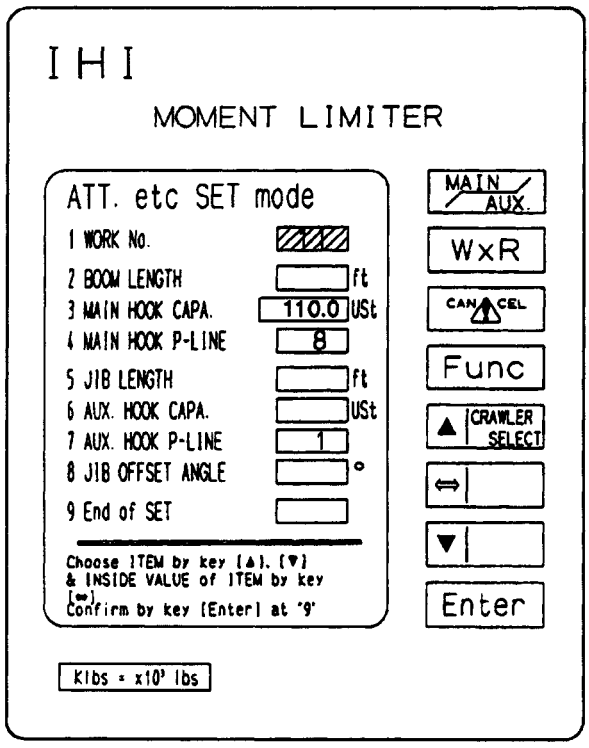
(6) If the sensor malfunctions or if the working radius is set incorrectly, the Error No. is displayed in the column of the working radius. Make sure that the Error No. is not displayed.

2. Setting of the working conditions

Function selection menu



Setting menu



(1) Press the Func key once in the standard menu, and the function selection menu as illustrated at left is displayed. If you want to return to the standard menu, press the Func or CANCEL key once.

(2) Proceed to the setting menu from the function selection menu.

In the function selection menu, press the CRAWLER SELECT or ▼ key to move the cursor (Reversed display) to "ATT. SET mode". Normally, the cursor is at "ATT. SET mode" when the function selection menu is displayed.

Press the Enter key once.

When pressing the Enter key, the menu is changed to the following setting menu (as shown at left).

(3) Set the working radius on the setting menu.

Press the CRAWLER SELECT or ▼ key to move the cursor to "WORK No." The item with the cell is reversed.

[1] Press the ⇔ key to set the value of the current attachment for "WORK No."

See Work Number Chart on Page 1-63.

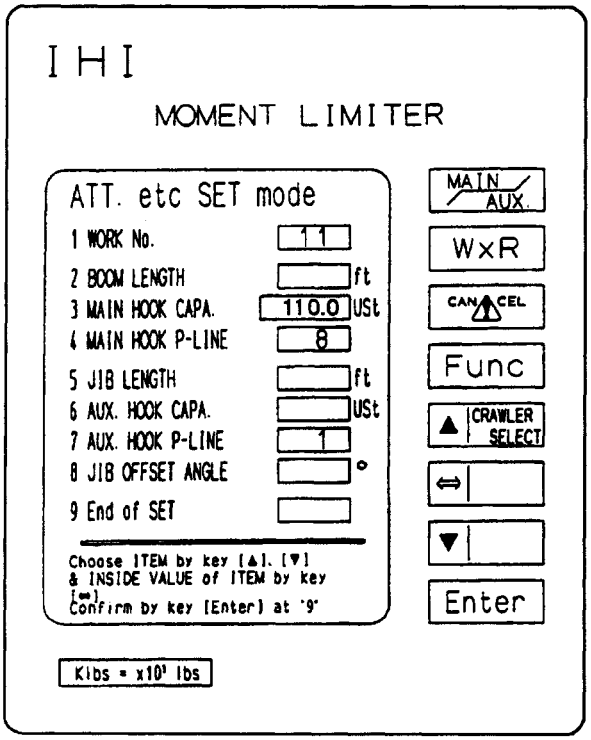
Each time the ⇔ key is pressed, the data included in the specification are displayed in order. Select a proper number.

[2] Setting of the boom length

Press the CRAWLER SELECT or ▼ key to move the cursor to "BOOM LENGTH". Press the ⇔ key to set the proper value for the length of the current boom.

Each time the ⇔ key is pressed, the boom length data included in the specification are displayed in order.

Setting menu



[3] Setting of the main hook capacity

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK CAPA." Press the ⇔ key to set the value of the current hook capacity.

Each time the ⇔ key is pressed, the main hook capacity data included in the specification are displayed in order. If the main hook is not installed, select "0.0".

[4] Setting of the part of line for the main hook

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK P-LINE". Press the ⇔ key to set the part of line for the current main hook.

Each time the ⇔ key is pressed, the "part of line" data included in the specification are displayed in order. If the main hook is not installed, select "1".

[5] Setting of the jib length

Press the ▲CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "JIB LENGTH" . Press the ⇔ key to set the value of the current jib length.

Each time the ⇔ key is pressed, the jib length data included in the specification are displayed in order. If the jib is not installed, select "0.0".

[6] Setting of the auxiliary hook capacity

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "AUX. HOOK CAPA." Press the ⇔ key to set the value of the current auxiliary hook capacity.

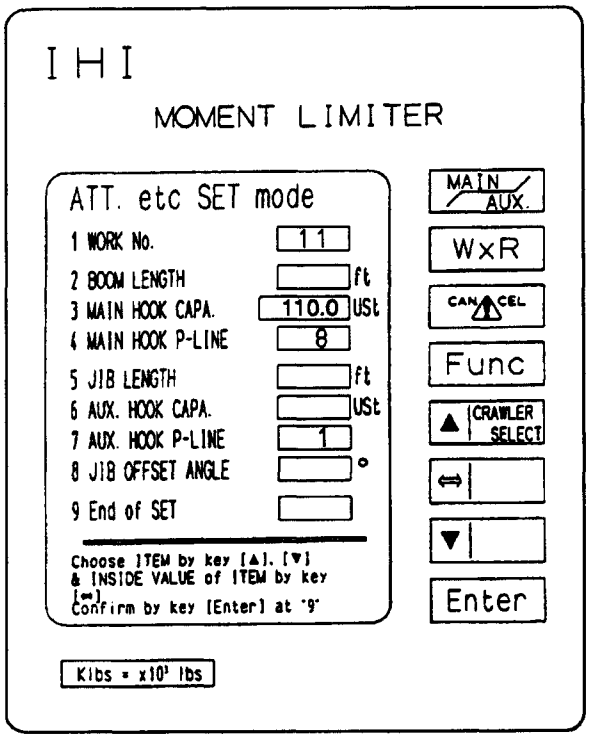
Each time the ⇔ key is pressed, the auxiliary hook capacity data included in the specification are displayed in order. If the auxiliary hook is not installed, select "0.0".

[7] Setting of the part of line for the auxiliary hook

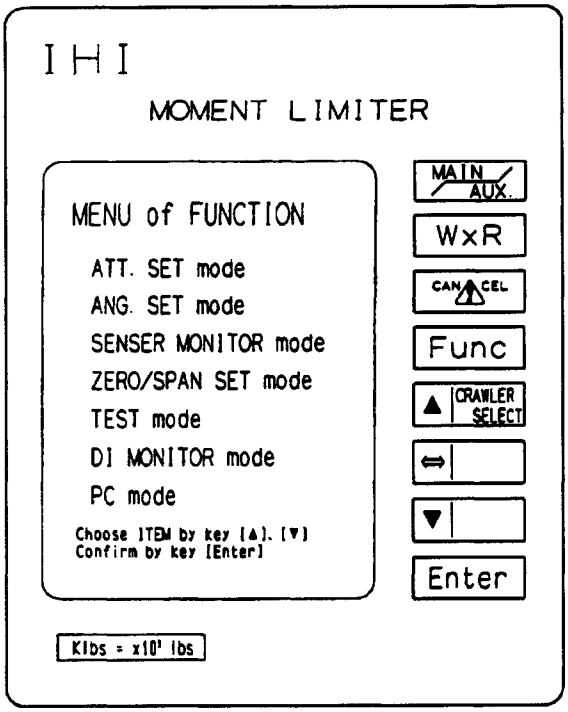
Press the ▲CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "AUX. HOOK P-LINE". Press the ⇔ key to set the part of line for the current auxiliary hook.

Each time the ⇔ key is pressed, the "part of line" data included in the specification are displayed in order. If the auxiliary hook is not installed, select "1".

Setting menu



Function selection menu



[8] Setting of the jib offset angle

Press the CRAWLER SELECT or ▼ key to move the cursor to "JIB OFFSET ANGLE". Press the ⇔ key to set the offset angle of the current auxiliary jib.

Each time the ⇔ key is pressed, the offset angle data included in the specification are displayed in order. For the auxiliary jib of the nominal 5 ft., the offset angle is automatically selected. If "0.0" is inputted to the jib length in the aforementioned [5], the offset angle is "0.0" and, even if the ⇔ key is pressed, the menu is not changed.

(4) Check of the set values

Make sure that the values set at the aforementioned [1] to [8] are set to the crane configuration.

Press the CRAWLER SELECT or ▼ key to move the cursor to "End of SET" and press the Enter key.

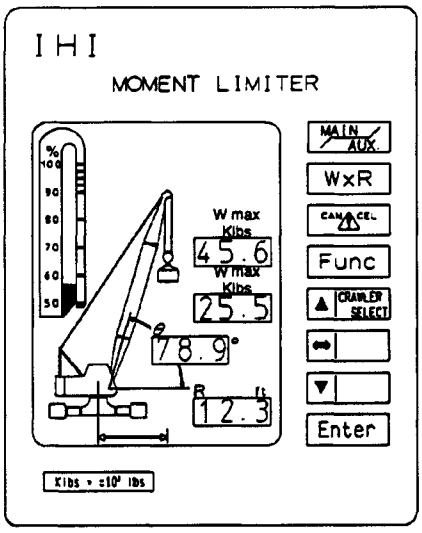
When pressing the Enter key, the displayed values are stored as the new set data and the function selection menu is automatically displayed.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [1] to [8] are ignored and the function selection menu is automatically set without the data change.

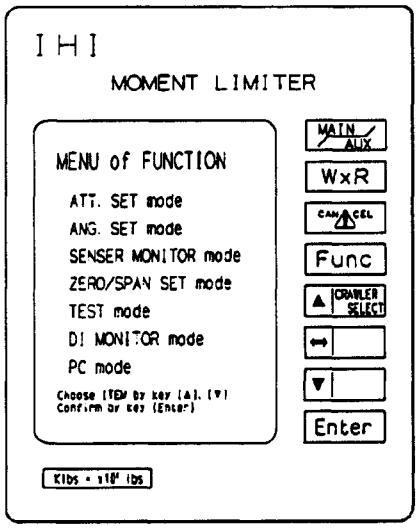
When the CANCEL key is pressed, the working conditions are not changed. Be careful.

Press the Func or CANCEL key once to return from the function selection menu to the standard menu.

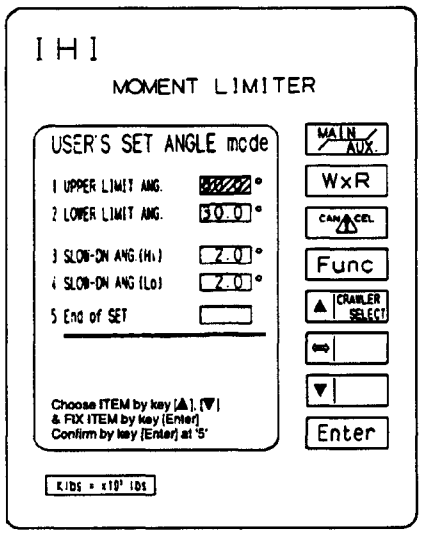
Standard menu



Function selection menu



Optional angle setting menu



3. Optional auto stop or alarm angle setting

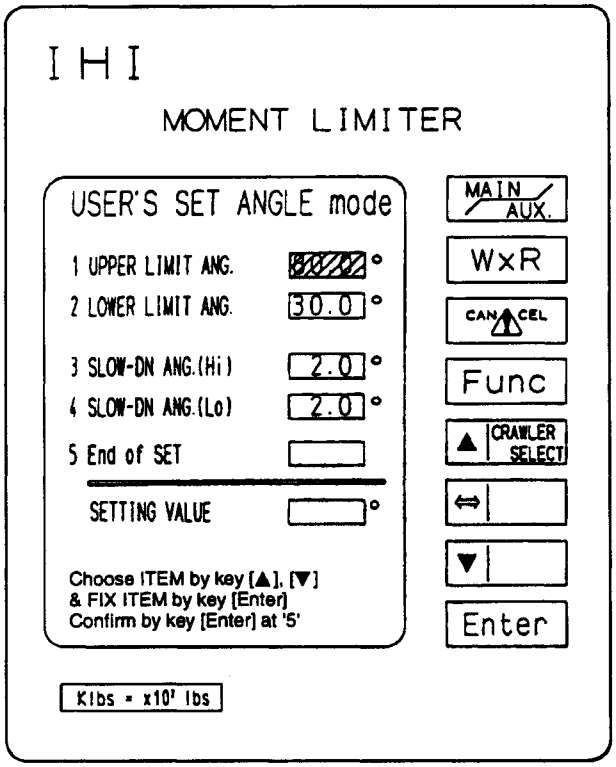
   If you want to set an optional angle, proceed from the function selection menu to the optional angle setting menu.

   Press the [Func] key once if changing from the standard menu to the function selection menu.

   Press the [CANCEL] or [Func] key once if changing from the function selection menu to the standard menu.

   (1) If changing from the function selection menu to the optional angle setting menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reversed display) to "ANG. SET mode". Then, press the [Enter] key.

Optional angle setting menu



(2) Setting of the boom optional upper limit angle

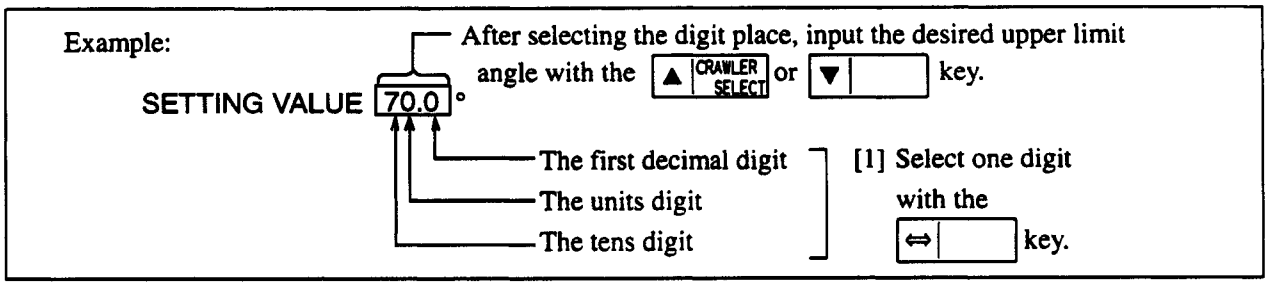
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "UPPER LIMIT ANG." Normally, the cursor is at "UPPER LIMIT ANG." when the optional angle setting menu is displayed.

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode, change menu by the ⇔ key, choose value by [▲], [▼] provisional DECISION by Enter .

[4] After setting the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.



In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "7" to the tens digit, so the boom optional upper limit angle is set to 70.0°. Set this angle to 80.0° or higher if not necessary.

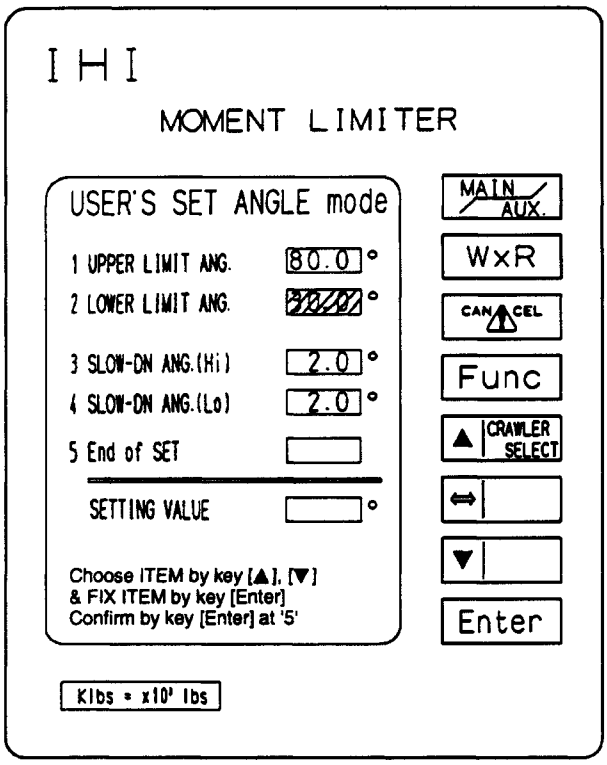
[5] After setting the boom optional upper limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "UPPER LIMIT ANG." column. If you want to stop setting the value, press the CANCEL key.

In the machine with the optional angle automatic stop function, when the boom has reached the set upper limit angle (70.0° in the above example), the alarm sounds and the boom hoisting stops.

In the machine without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 80.0°, the boom stops automatically and the alarm sounds.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional angle setting menu



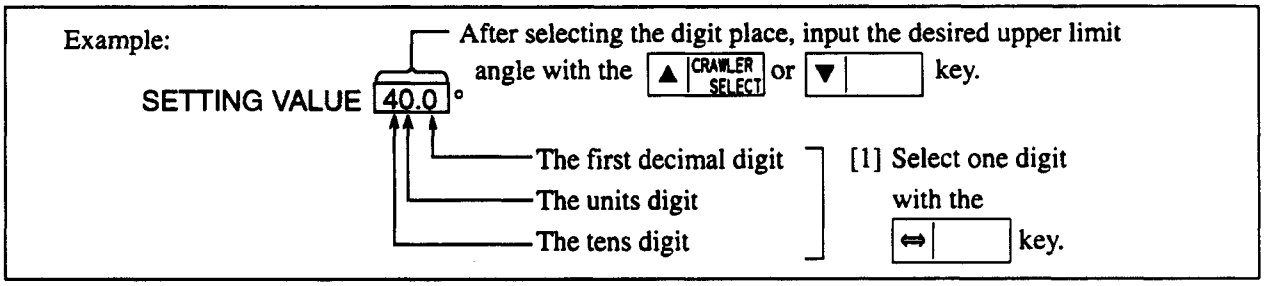
(3) Setting of the boom optional lower limit angle

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed display) to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After setting the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.



In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "4" to the tens digit and so the boom optional lower limit angle is set to 40.0°. Set this angle to 30.0° or lower if not necessary.

[5] After setting the boom optional lower limit angle in three digits, press the Enter key once.

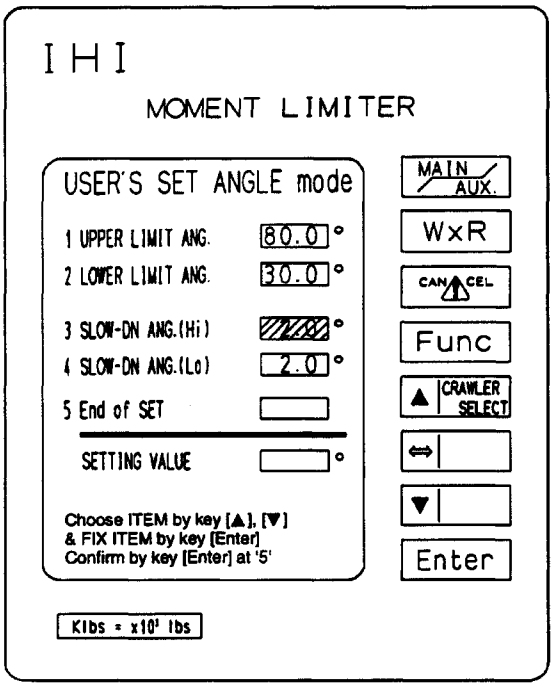
The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you want to stop setting the value, press the CANCEL key.

In the machine with the optional angle automatic stop function, when the boom has reached the set lower limit angle (40° in the above example), the alarm sounds and the boom lowering stops.

In the machine without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 30°, the boom stops automatically and the alarm sounds.

The machine with the "optional angle automatic stop" switch can use stop and "only alarm" properly.

Optional angle setting menu



(4) Setting of upper limit angle of gentle stop

This item is not displayed if this function is not installed on the machine.

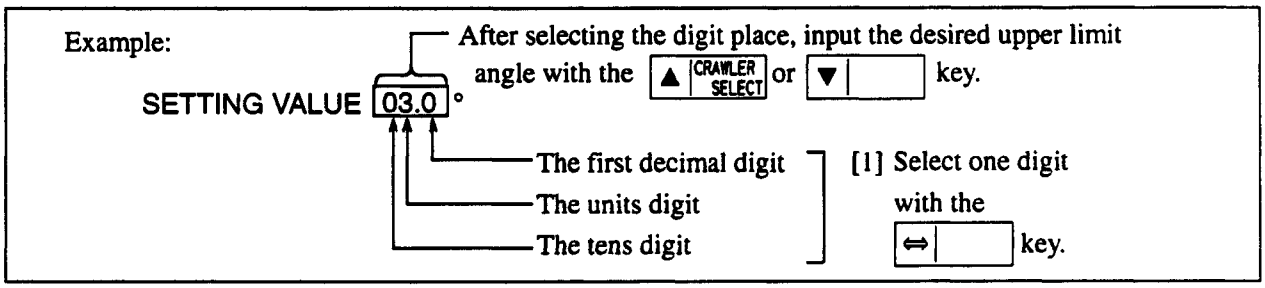
This function sets the optional angle at which the gentle operation (slow down) starts before the boom stops automatically when the boom is hoisting.

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (HI)".

[2] Press the Enter key once. The editing mode for setting the gentle operation angle is ready.

[3] Each time the ⇔ key is pressed, cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After setting the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ to input the desired value.



In the above example, "0" is inputted to the first decimal digit, "3" to the units digit and "0" to the tens digit and so the upper limit gentle operation angle is set to 3°. If the gentle operation is not necessary, set the angle (0.00). Normally, the standard is approximately 2°.

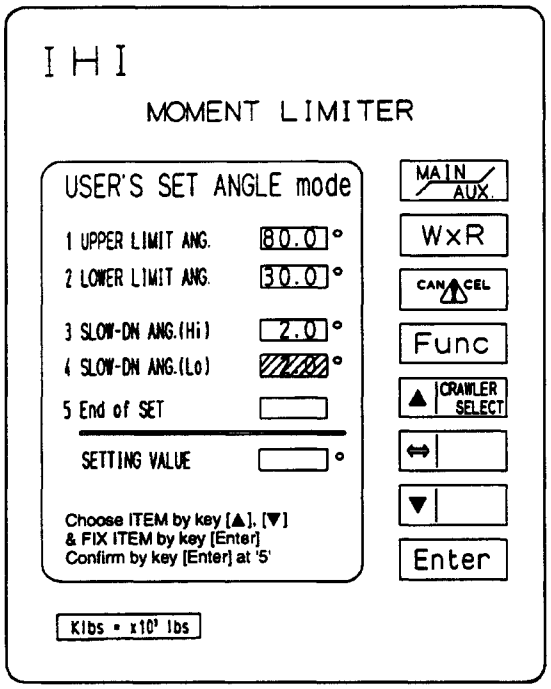
[5] After setting the upper limit gentle operation angle in three digits, press the Enter key once.

The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you want to stop setting the value, press the CANCEL key.

In the example of (2), the boom optional upper limit angle is set to 70°, and in the above example, the upper limit gentle operation angle is set to 3°. In such a case, the boom hoisting speed slows down when the boom angle is 67° and the boom hoisting stops automatically and the alarm sounds when the boom angle is 70°.

In the machine without the automatic stop function, the hoisting speed slows down at the boom angle of 67° and the alarm sounds at the boom angle of 70°. The boom hoisting stops automatically at the boom angle of 80°. On the machine without the automatic stop and slow-down function, only the alarm sounds.

Optional angle setting menu



(5) Setting of lower limit angle of gentle stop

This item is not displayed if this function is not installed on the machine.

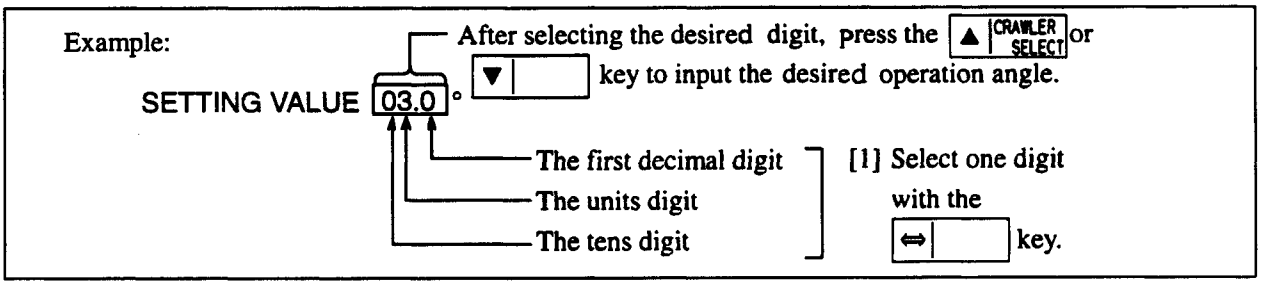
This function sets the optional angle at which the gentle operation (slow down) starts before the boom stops automatically when the boom is lowering.

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the gentle operation angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After setting the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.



In the above example, "0" is inputted to the first decimal digit, "3" to the units digit and "0" to the tens digit and so the boom lower limit gentle operation angle is set to 3°. If the gentle operation is not necessary, set the angle (0.00). Normally, the standard is approximately 2°.

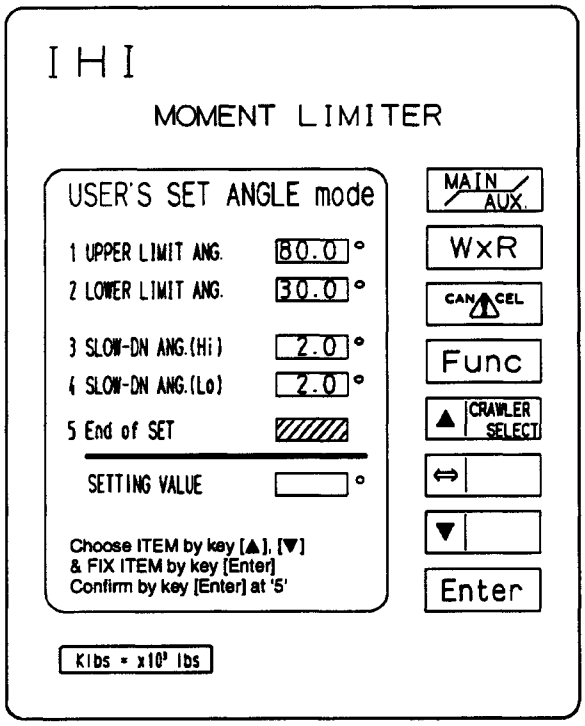
[5] After setting the optional lower limit gentle operation angle in three digits, press the Enter key once.

The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you want to stop setting the value, press the CANCEL key.

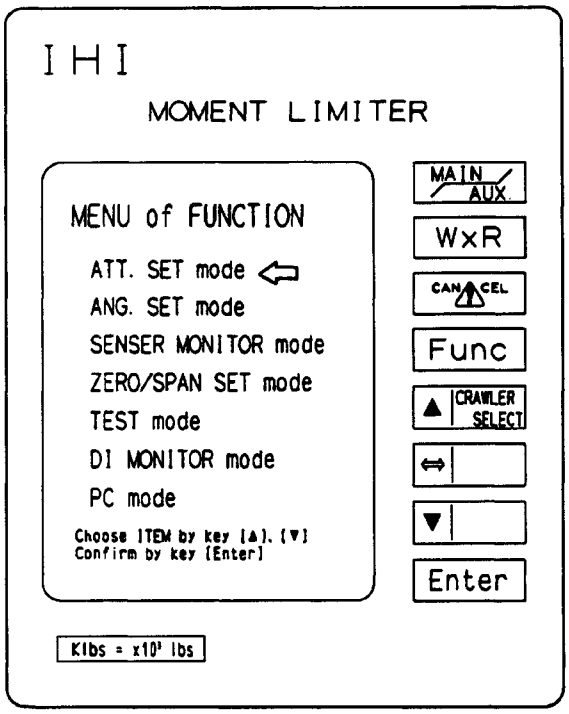
In the example of (3), the optional lower limit angle is set to 40°, and in the above example, the lower limit gentle operation angle is set to 3°. In such a case, the lowering speed slows down when the boom angle is 43° and the boom lowering stops automatically and the alarm sounds when the boom angle is 40°.

In the machine without the automatic stop function, the lowering speed slows down at the boom angle of 43° and the alarm sounds at the boom angle of 40°. The boom lowering stops automatically at the boom angle of 30°. On the machine without the automatic stop and slow-down function, only the alarm sounds.

Optional angle setting menu



Function selection menu



(6) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of items (2) to (5):

- The value of the boom upper limit angle
- The value of the boom lower limit angle
- The value of the upper limit gentle operation angle
- The value of the lower limit gentle operation angle

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

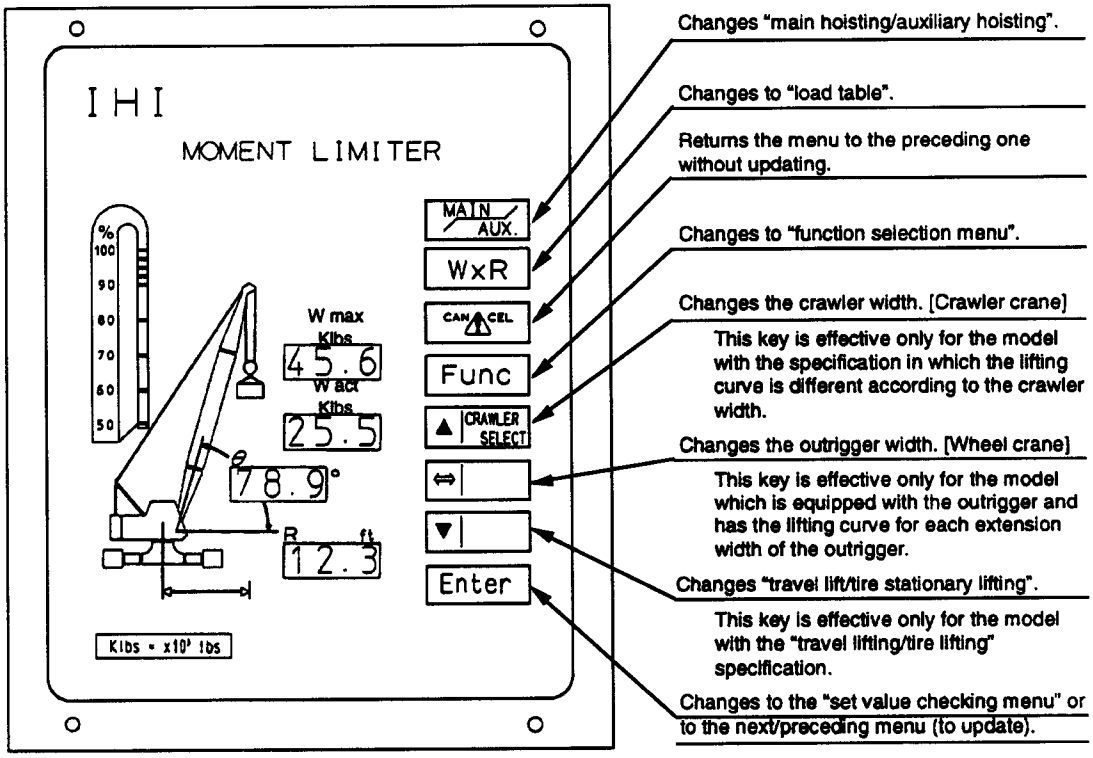
[4] If you want to stop setting, press the CANCEL key before pressing the Enter key.

If you want to change the function selection menu to the standard menu, press the Func or CANCEL key once.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned (1) to (8) are ignored and the function selection menu is automatically set without the data change.

When the CANCEL key is pressed, the working conditions are not changed. Be careful.

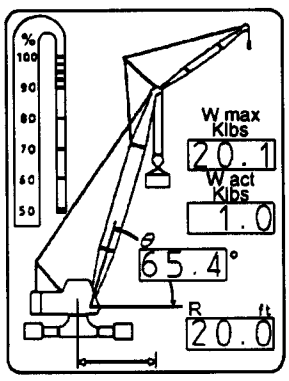
4. Standard menu and operation keys



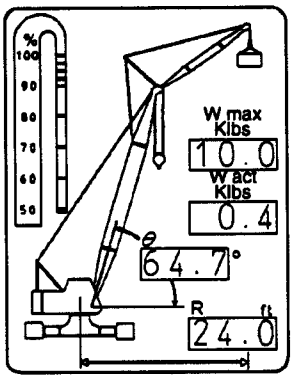
Standard menu

(1) Main/auxiliary selector key switch - MAIN AUX

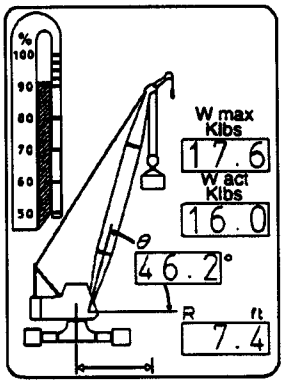
Press the main/auxiliary selector key switch MAIN AUX , the main hoisting work menu is changed to the auxiliary hoisting work menu. Press the MAIN AUX key again, and the menu is changed to the main hoisting work menu. Select the proper menu according to the actual crane configuration. It is not permissible to lift loads with the main hook and the jib hook at the same time.



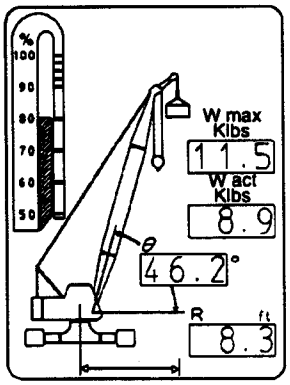
Main hoisting work with jib



Jib work



Main hoisting work with 1m jib

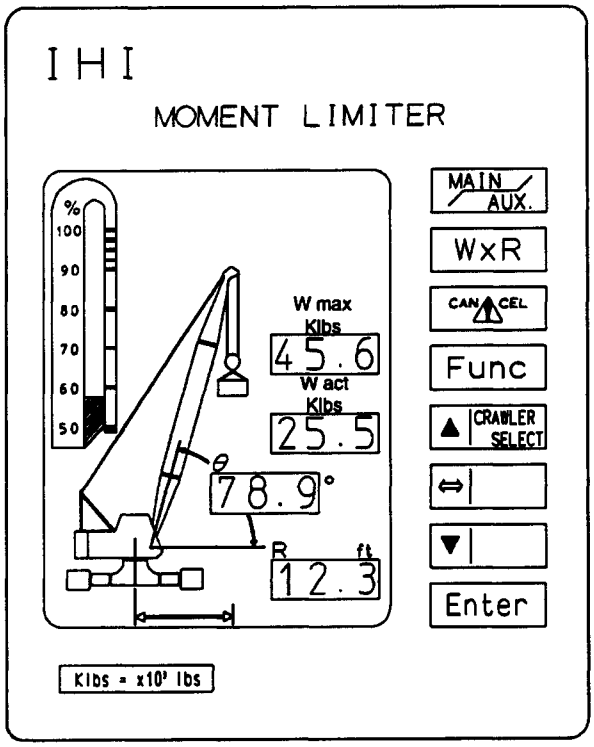


1m jib work

The values in the display unit are reference values required for the explanation. They have nothing to do with an actual lift.

(2) The selector switch to the load table - WxR

Standard menu



[1] Press the WxR switch once on the standard menu, and the load table is displayed. On the load table display, press the WxR or CANCEL key once and the standard menu appears.

The load table displays the following five items:

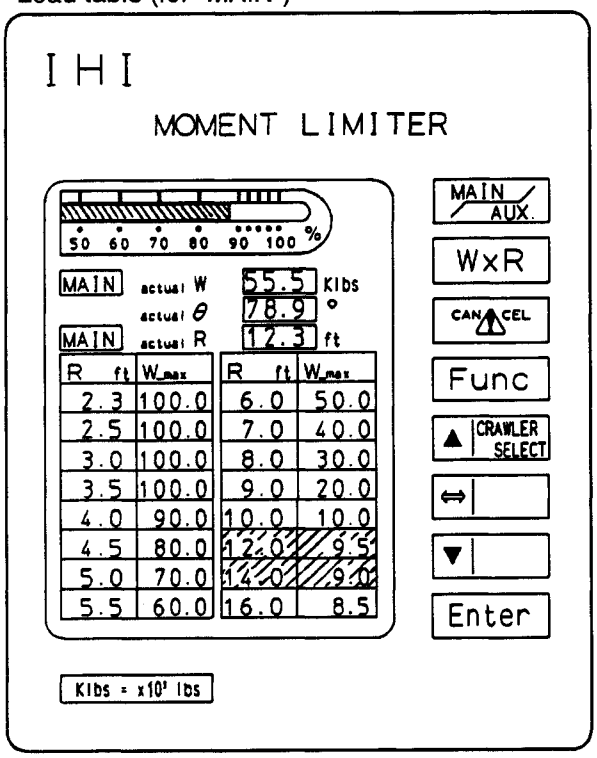
- Actual load for the main or auxiliary hoisting . . . . . Klbs
- Boom angle . . . . . °
- Working radius for the main or auxiliary hoisting . . Ft
- Working radius/allowable load table . . . . . Ft/klbs
- Load ratio. . . . . %

Select configuration, Main or Aux. hoist.

The following illustration is the "MAIN" table.

If you want the "AUX." table, press the MAIN AUX key switch.

Load table (for "MAIN")



[2] Working radius/allowable load table

In the load table, the shaded area of the working radius/allowable load table indicates the current crane working radius and allowable load.

The actual working radius is 12.3 ft. and is within the shaded area (12.0 ft. to 14.0 ft.). The operator can view the current working radius and allowable load according to this table.

If you want to display the data after 16.0 ft. for the working radius, press the ⇔ key once. The next data are displayed. If you want to return to the original data, press the ⇔ key.

[3] The upper bar graph on the screen indicates the ratio (load ratio) of the crane's current load (actual value) and the allowable value.

(3) Cancel key switch [CANCEL]

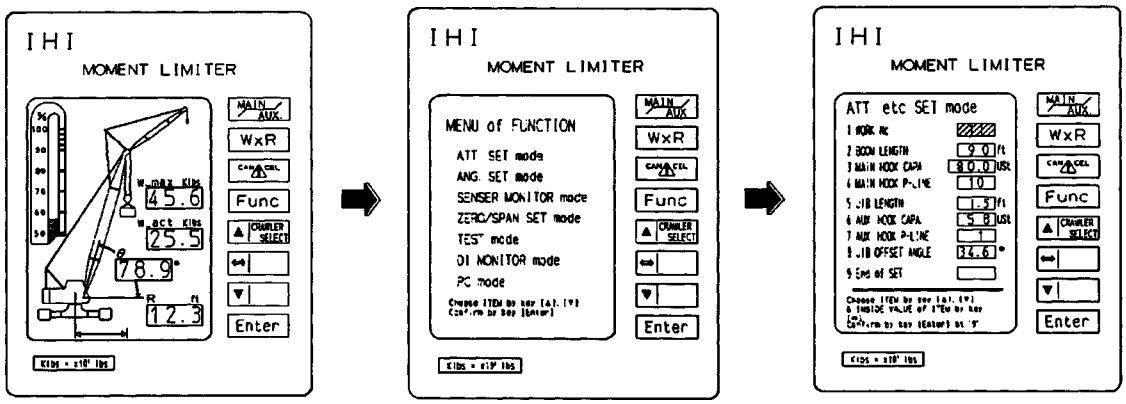
Press this key in the middle of setting for the crane working conditions or optional angle as mentioned above, and the setting operation stops and the original condition, before setting, is restored.

(4) The key switch to change to the function selection menu [Func]

When the working conditions have to be set, change the standard menu to the function selection menu and then select the desired items in the function selection menu with the cursor. Press the [Func] key once in the standard menu, and the function selection menu is displayed.

In the function selection menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reversed cell) to the desired item.

For example, set the cursor to "ATT. SET mode" and press the [Enter] key once. Then, "ATT. etc. SET mode" (working radius setting mode) is displayed.



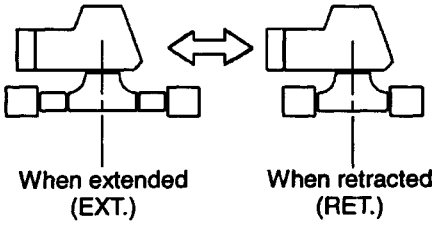
Standard menu | Function selection menu | Setting menu (ATT. etc SET mode)

Refer to "2. Setting of the working conditions" (page 1-71) for how to set the working conditions and how to return from the setting menu to the function selection menu. If the function selection menu has to be changed to the standard menu, press the [Func] or [CANCEL] key once.

(5) The key switch to change the crawler width [▲ CRAWLER SELECT]

On the crawler crane, this key is effective only for the model which rated overall lifting load is changed according to the crawler width. Press the [▲ CRAWLER SELECT] key once in the standard menu, and the illustrated crawler width is retracted. Press the key again, and the crawler width is extended.

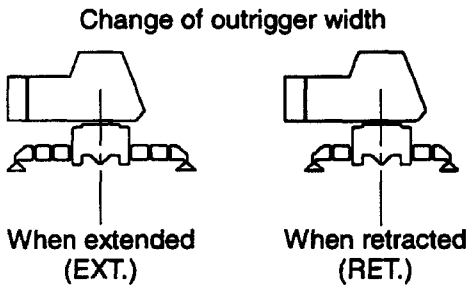
Change of crawler width



When extended (EXT.) | When retracted (RET.)

On the machine without the crawler width change specification, set the crawler width to the extended position. If the crawler width is retracted, "E114" is displayed and the alarm sounds. This key switch does not work on the wheel type.

(6) The key switch to change the outrigger width ⇔ (Wheel crane)

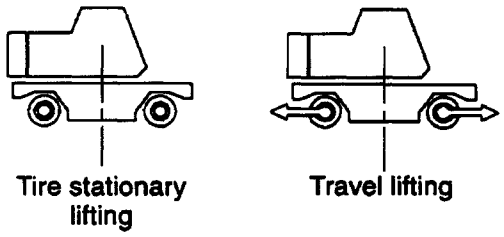


This key switch works when tires are used for the travelling unit. Press the key once, and the illustrated outrigger width is retracted. Press the key again, and the outrigger width is extended.

On the machine with outriggers, set the displayed picture to the machine current configuration.

On the crawler crane, this switch is used for setting the working conditions, etc.

(7) The key switch to change "tire stationary lifting/travel lifting" ▼ (Wheel crane)



This key switch works when tires are used for the travelling unit. Press the key once, and the displayed picture is changed to "travel lifting". Press the key again, and the displayed picture is changed to "tire stationary lifting".

On the crawler crane, this switch is used for setting the working conditions, etc.

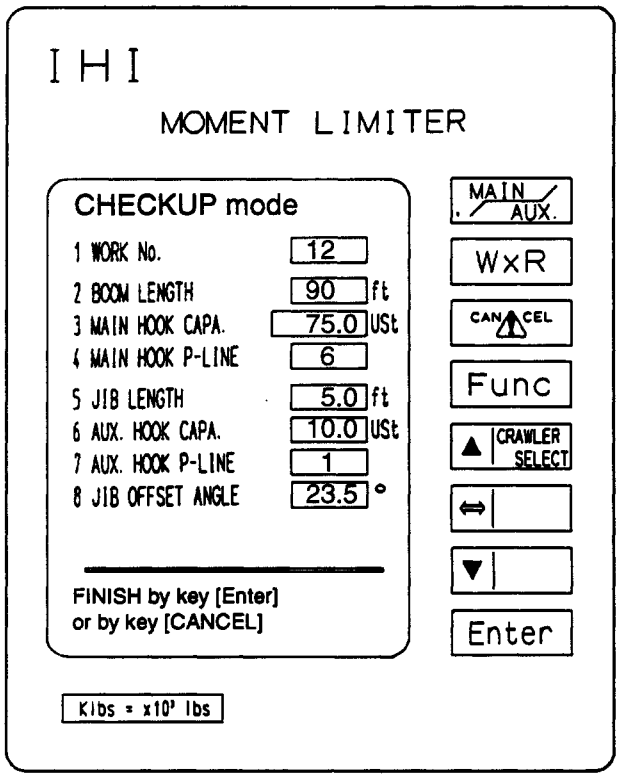
(8) The key switch to change to "set value checking menu" or to the next/preceding menu (to update)

Press the Enter key once in the standard menu, and the "Attachment setting" menu, which was set in the above mentioned "ATT etc. SET mode" menu, is displayed.

Press the Enter or CANCEL key in the setting menu, and the standard menu is restored.

In the set value checking menu, the operator can check the following values which were set in "Setting of the working conditions": Work No., boom length, main hook capacity, part of line for main hook, jib length, auxiliary hook capacity, part of line for auxiliary hook, jib offset angle.

Set value checking menu



In this menu, the operator can check the following eight items which are set currently.

1. Work No.
2. Boom length
3. Main hook capacity
4. Main hook: parts of line
5. Jib length
6. Auxiliary hook capacity
7. Auxiliary hook: parts of line
8. Jib offset angle

After checking the data, press the Enter or CANCEL key. The standard menu is restored.

5. Error messages and error codes

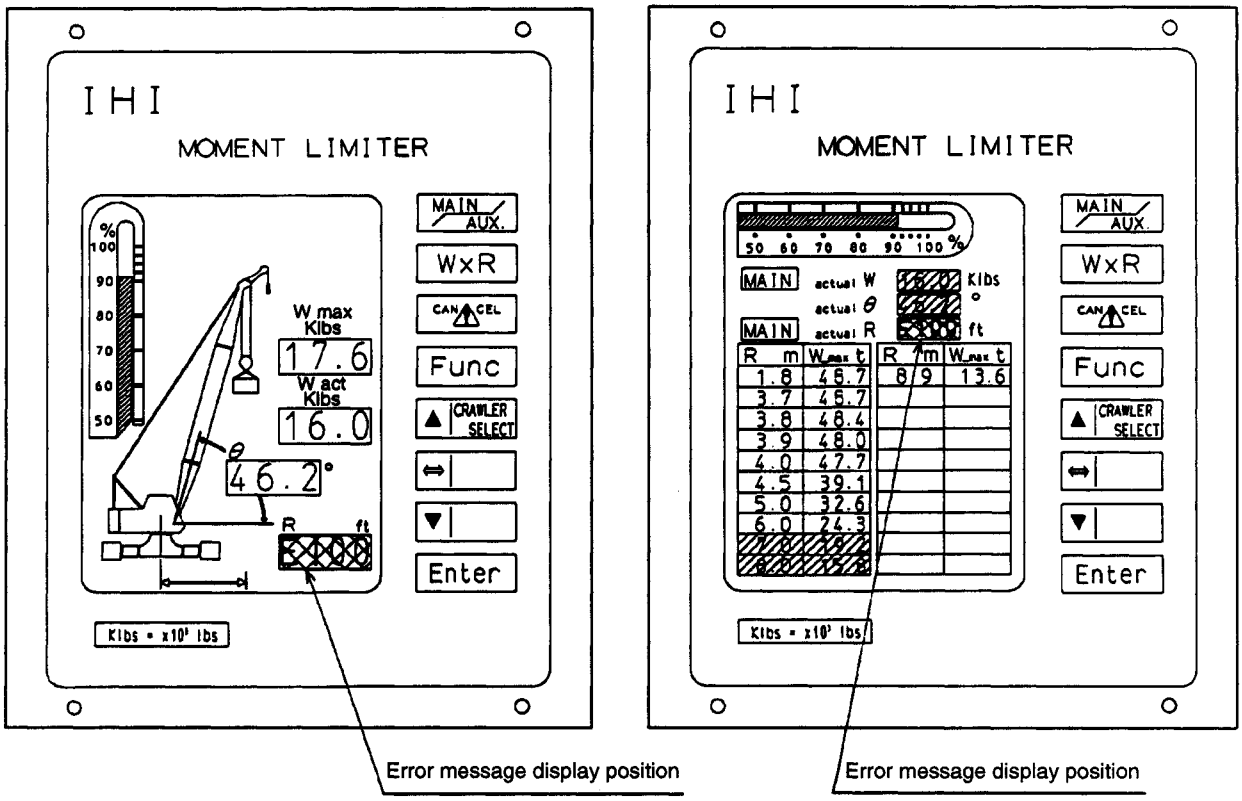
If a working condition inapplicable to the specification is set or if the sensor output is defective in the overload prevention device (moment limiter), the error is displayed on the screen.

The error is displayed as "Exxx" in the working radius column. The error display blinks and an alarm is heard. Refer to the illustrations on the next page.

The error codes and remedial measures are shown in the following table.

Error Code Table

Error No.	Causes	Check and Remedial Measures
EEEE	DSP (CPU) is defective.	Should repair or replace
E100	Boom angle detector is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the angle meter
E102	The load cell sensor is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the load cell
E114	The load table does not exist.	Check the set data Check the crawler width, etc.
E120	The communication is not proper between the CPU and the display unit.	Should repair or replace
E121	The memory is defective in the CPU.	Should repair or replace
E122	The internal mode selector LS is defective.	Should repair or replace

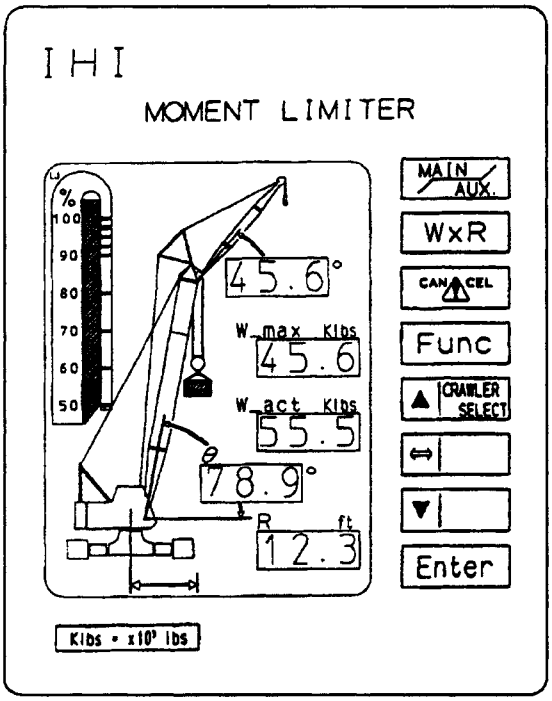


In both of the above illustrations, the error message is displayed as "E100" in the working radius column. "E100" blinks and an alarm is heard. Refer to "Error Code Table" for the causes and remedial measures of the errors.

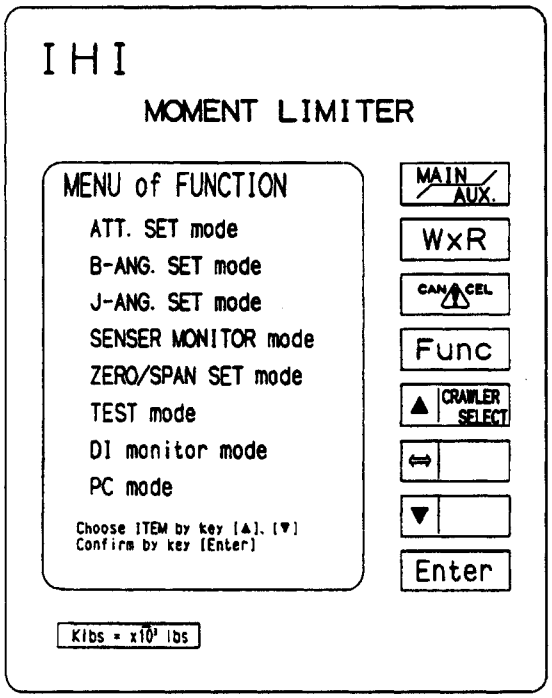
Setting of working conditions - luffing jib crane

1. The "power on" and subsequent procedure up to the display of the standard menu for handling the moment limiter mode switches (1) to (4) is the same as the standard crane, but the display contents show the items of the luffing jib crane.

Starting menu (Luffing jib crane)



Function selection menu



(4) After 5 seconds since the starting menu was displayed, the menu is changed to the standard menu. The standard menu shows the following items:

- Load ratio . . . . . %
- Jib angle . . . . . °
- Rated overall lifting load . . . . . Klbs (allowable load)
- Actual load. . . . . Klbs
- Boom angle . . . . . °
- Working radius. . . . . Ft.

(5) The standard menu is displayed for "boom lifting". If the operator has to change to "jib lifting", press the [MAIN AUX.] key switch. The load of "boom lifting" as illustrated at left moves to the jib side.

(6) If the sensor malfunctions or if the working radius is set incorrectly, the Error No. is displayed in the column of the working radius. Make sure that the Error No. is not displayed.

2. Setting of the working conditions

(1) Press the [Func] key once in the standard menu, and the function selection menu as illustrated at left is displayed. If you want to return to the standard menu, press the [Func] or [CANCEL] key once.

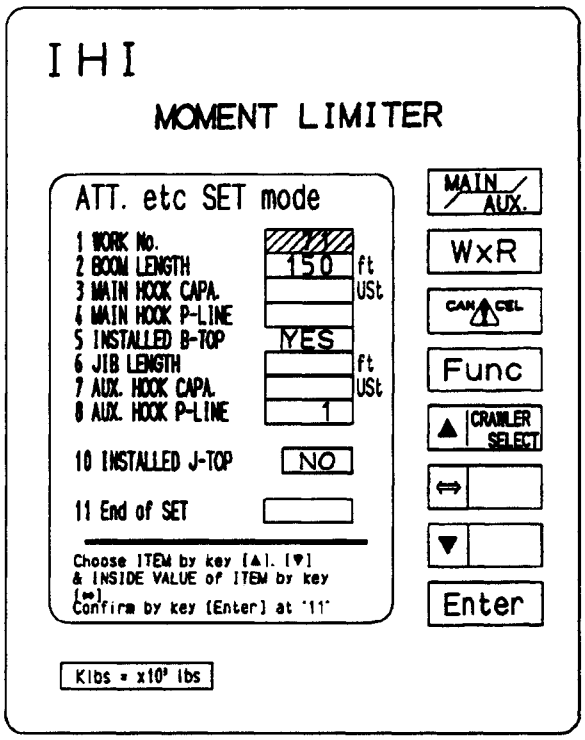
(2) Proceed to the setting menu from the function selection menu.

In the function selection menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (Reversed display) to "ATT. SET mode". Normally, the cursor is at "ATT. SET mode" when the function selection menu is displayed.

Press the [Enter] key once.

When pressing the [Enter] key, the menu is changed to the following setting menu (as shown at left).

Setting menu



(3) Set the working condition on the setting menu.

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "WORK No." The item with the cell is reversed.

[1] Press the ⇔ key to set the value of the current attachment for "WORK No."

Luffing jib crane Work Number 71

Each time the ⇔ key is pressed, the data included in the specification are displayed in order. Select a proper number.

[2] Setting of the boom length

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "BOOM LENGTH". Press the ⇔ key to set the proper value for the length of the current boom.

Each time the ⇔ key is pressed, the boom length data included in the specification are displayed in order.

[3] Setting of the main hook capacity

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK CAPA."

Press the ⇔ key to set the value of the current hook capacity.

Each time the ⇔ key is pressed, the main hook capacity data included in the specification are displayed in order. If the main hook is not installed, select "0.0".

[4] Setting of the part of line for the main hook

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK P-LINE".

Press the ⇔ key to set the part of line for the current main hook.

Each time the ⇔ key is pressed, the "part of line" data included in the specification are displayed in order. If the main hook is not installed, select "1".

[5] Setting of the boom top sheave

When Work No. 71 is set, "INSTALLED B-TOP" is automatically selected YES, and the cursor moves to "JIB LENGTH".

[6] Setting of the jib length

Press the ▲CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "JIB LENGTH" . Press the ⇔ key to set the value of the current jib length.

Each time the ⇔ key is pressed, the jib length data included in the specification are displayed in order. On the luffing jib crane, the hook which is mounted on the tower jib is the auxiliary hook.

[7] Setting of the auxiliary hook capacity

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "AUX. HOOK CAPA." Press the ⇔ key to set the value of the current auxiliary hook capacity.

Each time the ⇔ key is pressed, the auxiliary hook capacity data included in the specification are displayed in order. If the auxiliary hook is not installed, select "0.0". When the auxiliary jib length is already set in (6), set the hook capacity of auxiliary.

[8] Setting of the part of line for the auxiliary hook

Press the ▲CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "AUX. HOOK P-LINE". Press the ⇔ key to set the part of line for the current auxiliary hook.

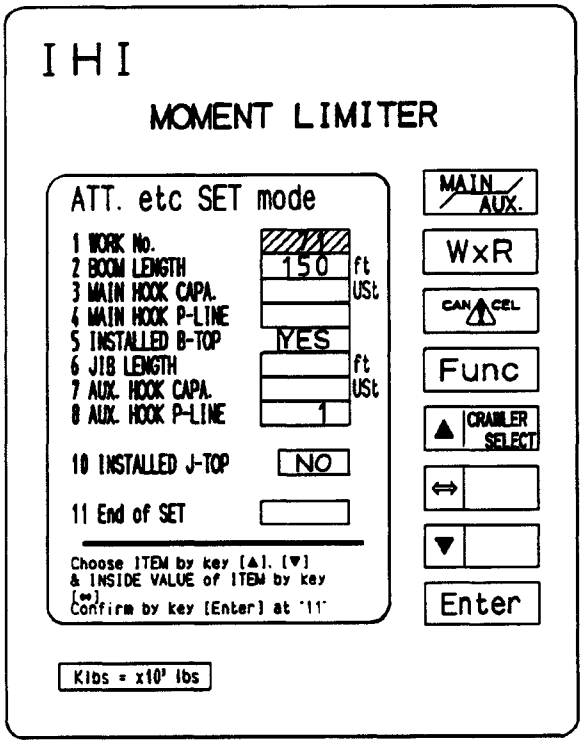
Each time the ⇔ key is pressed, the "part of line" data included in the specification are displayed in order. If the auxiliary hook is not installed, select "1". When the auxiliary jib length is already set in (6), set the parts of line of auxiliary hook.

[9] Setting of the jib top

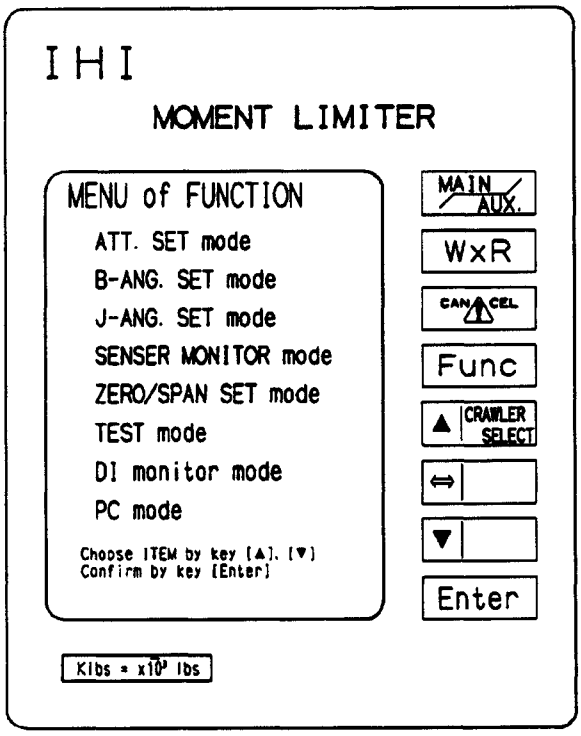
Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "INSTALLED J-TOP".

Press the ⇔ key to set the "NO". Jib top cannot be set.

Setting menu



Function selection menu



(4) Check of the set values

Make sure that the values set at the aforementioned [1] to [9] are set to the crane configuration.

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET" and press the Enter key.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

When pressing the Enter key, the displayed values are stored as the new set data and the function selection menu is automatically displayed.

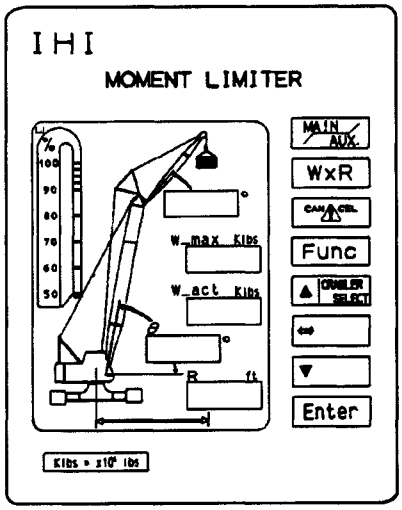
When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [1] to [9] are ignored and the function selection menu is automatically set without the data change.

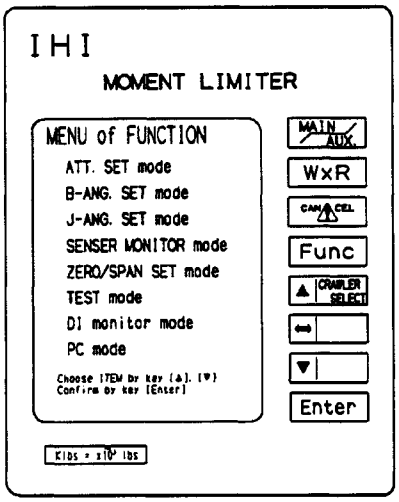
When the CANCEL key is pressed, the working conditions are not changed. Be careful.

Press the Func or CANCEL key once to return from the function selection menu to the standard menu.

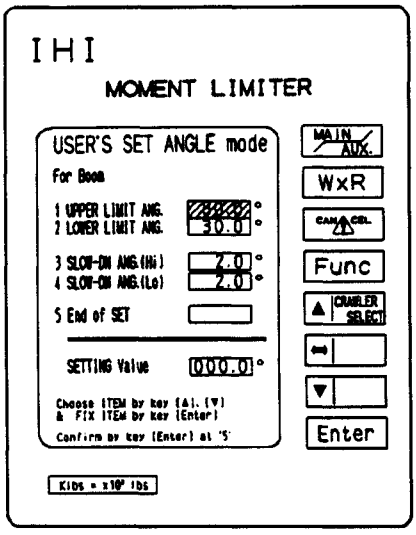
Standard menu



Function selection menu



Optional angle setting menu (for boom)



3. Optional auto stop or alarm angle setting

   If you want to set an optional angle, proceed from the function selection menu to the optional angle setting menu.

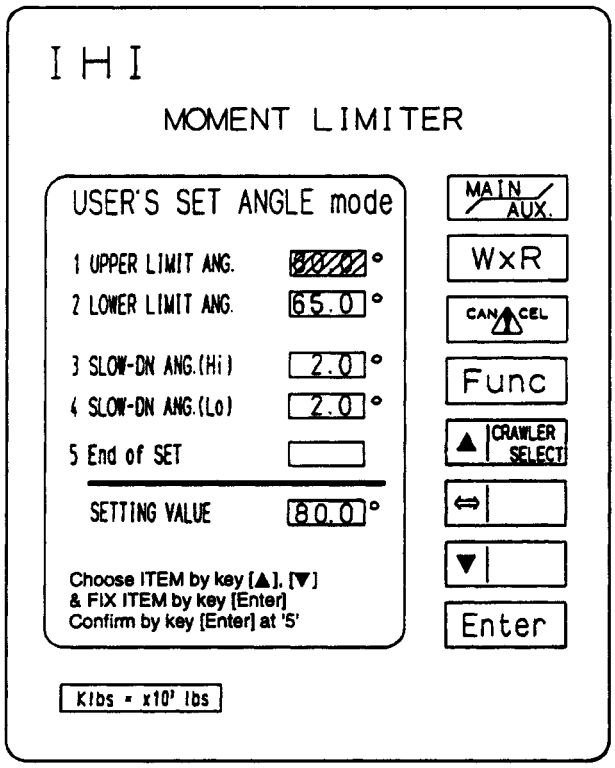
   Press the [Func] key once if changing from the standard menu to the function selection menu.

   Press the [CANCEL] or [Func] key once if changing from the function selection menu to the standard menu.

   (1) If changing from the function selection menu to the optional angle setting menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reversed display) to "B-ANG. SET mode".

   Then, press the [Enter] key.

Optional angle setting menu



(2) Setting of the boom optional upper limit angle

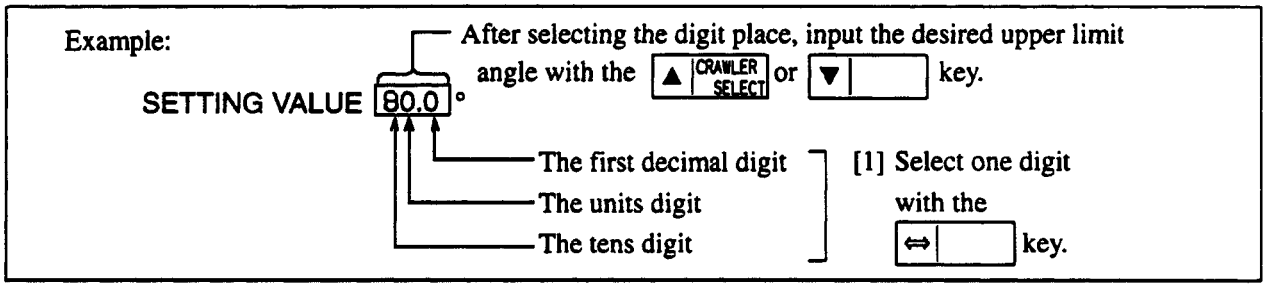
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "UPPER LIMIT ANG." Normally, the cursor is at "UPPER LIMIT ANG." when the optional angle setting menu is displayed.

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode, change menu by the ⇔ key, choose value by [▲], [▼] provisional DECISION by Enter .

[4] After setting the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.



In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "8" to the tens digit, so the boom optional upper limit angle is set to 80.0°. Set this angle to 90.0° or higher if not necessary.

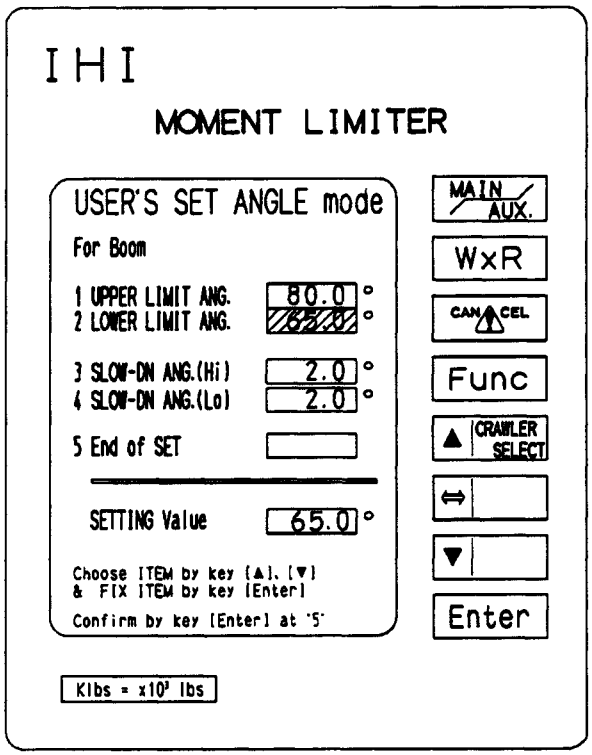
[5] After setting the boom optional upper limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "UPPER LIMIT ANG." column. If you want to stop setting the value, press the CANCEL key.

In the machine with the optional angle automatic stop function, when the boom has reached the set upper limit angle (80.0° in the above example), the alarm sounds and the boom hoisting stops.

In the machine without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 85.0°, in the case of main hoisting work or when the boom has reached 90° in the case of jib hoisting work, the boom stops automatically.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional angle setting menu



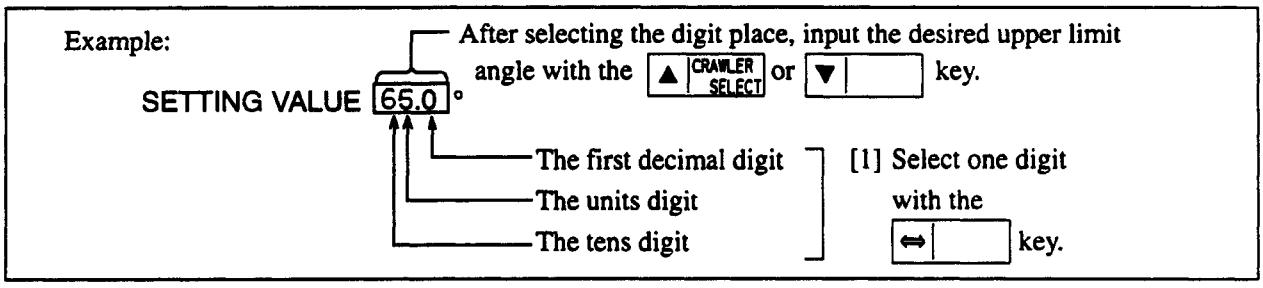
(3) Setting of the boom optional lower limit angle

[1] Press the CRAWLER SELECT ▲ or ▼ key to move the cursor (reversed display) to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After setting the cursor to the desired digit, press the CRAWLER SELECT ▲ or ▼ key to input the desired value.



In the above example, "0" is inputted to the first decimal digit, "5" to the units digit and "6" to the tens digit and so the boom optional lower limit angle is set to 65.0°. Set this angle to 30.0° or lower if not necessary.

[5] After setting the boom optional lower limit angle in three digits, press the Enter key once.

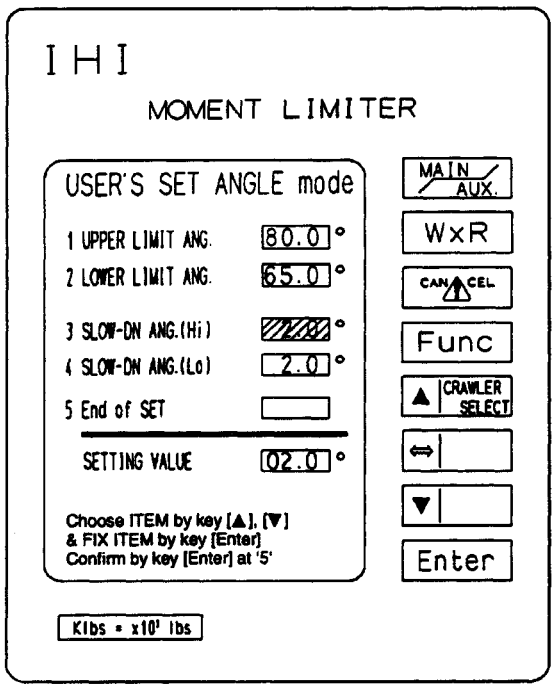
The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you want to stop setting the value, press the CANCEL key.

In the machine with the optional angle automatic stop function, when the boom has reached the set lower limit angle (65° in the above example), the alarm sounds and the boom lowering stops.

In the machine without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached the rated lower limit angle, the boom stops automatically. (Almost 30° in the case of main hoisting, almost 60° in the case of jib hoisting).

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional angle setting menu



(4) Setting of upper limit angle of gentle stop

This item is not displayed if this function is not installed on the machine.

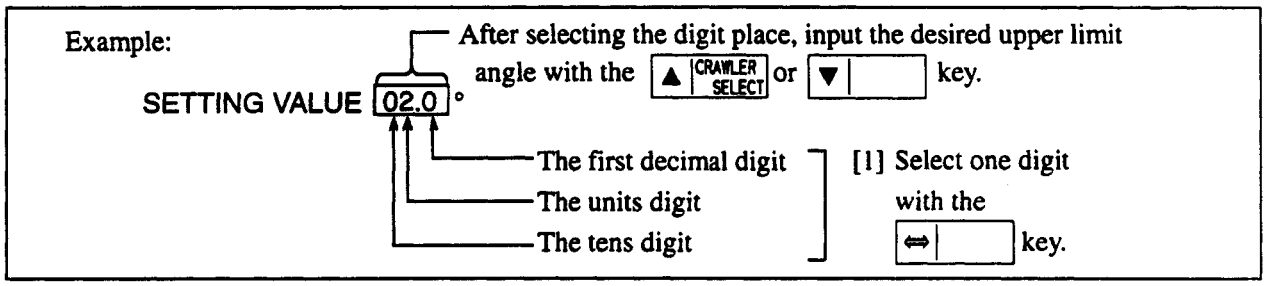
This function sets the optional angle at which the gentle operation (slow down) starts before the boom stops automatically when the boom is hoisting.

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (HI)".

[2] Press the Enter key once. The editing mode for setting the gentle operation angle is ready.

[3] Each time the ⇔ key is pressed, cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After setting the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ to input the desired value.



In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit and so the upper limit gentle operation angle is set to 2°. If the gentle operation is not necessary, set the angle (0.00). Normally, the standard is approximately 2°.

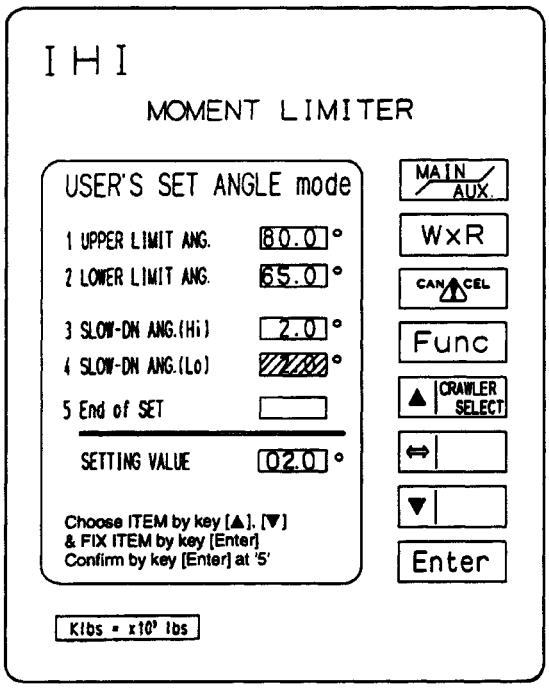
[5] After setting the upper limit gentle operation angle in three digits, press the Enter key once.

The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you want to stop setting the value, press the CANCEL key.

In the example of (2), the boom optional upper limit angle is set to 80°, and in the above example, the upper limit gentle operation angle is set to 2°. In such a case, the boom hoisting speed slows down when the boom angle is 78° and the boom hoisting stops automatically and the alarm sounds when the boom angle is 80°.

In the machine without the automatic stop function, the hoisting speed slows down at the boom angle of 78° and the alarm sounds at the boom angle of 80°. The boom hoisting stops automatically at the boom angle of 85° in the case of main hoisting work or 90° in the case of jib hoisting work.

Optional angle setting menu



(5) Setting of lower limit angle of gentle stop

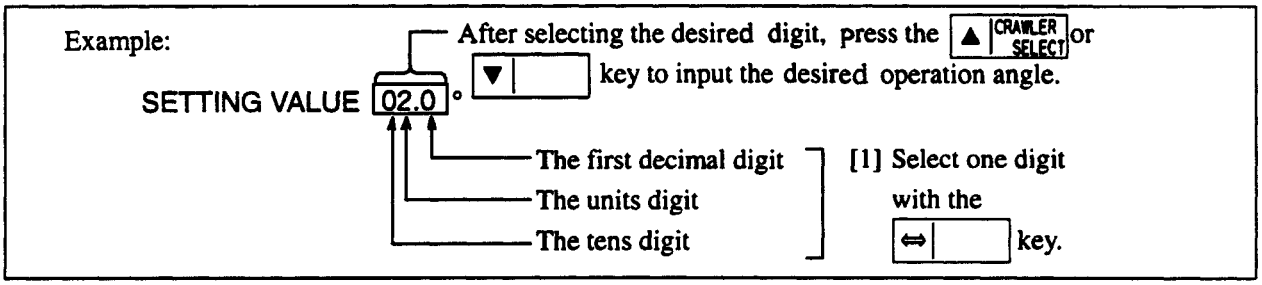
This function sets the optional angle at which the gentle operation (slow down) starts before the boom stops automatically when the boom is lowering.

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the gentle operation angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After setting the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.



In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit and so the boom lower limit gentle operation angle is set to 2°. If the gentle operation is not necessary, set the angle (0.00). Normally, the standard is approximately 2°.

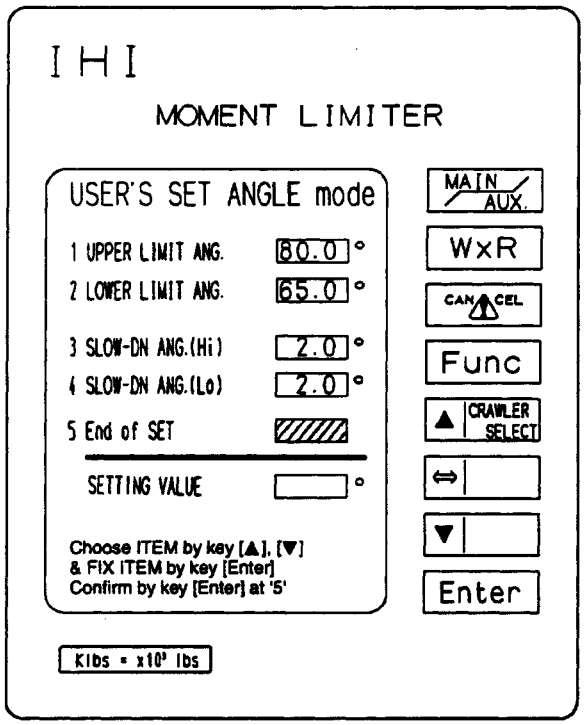
[5] After setting the optional lower limit gentle operation angle in three digits, press the Enter key once.

The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you want to stop setting the value, press the CANCEL key.

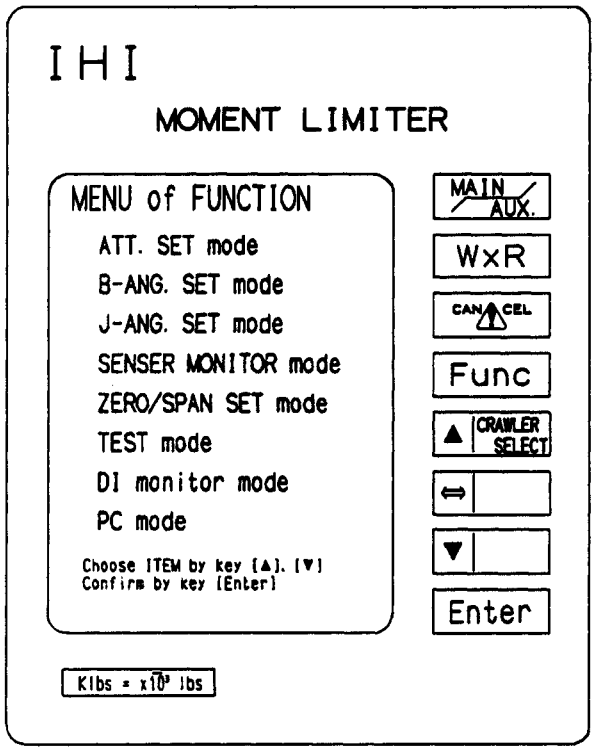
In the example of (3), the optional lower limit angle is set to 65°, and in the above example, the lower limit gentle operation angle is set to 2°. In such a case, the lowering speed slows down when the boom angle is 67° and the boom lowering stops automatically and the alarm sounds when the boom angle is 65°.

In the machine without the automatic stop function, the lowering speed slows down at the boom angle of 67° and the alarm sounds at the boom angle of 65°. The boom lowering stops automatically at the rated boom lower limit angle.

Optional angle setting menu



Function selection menu



(6) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of items (2) to (5):

- The value of the boom upper limit angle
- The value of the boom lower limit angle
- The value of the upper limit gentle operation angle
- The value of the lower limit gentle operation angle

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you want to stop setting, press the CANCEL key before pressing the Enter key.

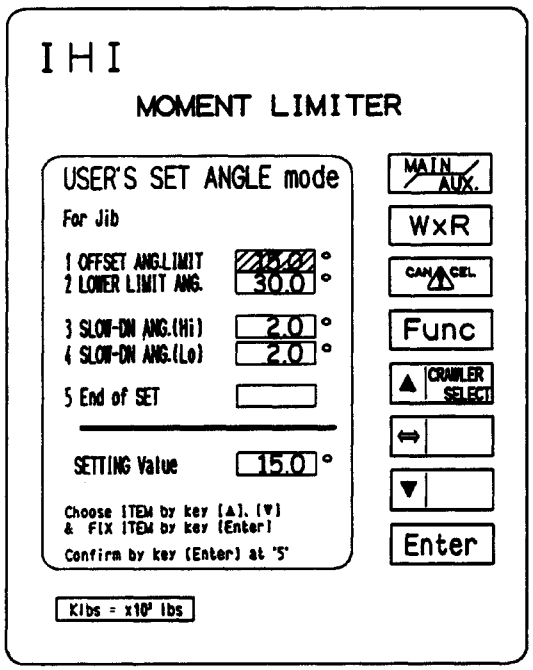
If you want to change the function selection menu to the standard menu, press the Func or CANCEL key once.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned (2) to (5) (USER'S SET ANGLE mode for Boom) are ignored and the function selection menu is automatically set without the data change.

When the CANCEL key is pressed, the working conditions are not changed. Be careful.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

Optional Angle Setting Menu



(7) Setting of the optional offset angle limit for jib

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "OFFSET ANG. LIMIT" Normally, the cursor is at "OFFSET ANG. LIMIT" when the optional angle setting menu is displayed.

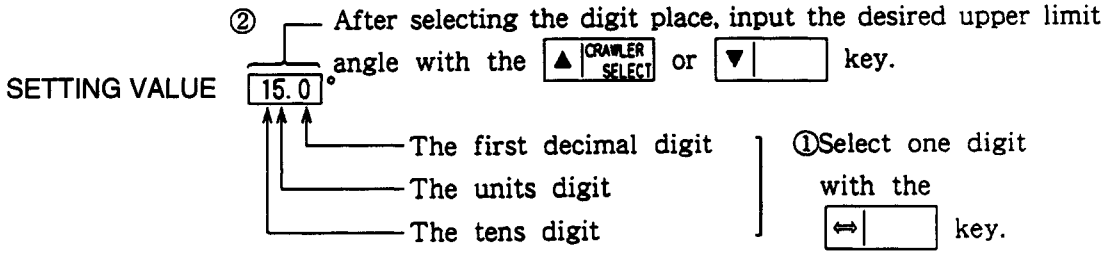
[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode, change menu by key ⇔ choose value by **[▲], [▼]** provisional decision by Enter

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



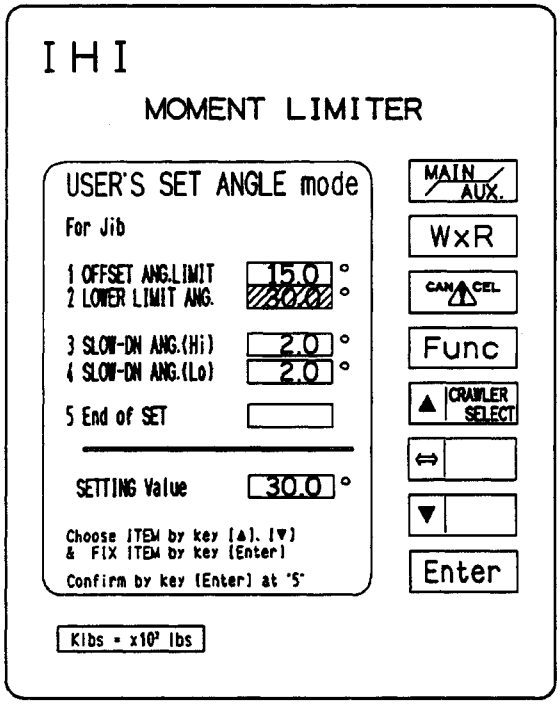
In the above example, "0" is inputted to the first decimal digit, "5" to the units digit and "1" to the tens digit, and so the jib optional offset upper limit angle is set to 15.0°. Set this angle to 10.0° if not necessary.

[5] After setting the jib optional offset upper limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "OFFSET ANG. LIMIT" column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the jib has reached the set jib offset limit angle (15° in the above example), the alarm sounds and the jib hoisting stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the jib has reached the jib offset angle of 10°, the jib stops automatically.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(8) Setting of the jib optional lower limit angle

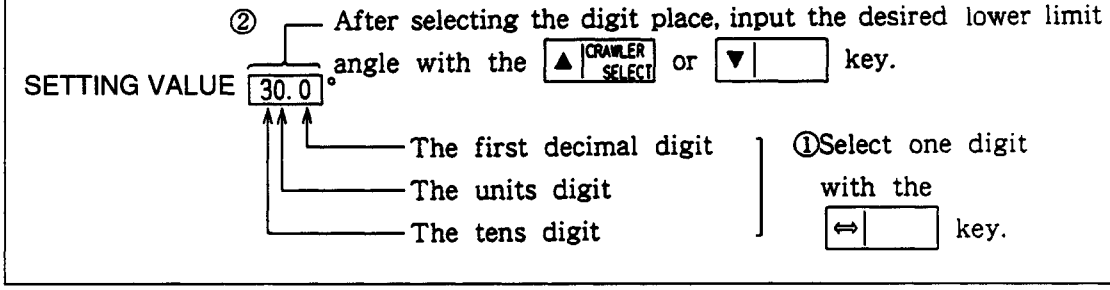
[1] Press the CRAWLER SELECT or ▼ key to move the cursor (reversed display) to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



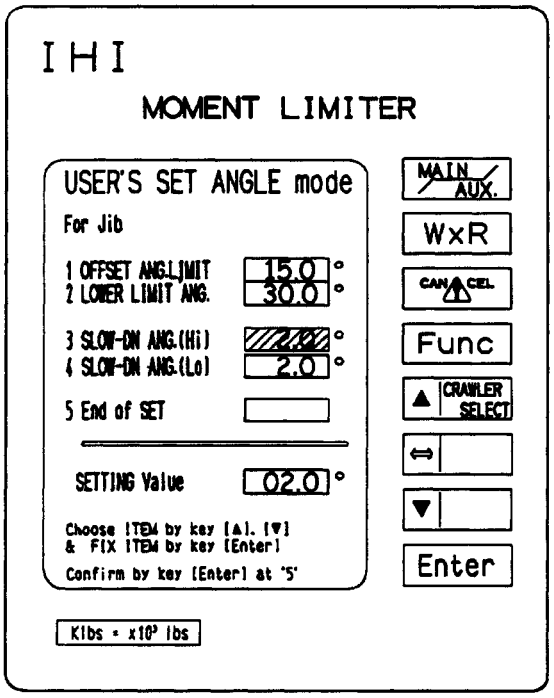
In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "3" to the tens digit, and so the jib optional lower limit angle is set to 30.0° . Set this angle to 15.0° or lower if not necessary.

[5] After setting the jib optional lower limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the jib has reached the set lower limit angle (30° in the above example), the alarm sounds and the jib lowering stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the jib has reached 15°, the jib stops automatically. When the jib has reached the jib rated lower limit angle regardless of the jib optional lower limit angle, it stops automatically. The jib rated lower limit angle is different according to the combination of the boom length and jib length.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(9) Setting of the upper limit gentle operation angle of jib

This function sets the optional angle at which the gentle operation (slow-down) starts before the jib stops automatically when the jib is hoisting.

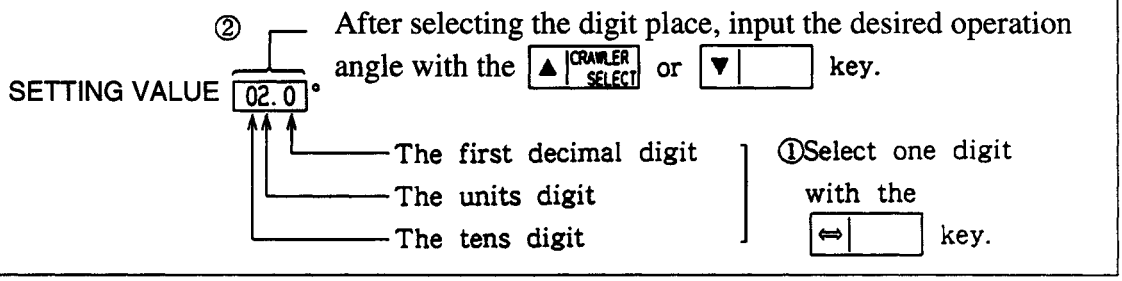
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Hi)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

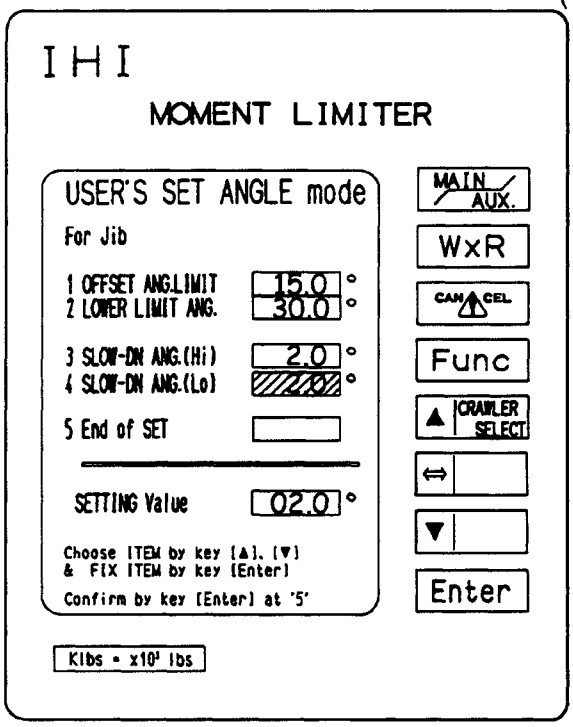


In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the upper limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle (0.00). Normally, the standard minimum slow-down angle is 2.0° .

[5] After setting the upper limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (7), the jib optional offset angle is set to 15°, and in the above example, the upper limit slow-down operation angle is set to 2°. In such a case, the jib hoisting speed slows down when the jib offset angle is 17° and the jib hoisting stops automatically and the alarm sounds when the jib offset angle is 15°.

If the machine is without the automatic stop function, both the hoisting speed slows down and the alarm sounds. But when the jib offset angle has reached 10°, the jib hoisting stops automatically.

Optional Angle Setting Menu



(10) Setting the lower limit of gentle operation angle of jib

This function sets the optional angle at which the gentle operation (slow-down) starts before the jib stops automatically when the jib is lowering.

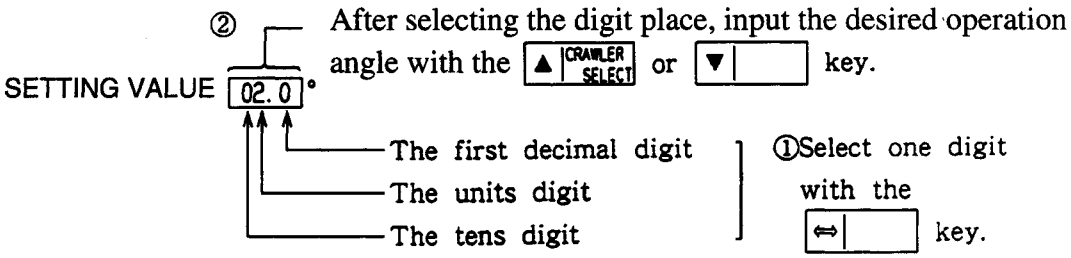
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

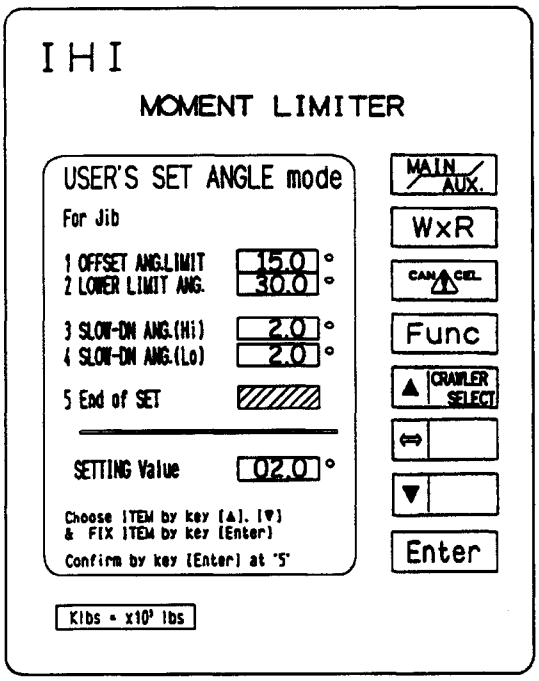


In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the boom lower limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle (0.00). Standard minimum slow-down angle is approximately 2.0° .

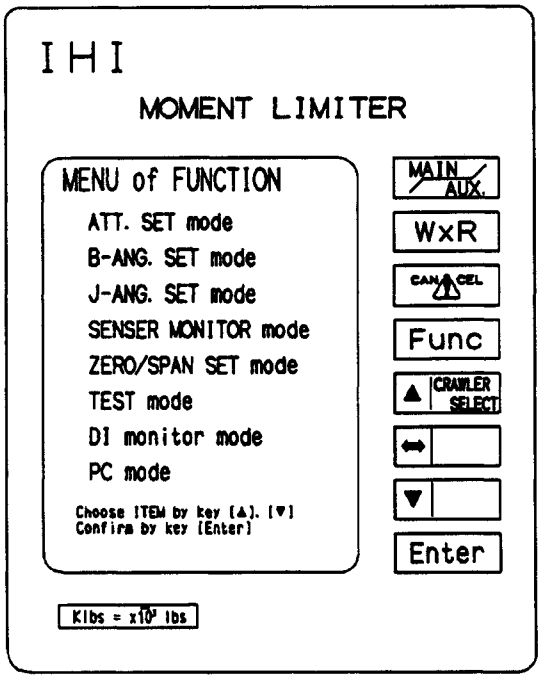
[5] After setting the optional lower limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (8), the optional lower limit angle is set to 30°, and in the above example, the lower limit slow-down operation angle is set to 2°. In such a case, the lowering speed slows down when the jib angle is 32° and the jib lowering stops automatically and the alarm sounds when the jib angle is 30°.

If the machine is without the automatic stop function, the lowering speed slows down at the jib angle 32° and the alarm sounds at the jib angle 30°. The jib lowering stops automatically at the rated jib lower limit angle.

Optional Angle Setting Menu



Function Selection Menu



(11) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of the items (7) ~ (10):

- The value of the jib offset limit angle
- The value of the jib lower limit angle
- The value of the jib slow-down operation angle (Hi)
- The value of the jib slow-down operation angle (Lo)

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you desire to stop setting, press the CANCEL key before pressing the Enter key.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [7] ~ [10] (USER'S SET ANGLE mode for Jib) are ignored and the function selection menu is automatically set without the data change.

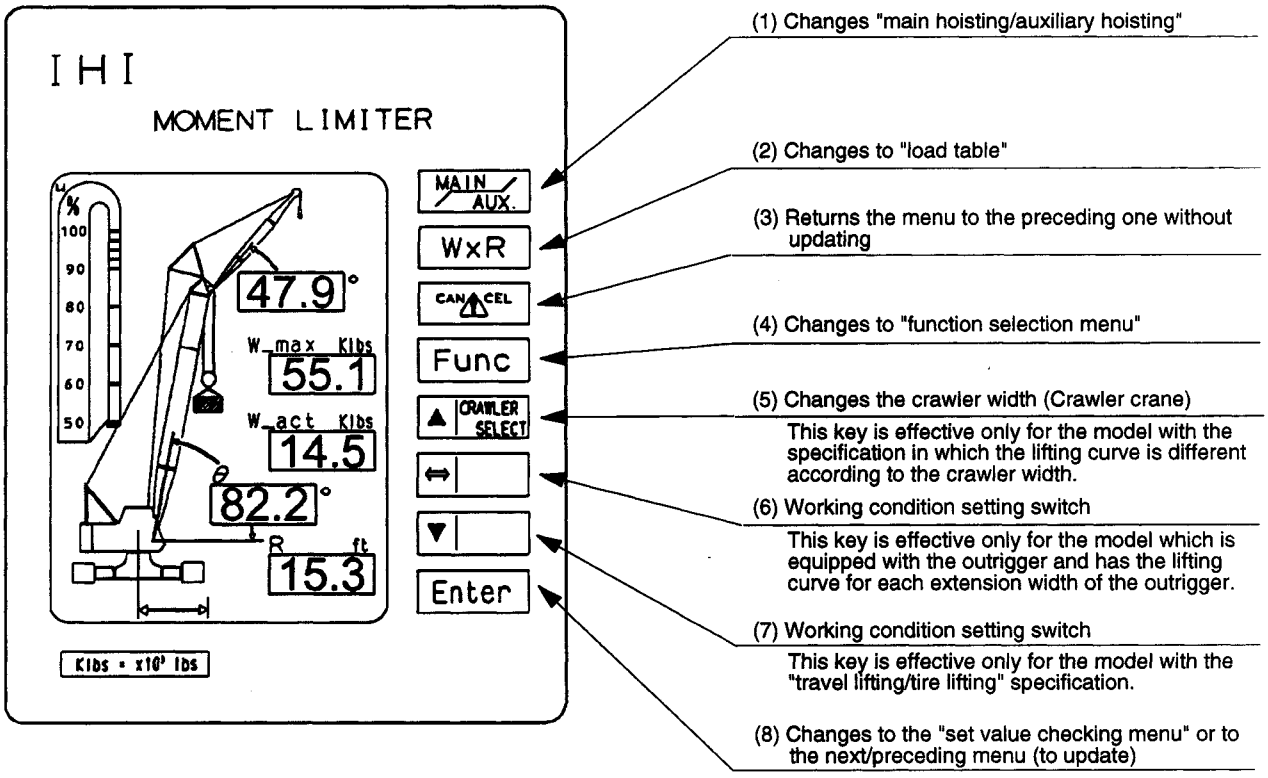
When the CANCEL key is pressed, the working conditions are not changed. Be careful.

If you desire to change the function selection menu to the standard menu, press the Func or CANCEL key once.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

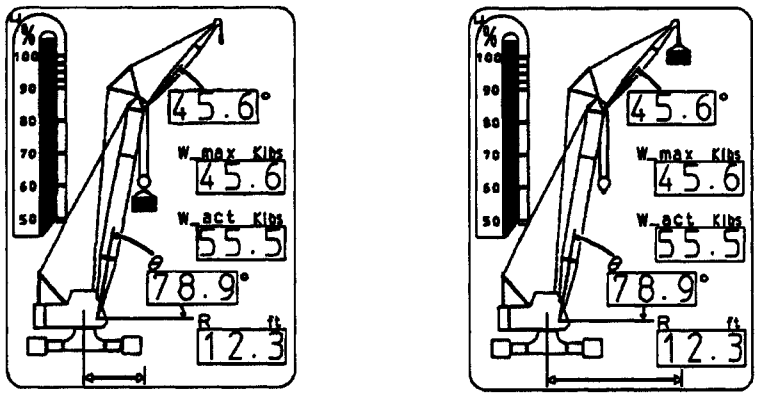
4. Standard menu and operation keys

Standard Menu



(1) Main/auxiliary selector key switch [MAIN AUX]

Press the main/auxiliary selector key switch [MAIN AUX], the main hoisting work menu is changed to the auxiliary hoisting work menu. Press the [MAIN AUX] key again, and the menu is changed to the main hoisting work menu. Select a proper menu according to the actual crane configuration. It is not permitted to lift loads with the main hook and the jib hook at the same time.

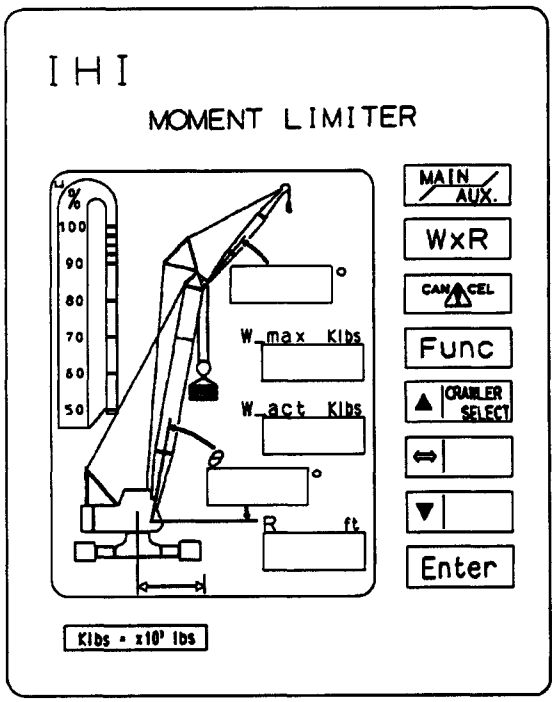


Main hoisting work **Jib hoisting work**

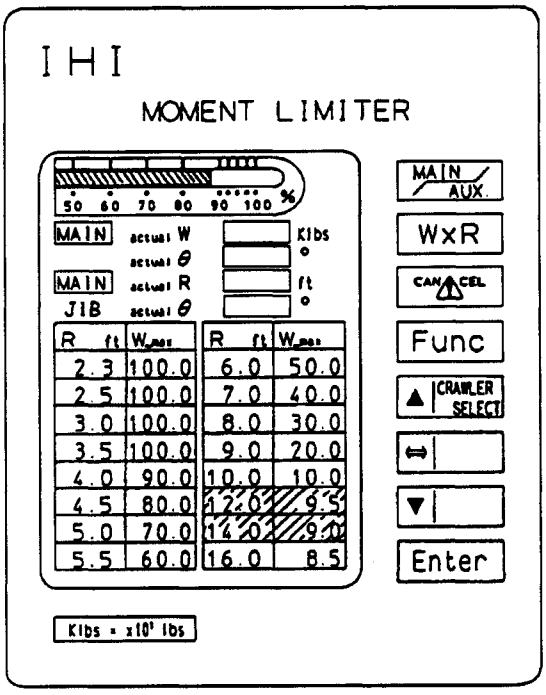
Luffing Jib Crane

The values in the display unit are reference values required for the explanation. They have nothing to do with an actual lift.

Standard Menu



Load Table (for "MAIN")



(2) The selector switch to the load table [WxR]

[1] Press the [WxR] switch once on the standard menu, and the load table is displayed. On the load table display, press the [WxR] or [CANCEL] key once, and the standard menu appears.

The load table displays the following six items:

- Load ratio . . . . . %
- Actual load for the main or auxiliary hoisting . . . . . Klbs
- Boom angle . . . . . °
- Working radius for the main or auxiliary hoisting . . . . . Ft.
- Jib angle . . . . . °
- Working radius/allowable load table . . . . . Ft. Klbs

The following illustration is the "MAIN" table. If you want the "AUX." table, press the [MAIN AUX] key switch.

[2] Working radius/allowable load table

In the load table, the shaded area of the working radius/allowable load table indicates the current crane working radius and allowable load.

The actual working radius is 12.3 ft. and is within the shaded area, 12.0 ft. ~ 14.0 ft. The operator can view the current working radius and allowable load according to this table.

To display the data after 16.0 ft. for the working radius, press the [⇔] key once. The next data are displayed. To return to the original data, press the [⇔] key.

[3] The upper bar graph on the screen indicates the ratio (load ratio) of the crane's current load (actual value) and to the allowable safe working load.

(3) Cancel key [CANCEL]

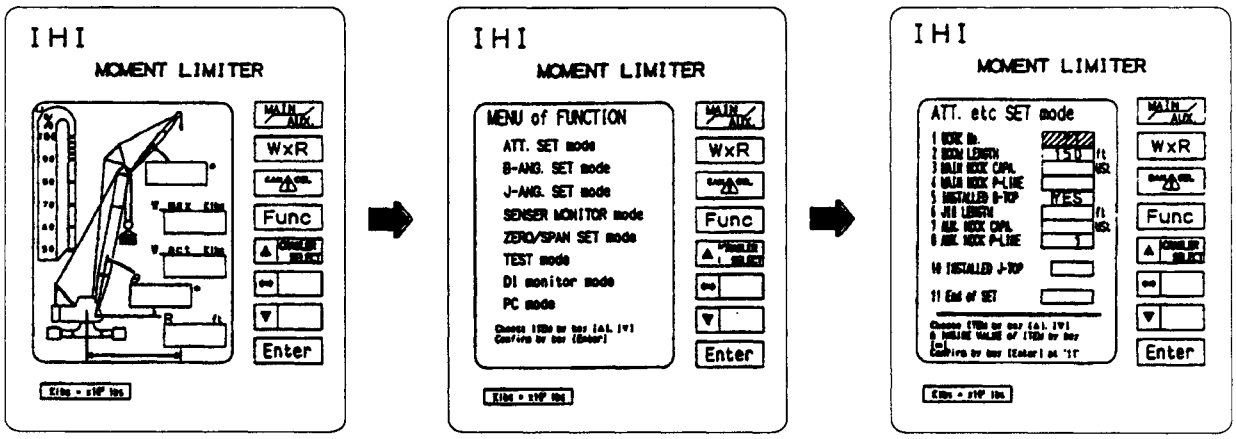
Press this key in the middle of setting for the crane working conditions or optional angle as mentioned above, the setting operation stops and the original condition before setting is restored.

(4) Function key - to change to the function selection menu [Func]

When the working conditions have to be set, change the standard menu to the function selection menu and then select the desired items in the function selection menu with the cursor.

Press the [Func] once in the standard menu and the function selection menu is displayed. In the function selection menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reversed cell) to the desired item.

For example, move the cursor to "ATT. SET mode" and press the [Enter] key once. Then, "ATT. etc. SET mode" (working radius setting mode) is displayed.



Standard Menu **Function Selection Menu** **Setting Menu (ATT. etc. SET mode)**

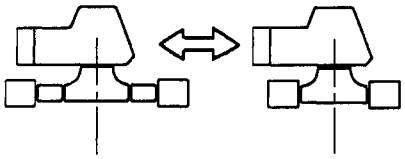
Refer to "(2) Setting of the working conditions" for how to set the working conditions and how to return from the setting menu to the function selection menu. If the function selection menu has to be changed to the standard menu, press the [Func] or [CANCEL] key once.

(5) Crawler select key - to change the crawler width [▲ CRAWLER SELECT]

In the crawler crane, this key is effective only for the model which rated overall lifting load is changed according to the crawler width.

Press the [▲ CRAWLER SELECT] key once in the standard menu, and the illustrated crawler width is retracted. Press the key again, and the crawler width is extended.

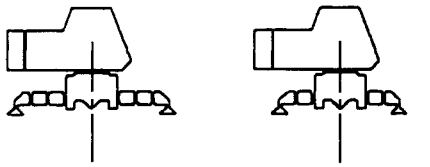
Change of Crawler Width



When extended (EXT.) **When retracted (RET.)**

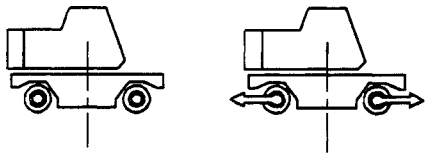
On the machine without the crawler width change specification, set the crawler width to the extended condition. If the crawler width is retracted, "E114" is displayed and the alarm sounds. This key switch does not work on the wheel type.

Change of Outrigger Width



When extended (EXT.) **When retracted (RET.)**

(6) [⇔] This key is used for setting the working conditions and changing information. This key switch works when tires are used for the travelling unit. Press the key once, and the illustrated outrigger width is retracted. Press the key again, and the outrigger width is extended. On the machine with outriggers, set the displayed picture to the machine current condition. On the crawler crane, this switch is used for setting the working conditions, etc.



Tire Stationary Lifting **Travel Lifting**

(7) [▼] This key is used for setting the working conditions and scrolling down through the menus. This key switch works when tires are used for the travelling unit. Press the key once, and the displayed picture is changed to "travel lifting". Press the key again, and the displayed picture is changed to "tire stationary lifting". On the crawler crane, this switch is used for setting the working conditions, etc.

(8) This key is used to change to "set value checking menu" or to the next/preceding menu (to update)

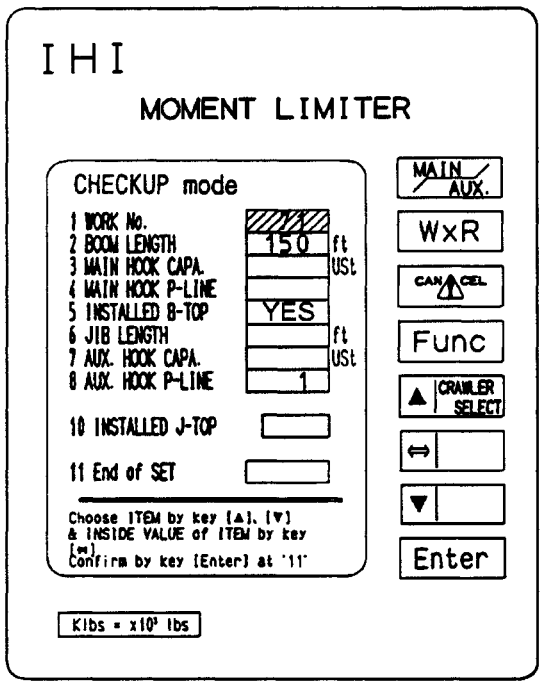
Press the [Enter] key once in the standard menu, and the "Attachment setting" menu, which was set in the above-mentioned "ATT etc. SET mode" menu, is displayed.

Press the [Enter] or [CANCEL] key in the setting menu, and the standard menu is restored.

In the set value checking menu, the operator can check the following values which were set in "Setting of the working conditions":

- Work No.
- Boom length
- Main hook capacity
- Part of line for main hook
- Jib length
- Auxiliary hook capacity
- Part of line for auxiliary hook
- Jib offset angle

Set Value Checking Menu



In this menu, the operator can check the following nine items which are set currently:

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Installed boom top (YES)
6. Jib length
7. Auxiliary hook capacity
8. Part of line for auxiliary hook
10. Installed jib top (NO)

After checking the data, press the Enter or CANCEL key. The standard menu is restored.

4. Error messages and error codes

If a working condition inapplicable to the specification is set or if the sensor output is defective in the overload prevention device (moment limiter), the error is displayed on the screen.

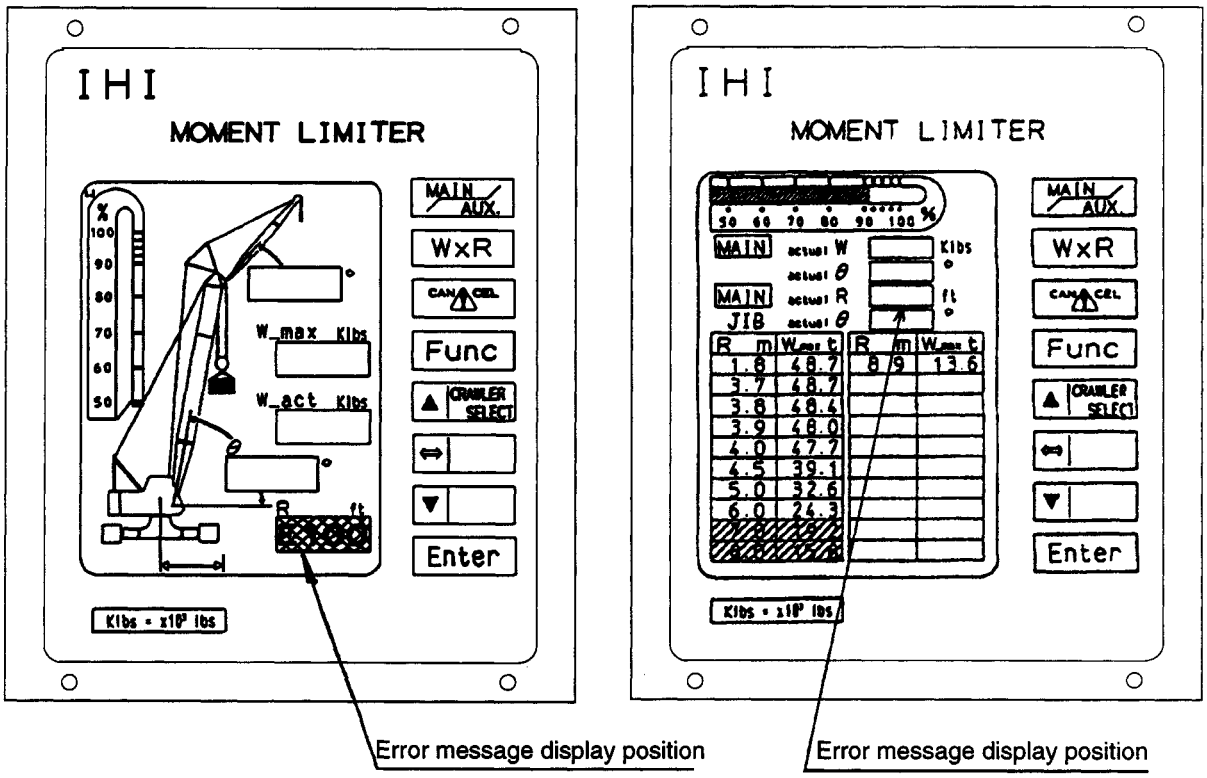
The error is displayed as "Exxx" in the working radius column. The error display blinks and an alarm is heard. Refer to the illustrations on the next page.

The error codes and remedial measures are shown in the following table.

Error Code Table

Error No.	Causes	Check and Remedial Measures
EEEE	DSP (CPU) is defective.	Should repair or replace
E100	Boom angle detector is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the angle meter
E102	The load cell sensor is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the load cell
E114	The load table does not exist.	Check the set data Check the crawler width, etc.
E120	The communication is not proper between the CPU and the display unit.	Should repair or replace
E121	The memory is defective in the CPU.	Should repair or replace
E122	The internal mode selector LS is defective.	Should repair or replace

ML-D3A

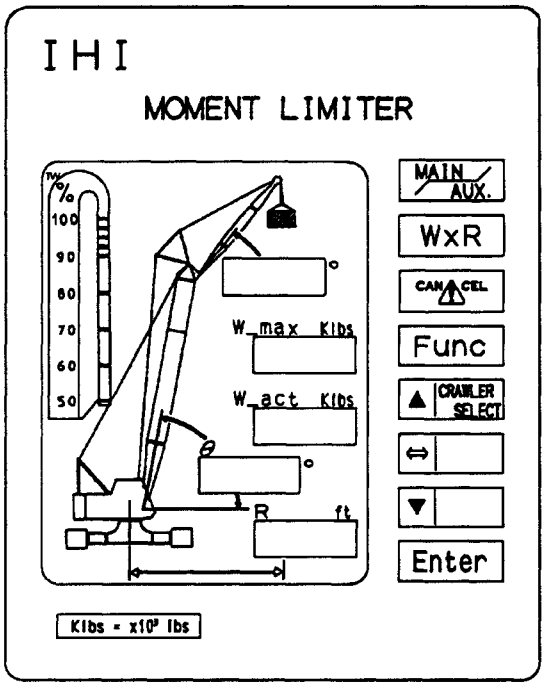


In both of the above illustrations, the error message is displayed as "E100" on the working radius column. "E100" blinks and an alarm is heard. Refer to "Error Code Table" for the causes and remedial measures of the errors.

Setting of working conditions at work No. 81 (Luffing Tower Crane)

1. The "power on" and subsequent procedure up to the display of the standard menu for handling the moment limiter mode switches (1) - (4) is the same as the standard crane. But the display contents show the items of the luffing tower crane.

Standard Menu (Luffing Tower Crane)



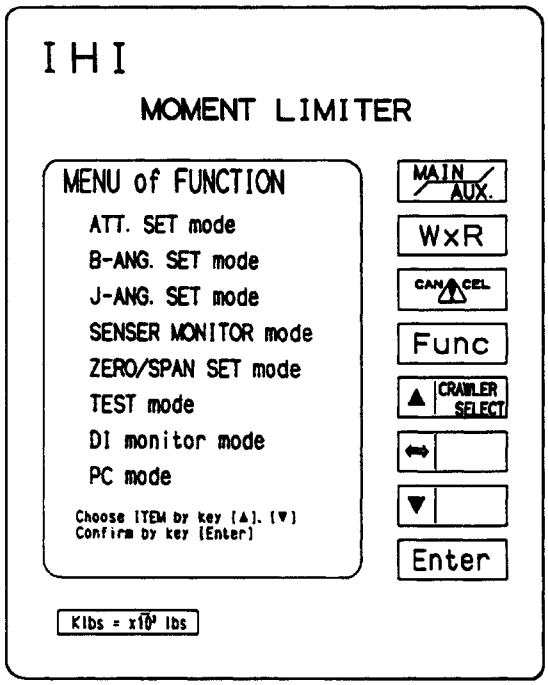
(4) After 5 seconds since the starting menu was displayed, the menu is changed to the standard menu. The standard menu shows the following items:

- Load ratio . . . . . .%
- Jib angle . . . . . .°
- Rated overall lifting load . . . . .Klbs. (allowable load)
- Actual load . . . . . .Klbs.
- Boom angle. . . . . .°
- Working radius . . . . . .Ft.

(5) The standard menu is displayed for "boom lifting". If the operator has to change to "jib lifting", press the MAIN AUX key switch. The load of "boom lifting" as illustrated left moves to the jib side.

(6) If the sensor malfunctions or if the working conditions are set incorrectly, an error No. is displayed in the column of the working radius. Make sure that an error No. is not displayed.

Function Selection Menu



2. Setting of the working conditions

(1) Press the Func key once in the standard menu, and the function selection menu as illustrated left is displayed. If you want to return to the standard menu, press the Func or CANCEL key once.

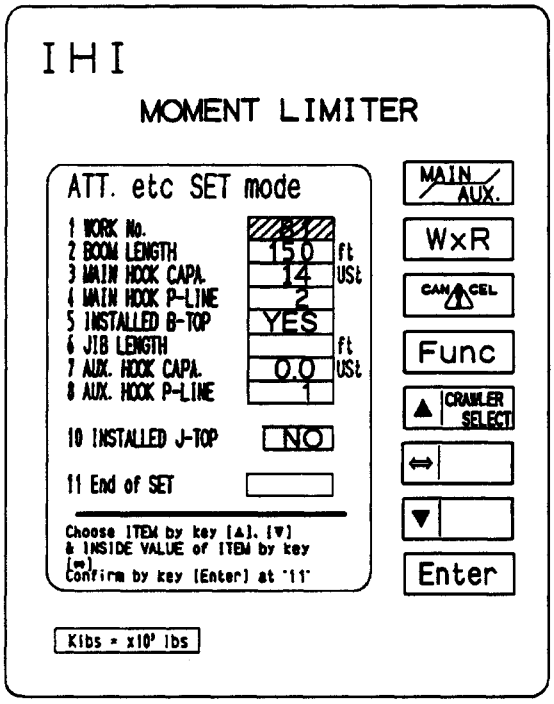
(2) Proceed to the setting menu from the function selection menu.

In the function selection menu, press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed display) to "ATT. SET mode". Normally, the cursor is at "ATT. SET mode" when the function selection menu is displayed.

Press the Enter key once.

When pressing the Enter key, the menu is changed to the following setting menu.

Setting Menu



(3) Set the Working condition on the setting menu. Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "WORK NO." The item with the cell is reversed.

[1] Press the ⇔ key to set the value of the current attachment for "WORK NO."

Work No. Luffing tower crane 81

Each time the ⇔ key is pressed, the data included in the specification are displayed in order. Select the proper work number.

[2] Setting of the boom length

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "BOOM LENGTH". Press the ⇔ key to set the proper value for the length of the current boom. Each time the ⇔ key is pressed, the boom length data included in the specification are displayed in order.

[3] Setting of the main hook capacity

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK CAPA." Press the ⇔ key to set the value of the current hook capacity.

Each time the ⇔ key is pressed, the main hook capacity data included in the specification are displayed in order. If the main hook is not installed, select "0.0".

[4] Setting of the parts of line for the main hook

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "MAIN HOOK P-LINE". Press the ⇔ key to set the parts of line for the current main hook. Each time the ⇔ key is pressed, the "parts of line" data included in the specification are displayed in order. If the main hook is not installed, select "1".

[5] Setting of the boom top sheave

Press the ▲CRAWLER SELECT or ▼ key to move the cursor to "INSTALLED B-TOP". If the top sheave is mounted, select "YES". If the top sheave is not mounted, select "NO". Whether the top sheave is used or not affects the rated overall lifting load. Select the condition appropriate to the actual machine.

[6] Setting of the jib length

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "JIB LENGTH". Press the ⇔ key to set the value of the current jib length.

Each time the ⇔ key is pressed, the jib length data included in the specification are displayed in order. On the luffing tower crane, the hook which is mounted on the tower jib is the main hook.

[7] Setting of the auxiliary hook capacity

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "AUX. HOOK CAPA.". Press the ⇔ key to set the "0.0".

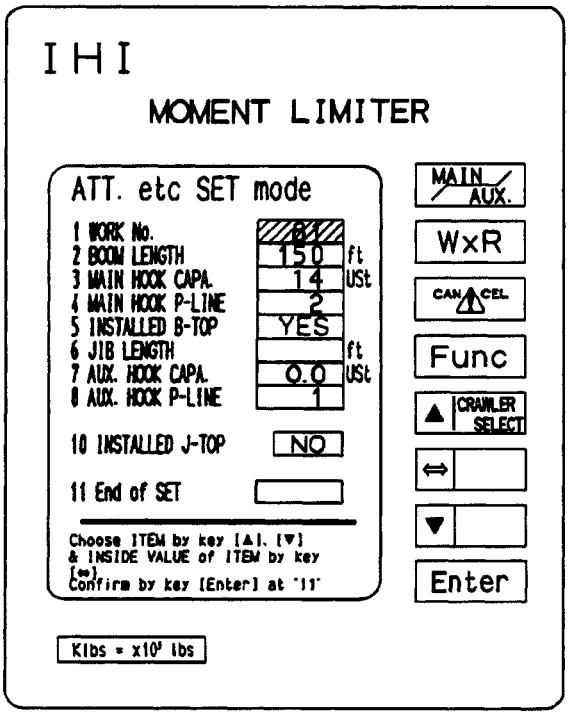
[8] Setting of the parts of line for the auxiliary hook

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "AUX. HOOK P-LINE". Press the ⇔ key to set the "1" part of line.

[10] Setting of the jib top

Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "INSTALLED J-TOP". Press the ⇔ key to set the "NO". Jib top cannot be set.

Setting Menu



(4) Check of the set values

Make sure that the values set at the aforementioned [1] ~ [10] are set to the crane configuration.

Press the CRAWLER SELECT or ▼ key to move the cursor to "End of SET" and press the Enter key.

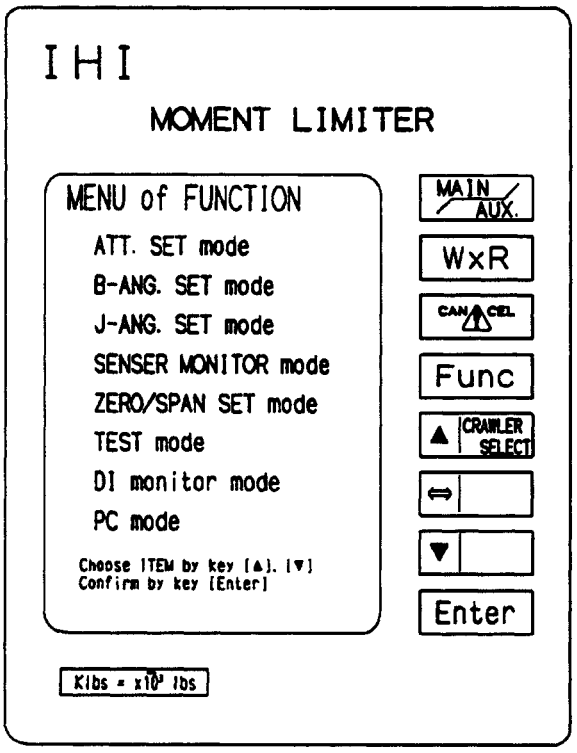
When pressing the Enter key, the displayed values are stored as the new set data and the function selection menu is automatically displayed.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [1] ~ [10] are ignored and the function selection menu is automatically set without the data change.

When the CANCEL key is pressed, the working conditions are not changed. Be careful.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated) Press the Enter key again.

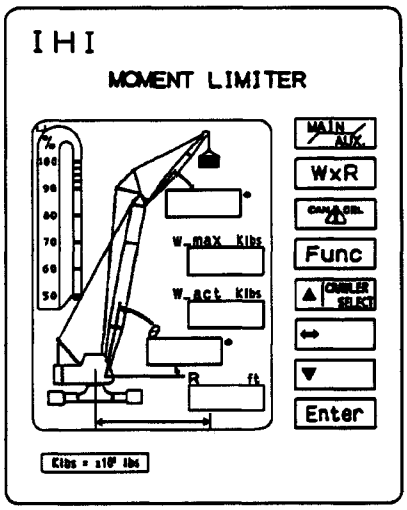
Function selection menu



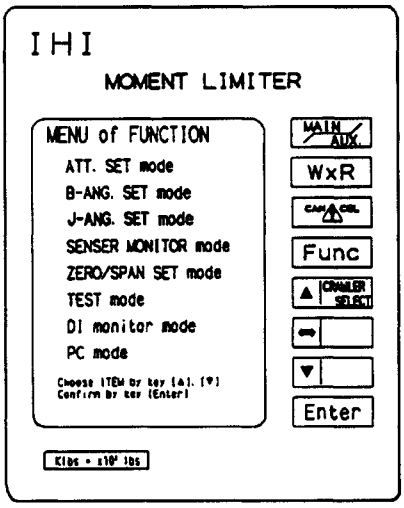
Press the Func or CANCEL key once to return from the function selection menu to the standard menu.

3. Optional auto stop or alarm angle setting

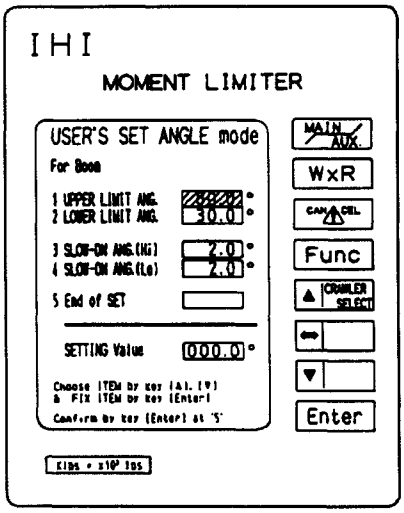
Standard Menu



Function Selection Menu



Optional Angle Setting Menu



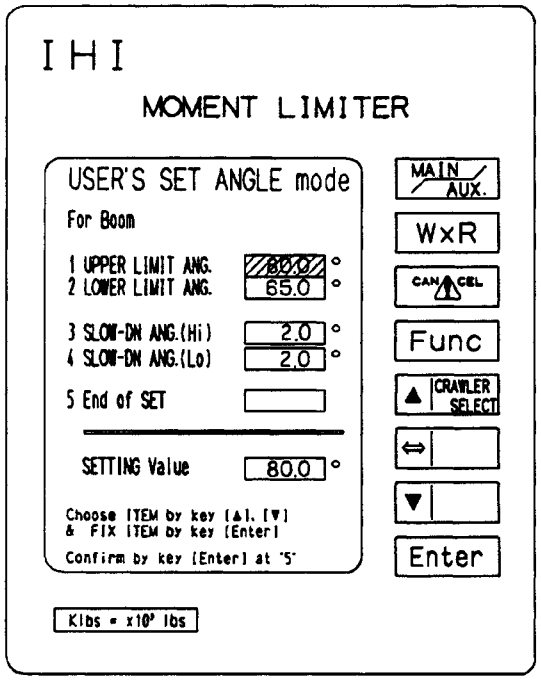
If you desire to set an optional angle, proceed from the function selection menu to the optional angle setting menu.

Press the [Func] key once if changing from the standard menu to the function selection menu.

Press the [CANCEL] or [Func] key once if changing from the function selection menu to the standard menu.

(1) If changing from the function selection menu to the optional angle setting menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reverse display) to "B-ANG. SET mode". Then, press the [Enter] key.

Optional Angle Setting Menu



(2) Setting of the boom optional upper limit angle

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "UPPER LIMIT ANG." Normally, the cursor is at "UPPER LIMIT ANG." when the optional angle setting menu is displayed.

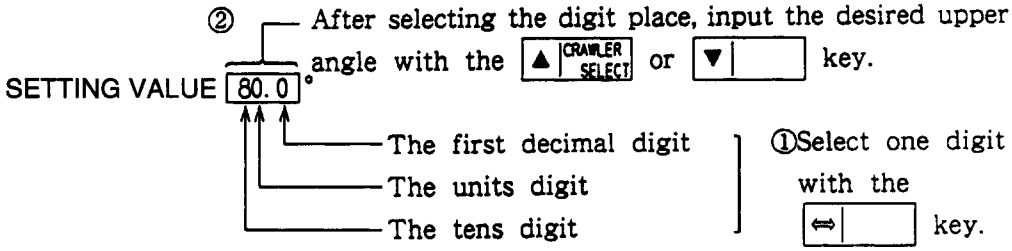
[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode, change menu by key ⇔ choose value by [▲], [▼] provisional decision by Enter

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



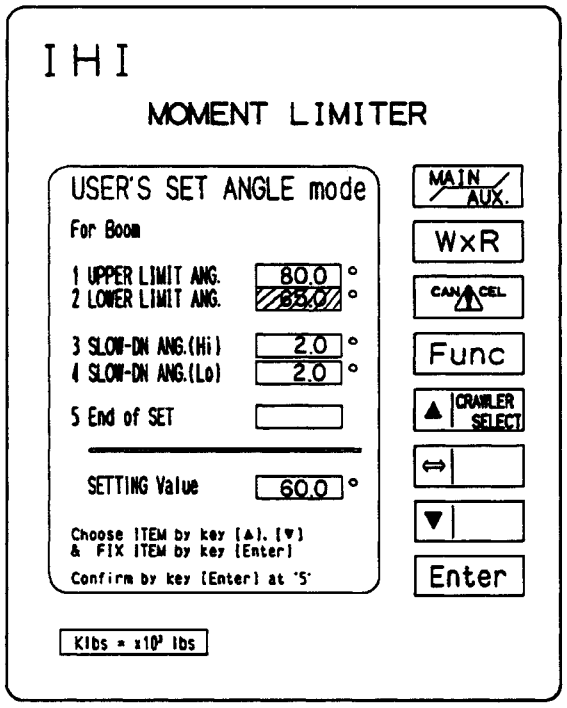
In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "8" to the tens digit, and so the boom optional upper limit angle is set to 80.0°. Maximum upper limit angle is 90.0° .

[5] After setting the boom optional upper limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "UPPER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set upper limit angle (80° in the above example), the alarm sounds and the boom hoisting stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached 90°, the boom stops automatically.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(3) Setting of the boom optional lower limit angle

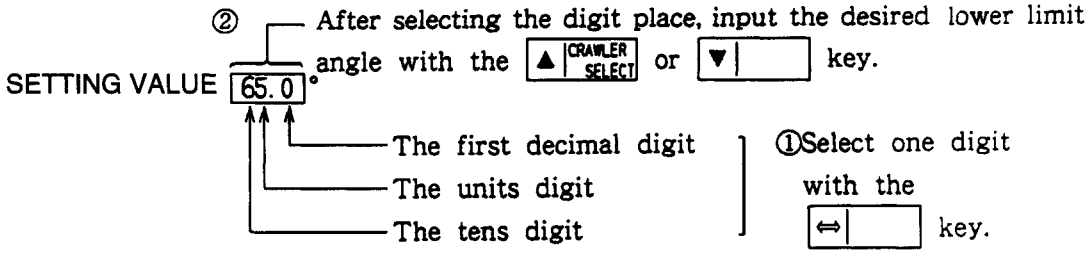
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



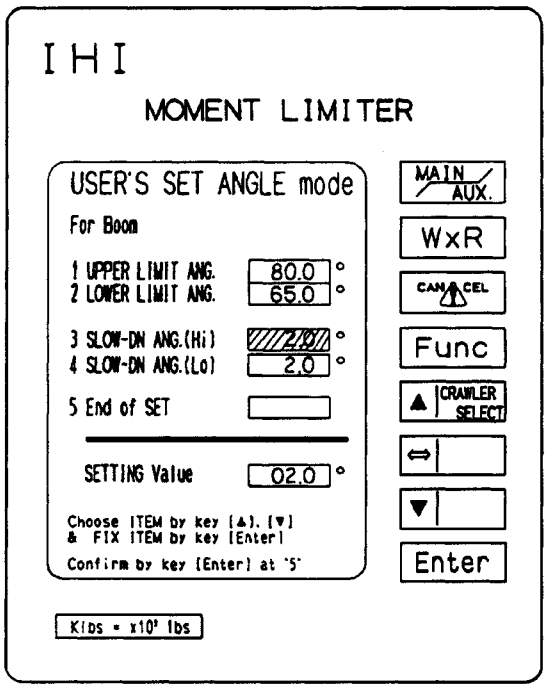
In the above example, "0" is inputted to the first decimal digit, "5" to the units digit and "6" to the tens digit, and so the boom optional lower limit angle is set to 65.0° . Minimum lower limit angle is 60.0° .

[5] After setting the boom optional lower limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the boom has reached the set lower limit angle (65° in the above example), the alarm sounds and the boom lowering stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the boom has reached the lower limit angle of 60°, the boom stops automatically.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(4) Setting of the upper limit gentle operation angle of boom

This function sets the optional angle at which the gentle operation (slow-down) starts before the boom stops automatically when the boom is hoisting.

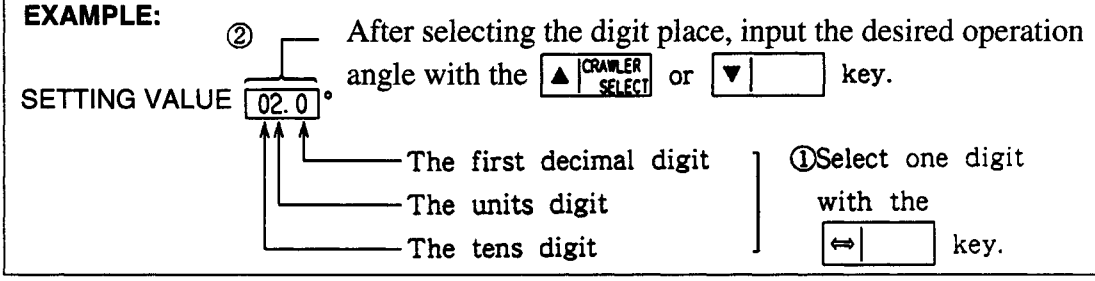
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Hi)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

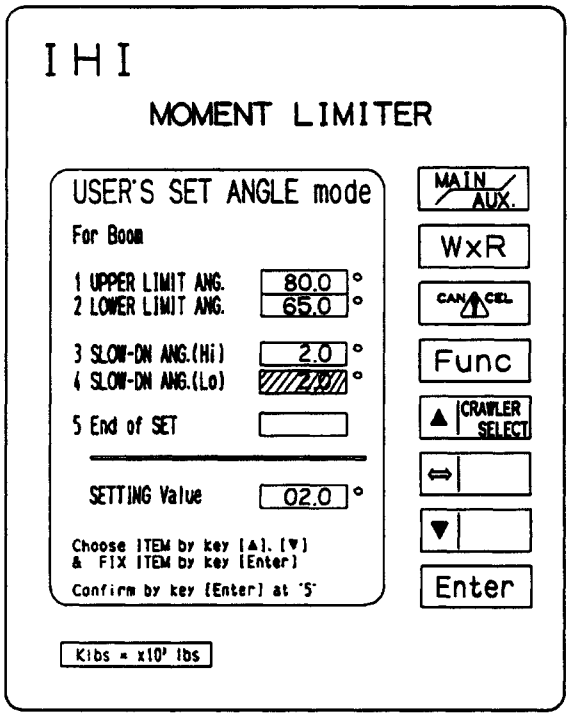


In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the upper limit slow-down angle is set to 2.0°. If the slow-down operation is not necessary, set the angle (0.00). Standard minimum slow-down angle is 2.0°.

[5] After setting the upper limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (2), the boom optional upper limit angle is set to 80°, and in the above example, the upper limit slow-down operation angle is set to 2°. In such a case, the boom hoisting speed slows down when the boom angle is 78° and the boom hoisting stops automatically and the alarm sounds when the boom angle is 80°.

If the machine is without the automatic stop function, the hoisting speed slows down at the boom angle 78° and the alarm sounds at the boom angle 80°. The boom hoisting stops automatically at the boom angle 90°.

Optional Angle Setting Menu



(5) Setting of the lower limit gentle operation angle of boom

This function sets the optional approach angle at which the gentle operation (slow-down) starts before the boom stops automatically when the boom is lowering.

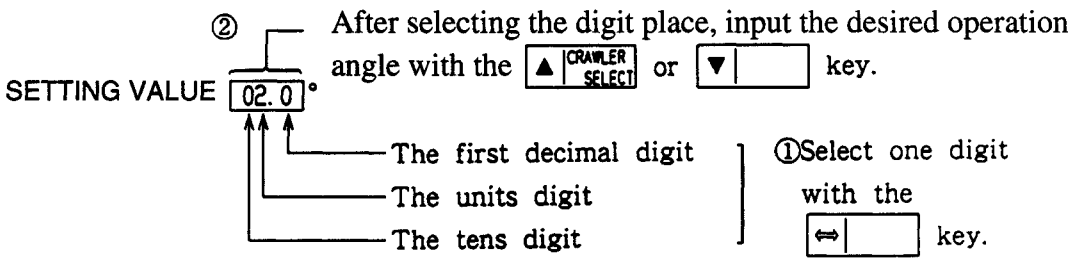
[1] Press the ▲CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

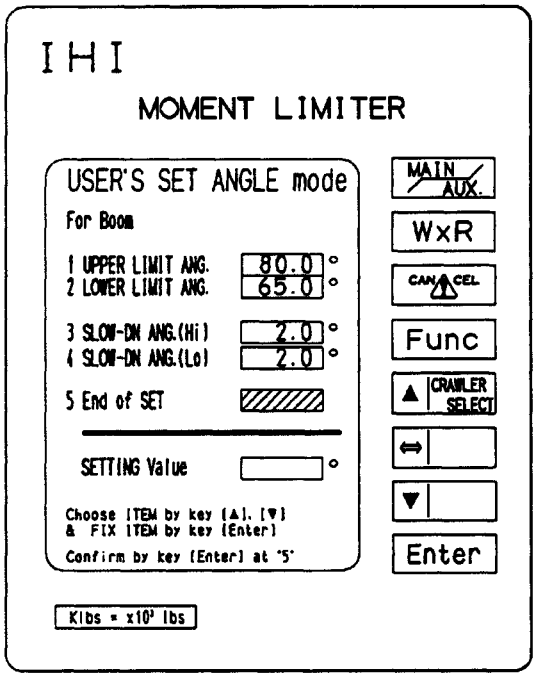


In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the boom lower limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle (0.00). Standard minimum slow-down angle is approximately 2.0° .

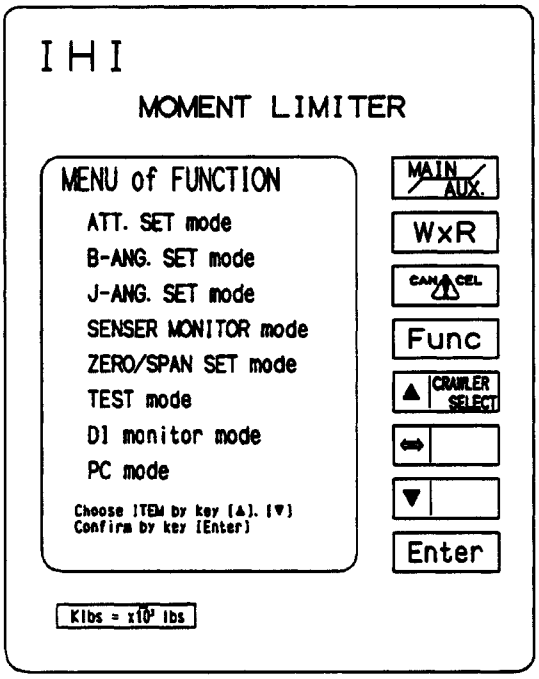
[5] After setting the optional lower limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (3), the optional lower limit angle is set to 65°, and in the above example, the lower limit slow-down operation angle is set to 2°. In such a case, the lowering speed slows down when the boom angle is 67° and the boom lowering stops automatically and the alarm sounds when the boom angle is 65°.

If the machine is without the automatic stop function, the lowering speed slows down at the boom angle 67° and the alarm sounds at the boom angle 65°. The boom lowering stops automatically at the rated boom lower limit angle.

Optional Angle Setting Menu



Function Selection Menu



(6) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of the items (2) ~ (5):

- The value of the boom upper limit angle
- The value of the boom lower limit angle
- The value of the upper limit slow-down operation angle
- The value of the lower limit slow-down operation angle

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you desire to stop setting, press the CANCEL key before pressing the Enter key.

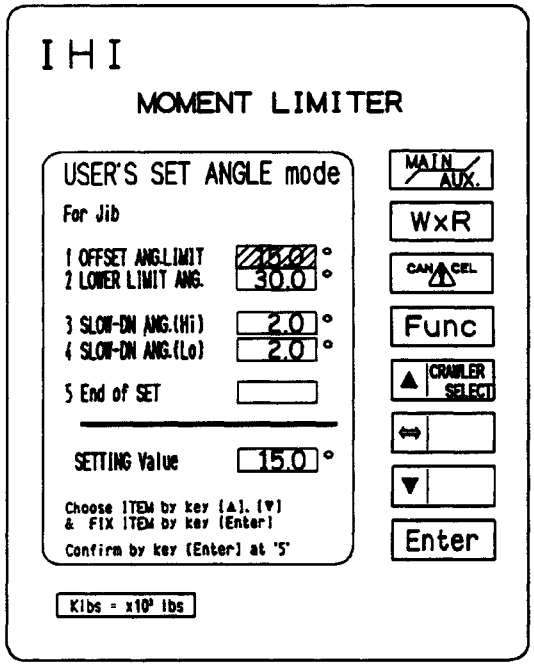
If you desire to change the function selection menu to the standard menu, press the Func or CANCEL key once.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [2] ~ [5] (USER'S SET ANGLE mode for Boom) are ignored and the function selection menu is automatically set without the data change.

When the CANCEL key is pressed, the working conditions are not changed. Be careful.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

Optional Angle Setting Menu



(7) Setting of the optional offset angle limit for jib

[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "OFFSET ANG. LIMIT" Normally, the cursor is at "OFFSET ANG. LIMIT" when the optional angle setting menu is displayed.

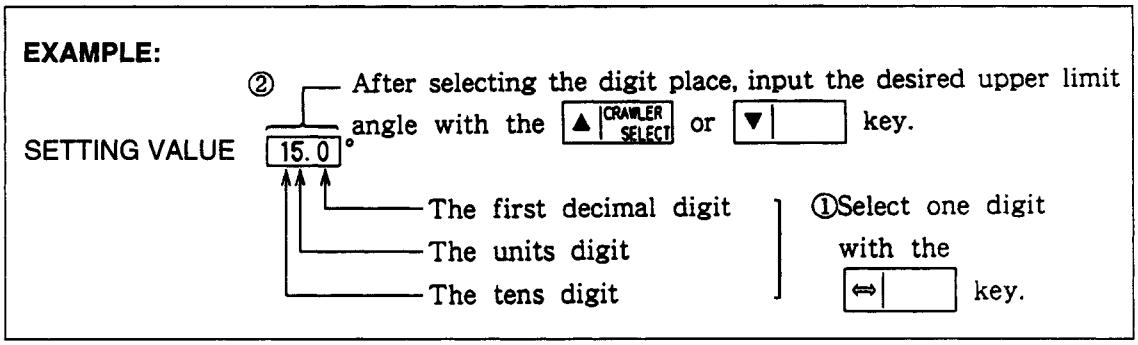
[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

In case in editing mode, change menu by key ⇔ choose value by [▲], [▼] provisional decision by Enter

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



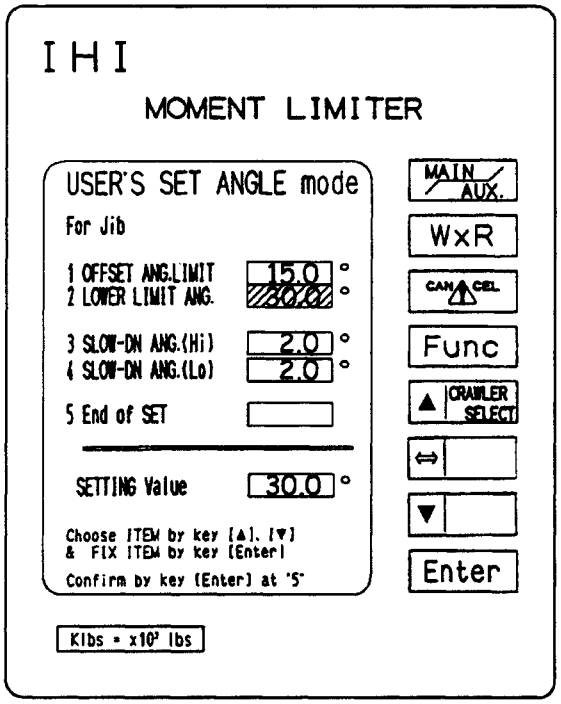
In the above example, "0" is inputted to the first decimal digit, "5" to the units digit and "1" to the tens digit, and so the jib optional offset limit angle is set to 15.0°. Set this angle to 10.0° if not necessary.

[5] After setting the jib optional offset limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "OFFSET ANG. LIMIT" column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the jib has reached the set jib offset limit angle (15° in the above example), the alarm sounds and the jib hoisting stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the jib has reached the rated jib offset angle of 10°, the jib stops automatically.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(8) Setting of the jib optional lower limit angle

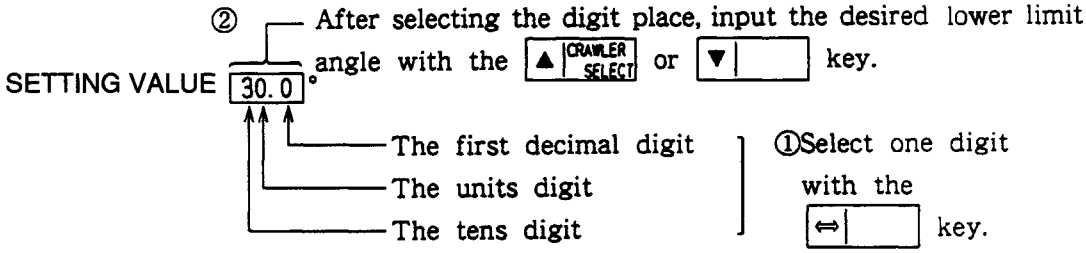
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed display) to "LOWER LIMIT ANG."

[2] Press the Enter key once. The editing mode for setting the optional angle is ready and the lower "SETTING VALUE" column is usable.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:



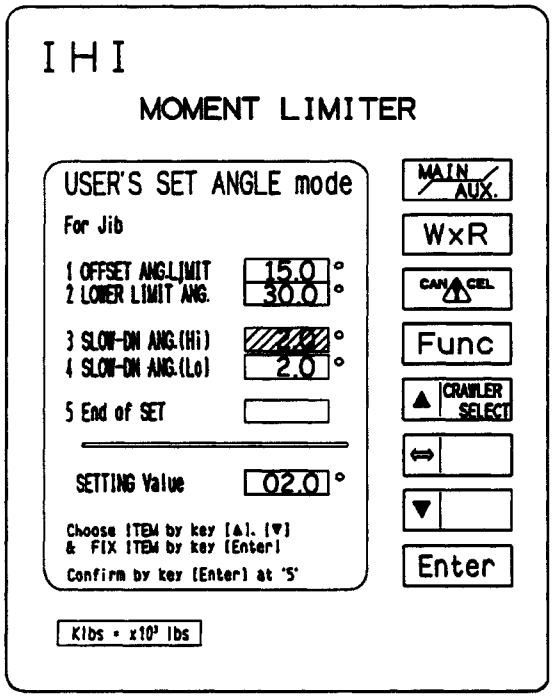
In the above example, "0" is inputted to the first decimal digit, "0" to the units digit and "3" to the tens digit, and so the jib optional lower limit angle is set to 30.0° . Set this angle to 15.0° or lower if not necessary.

[5] After setting the jib optional lower limit angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "LOWER LIMIT ANG." column. If you decide to stop setting the values, press the CANCEL key. If the machine is set up with the optional angle automatic stop function, when the jib has reached the set lower limit angle (30° in the above example), the alarm sounds and the jib lowering stops.

If the machine is without the optional angle automatic stop function, only the alarm sounds. But, when the jib has reached the rated 15°, the jib stops automatically. When the jib has reached the jib rated lower limit angle regardless of the jib optional lower limit angle, it stops automatically. The jib rated lower limit angle is different according to the combination of the boom length and jib length.

The machine with the "optional angle automatic stop" switch can use "stop" and "only alarm" properly.

Optional Angle Setting Menu



(9) Setting of the upper limit gentle operation angle of jib

This function sets the optional approach angle at which the gentle operation (slow-down) starts before the jib stops automatically when the jib is hoisting.

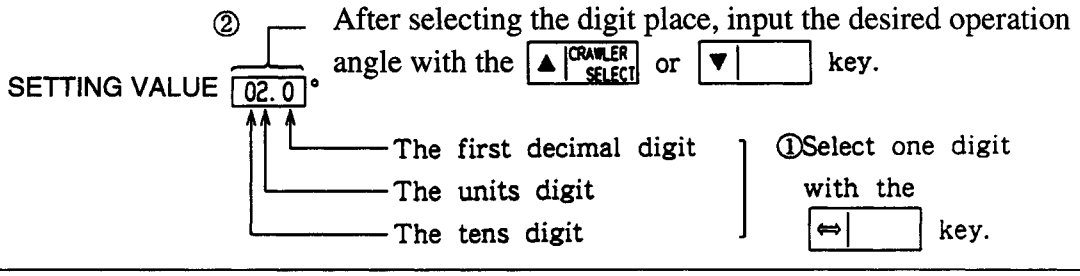
[1] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Hi)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲ CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

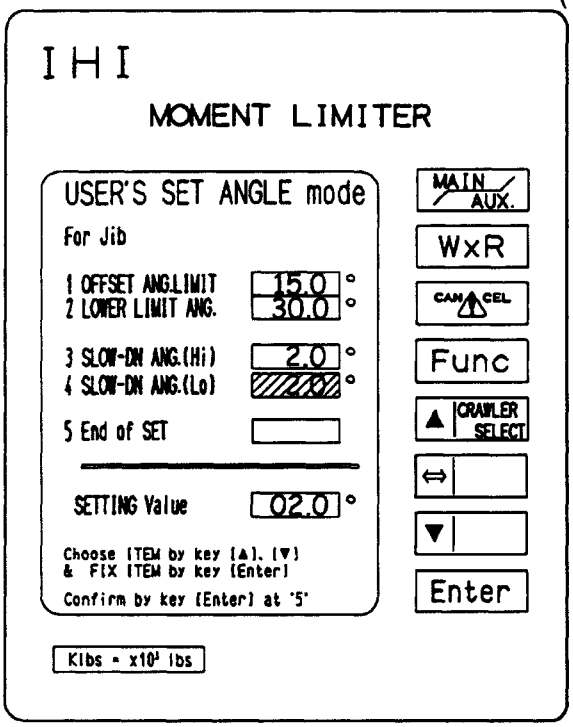


In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the upper limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle (0.00). Standard minimum slow-down angle is 2.0° .

[5] After setting the upper limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Hi)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (7), the jib optional offset angle is set to 15°, and in the above example, the upper limit slow-down operation angle is set to 2°. In such a case, the jib hoisting speed slows down when the jib offset angle is 17° and the jib hoisting stops automatically and the alarm sounds when the jib offset angle is 15°.

If the machine is without the automatic stop function, both the hoisting speed slows down at the jib offset angle of 17° and the alarm sounds. But when the jib offset angle has reached 10°, the jib hoisting stops automatically.

Optional Angle Setting Menu



(10) Setting the lower limit of gentle operation angle of jib

This function sets the optional approach angle at which the gentle operation (slow-down) starts before the jib stops automatically when the jib is lowering.

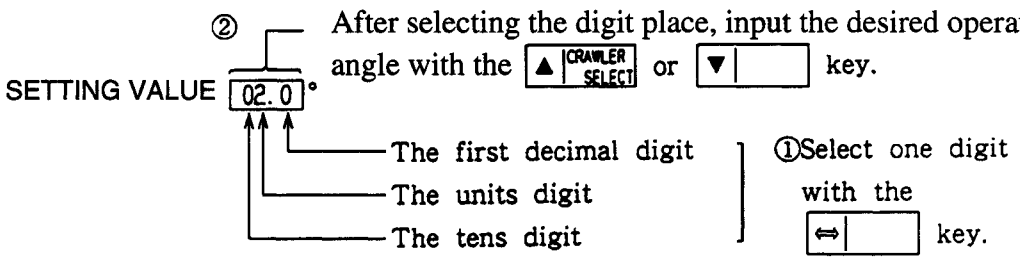
[1] Press the ▲CRAWLER SELECT or ▼ key to move the cursor (reversed cell) to "SLOW-DN ANG. (Lo)".

[2] Press the Enter key once. The editing mode for setting the slow-down angle is ready.

[3] Each time the ⇔ key is pressed, the cursor moves horizontally in this order: the first decimal digit, the units digit and the tens digit, in the lower "SETTING VALUE" column.

[4] After moving the cursor to the desired digit, press the ▲CRAWLER SELECT or ▼ key to input the desired value.

EXAMPLE:

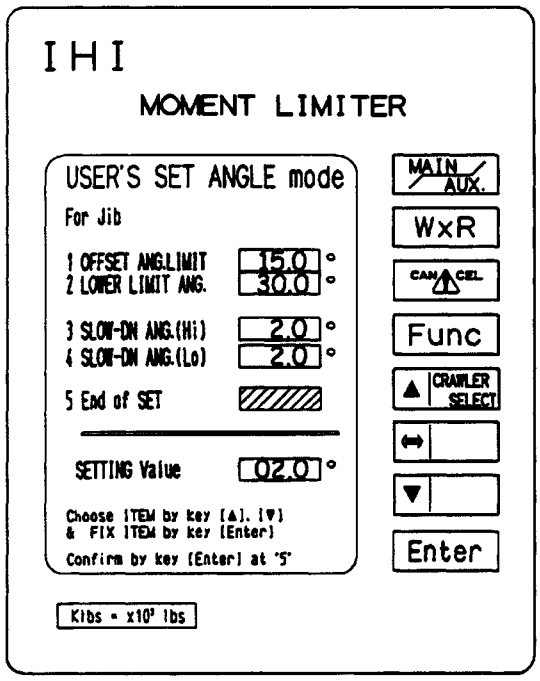


In the above example, "0" is inputted to the first decimal digit, "2" to the units digit and "0" to the tens digit, and so the boom lower limit slow-down angle is set to 2.0° . If the slow-down operation is not necessary, set the angle (0.00). Standard minimum slow-down angle is approximately 2.0° .

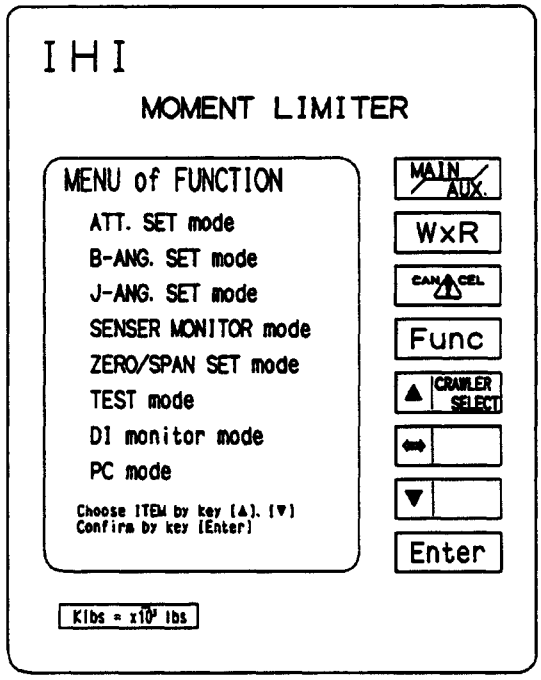
[5] After setting the optional lower limit slow-down operation angle in three digits, press the Enter key once. The value set in the "SETTING VALUE" column is displayed in the "SLOW-DN ANG. (Lo)" column. If you decide to stop setting the values, press the CANCEL key. In the example of (8), the optional lower limit angle is set to 30°, and in the above example, the lower limit slow-down operation angle is set to 2°. In such a case, the lowering speed slows down when the jib angle is 32° and the jib lowering stops automatically when the jib angle is 30°.

If the machine is without the automatic stop function, the lowering speed slows down at the jib angle 32° and the alarm sounds at the jib angle 30°. When the jib angle has reached the rated jib lower limit angle, the jib lowering stops automatically.

Optional Angle Setting Menu



Function Selection Menu



(11) Decision for angle setting

[1] Make sure that the proper values are set in the above setting procedure of the items (7) ~ (10):

- The value of the jib offset limit angle
- The value of the jib lower limit angle
- The value of the jib slow-down operation angle (Hi)
- The value of the jib slow-down operation angle (Lo)

[2] Press the ▲ CRAWLER SELECT or ▼ key to move the cursor to "End of SET".

[3] Press the Enter key. The data on the screen are updated and the menu is automatically returned to the function selection menu.

[4] If you desire to stop setting, press the CANCEL key before pressing the Enter key.

Before pressing the Enter key, if the CANCEL key is pressed, the values set in the aforementioned [7] ~ [10] (USER'S SET ANGLE mode for Jib) are ignored and the function selection menu is automatically set without the data change.

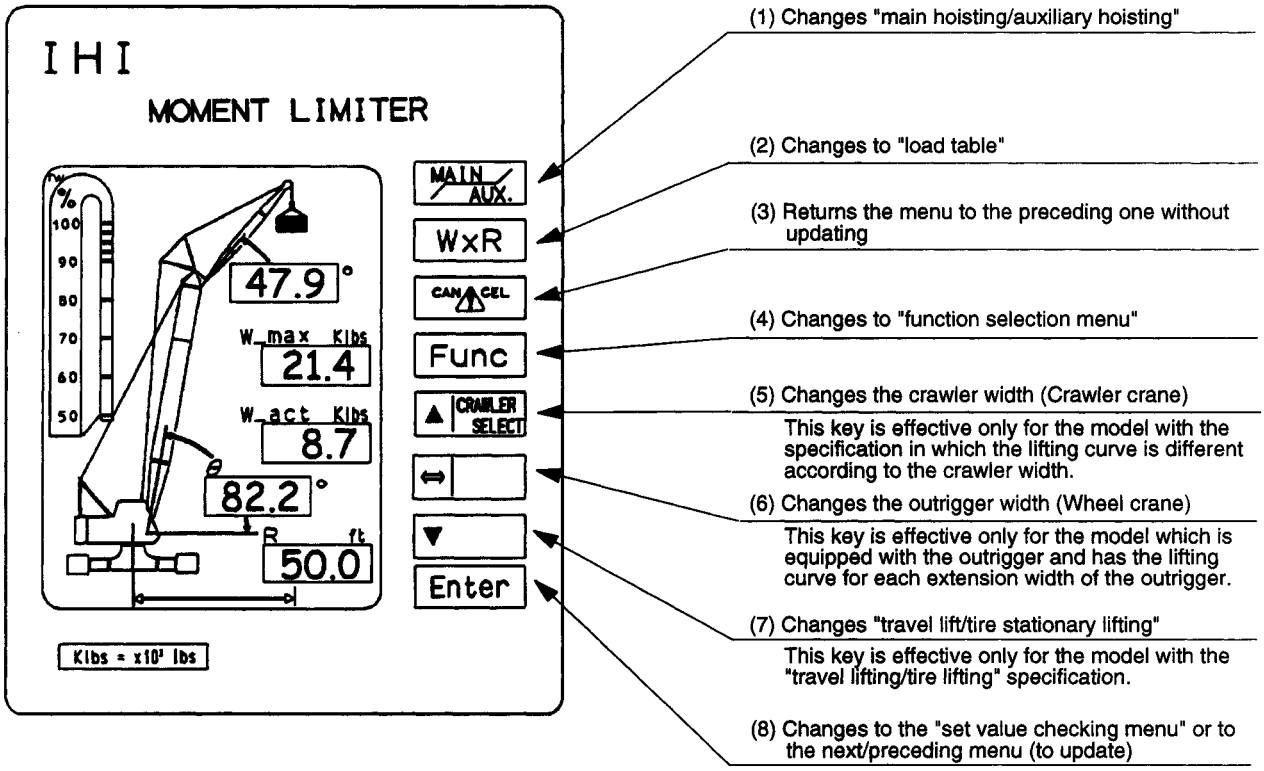
When the CANCEL key is pressed, the working conditions are not changed. Be careful.

If you desire to change the function selection menu to the standard menu, press the Func or CANCEL key once.

When "E123" is displayed in the "End of SET" column, it means that the new set data are not stored (or updated). Press the Enter key again.

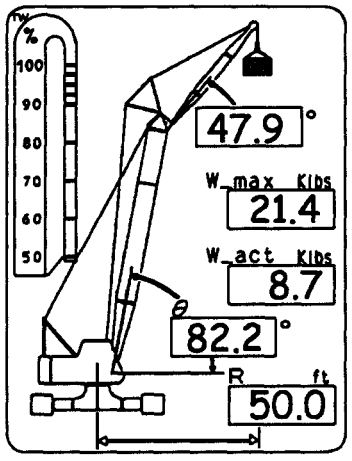
4. Standard menu and operation keys

Standard Menu



(1) Main/auxiliary selector key switch [MAIN AUX]

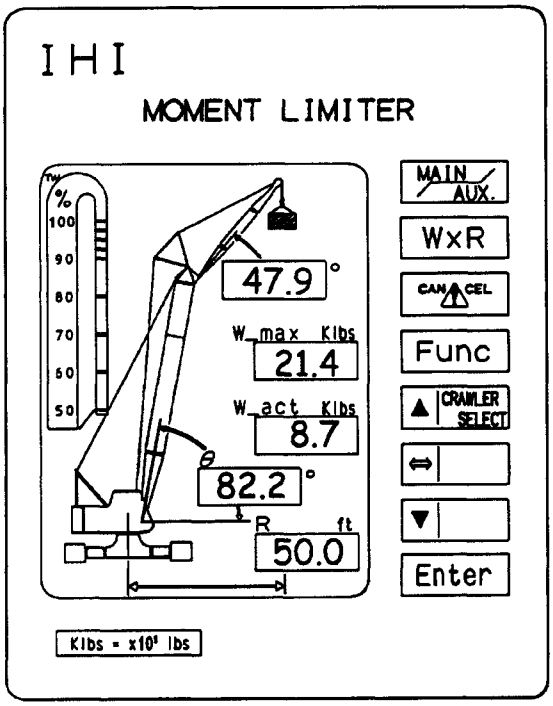
Press the main/auxiliary selector key switch [MAIN AUX], the main hoisting work menu is changed to the auxiliary hoisting work menu. Press the [MAIN AUX] key again, and the menu is changed to the main hoisting work menu. Select a proper menu according to the actual crane configuration. It is not permitted to lift loads with the main hook and the jib hook at the same time. There is no change of the main hoist and auxiliary hoist at the tower crane.



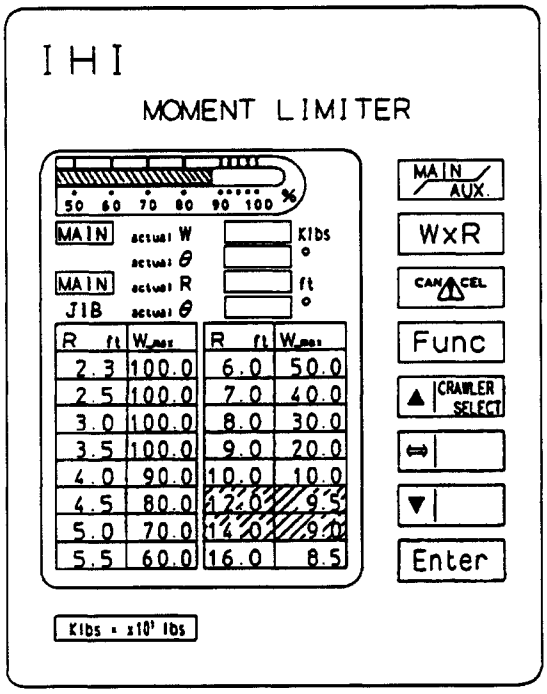
Tower crane work

The values in the display unit are reference values required for the explanation. They have nothing to do with an actual lift.

Standard Menu



Load Table (for "MAIN")



(2) The selector switch to the load table [WxR]

[1] Press the [WxR] switch once on the standard menu, and the load table is displayed. On the load table display, press the [WxR] or [CANCEL] key once, and the standard menu appears.

The load table displays the following six items:

- Actual load for the main or auxiliary hoisting . . . . . Klbs
- Boom angle . . . . . °
- Working radius for the main or auxiliary hoisting . . . . . Ft.
- Jib angle . . . . . °
- Working radius/allowable load table . . . . . Ft. Klbs
- Load ratio . . . . . %

The following illustration is the "MAIN" table. If you want the "AUX." table, press the [MAIN AUX] key switch.

[2] Working radius/allowable load table

In the load table, the shaded area of the working radius/allowable load table indicates the current crane working radius and allowable load.

The actual working radius is 12.3 ft. and is within the shaded area, 12.0 ft. ~ 14.0 ft. The operator can view the current working radius and allowable load according to this table.

To display the data after 16.0 ft. for the working radius, press the [⇔] key once. The next data are displayed. To return to the original data, press the [⇔] key.

[3] The upper bar graph on the screen indicates the ratio (load ratio) of the crane's current load (actual value) and to the allowable safe working load.

(3) Cancel key [CANCEL]

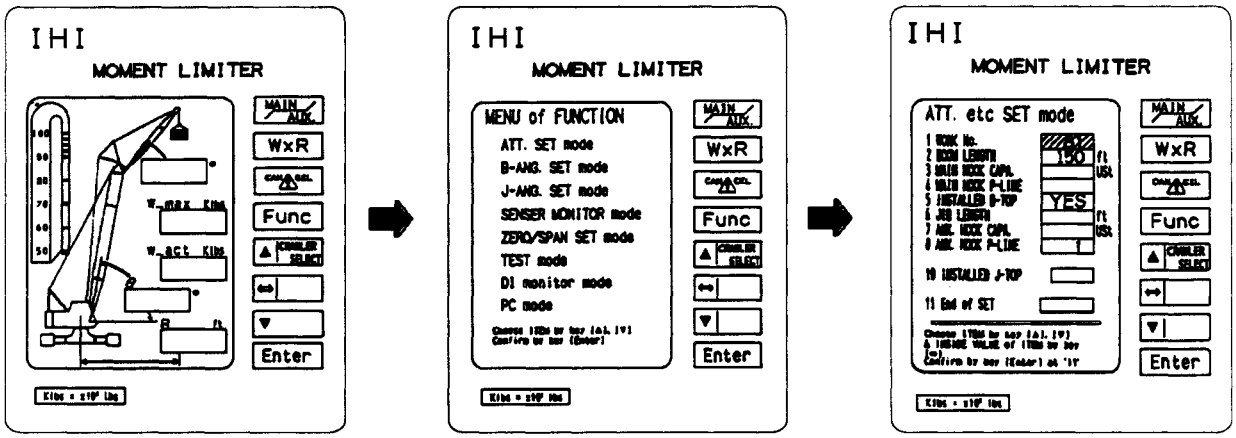
Press this key in the middle of setting for the crane working conditions or optional angle as mentioned above, the setting operation stops and the original condition before setting is restored.

(4) Function key - to change to the function selection menu [Func]

When the working conditions have to be set, change the standard menu to the function selection menu and then select the desired items in the function selection menu with the cursor.

Press the [Func] once in the standard menu and the function selection menu is displayed. In the function selection menu, press the [▲ CRAWLER SELECT] or [▼] key to move the cursor (reversed cell) to the desired item.

For example, move the cursor to "ATT. SET mode" and press the [Enter] key once. Then, "ATT. etc. SET mode" (working condition setting mode) is displayed.



Standard Menu | **Function Selection Menu** | **Setting Menu (ATT. etc. SET mode)**

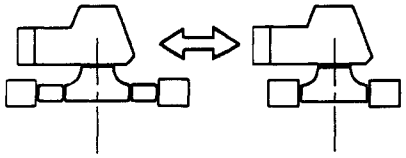
Refer to "(2) Setting of the working conditions" for how to set the working conditions and how to return from the setting menu to the function selection menu. If the function selection menu has to be changed to the standard menu, press the [Func] or [CANCEL] key once.

(5) Crawler select key - to change the crawler width [▲ CRAWLER SELECT]

In the crawler crane, this key is effective only for the model which rated overall lifting load is changed according to the crawler width.

Press the [▲ CRAWLER SELECT] key once in the standard menu, and the illustrated crawler width is retracted. Press the key again, and the crawler width is extended.

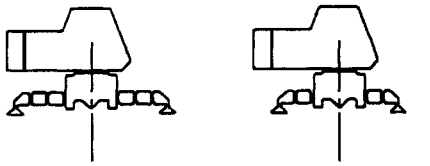
Change of Crawler Width



When extended (EXT.) **When retracted (RET.)**

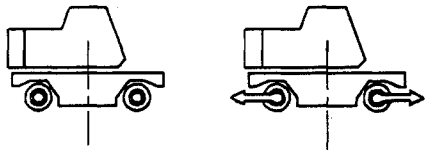
On the machine without the crawler width change specification, set the crawler width to the extended condition. If the crawler width is retracted, "E114" is displayed and the alarm sounds. This key switch does not work on the wheel type.

Change of Outrigger Width



When extended (EXT.) **When retracted (RET.)**

(6) [⇔] This key is used for setting the working conditions and changing information. This key switch works when tires are used for the travelling unit. Press the key once, and the illustrated outrigger width is retracted. Press the key again, and the outrigger width is extended. On the machine with outriggers, set the displayed picture to the machine current condition. On the crawler crane, this switch is used for setting the working conditions, etc.



Tire Stationary Lifting **Travel Lifting**

(7) [▼] This key is used for setting the working conditions and scrolling down through the menus. This key switch works when tires are used for the travelling unit. Press the key once, and the displayed picture is changed to "travel lifting". Press the key again, and the displayed picture is changed to "tire stationary lifting". On the crawler crane, this switch is used for setting the working conditions, etc.

(8) This key is used to change to "set value checking menu" or to the next/preceding menu (to update)

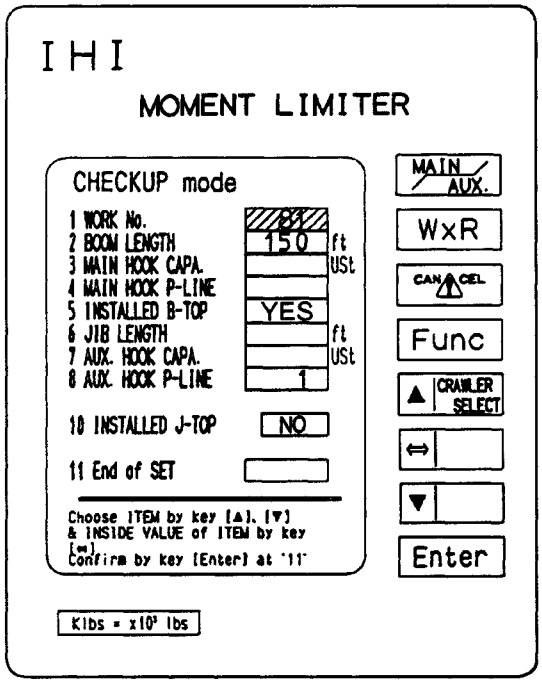
Press the [Enter] key once in the standard menu, and the "Attachment setting" menu, which was set in the above-mentioned "ATT etc. SET mode" menu, is displayed.

Press the [Enter] or [CANCEL] key in the setting menu, and the standard menu is restored.

In the "Set value checking" menu, the operator can check the following values which were set in "Setting of the working conditions":

- Work No.
- Boom length
- Main hook capacity
- Part of line for main hook
- Jib length
- Auxiliary hook capacity
- Part of line for auxiliary hook
- Jib offset angle

Set Value Checking Menu



In this menu, the operator can check the following nine items which are set currently:

1. Work No.
2. Boom length
3. Main hook capacity
4. Part of line for main hook
5. Installed boom top (YES)
6. Jib length
7. Auxiliary hook capacity
8. Part of line for auxiliary hook
10. Installed jib top (NO)

After checking the data, press the Enter or CANCEL key. The standard menu is restored.

4. Error messages and error codes

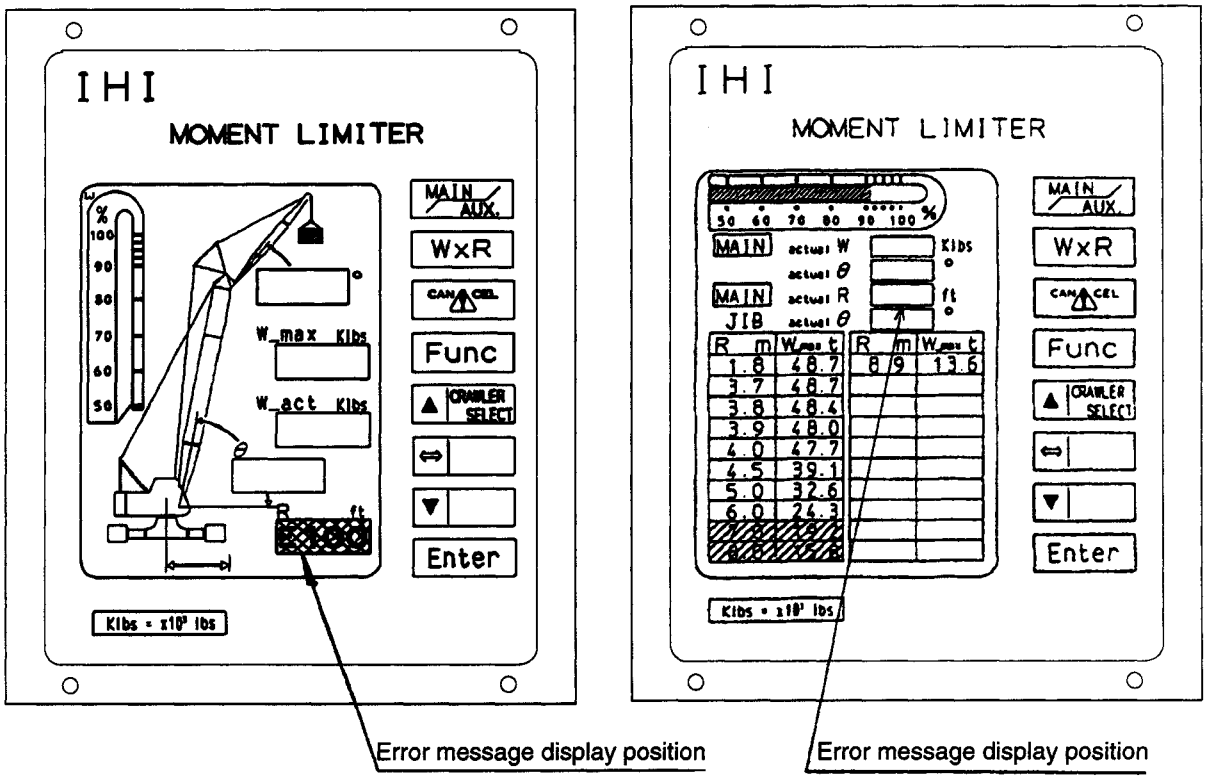
If a working condition inapplicable to the specification is set or if the sensor output is defective in the overload prevention device (moment limiter), the error is displayed on the screen.

The error is displayed as "Exxx" in the working radius column. The error display blinks and an alarm is heard. Refer to the illustrations on the next page.

The error codes and remedial measures are shown in the following table.

Error Code Table

Error No.	Causes	Check and Remedial Measures
EEEE	DSP (CPU) is defective.	Should repair or replace
E100	Boom angle detector is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the angle meter
E102	The load cell sensor is defective (the regular output value is not proper).	Check the wiring Check the IN/OUT voltage Replace the load cell
E114	The load table does not exist.	Check the set data Check the crawler width, etc.
E120	The communication is not proper between the CPU and the display unit.	Should repair or replace
E121	The memory is defective in the CPU.	Should repair or replace
E122	The internal mode selector LS is defective.	Should repair or replace



In both of the above illustrations, the error message is displayed as "E100" on the working radius column. "E100" blinks and an alarm is heard. Refer to "Error Code Table" for the causes and remedial measures of the errors.

6-3 Caution handling overload prevention device (moment limiter)

1. When starting the machine, auto stop sometimes works. Turn the bypass switch to released side once and start the work.
2. If load reaches 90% of the allowable value, the warning buzzer sounds intermittently.
3. If load exceeds the allowable value, the warning buzzer sounds continuously and the auto stop device works. The operation for the dangerous side, namely, hoisting the load and lowering of the main boom (jib) cannot be done.
4. When the auto stop device works, return the crane to the safe area, the automatic stop is released in about 2 seconds and all the operations can be done.
5. If the boom is positioned over the upper limit angle or beneath lower limit angle set optionally, a warning sound occurs.
6. If the boom is beneath the specified angle, the buzzer sounds and the crane stops automatically, even if a load is not suspended.
7. Set the overload prevention device according to the working conditions.

   (1) Select the Work No. of the setting screen according to the table on Page 1-63.

   (2) Select the item mode according to the machine actual conditions.

   (3) After setting is ended, return to the standard screen.

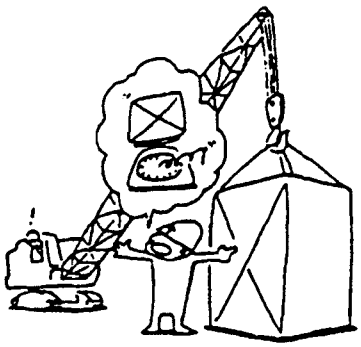
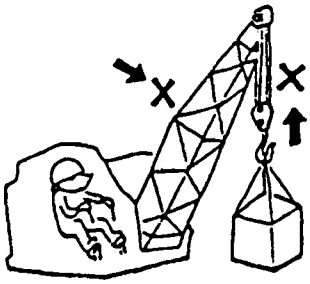
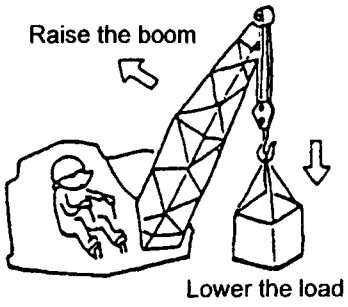
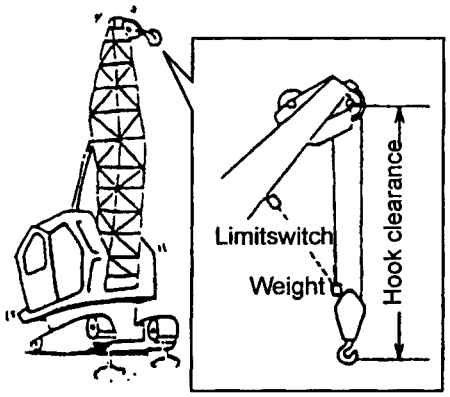
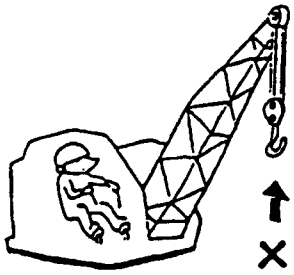
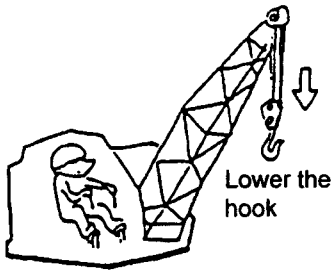
8. The boom/jib selector switch returns to the boom lifting side automatically if the power of the overload prevention device is turned off. Check the machine and set the mode.
9. Refer to the description for handling the moment limiter for details.

NOTICE

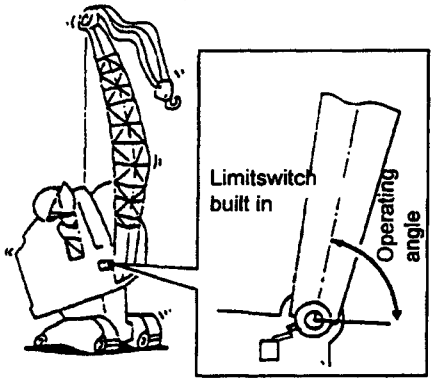
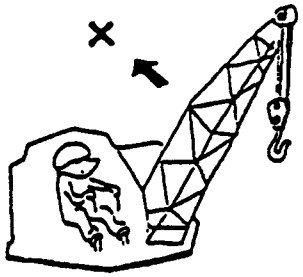
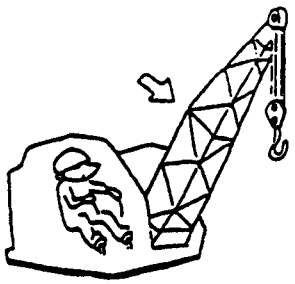
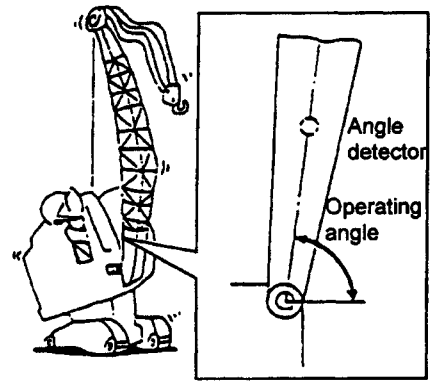
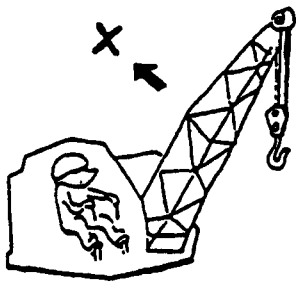
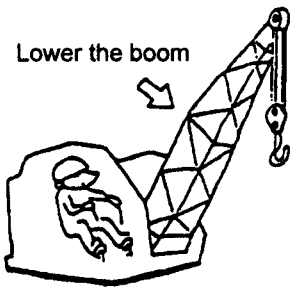
1. **Before starting operation, change the display to the setting screen and make sure that the crane status is set to the proper set values.**
2. **Check the operation of the auto stop device without load.**

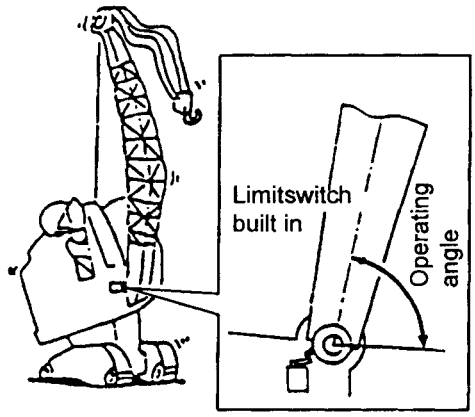
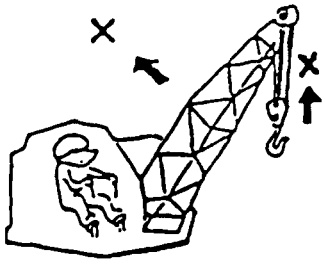
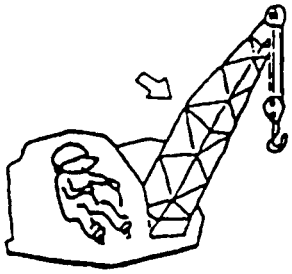
7. RELEASE OF OPERATOR AID ON ITS ACTIVATION

7-1 Overload prevention device, hook over hoisting prevention device

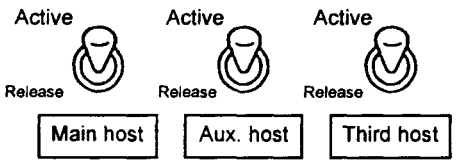
Device	Function	Releasing Method
1. Moment limiter (Overload prevention device) 		
The computer unit compares the actual load with the permissible load (rated overall load). At 90% of the permissible load, the warning buzzer sounds intermittently. At 100% of the permissible load, the warning buzzer sounds continuously.	1 Operations on the dangerous side (boom lowering and load hoisting) stop and remain impossible. 2 The warning buzzer beeps ● Moment limiter warning buzzer	1 Raise the boom or lower the load until the machine returns to the safe zone (moment limiter warning buzzer stops). 2 Return the crane to the safe area, an automatic stop is released in about 2 seconds and all the operation can be done.
2. Hook overhoisting prevention device 		
If the hook is hoisted beyond the specified height, the limit switch will be activated. Minimum hook clearance: Standard crane main boom operation..... 13 ft. Standard crane jib operation .. 12 ft.	1 Hook hoisting operation stops. 2 The warning buzzer beeps.	1 Lower the hook. *This device is reset when the warning buzzer sound stops.

7-2 Boom overhoisting prevention device, upper limit stop device

Device	Function	Releasing Method
3. Boom overhoisting prevention device (Boom hoisting throwout unit)  When the boom is overhoisted beyond the specified angle, the limit switch will be activated. Maximum operating angle Crane . . . . . 81°	 1 Boom hoisting is stopped.	 1 Lower the boom *This device is reset when the warning buzzer sound stops.
4. Boom high-angle stopper  When the boom overhoisting stopping device is not activated, the computer unit operates in response to angle detection with the angle detector. Maximum operating angle Crane . . . . . 82°	 1 Boom hoisting is stopped. 2 The warning buzzer beeps.	 1 Lower the boom. *This device is reset when the warning buzzer sound stops.

Device	Function	Releasing Method
5. Second throwout unit 		
When the boom is hoisted beyond the specified angle, the limit switch at the left boom foot will be activated. Operating angle: Crane . . . . . 83°	1 Boom hoisting is stopped. 2 Winding of the main and auxiliary winches is stopped. 3 Winding of the third drum is stopped. *Simultaneously, the warning buzzer beeps.	1 Lower the boom. *This device is reset when the warning buzzer sound stops.

7-3 Hook overhoist prevention device switch



(Mounted above the right control panel against the main hoist clutch)

- Of the main, auxiliary and third hoist switches shown at left, the switch of the winch used for crane work, etc., must be turned to the "active" side without fail.

  Example: When only the main hoisting hook is mounted, the main winch switch must be turned to the "active" side. At this time, the auxiliary and third hoist switches must be turned to the release side.

This is because the limit switch for overhoisting prevention employs a b-contact type. Unless set at the "active" side, the relevant overhoisting prevention device won't operate.

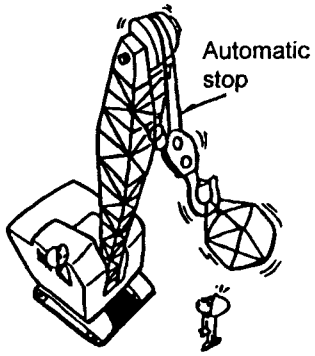
⚠ CAUTION

1. **If the boom is lowered to the ground at the time of disassembly or assembly of the attachment, hook over wind prevention device switch must be turned to the "release" side. This switch must be turned to the "active" side after lifting the boom off the ground.**

   For lowering the boom, this switch must be turned to the "release" side just before the overhoisting status is detected. The hook overhoisting prevention device switch is located above the control panel in the right hand machinery cab.
2. **During operation, the relevant prevention device switch (shown in the figure above) must always be turned to the "active" side. If it is not at the "active" side, the hook overhoisting prevention device does not operate.**

8. HANDLING OF OPERATOR AID

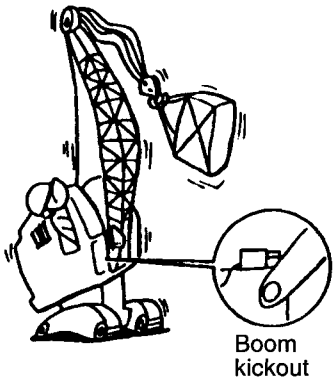
1. Avoid reliance on the operator aids.
2. Operations should be carried out within a range where the function cutouts will not activate. Operations should be based on recognition that the operator aid is provided as a final emergency means. Avoid such operations which frequently activate the hook overhoisting prevention device or boom overhoisting prevention device.



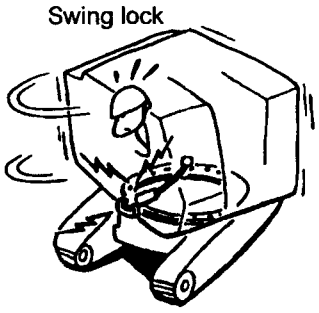
   a. For safe and efficient crane operation, it is recommended to utilize the overload prevention device for checking the current load ratio and working radius and avoid a condition which triggers automatic stop.
   b. In operation, crane functions should be used with an adequate margin secured against a condition where automatic stop is caused.
   c. If the machine stops due to activation of the function cutouts, first apply the drum brake securely, then take the subsequent step for restoring normalcy.

⚠ CAUTION

When a heavy load is suspended, avoid hoisting the boom at a high angle close to the boom kickout activation angle (80°) when possible. This is required because as the load is set down, the tension on the boom suspension is relieved. As the tension is relieved, the boom angle will increase which may cause the boom kickout switch to activate.



- Boom kickout activation angle. . . . . 81°
- Automatic stop due to moment limiter . . 80°
  (Rated upper limit angle)



⚠ DANGER

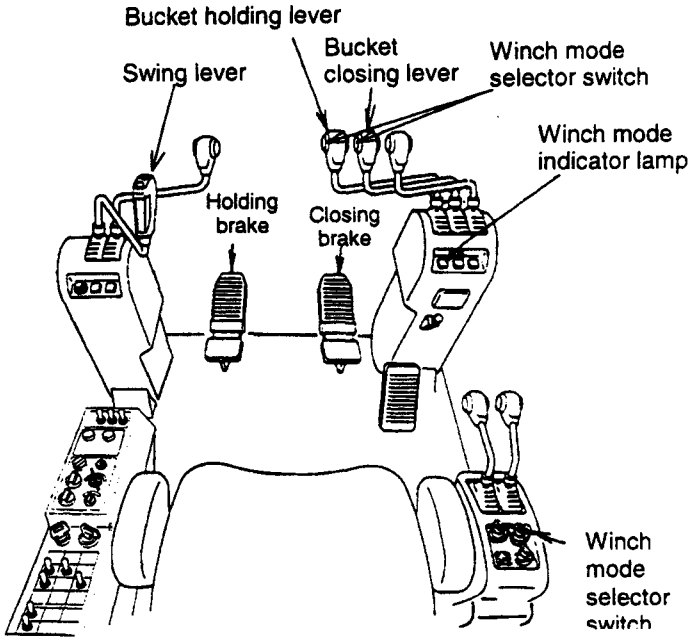
1. **If the crane is operated while the overload prevention device switch is in the erection or transportation position, the overload prevention device does not function and overload may turn over the crane. When the crane is disassembled or assembled, the overload prevention device switch is temporarily at "ERECTION". If the crane is operating, set the switch at "OPERATION".**
2. **If the overload prevention device in the moment limiter is activated (hoist & boom functions stop) because of overload, do not turn the bypass key switch to the released position and continue to hoist or boom down. The crane may tip over or structural failure or damage could occur.**

9. CLAMSHELL OPERATION

Operating procedure

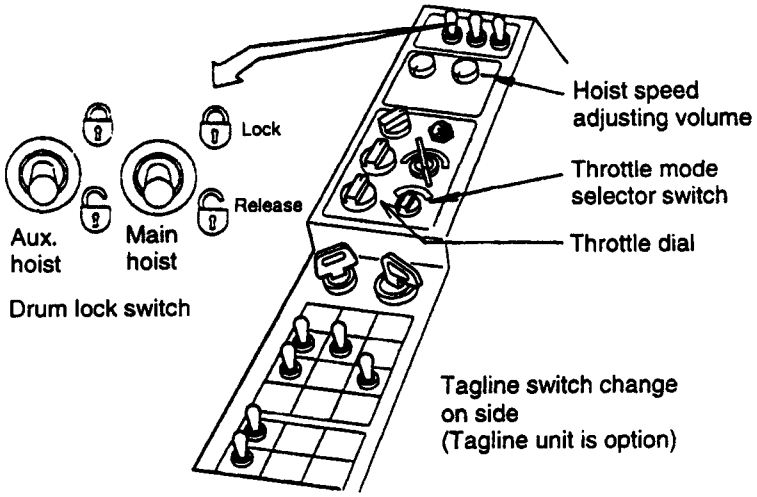
Since the usual operation is mostly carried out with the foot brake, explanation is given here in the foot mode. If the digging depth is large or overheating of the brake drum is expected, the automatic brake mode may be employed.

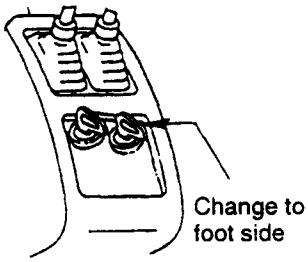
1. With the brake depressed, change over the winch mode selector switch of the right-side box to the foot mode.



2. Change over the selector switch at the head of the hoist lever to the foot mode side. Make sure that the mode indicator lamp at the root of the lever is lit.

3. Turn the hoisting speed selector switch to the "Low" speed. (Main & Aux. same speed)





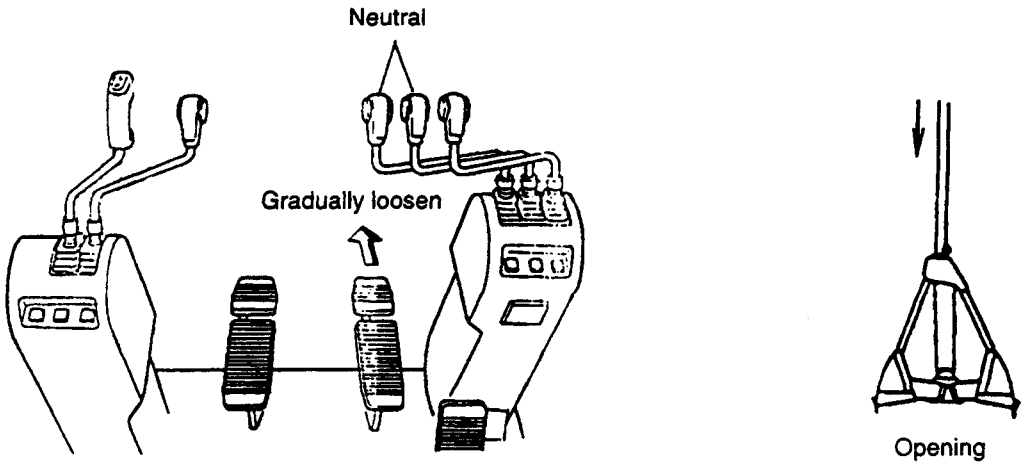
4. Determine the engine speed changing rate with the throttle mode switch, and the minimum engine speed with the throttle dial switch. The engine speed range above the minimum speed is controlled by the grip throttle of the swing lever.
5. Release the drum lock of both the main and auxiliary winches. Press to the side where the unlocked status is drawn. Next, set the hydraulic circuit select switch to the tagline position, and set the tagline select switch to "ON". Now, operate the tagline.

6. Opening the bucket:

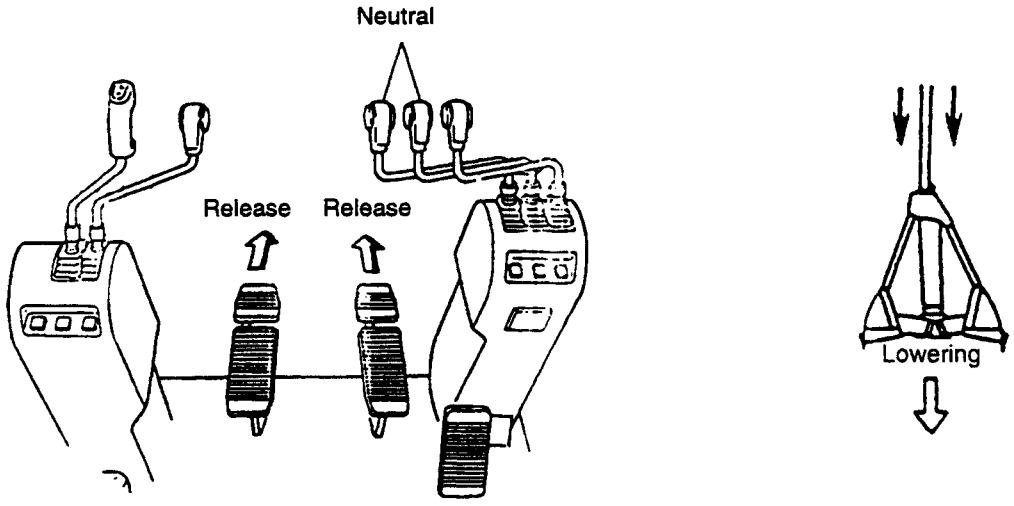
   Set the bucket closing lever and holding lever at neutral. Both brake pedals should be kept depressed.

   Then, release the closing brake pedal slowly to open the bucket.

   Pay attention not to release the closing brake excessively, otherwise the closing rope may be wound irregularly.



7. Lowering the bucket:



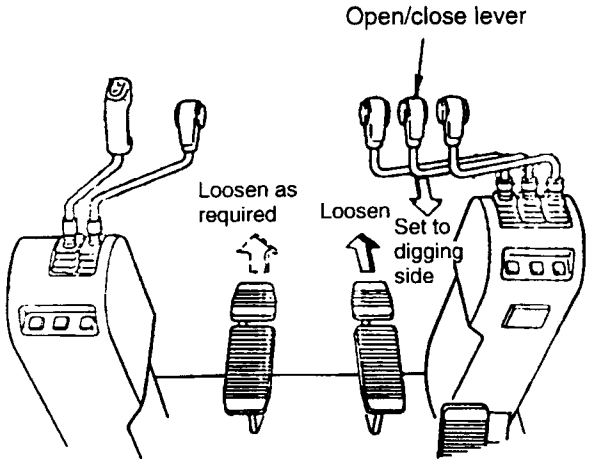
   Release both the closing brake and the holding brake, and gently lower the bucket onto the substance to be dug.

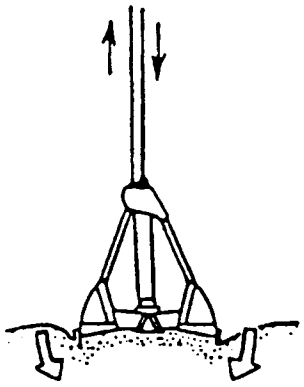
   Release both ropes by the same amount so as not to close the bucket. Adjust the holding side with reference to the rope on the closing side.

   Lower the bucket in the open status. It is desirable to master the skill of operating the left and right foot brakes as early as possible.

8. Digging:

   With the closing brake released, set the closing lever to the digging side. Loosen the holding brake gradually in response to the capacity and digging depth of the bucket.



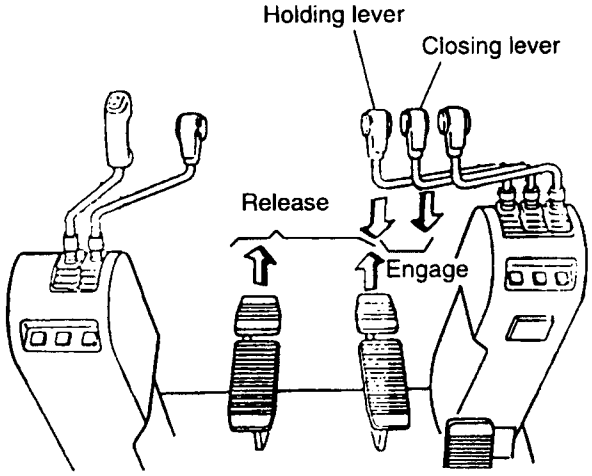


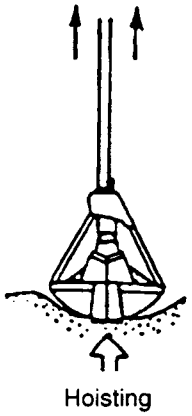
9. Hoisting the bucket:

   As soon as the bucket closes on completion of digging, pull the holding lever toward you in order to hoist the bucket via the digging and holding ropes.

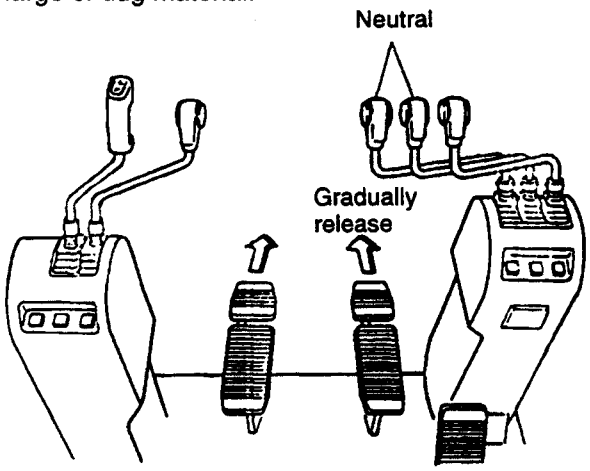
   If winding is uneven between the two ropes, the winding speed is reduced on the tenser side. Careful operation is required so as not to drop the held material (priority should be given to the closing rope).

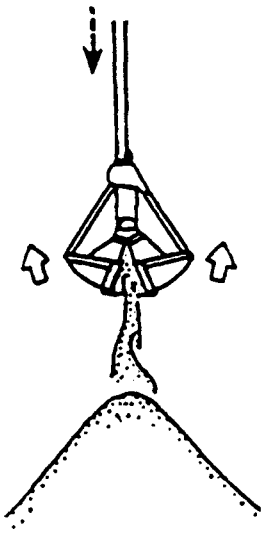
   Swing the superstructure to the determined discharge position. Swing operation should be carried out slowly. Abrupt swinging will cause the load to swing outside due to a centrifugal force. Therefore, the working distance will increase.





10. Discharge of dug material:



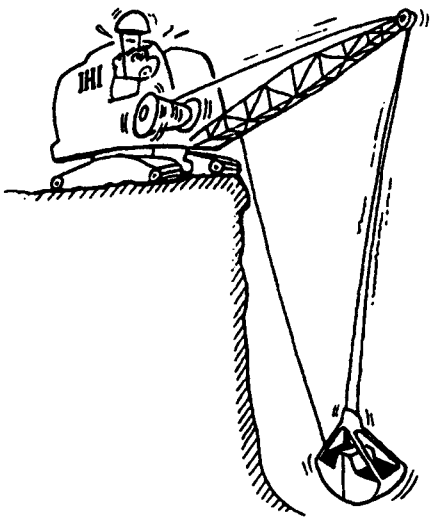


When the bucket comes to the determined position, return both levers to neutral with the closing and support brake pedals depressed. Discharge the dug material by gradually loosening the closing brake. Pay attention not to loosen the brake excessively, otherwise the wire rope is loosened unnecessarily, causing irregular winding.

NOTICE

1. If the wire rope is short, it is paid out completely from the drum before the bucket reaches the digging point. In this case, there is a risk of the drum being broken or the wire rope being cut off.

   For any kind of work, the rope should be left on the drum by two or more windings.
2. If the wire rope is too long, it is apt to be wound irregularly because of winding in many layers. As a result, the rope may be damaged and reach the end of its service life earlier.
3. Always check the condition of the ground and perform the swing operation as slowly as possible. During the swing operation, take care not to hit the bucket against other equipment.
4. Cargo handling work is classified as the one by mobile crane.



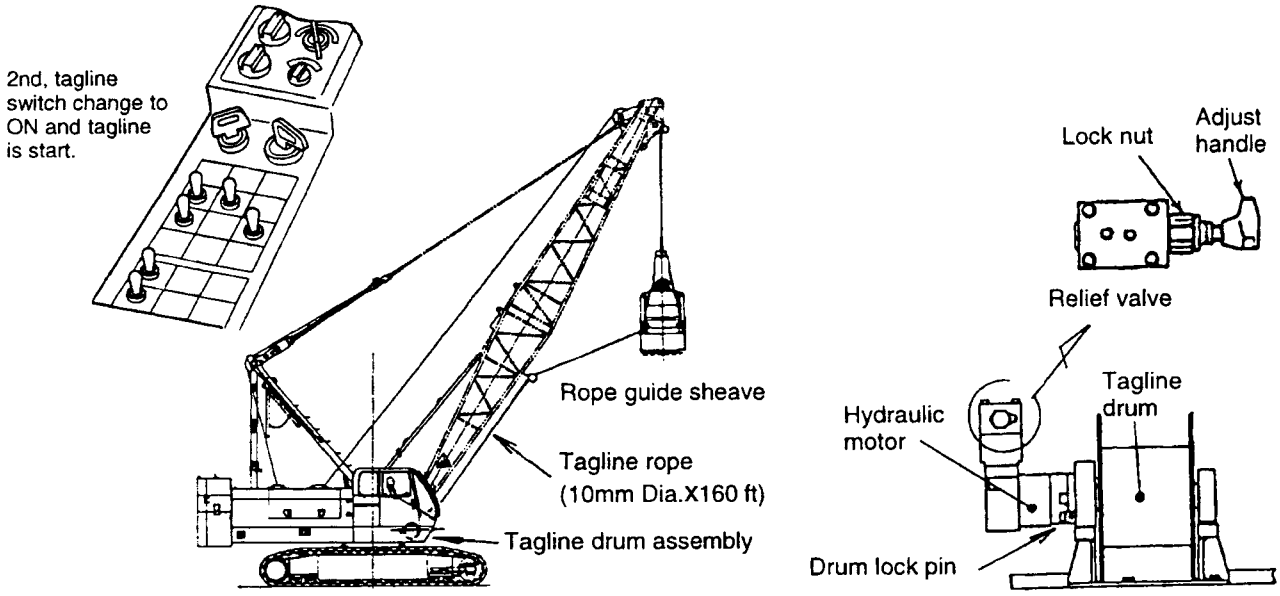
10. HANDLING OF HYDRAULIC TAGLINE (OPTIONAL SPECIFICATION)

10-1 Outline

This equipment is used to prevent the bucket from swaying during clamshell operation. The bucket tensile force is adjusted by matching the relief valve pressure with the present work.

10-2 How to adjust tensile force (adjustment of relief valve in hydraulic motor section)

When screwing in the adjust handle with the lock nut loosened, the pressure rises to increase the tensile force, and the force weakens when turning back the adjust handle. (Adjustable range: 0 to 1420 psi). After adjustment, lock the nut securely.



If the tensile force is excessive, the bucket is pulled toward the operator, and it is swung outside if the force is inadequate. It will be an overload, if a work radius increased, so be careful. Adjust the tensile force so as to match the working state.

The pump for the tagline pump (P5 pump) is used for delivering pressurized fluid to the tagline hydraulic motor. Therefore, when the tagline is unused, energy can be saved by turning back the relief valve to 0 psi and lock the drum by inserting the lock pin into the tagline drum.

⚠ CAUTION

1. **When use of the hydraulic tagline is not intended for a long time, fully loosen the relief valve and lock the drum by inserting the lock pin into the tagline drum to prevent danger. Set the pressure of the tagline motor to "0" by adjusting the tagline motor.**
2. **When the tagline drum is rotating in the rope winding direction, be careful not to be caught by the tagline if you work near it.**
3. **When the engine starts, in hydraulic circuit select switch to tagline side and tagline switch select "ON", the rope is pulled suddenly by the tagline operation. Be careful.**

11. PRECAUTIONS FOR WIND AND HIGH TENSION ELECTRIC WIRES

11-1 Influence by wind

When wind blows against a mobile crane, various problems occur. For example, the swaying load hits the buildings around it, the slinging worker is exposed to danger, overload may be applied to the crane, the operation is hindered the crane may tip over, etc. These problems are caused by the wind pressure against the boom and load or the wind load made by the wind pressure. The machine is more liable to be influenced by wind as the boom is longer, the wind velocity is higher, the load receiving area is larger, or the load position is higher. The mobile crane is designed to have the strength against the wind velocity of 36 MPH (16m/sec). When this value is divided by the speed ratio of the maximum instantaneous wind velocity and maximum average wind velocity (approx. 1.5 times), "24 MPH" ("10.7m/sec"), which is Class 6 24~31 MPH (10.8~13.8m/sec) in Beaufort scale, is obtained.

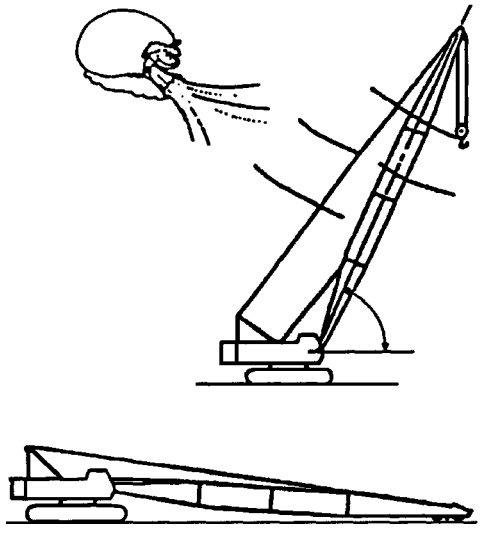
⚠ CAUTION

1. **Constantly be careful about a weather report or the indication of anemometer, and understand the velocity of wind.**
2. **The wind velocity, which is a wind load made by the wind pressure, may cause the crane to tip over or the boom to fall backward. Especially when the boom is long, wind affects it greatly. If the maximum average wind velocity exceeds 22 MPH (10m/sec), stop the crane operation. "Maximum average wind velocity" means the average wind velocity 33 ft. (10m) above the ground for 10 minutes. In general, the maximum instantaneous wind velocity is 1.5~1.7 times the maximum average wind velocity, and its ratio is called "gust factor". When the maximum average wind velocity is 22 MPH (10m/sec), the maximum instantaneous wind velocity is 36 MPH (16m/sec). This maximum instantaneous wind velocity affects the crane. The higher it is above the ground, the larger the wind velocity is. Moreover, the wind velocity is larger at the bottom between the buildings. Determine to continue or stop the operation, as safety is given the highest priority.**

Countermeasure against wind

The following shows the countermeasures when the weather report tells that the maximum average wind velocity exceeds 22 MPH (10m/sec) or 34 MPH (15m/sec).

1. When the average wind velocity (of the weather report) exceeds 22 MPH (10m/sec), stop the operation and carry out the following procedures:
   a. Put the load on the ground & release it from the hook.
   b. Set the boom angle to approx. 70°.
   c. Swing the machine so that the counterweight may be in the windward side. The boom back should be against the wind.
   d. Apply the brake and lock for hoisting/swinging, and then stop the engine.
2. If the wind velocity is going to exceed 34 MPH (15m/sec), lay down or fold the long boom. If it is going to exceed 45 MPH (20m/sec), also put all the booms and tower boom on the ground.
   a. Put the load on the ground & release it from the hook.
   b. Lower the boom to the ground. If swinging is necessary, set the boom angle to approx. 70°.
   c. Apply the brake and lock for hoisting/swinging, and then stop the engine.



Beaufort scale

	Name	On Land	Velocity mph (sec/m)
1	Light air	Smoke is swaying but anemometer does not detect.	.7~3 (0.3 ~1.5)
2	Light breeze	Feels breeze on the face. Leaves move. Anemometer senses.	4~7 (1.6 ~ 3.3)
3	Gentle breeze	Leaves and twigs move constantly. Light flag sways.	8~12 (3.4 ~5.4)
4	Moderate breeze	A dust cloud goes up and wastepaper is stirred up.	13~18 (5.5 ~7.9)
5	Fresh breeze	Bushes move. Waves occur in a pond or marsh.	19~24 (8.0 ~10.7)
6	Strong breeze	Boughs move. The electric wires sound and it is hard to hold an umbrella.	25~31(10.8 ~13.8)
7	Moderate gale	A whole tree sways and it is hard to walk against the wind.	32~38 (13.9~17.1)
8	Fresh gale	Branches are broken. It is impossible to walk against the wind.	39~46 (17.2~20.7)
9	Strong gale	The house chimney falls and roofing tiles come off.	47~55 (20.8~24.4)
10	Whole gale	A tree is rooted up. The houses are extremely damaged. Such damage is unusual on land.	56~64 (24.5~28.4)
11	Storm	A wide range is greatly damaged. It seldom occurs.	65~73 (28.5~32.6)
12	Hurricane		74 + (32.7 +)

11-2 Precautions when working near the high tension electric wires

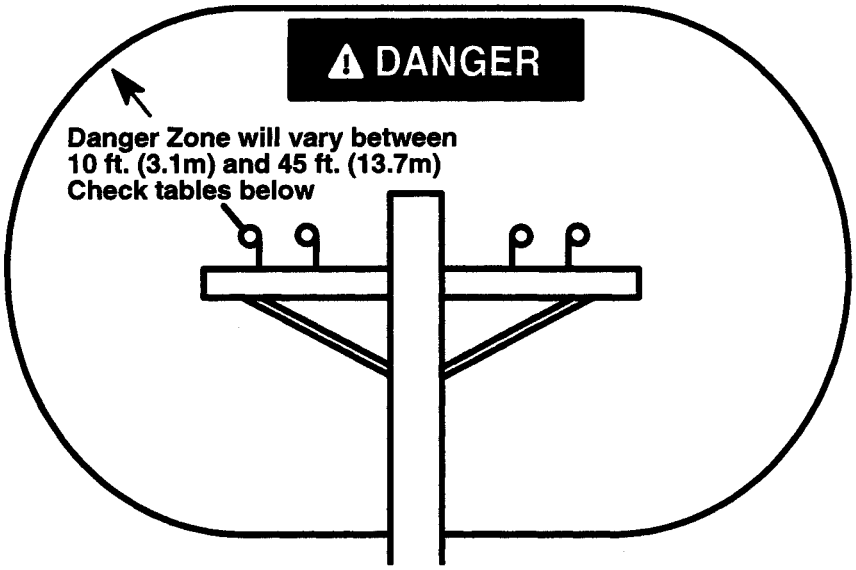
⚠ DANGER

When a crane is operated near the high-tension electric wires, consult with the electric power company beforehand. An electric power company must install the protective tube for insulation. Keep the minimum isolation distance from the high-tension electric wires. If a crane touches a high-tension electric wire, the lifting worker is exposed to be injured first of all. Wear rubber or leather shoes and gloves. If a special high-tension electric wire is used, a person may take an electric shock only by approaching it.

Take the following procedures if touching a high-tension electric wire:

1. **Separate the crane from the electric wire gently, or contact the electric power company to take emergency measures such as stop of power supply.**
2. **If the above procedure cannot be done, the operator must jump out as far as possible. Don't let personnel in the area touch the crane. An electric shock may occur.**
3. **If someone has taken an electric shock, help him after the crane is fully separated from the electrified substance. If touching the substance carelessly, you will take an electric shock. An electric shock not only causes great damage to the persons concerned, but also causes secondary damage on the society by the power failure, etc. Restitution will be great. When using a crane near the high-tension electric wires, carry out the work safely.**

DANGER ZONE NEAR ELECTRICAL TRANSMISSIONS LINES



When operating near high voltage power lines:

NORMAL VOLTAGE (Phase to Phase)					MINIMUM REQUIRED CLEARANCE	
From	0	to	50	KV	10 Ft.	(3.1m)
Over	50	to	200	KV	15 Ft.	(4.6m)
Over	200	to	350	KV	20 Ft.	(6.1m)
Over	350	to	500	KV	25 Ft.	(7.6m)
Over	500	to	750	KV	35 Ft.	(10.7m)
Over	750	to	1,000	KV	45 Ft.	(13.7m)

While in transit with no load and boom or mast lowered:

NORMAL VOLTAGE (Phase to Phase)					MINIMUM REQUIRED CLEARANCE	
From	0	to	.75	KV	4 Ft.	(1.2m)
Over	.75	to	50	KV	6 Ft.	(1.8m)
Over	50	to	345	KV	10 Ft.	(3.1m)
Over	345	to	750	KV	16 Ft.	(4.9m)
Over	750	to	1,000	KV	20 Ft.	(6.1m)

NOTE: Consult local power company for specific (on site) recommendations. Always be aware of and observe applicable ordinances.

11-3 Precautions for lightning

DANGER

1. **Lightning damages a crane and injures the persons around. If lightning is going to occur, stop the crane operation and put the boom on the ground. If lightning has struck a crane, check every section carefully and make sure that there is no problem. Then, start the crane. Also, check the inside of the wire ropes.**
2. **If the weather forecast says that lightning is approaching, stop the crane operation and engine. Then, disconnect the electrical cables for the boom from the harness for the base machine and relay connector. If this is done, damage can be minimized if lightning strikes the crane.**

Section 2

DISASSEMBLY, ASSEMBLY AND TRANSPORTATION

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12/00

IMPORTANT NOTES CONCERNING RIGGING

The information given in this section of the book covers many different combinations of booms and jibs applicable to the general cranes.

Because we manufacture machines which are extremely specialized, we recommend that you check your ratings charts which are provided with your machine before attempting some type of combination your machine may not be equipped for.

All limitations are very clearly explained in our ratings charts. Use the following information with these limitations in mind.

Performance data according to model is given in the "Specifications" section. However, this is not intended to take the place of a rating.

Should any questions arise, feel free to contact the American Crane Customer Service Department for prompt assistance.

American Crane Corporation assumes no responsibility for misuse of data supplied in the operator's manual as a general guide.

BOOM ASSEMBLY, DISASSEMBLY, AND BOOM LENGTH CHANGES

This set of procedures is organized according to the following outline:

I. Assembly and Boom Raising Procedures
   - A. Essential Safety Precautions
   - B. Boom Assembly with Service Crane On-Site Assembly (Method "A")
   - C. Boom Assembly with Service Crane Pre-Assembly (Method "B")
   - D. Boom Assembly without Service Crane

II. Disassembly and Boom Lowering Procedures
   - A. Essential Safety Precautions
   - B. Boom Disassembly with Service Crane
   - C. Boom Disassembly without Service Crane

III. Boom Shortening or Lengthening

These procedures are intended for all standard booms (excluding only those booms used with a floating mast) which are approved for American Crane crawler, self-propelled and truck-mounted cranes. Requirements for locomotive and pedestal cranes are specialized and will vary somewhat from the recommended procedures given here.

Depending upon the type of assist equipment available at the job site, and the specific task to be performed, any one of the working procedures listed above may be called for at any given time. It is the responsibility of the crane owner and operator to determine the adequacy of available service equipment, and the method of assembly or disassembly to be used. Along with following the correct set of step-by-step procedures, it is vital that the appropriate general safety precautions (I-A. or II-A., above) are observed.

COLORS:

RED

WHITE

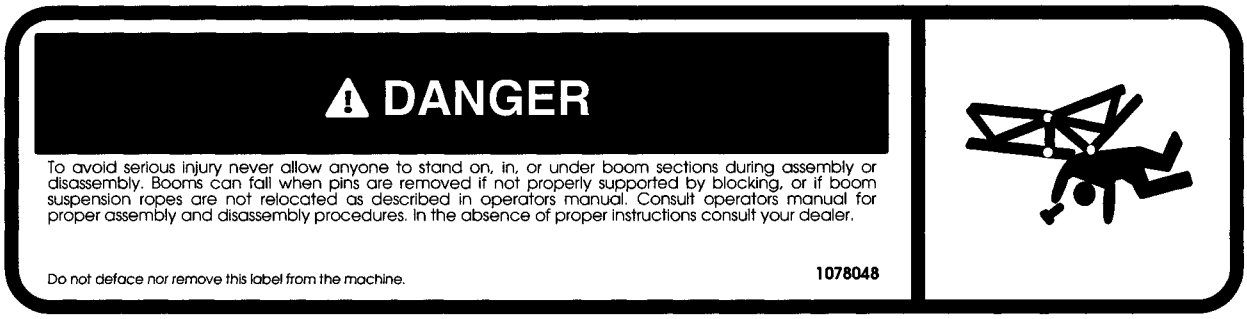


Figure 1

I. Assembly and Boom Raising Procedures

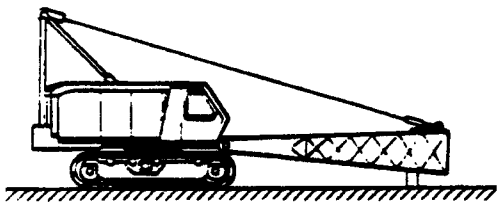
A. Essential Safety Precautions for Assembly and Boom Raising

1. Before starting any procedure, make sure the crane and boom are standing level on a firm, uniformly supporting surface. Attempting to work over uneven and unstable terrain can produce accidents. Sudden loss of support and unexpected weight shifts can cause injury to personnel and damage to components. If the operating surface is not level or adequately supporting, crane mats must be used.
2. Keep the boom off the ground. Always rest the boom - or individual boom sections - on blocking rather than on the ground, to avoid damaging chords, sheaves, or load line. Never ride in or on the boom during any part of the assembly or raising procedure.
3. Before assembling the boom, inspect all chords, lacing and splice connections for damaged or bent areas. Any cracks, deep scratches, gouges on the chords, or dented or deformed lacings will severely weaken the structural integrity of the boom. If damage is found, the boom section involved must not be used until repairs are made.
4. Damage to boom sections occurs most often during handling, either before or after transport or during assembly. Take care when attaching slings. Never attach slings to light lacing members, only to chords or plated areas. Use synthetic web slings whenever possible to avoid cutting or scratching chords. If wire rope slings are used, protect the chords with softeners - for example, 2" x 4" wood splints placed between the sling and boom.
5. The A-frame must always be fully raised whenever the outer bail is pinned to the boom inner for handling boom sections or whenever the completed boom is raised for work.
6. The force of the wind on individual boom sections can be dangerously unpredictable, depending upon the direction and speed of the wind as well as on the individual length of the section and its angle to the wind. Postpone completing the boom assembly and erection procedure whenever wind gusts are creating hazardous conditions.
7. Never stand underneath a boom section while driving pins in or out. Never remove any pin from between boom sections unless you are certain all boom sections are adequately supported and cannot fall, scissor or jerk when the pin is removed. Always stand well clear of boom pins being removed! When the boom is on the ground on blocking, ready for disassembly, there may still be some load on individual pin connections. Under pressure from the weight of one or both of the adjoining sections, pins may fly out of their bores, as they are driven out, with explosive force.
8. It is vital that, no matter which boom assembly procedure is used, the correct sequence of steps is followed, in the specified order, to prevent injury or death to personnel and damage to equipment. American cranes self-erect all boom or boom-jib combinations shown on the machine's Rating Chart, unless specifically stated otherwise. In general, the erection (or lowering) of near maximum boom or boom-and-jib combinations can only be accomplished over the end of the crane's lower works. On crawler cranes the boom must be erected (or lowered) directly over the idler end of the crawler lower with idler tumblers securely blocked. On rubber tired cranes the outriggers must be fully extended and set, and the boom erected or lowered directly over the rear of the carrier. Keep this in mind when laying out boom for assembly, and especially before lowering a boom for disassembly. Follow the boom-jib erection table and the boom-jib composition table on the crane's Rating Chart for maximum erection capability (and reduced capability of erection performed over the side), as well as the proper boom-jib sections to be used and their order of composition. Erection or lowering boom over the side of the machine must only be performed with the crawler sideframes fully extended or with outriggers fully extended and set.

9. Never attempt to raise an assembled boom from the ground when wind speeds exceed those listed in the boom combination/wind speed table on Page 3499.1.
10. Before a boom is raised, always look it over carefully to make sure no lines or pendants are hung up on the boom. Look at all boom and pendant pins to see that they are completely installed with keeper pins secured. Also look out for loose timbers or rigging hardware left on or in the boom. As the boom is raised these will fall and could injure or kill someone.
11. When raising (or lowering) a boom, pay out load line so that the load block and any suspended tackle is on the ground whenever the boom is below the lowest boom angle shown on the crane's Rating Charts. Before lowering a boom, lay tackle and block to one side or the other to prevent interference with the boom when it is lowered down to blocking.
12. The weight of accessories added in the field such as lights, cables or timbers fastened to the boom will reduce the crane's self-erection capability. Consult American Crane to determine the effect of such accessories.

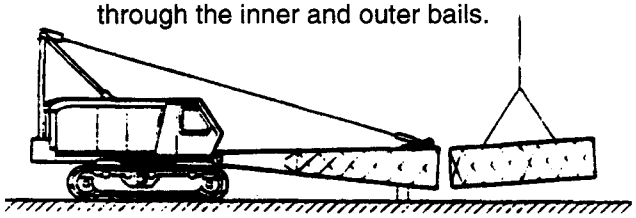
I. Assembly and Boom Raising Procedures

B. Boom Assembly with a Service Crane - On-Site Assembly Method (Method "A").



1. Make sure all safety precautions (Section I-A.) are observed before starting the assembly sequence. Use the service crane to pin the boom inner section to the machinery deck.

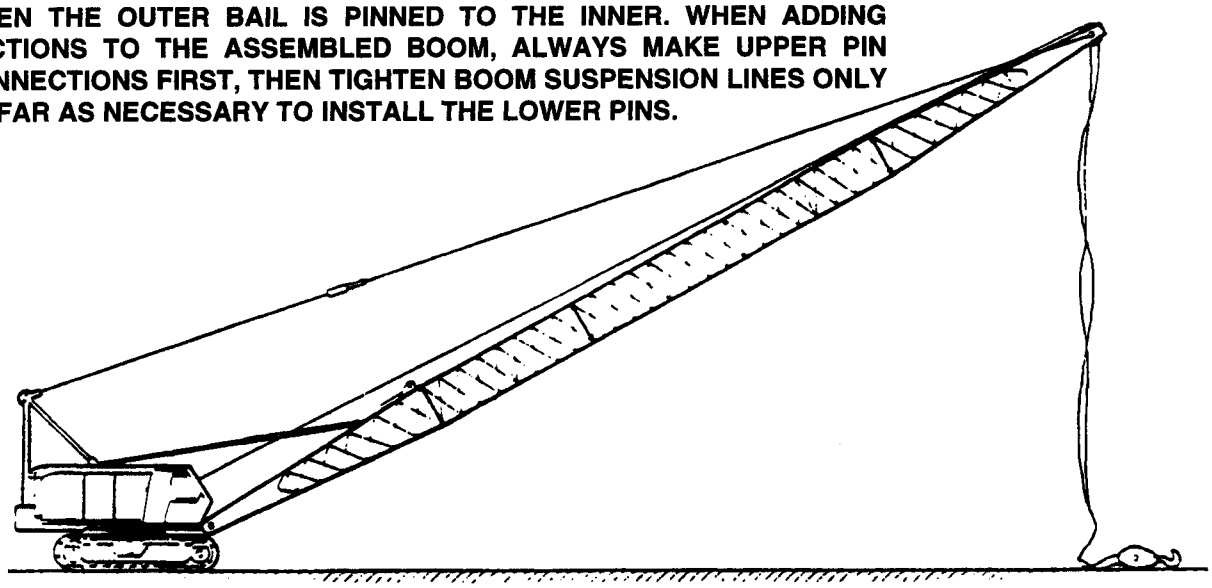
   Place enough blocking under the outer end of the section to allow the next section to be pinned on without hitting the ground. Connect the outer bail to the ears on the end of inner section, using required adapter links where necessary. Reeve the boom hoist line from the boom hoist drum through the inner and outer bails.



2. Using the service crane, bring in the next adjoining section and pin it to the inner. Follow the boom composition table included with the crane's Rating Chart for the proper sequence of assembly. To allow upper pin connections to be made more easily, place slings so that the boom section is tipped slightly. (Refer to the illustration above.) To assist in making the lower pin connection, after upper pins have been installed, release the service crane slightly, allowing boom section to pivot on the upper pins until lower connection holes line up. Before setting the boom down, lift the connected sections up and move blocking out to the far end of the last installed section. Repeat this procedure, one section at a time, all the way out to the boom tip. Always move the blocking to the far end of the boom before adding the next section.
3. After the tip section has been pinned to the rest of the boom, measure all pendants carefully to make sure the total length of both and the right and left side pendants will be equal. Connect the appropriate pendants between the outer bail and boom tip. Disconnect the bail from the inner when pendants have been connected.
4. Install boom stops. Before raising the boom to working position, read through the checklist of safety precautions (Section I-A, Items 1-12). The boom can be raised to working height when all safety precautions have been observed. Watch suspension ropes and pendants to make sure they don't catch on boom pins or cotter pins.

⚠ WARNING

NEVER ATTEMPT TO RAISE THE WHOLE BOOM UP OFF OF BLOCKING WHEN THE OUTER BAIL IS PINNED TO THE INNER. WHEN ADDING SECTIONS TO THE ASSEMBLED BOOM, ALWAYS MAKE UPPER PIN CONNECTIONS FIRST, THEN TIGHTEN BOOM SUSPENSION LINES ONLY AS FAR AS NECESSARY TO INSTALL THE LOWER PINS.



I. Assembly and Boom Raising Procedures

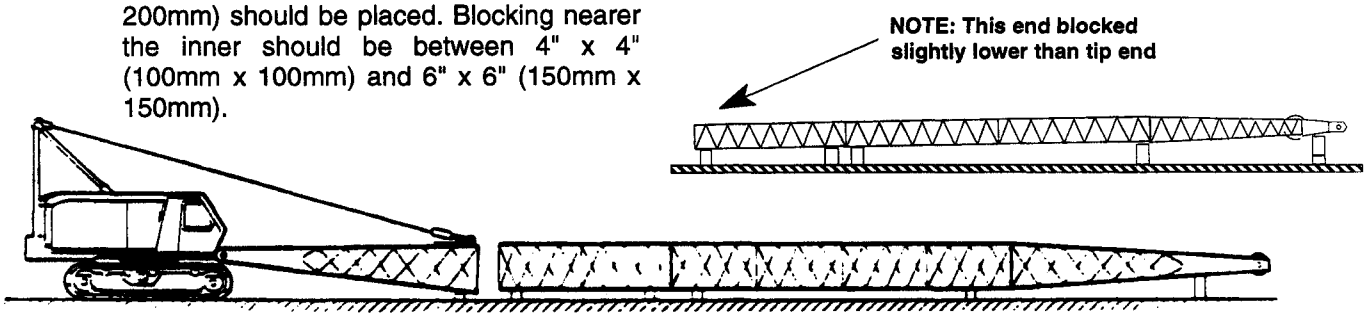
C. Boom Assembly with a Service Crane - Pre-Assembly Method (Method "B").

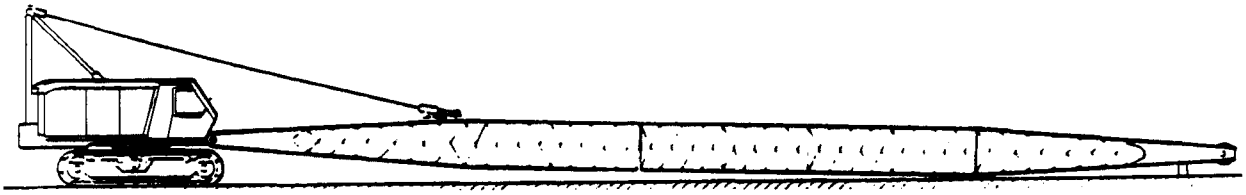
1. If the crane is not at the same location as the boom, but is to arrive at the job site later, the boom may be pre-assembled on blocking ahead of time, using an on-site service crane. This can also be done with longer combinations, to avoid the need for moving blocking out to the end each time another section is added (as in Method A). Except for the boom inner section, which is always pinned to the machinery deck before the pin connections are made to the first center section, the boom should be pre-assembled on blocking that is slightly higher out towards the tip section than it is near the first center section. The illustration below shows the approximate location where taller blocking (minimum recommended size 8" x 8", or 200mm x 200mm) should be placed. Blocking nearer the inner should be between 4" x 4" (100mm x 100mm) and 6" x 6" (150mm x 150mm).

   Follow the boom composition table on the crane's Rating Chart for the proper sequence of boom sections to be assembled.

2. Pin the boom inner section to the machinery deck of the crane. Lower the inner section down to blocking in front of the machine, so that the outer bail can be connected to the ears on the end of the inner section. Reeve the boom hoist line from the boom hoist drum through the inner and outer bails.
3. Move the crane forward and connect the two top pins of the inner section to the adjacent center section. The weight of the boom must be entirely supported on blocking as the pins are installed.

Note: It will be easier to make this connection if the blocking has been arranged as recommended in C.1, above; higher toward the tip and lower under the first center section.





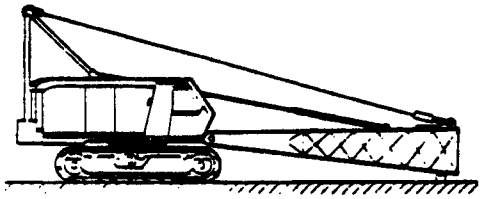
WARNING

DO NOT ATTEMPT TO PICK THE COMPLETE BOOM OFF THE BLOCKING. THE WEIGHT OF THE BOOM SHOULD SAFELY PIVOT ON THE UPPER PIN CONNECTIONS AND THE TALLER BOOM BLOCKING NEAR THE TIP SECTION.

4. Raise the boom slightly, using the boom suspension lines, so that the bottom two splice pins can be inserted.
5. Lower the boom down on blocking until bail lines are slack, and the outer bail is laying flat supported on the bail rest. Repeat Steps B 3 and B 4 from the previous procedure (I-B) to install pendants and boom stops.

I. Assembly and Boom Raising Procedures

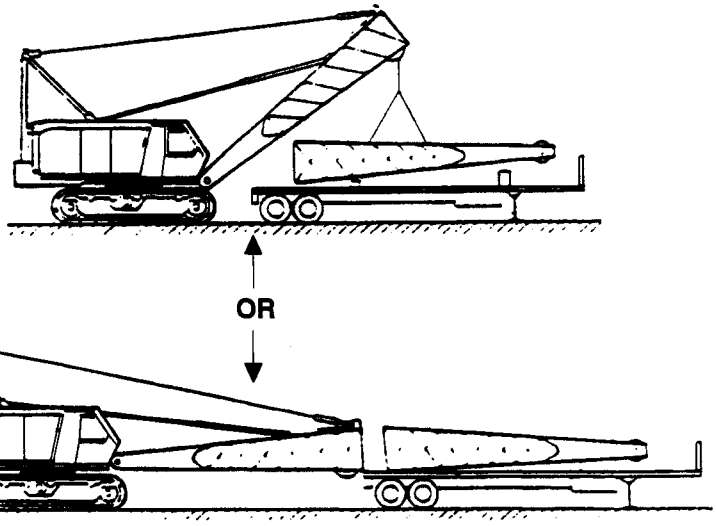
D. Boom Assembly without Service Crane

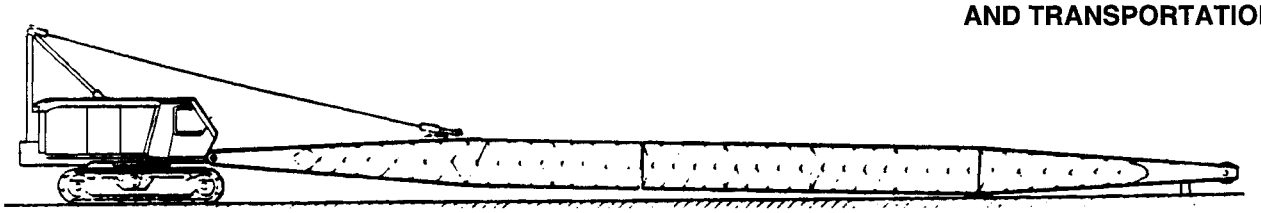


1. When no service crane is available to assist with boom assembly, the crane can use its own inner section to unload and assemble the complete boom, section by section. The inner section must already be in place, the boom suspension line reeved and the outer bail pinned to the end of the inner section. To prevent pulling the inner section over backwards while raising and lowering, install crane boom stops before handling other boom sections.
2. Remove the boom tip section from the transporting truck. This can be done either with the counterweight handling sheaves in the boom inner (if available) or by pinning the tip directly to the boom inner. Move the tip to a clear area where the boom can be assembled and lay it on blocking. Unpin the tip from the inner if it was carried in that way.
3. When joining new sections to the tip, or to whatever length of boom has already been assembled on blocking, the blocking should be supporting the weight of the boom sections at all times.

WARNING

NEVER ATTEMPT TO RAISE THE WHOLE BOOM FROM OFF BLOCKING WHEN THE OUTER BAIL IS PINNED TO THE INNER. WHEN ADDING SECTIONS TO THE ASSEMBLED BOOM, ALWAYS MAKE UPPER PIN CONNECTIONS FIRST, THEN TIGHTEN BOOM SUSPENSION LINES ONLY AS FAR AS NECESSARY TO INSTALL THE LOWER PINS.





4. Unload the next boom section (working back from the tip) by repeating whichever procedure was used in the previous step. Follow the boom composition table on the crane's Rating Chart for the proper sequence and move the next specified adjacent section to the tip and pin the two together on blocking. If there are no counterweight handling sheaves in the inner section of the boom, careful disassembly is required each time the inner is unpinned from the last assembled section. After lower pin connections are assembled to the boom sections on blocking, do not slack off on the boom suspension lines. Take a strain into the boom suspension lines to remove the load from the bottom pins on the end of the inner section. Take these pins out first, then disassemble the upper pin connections. Repeat this procedure with each succeeding boom section. Always lift the blocked sections only enough to assemble (or disassemble) lower pin connections.
5. After the last section has been pinned in place, measure all pendants carefully to make sure the total length of the right and left side pendants will be equal. Connect the appropriate pendants between the outer bail and the boom tip. Disconnect the bail from the boom inner. Before raising the boom to working position read through the checklist of safety precautions (Section I-A, Items 1-12). The boom can be raised to working height when all safety precautions have been observed. Watch suspension ropes and pendants to make sure they don't catch on boom pins or cotter pins.

II. Disassembly and Boom Lowering Procedures

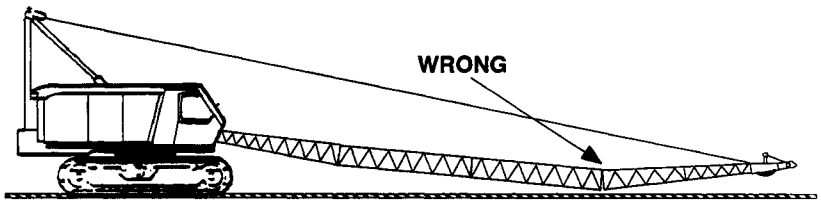
A. Essential Safety Precautions for Boom Lowering and Disassembly

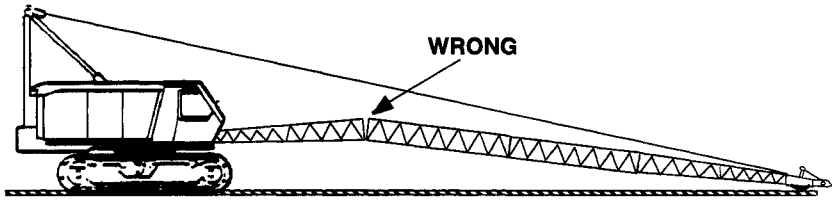
1. When preparing to lower and disassemble the boom, observe all of the precautions that apply to boom raising. Read through the list of safety procedures (Section I-A). In addition:
2. Never attempt to lower near maximum boom or boom-jib combinations when wind speeds or gusts are approaching the limits shown for that boom combination in the wind speed table (Page 3499.1). Be especially careful when winds are blowing from behind the crane, in the same direction that the boom tip is pointing.
3. Never attempt to lower near the maximum amount of boom or boom-jib combination if there is a heavy accumulation of ice or snow on the boom.
4. When lowering a boom past the longest radius on the crane's Rating Chart, reduce the boom lowering speed gradually to prevent a possible shock load on the boom or tipping. When lowering the boom on all friction machines, boom lowering speed can be reduced by setting the main hoist brake and slightly engaging the main hoist clutch. This will slow the gear train and retard the boom speed, as the clutch tries to turn the drum with the brake set. On Model HC-110, select slow speed by depressing the switch located on the left side of the boom lever grip.

⚠ WARNING

5. **NEVER REMOVE ANY PIN FROM A BOOM SECTION UNLESS YOU ARE ABSOLUTELY CERTAIN THE BOOM IS ADEQUATELY SUPPORTED AND CANNOT FALL, SCISSOR OR JERK WHEN THE PIN IS REMOVED. NEVER STAND UNDERNEATH A BOOM SECTION WHILE DRIVING PINS IN OR OUT.**

6. Always stand well clear of boom pins being removed! When the boom is on the ground on blocking, ready for disassembly, there may still be some load on individual pin connections. Under pressure from the weight of one or both of the adjoining sections, pins may fly out of their bores as they are driven out, with explosive force.
7. Disassembly of any pin-connected boom can be hazardous. Never remove upper or lower pins until boom is lowered to the ground on secure blocking and the outer bail has been pinned to the inner section. The illustrations show what will happen if pin connections are broken in the wrong places.



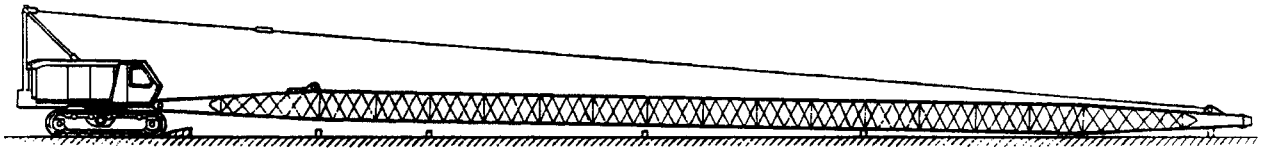


B. Boom Disassembly with Service Crane

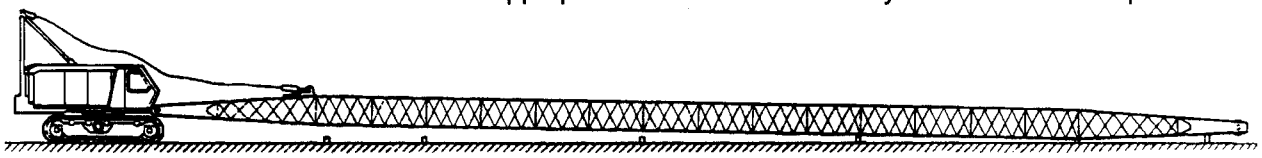
Note: All boom disassembly procedures begin with the next two steps B-1 and B-2. Refer to these steps when disassembling the boom without a service crane, or when lowering the boom to change composition.

1. After making sure that all general safety precautions pertaining to boom disassembly have been observed, lower the boom onto blocking. There should be enough blocking available for completely supporting the boom - and individual boom sections - when the boom is lowered and disassembled. For lowering the boom, blocking will be adequate if the tip is just off the ground - the rest of the boom will then be safely above ground level, at a good working height.

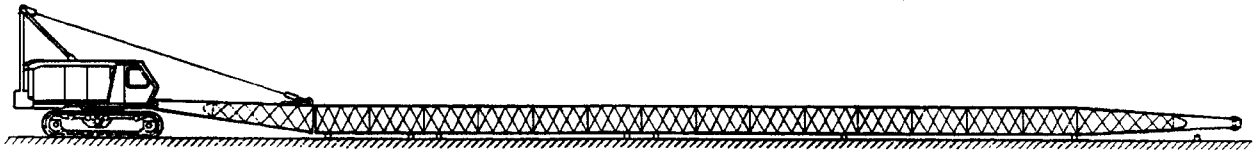
   With a few inches of clearance between the blocking and the boom chords just ahead of the inner section, there will be working room, if required, to take the load off the lower pin connections.



2. When the boom is completely down on blocking, slack the boom suspension lines completely and pin the outer bail to the boom inner section. Use appropriate links where necessary. Remove all boom pendants.

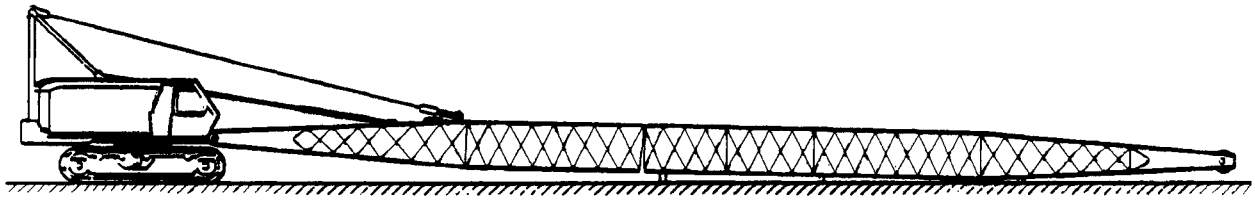


3. With the boom tip supported on blocking, take a strain into the boom suspension line which is attached to the boom inner. This will remove the load from the bottom pins between the inner and the first center section. Remove the bottom pins between the inner and the first center section and allow the center sections to lower onto the prepared blocking.



WARNING

DO NOT ATTEMPT TO RAISE THE WHOLE BOOM OFF THE BLOCKING WITH THE BAIL PINNED TO THE INNER SECTION.

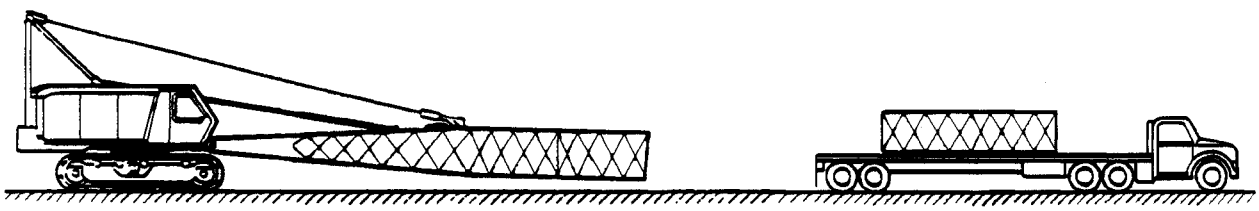


4. Remove the top pins between the inner and the first center section and back the crane away from the remainder of the assembled boom. Use the service crane to disassemble the boom center sections and tip. The service crane can then remove the inner section from the crane after the bail has been unreeved.

C. Boom Disassembly without Service Crane

1. The boom lowering procedure and blocking requirements are the same whether or not a service crane is available to assist with boom disassembly. Begin this procedure by following Steps 1 and 2 in the previous section (II-B1 and II-B2).
2. With the boom tip supported on blocking, take a strain into the boom suspension line which is attached to the boom inner. This will remove the load from the bottom pins between the first two center sections. Remove the bottom pins and lower the boom down on prepared blocking.
3. When there are no counterweight handling sheaves on the inner, lower the boom all the way down on blocking and remove the upper pins between the first two center sections. Carry the first center section away pinned to the inner and unload it for transport by unpinning it from the inner. (This is the reverse of the Procedure for Assembly without a Service Crane.)

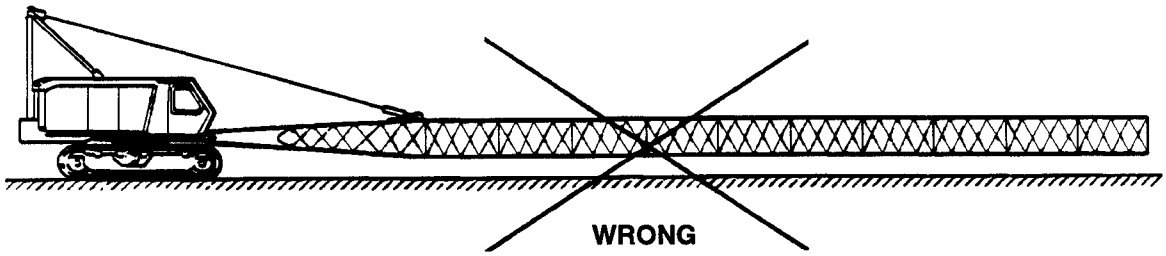
Note: If the boom can be disassembled using the counterweight handling sheaves in the boom inner, then repeat the first <u>three</u> steps of the previous procedure and disassemble the lower pin connection between the inner and the first center section. Lower the boom all the way down on blocking and remove the upper pins. Proceed with disassembly using the counterweight handling sheaves on the inner section.



4. Return with the crane and re-pin the top pins of the inner to the next center section. Take a strain into the boom suspension until the bottom pin holes are aligned and the bottom pins can be installed, then remove the bottom (and after them, the top pins) between the first two center sections to remove the boom section. Carry the boom section to the unloading point and repeat the process until all boom sections have been disassembled.

⚠ WARNING

UNDER NO CIRCUMSTANCES SHOULD MORE THAN TWO CENTER SECTIONS BE CANTILEVERED BEYOND THE BOOM INNER AT ANY ONE TIME. NEVER TRY TO LIFT THE ENTIRE BOOM WITH THE OUTER BAIL PINNED TO THE INNER SECTION.



WRONG

III. Boom Shortening or Lengthening

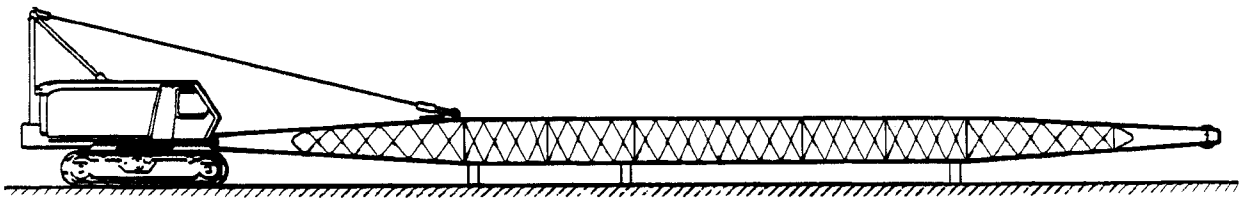
1. The boom must be fully lowered down to solid blocking every time boom composition is changed, to add or remove sections.

   The boom lowering procedure and blocking requirements are the same whether the boom is being lowered for disassembly or to change composition. Begin this procedure by following steps 1 and 2 for Disassembly with Service Crane (II B1 and II B2).

2. With the boom tip supported on blocking just above ground level, take a strain in the boom suspension line to remove some of the load in the boom bottom pins.

⚠ WARNING

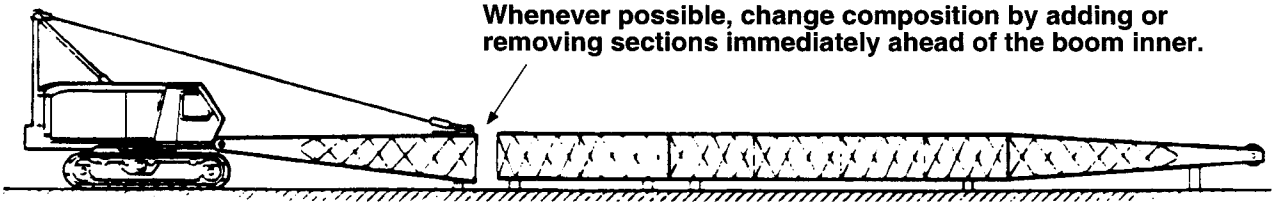
DO NOT ATTEMPT TO RAISE THE WHOLE BOOM OFF THE BLOCKING WITH THE BAIL PINNED TO THE INNER SECTION.



⚠ WARNING

THE PROPER WAY TO DISASSEMBLE PIN-CONNECTED BOOMS IS WITH THE OUTER BAIL CONNECTED TO THE INNER SECTIONS. WITH THE BAIL IN THIS POSITION THE BOOM IS SUPPORTED ONLY ON ONE END (OR CANTILEVERED). MAXIMUM BOOM LIFTING CAPABILITY IS REDUCED TO AT MOST THE BOOM INNER SECTION AND THE NEXT TWO CENTER SECTIONS.

1. Follow the boom composition chart (page 2-73) to make sure of the sequence of new boom assembly and to identify the splice points at which pin connections must be disassembled to add or remove sections. Unpin one pair of lower pins first, then remove the pins above them after the boom is all the way down on blocking.
2. Use an assist crane for changing boom composition if available. If no assist crane is available to perform this function, the crane must use its own inner section to change boom composition as required.



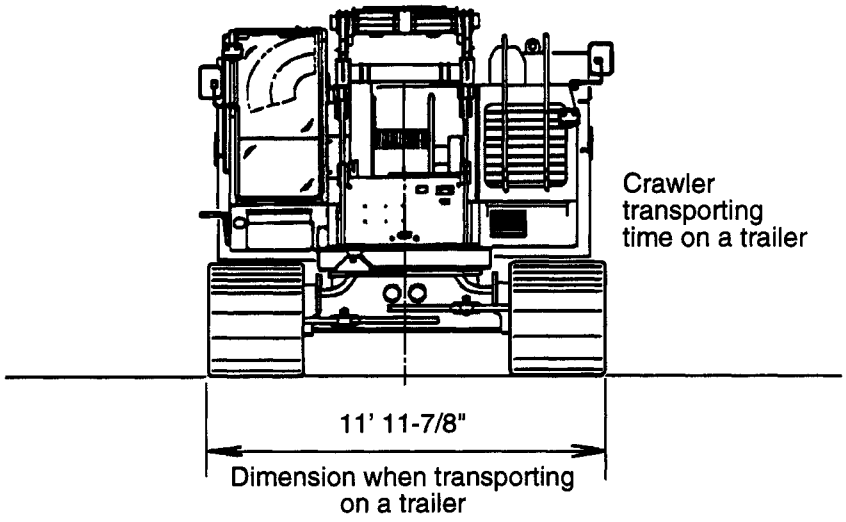
3. After changes are made, travel the crane back and pin the upper pins to the boom sections still on the ground. Take a strain of the boom suspension so that bottom pins can be inserted and then add or remove pendants as needed. The bail can then be unpinned from the boom inner section. The boom can now be raised following the procedures outlined in Section I, "Assembly and Boom Raising Procedures" for safe boom assembly and raising.

⚠ WARNING

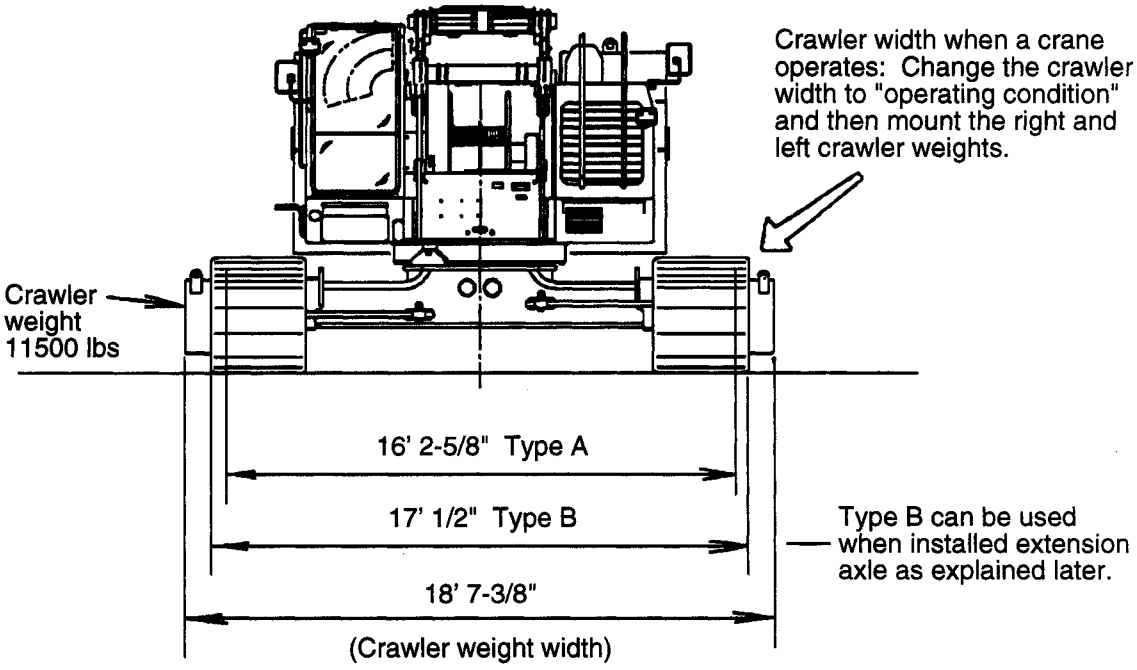
ALWAYS OBSERVE THE WIND SPEED LIMITATIONS (SHOWN IN THE TABLE ON PAGE 3499.1, "IMPORTANT LOAD LIFTING RESTRICTIONS AND REGULATIONS" SECTION IN THE FRONT OF THIS MANUAL) WHEN PERFORMING ANY BOOM ASSEMBLY OR DISASSEMBLY PROCEDURE.

1. CHANGE OF CRAWLER WIDTH

1-1 Crawler width

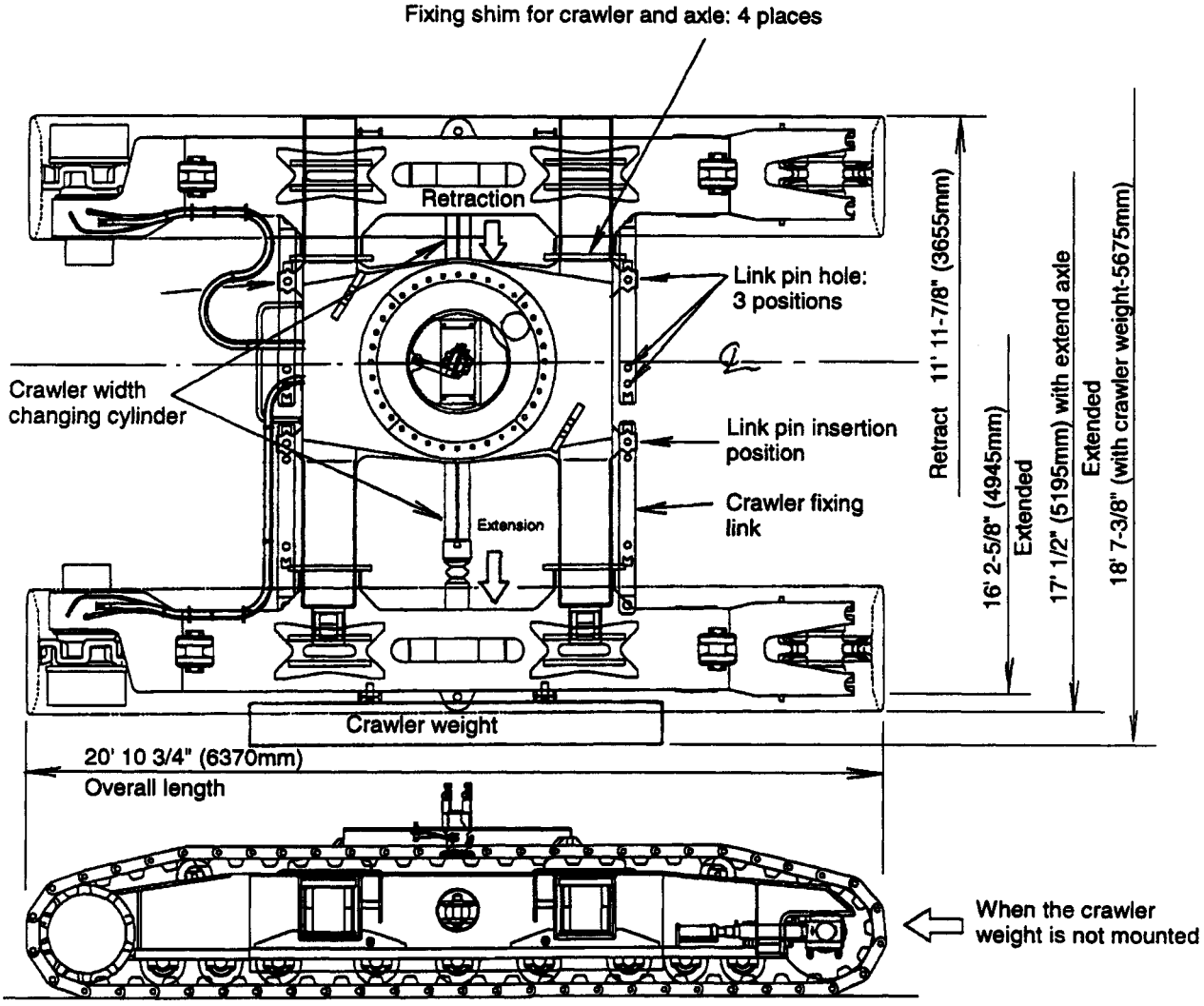


Crane operating condition



1-2 How to fix the crawler width, axle and crawler frame

- Transportation: 11' 11-7/8" (3655mm)
- Extended for operation type A: 16' 2-5/8" (4945mm) Middle extended position
- Extended for operation type B: 17' -1/2" (5195mm) Maximum extended position (extension axle is used)



Change the crawler width by extending or retracting the crawler width changing cylinder.

Retract the crawler width fully, and the overall crawler width is 11' 11-7/8" (3655mm).

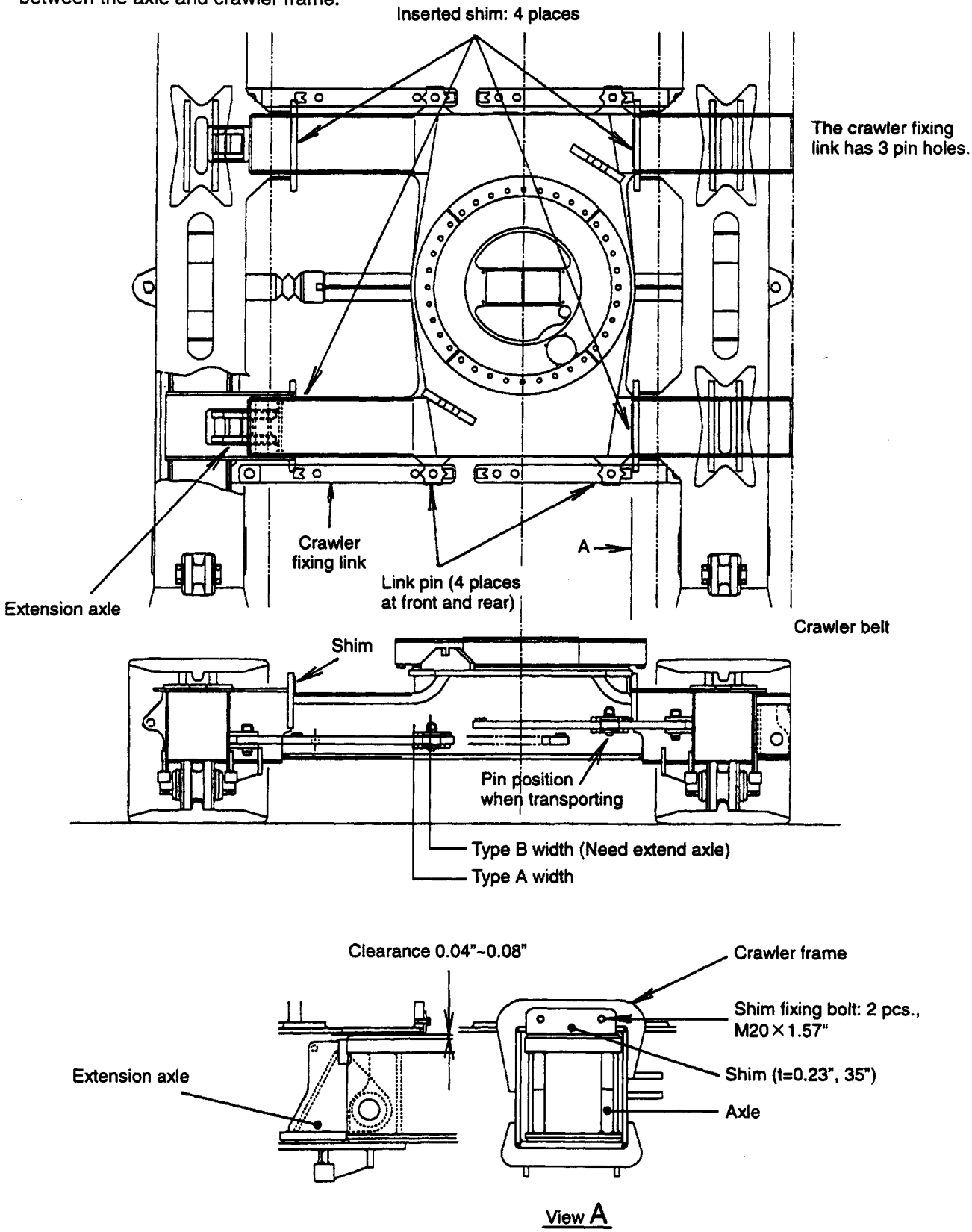
Extend the crawler width to the middle position, and the overall crawler width is 16' 2-5/8" (4945mm).

Set the crawler width to the maximum extension position, and the overall crawler width is 17'-1/2" (5195mm).

When you want to set the crawler width to 17'-1/2" (5195mm), the extension axle must be attached to the axle.

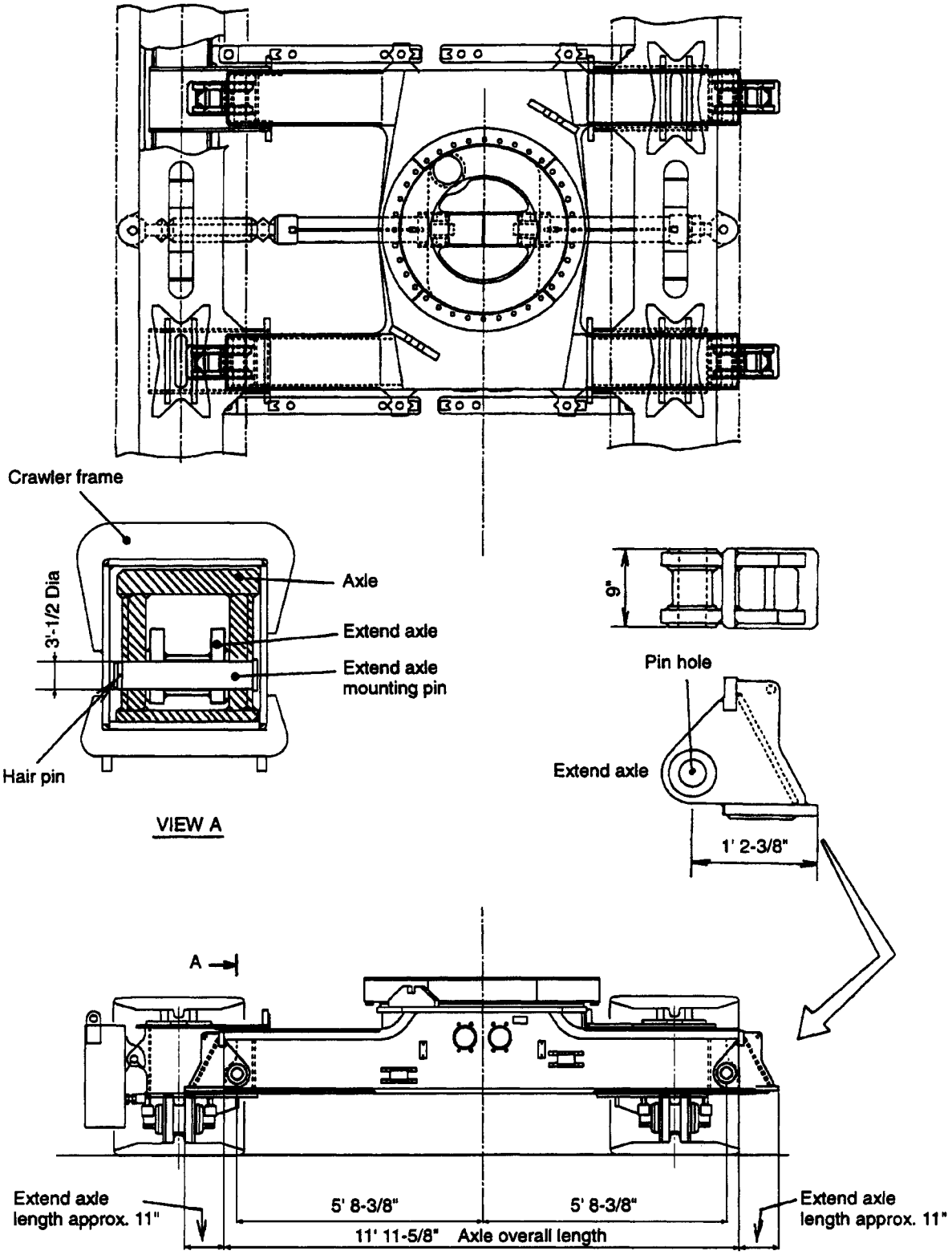
The overall width including the crawler weight width is 18' 7-3/8" (5675mm).

The crawler frame and axle are fixed by the crawler link pins (at 4 places) and shims (at 4 places) inserted between the axle and crawler frame.



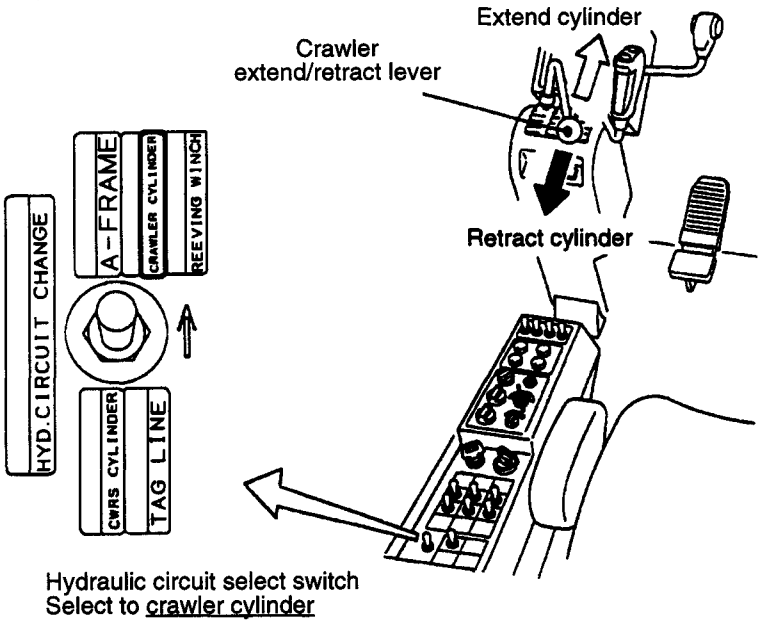
1-3 How to mount the extension axle

By using the extension axle mounting pins, mount the extension axle on the 4 axle ends. Set a hairpin to the mounting pin to prevent the mounting pin from falling off.

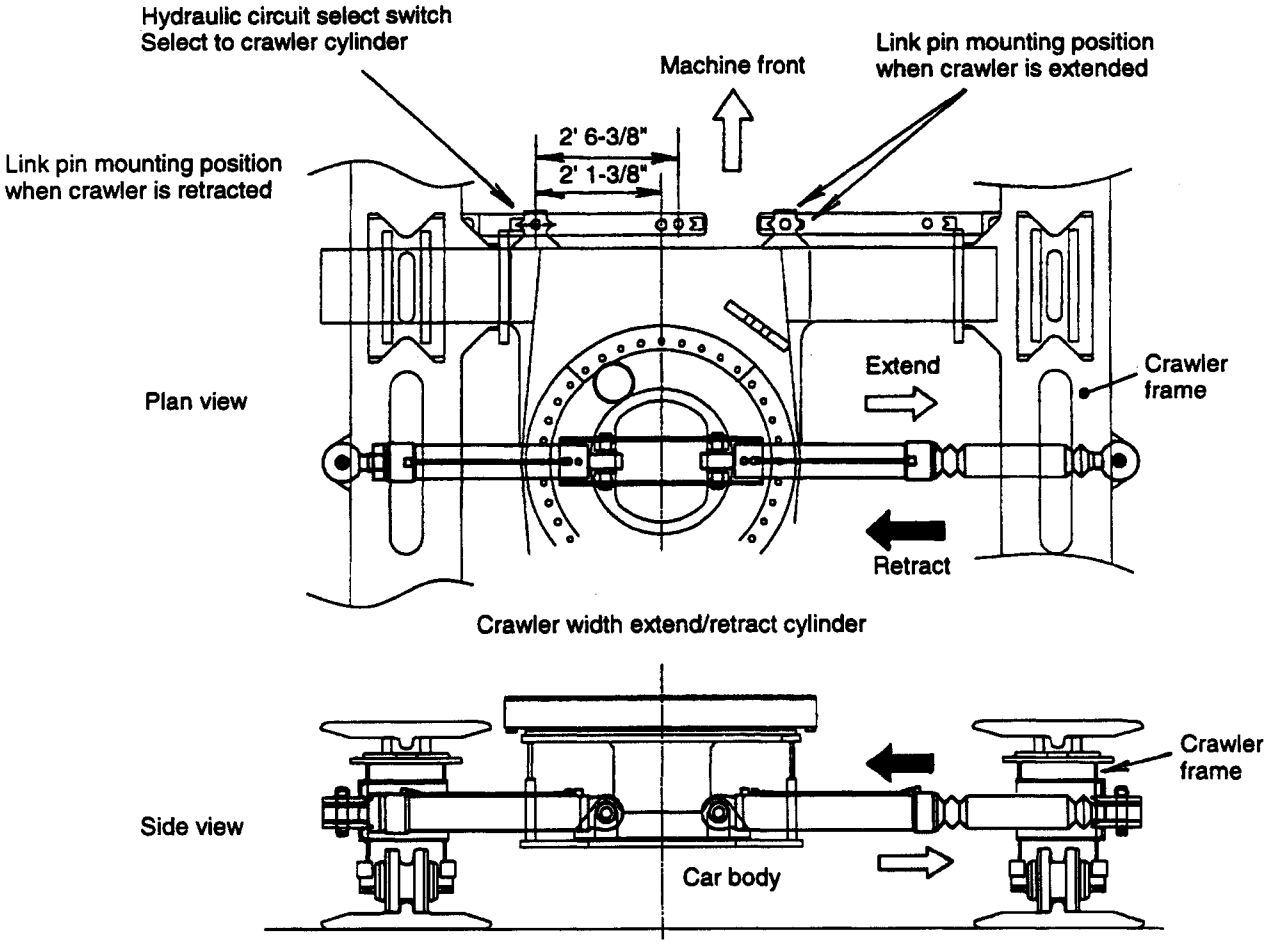


When the extension axle is mounted, one side of the axle is lengthened by approx. 11"

1-4 Control levers and switches



Hydraulic circuit select switch
Select to crawler cylinder

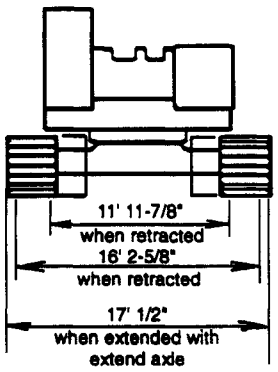


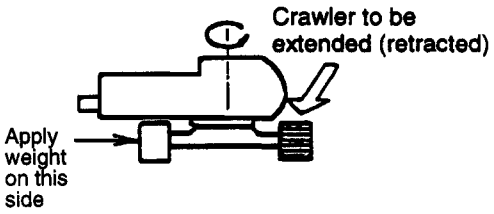
1-5 How to change crawler width

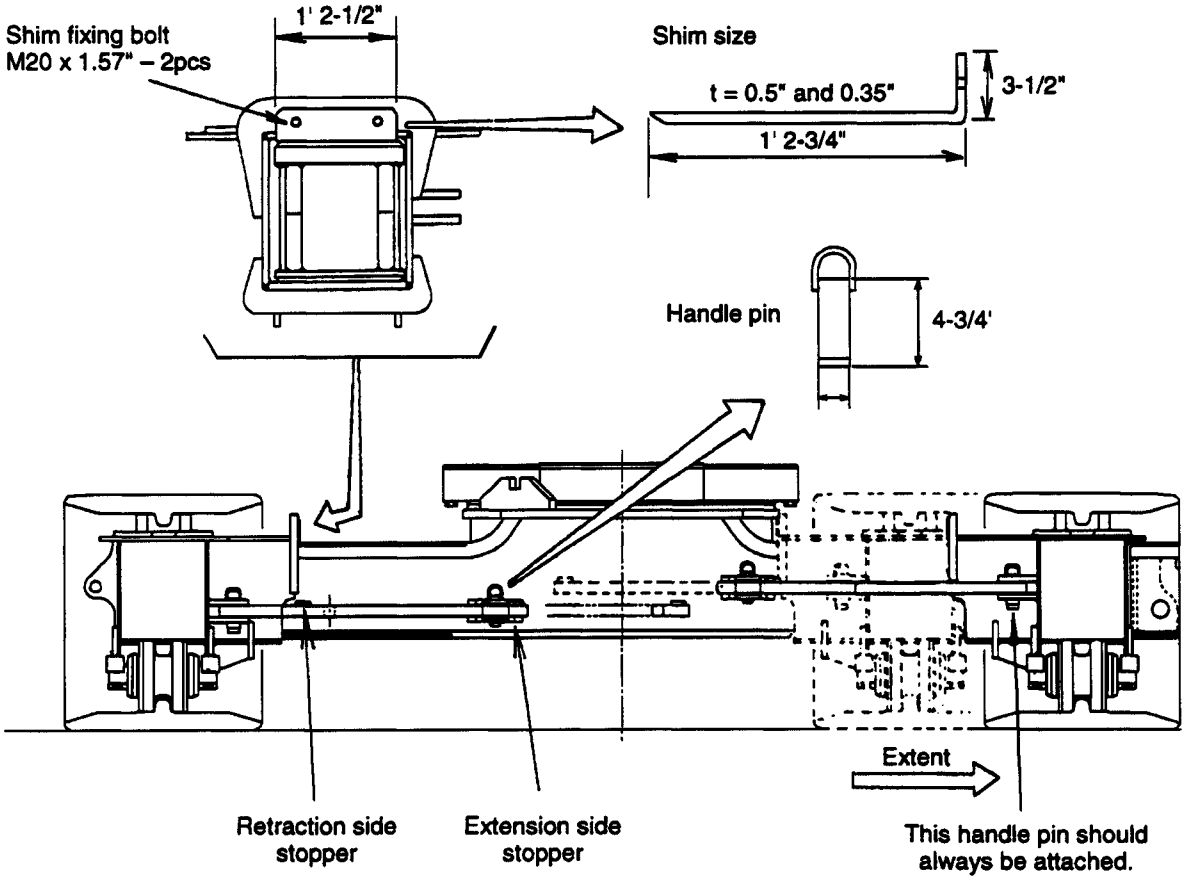
Although the front attachment and counterweight must be removed as a rule, the crawler width is changeable beforehand in the position shown (when unavoidable).

1. Move the crane to level ground. Operation tends to be easier on muddy ground rather than concrete. Each crawler is shiftable by dimension as shown in the figure at right.
2. In order to reduce the weight applied to the crawler to be shifted, swing the superstructure toward the opposite crawler so as to apply the weight of the superstructure, thereby facilitating crawler extension/retraction.

   The superstructure must be swung gradually with utmost care.
3. Check the ground condition so that it does not create a problem in extension or retraction of crawler.
4. Remove the shim fastening bolt and shim at 4 points front and rear to release the fixed status of the crawler frame and axle (or remove the wedge pack).

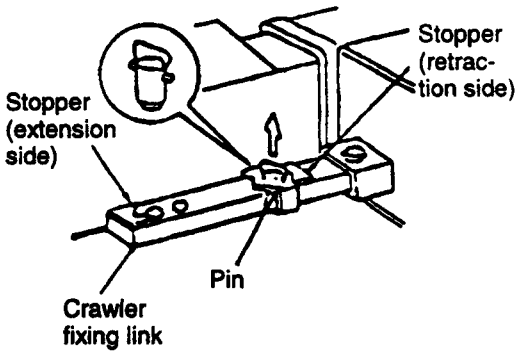






5. Pull out the two crawler fixing link pins at the front and rear (pins of the crawler to be extended or retracted). The crawler fixing link pins of the opposite crawler must be kept inserted.
6. Adjust the engine speed to about 1,200 rpm and increase or decrease the crawler width by manipulating the crawler extend/retract lever.

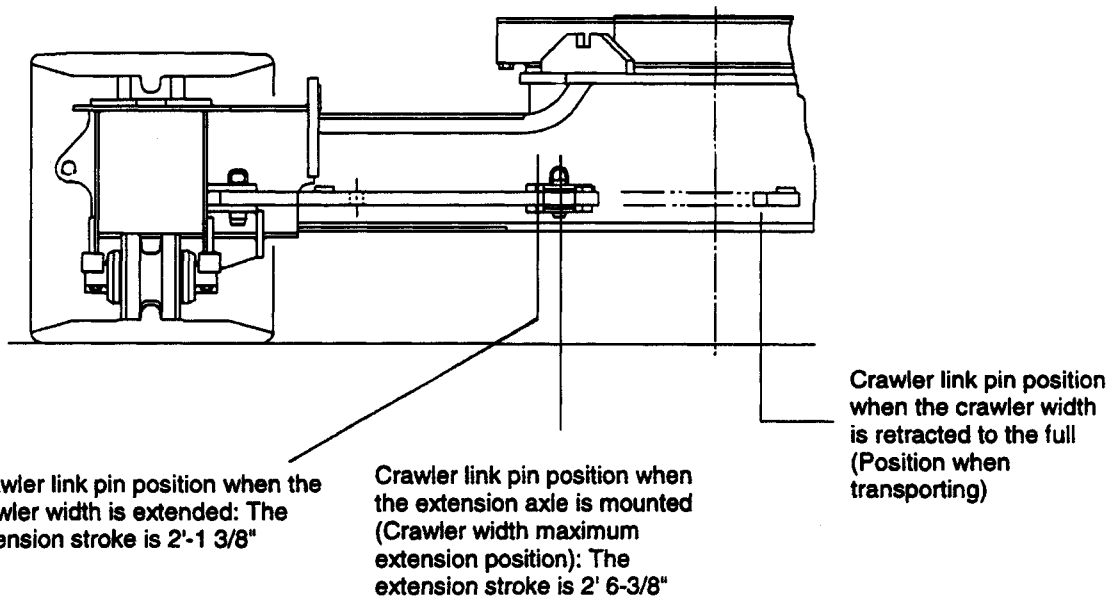
   If the crawler is difficult to shift because of resistance applied on it, the crawler extend/retract lever should be manipulated while driving (travelling) the crawler to be extended or retracted at a very slow speed. This measure may be required particularly for retracting the crawler.
7. After the crawler has been extended or retracted up to the stopper of the crawler link, the pin must be inserted to fix the crawler frame and axle.
8. Insert the shim and tighten the shim fastening bolts, which were removed in previous step (4), in order to fix the crawler frame and axle.
9. Repeat steps (2) through (8) for changing the width of the opposite crawler.



⚠ CAUTION

Do not extend to maximum crawler width, when not mounted on extension axle.

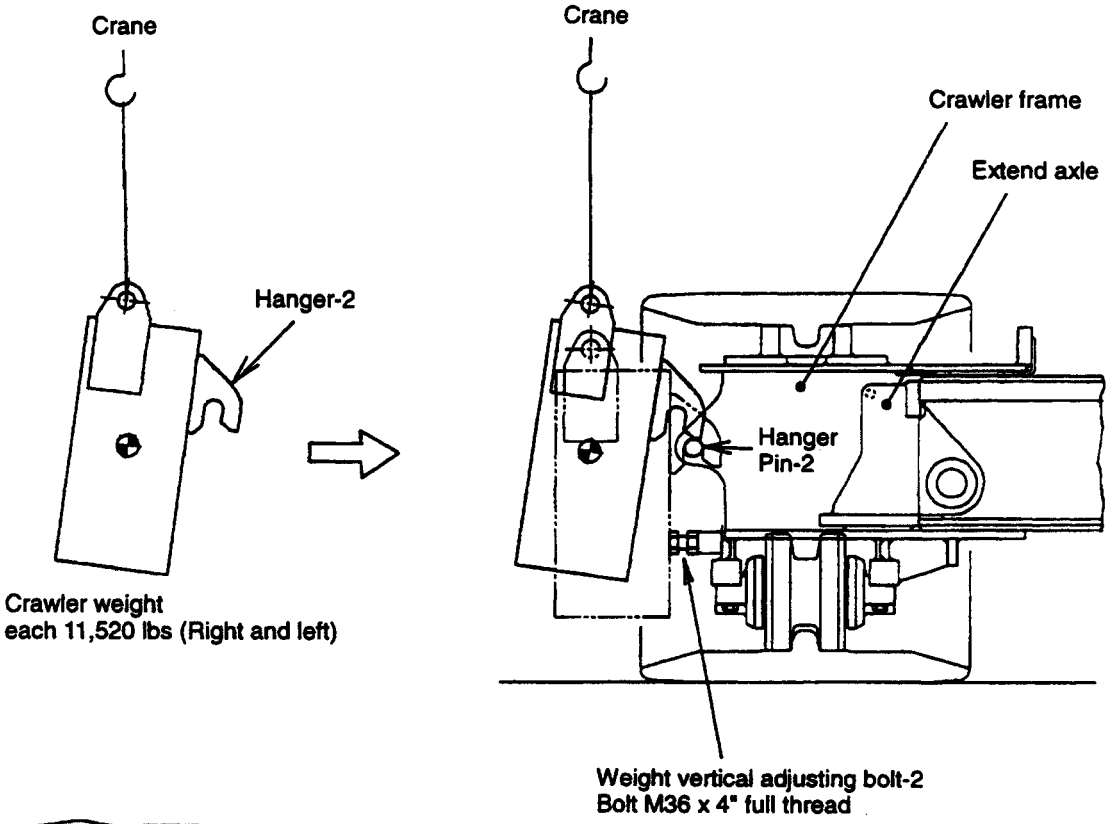
It should be mounted on extension axle before extending to maximum crawler width as shown on next page.

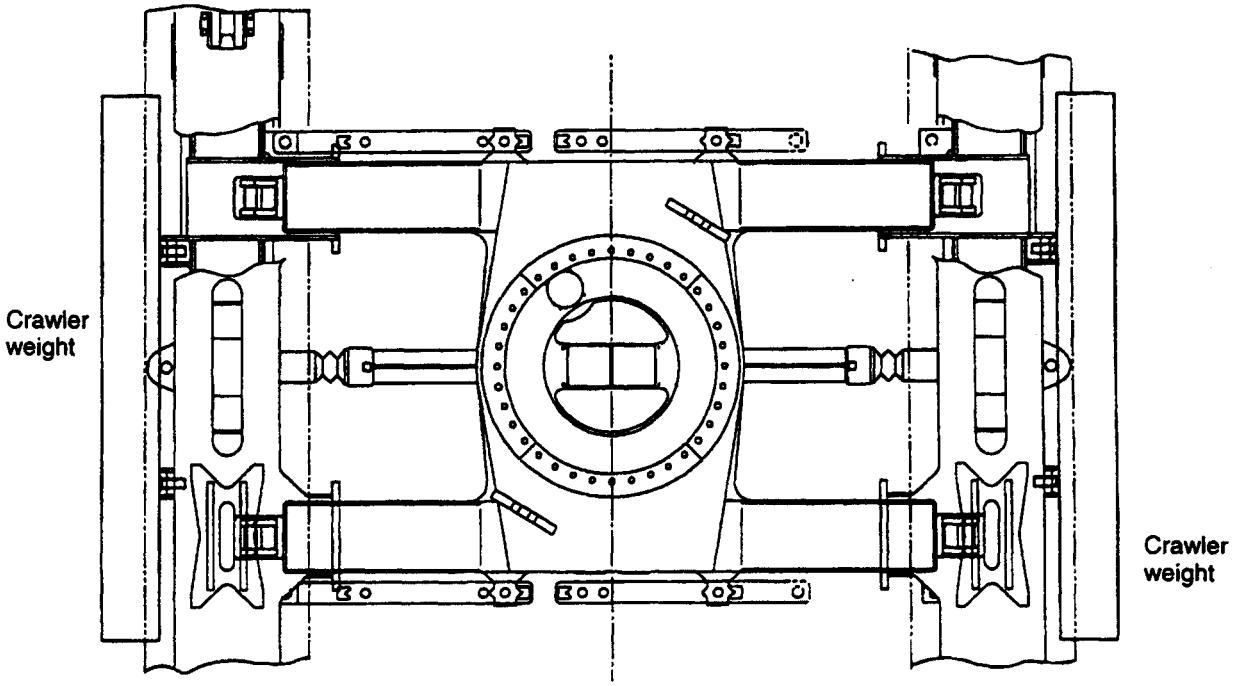


1-6 How to mount crawler weight

Lift the weight and put the hanger of the weight on the hanger pin of the crawler frame.

Adjust the perpendicularity of the weight with the adjusting bolt. Mount the crawler weight on the opposite side.

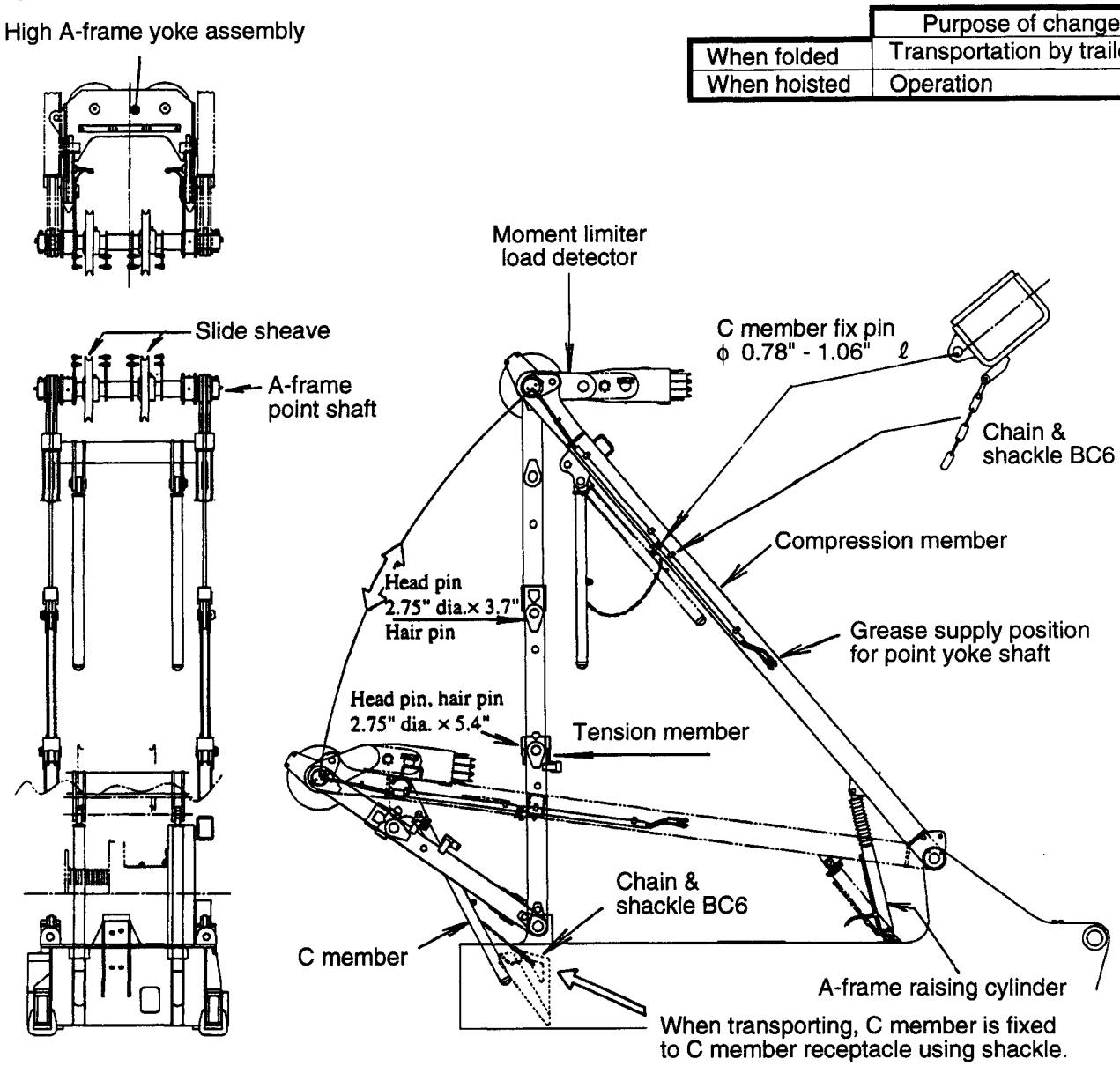




2. HANDLING OF A-FRAME

2-1 Structure of A-frame

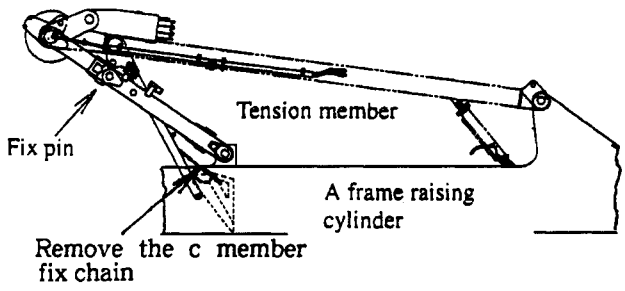
	Purpose of change
When folded	Transportation by trailer
When hoisted	Operation

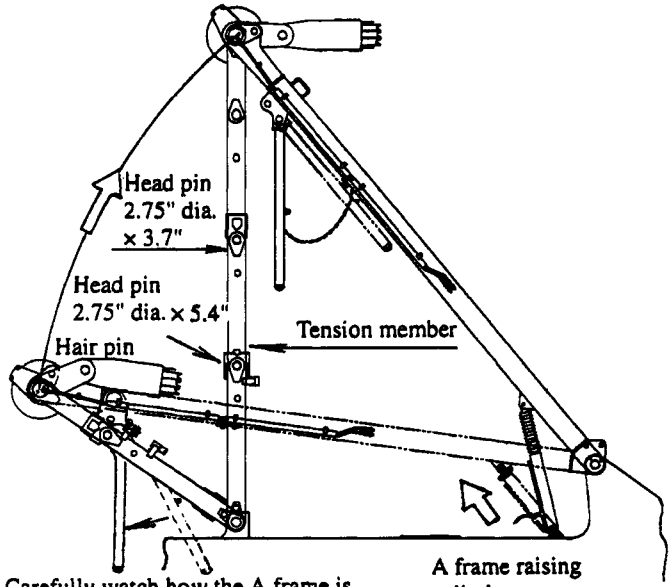


NOTICE

1. **Operate the crane while the A-frame is hoisted. If it is operated with the A-frame folded, an excessive force will be applied to the member and boom hoist rope. They may be damaged.**
2. **Before hoisting the A-frame, remove the "C" member fixing chain and shackle. When the A-frame has been hoisted, fix the "C" member on the compression member with the pin.**
3. **When lowering the A-frame, remove the "C" member fixing pin and, by using the shackle, set the chain to the compression member.**

2-2 Change of A-frame height



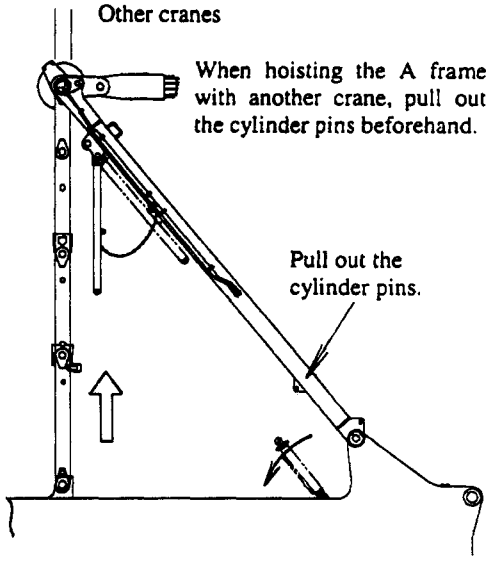


Changing procedure

1. Remove the C member fix chain. Set the engine speed to 950 min^{-1} (idling speed) and turn the hydraulic circuit selector switch to the A-frame side.
2. Pull out fix pins from tension member.

   *When pulling out pins, slightly move the A-frame lever to the extension side, so that a force will not be applied to the fix pins.
3. After pulling out fix pins, set the A-frame lever to "UP" and hoist the A-frame.
4. After the A-frame has been hoisted completely, insert the two fix pins (left/right) which were removed in step (2).

   #Take care not to omit insertion of the locking hairpins.



⚠ WARNING

Observe the following items to avoid danger:

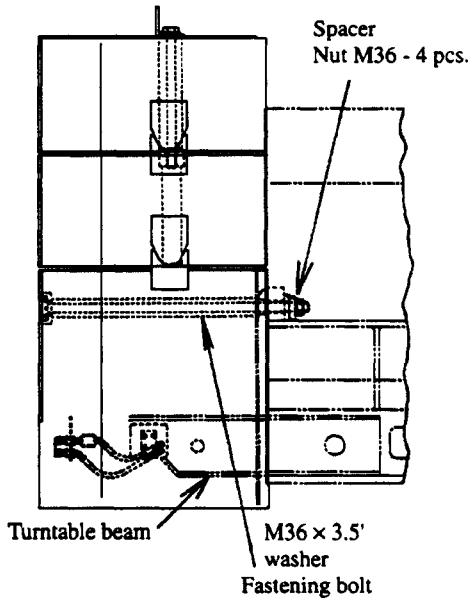
1. **When handling the A-frame, never enter the A-frame moving range. You may be caught by the A-frame.**
2. **If the attachment is mounted on the machine, be sure to keep the end of the attachment placed on the ground. Don't go under the attachment.**
3. **Before hoisting the gantry, make sure that the wire harness for the load detector (load cell) of the moment limiter has an adequate length. If the wire harness is short, it may be cut or damaged.**
4. **For hoisting the gantry with another crane, be sure to pull out the pin from the A-frame hoisting cylinder shown above. If the A-frame is hoisted without pulling out the pin, a negative pressure is generated in the cylinder, which may damage other components in the circuit.**
5. **Insert or pull out the pins from the outside of the A-frame after maintaining the footing.**
6. **Don't put your finger or hand into the pin hole.**

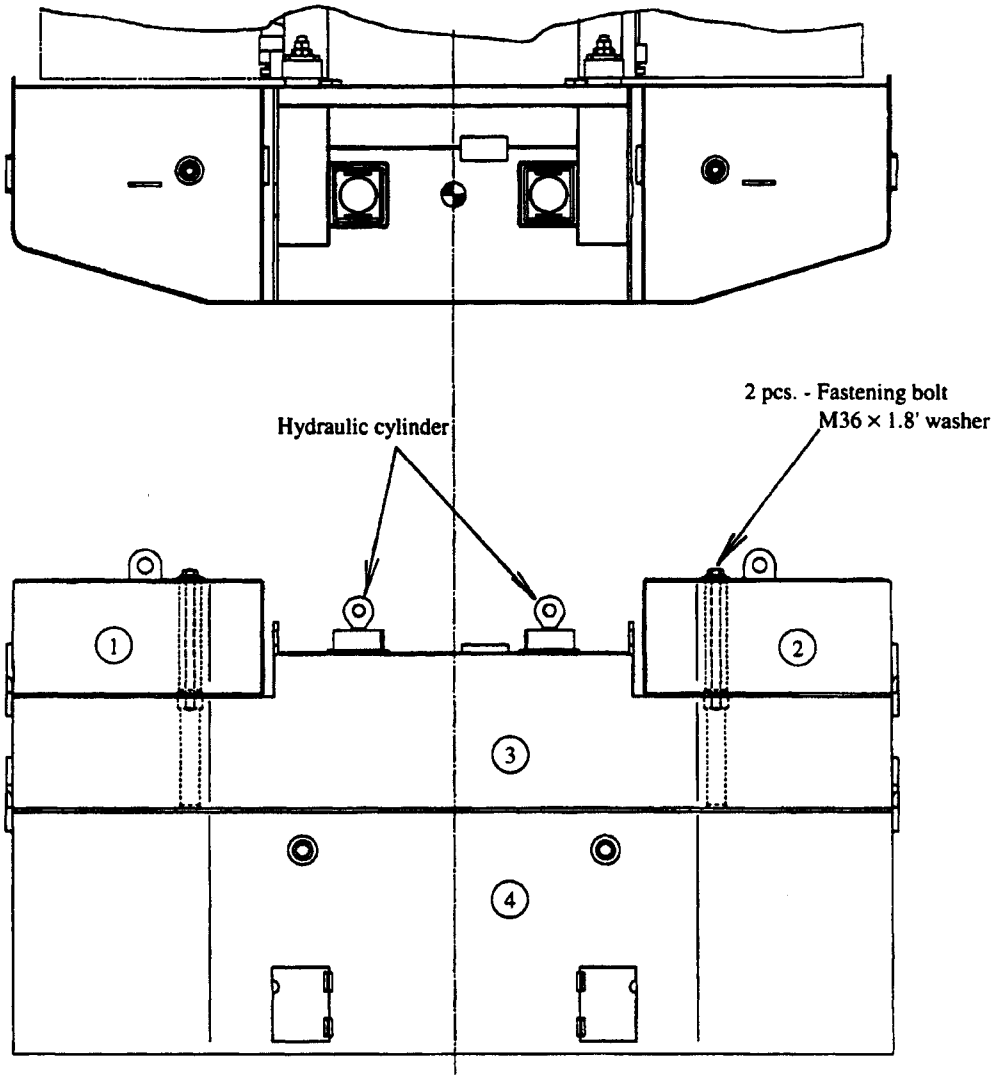
3. MOUNTING OF COUNTERWEIGHT

Unit: Lbs.

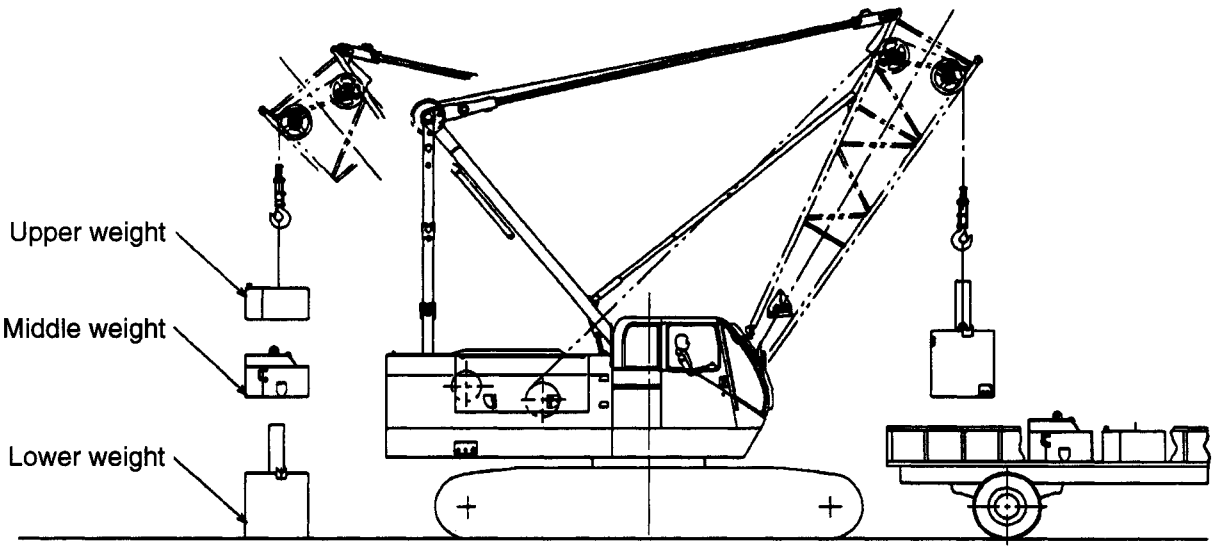
Ref. No.	Mounting Position	Weight
1	Upper left	4400
2	Upper right	4400
3	Middle	12130
4	Lower	31970
TOTAL WEIGHT		**52900**

3-1 Weight outline

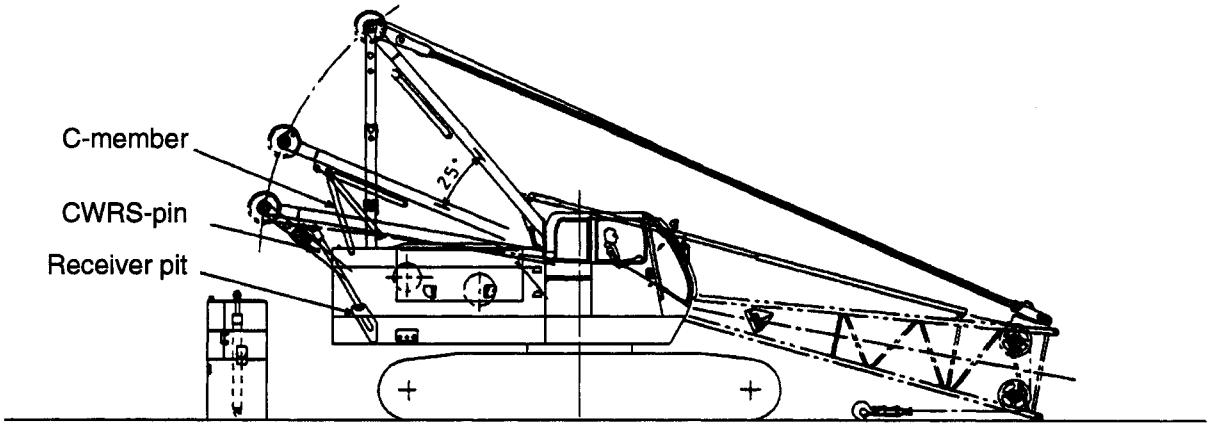




3-2 Counterweight installation method of standard crane



1. Unloading/piling the counterweight (using inner boom)
   a. Unload the counterweight and attachment.
   b. Pile the upper and middle weight on lower weight.



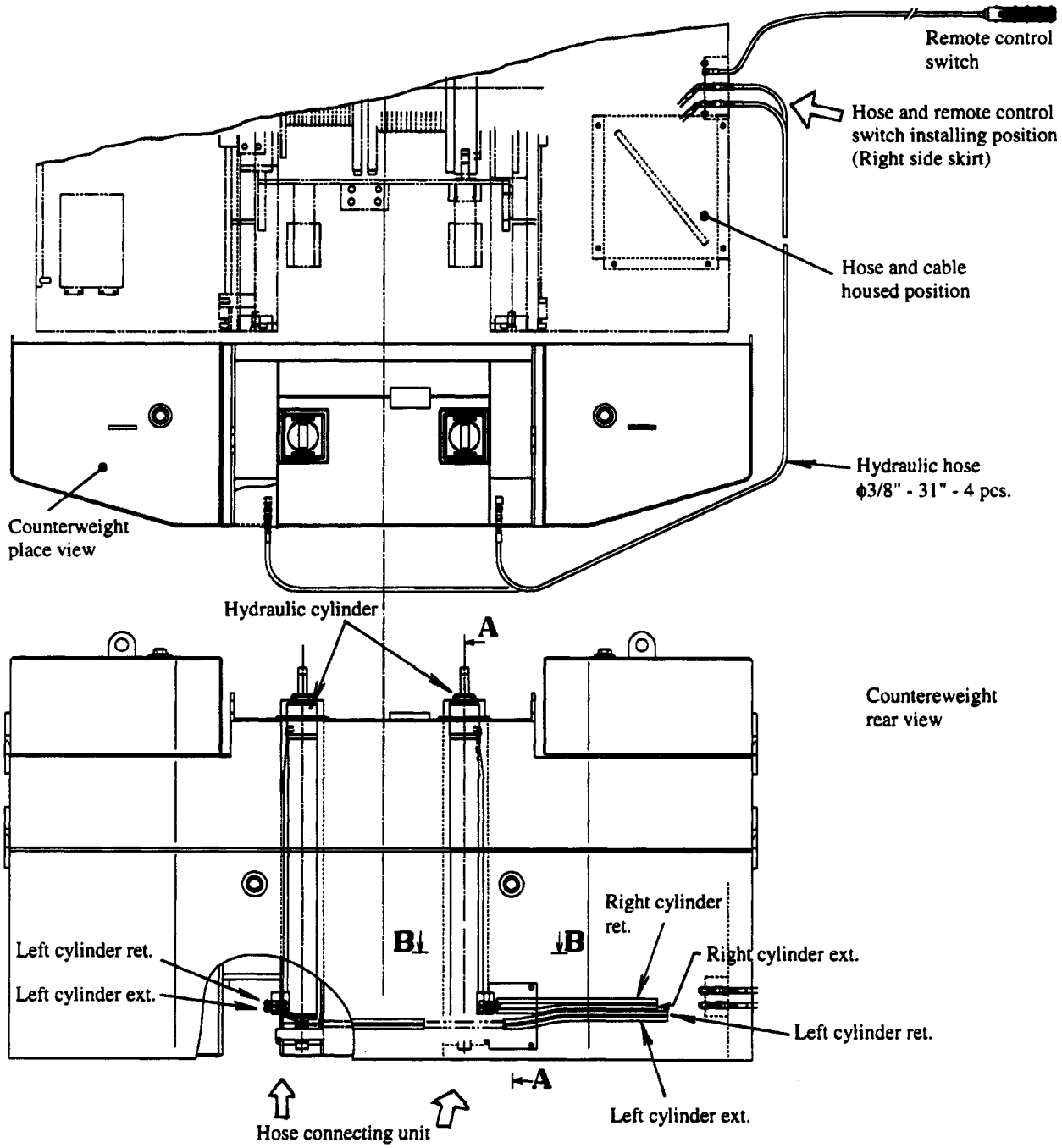
2. Setting the A-frame
   a. Lower the inner boom and put it on the ground.
   b. Unlock the C-member for hanging position.
   c. Lower the A-frame and check that C-member is properly inserted into the receiver pit.
   d. Insert the CWRS pins to fix the tension members.

Installation of the counterweight cylinder hydraulic hose and control switch

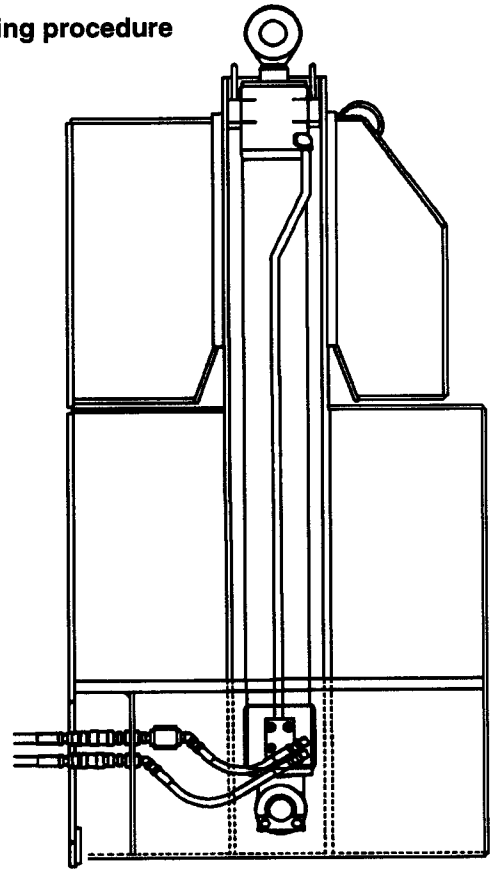
Install the 4 hydraulic hoses to the 2 hydraulic cylinders. The hoses of the actuator line should be installed at the side of skirt at the right of the machine.

Install the 2 hydraulic hoses to each of the 2 hydraulic cylinders.

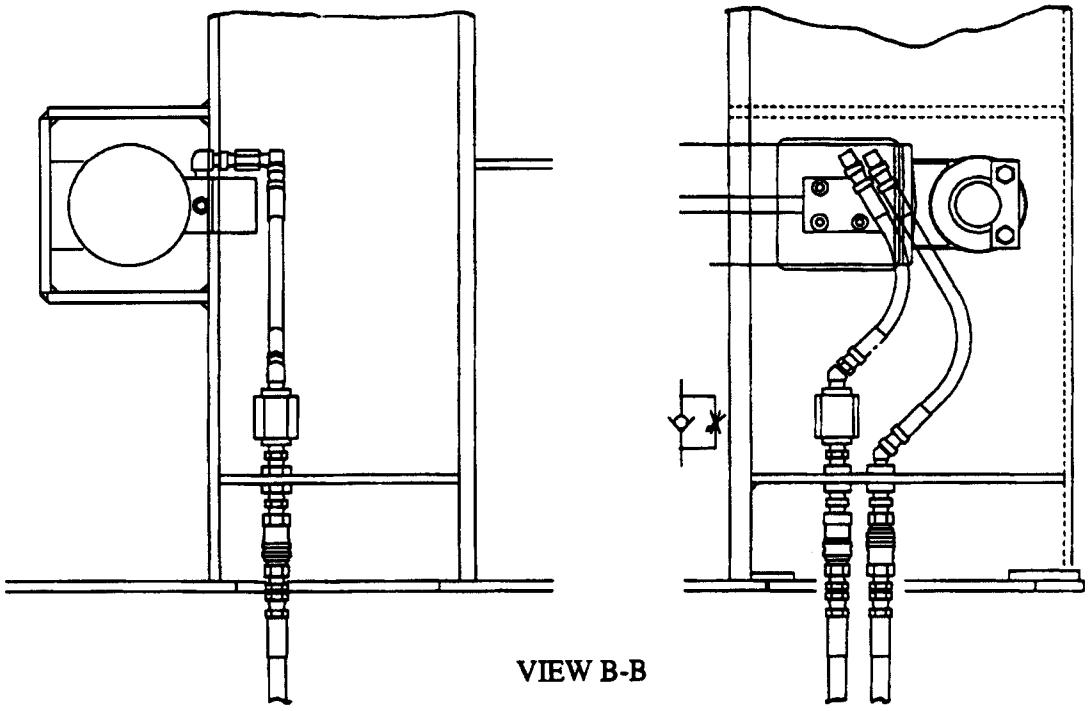
Connect the remote control switch to the right of the hydraulic hoses.



Hose connecting procedure



VIEW A-A

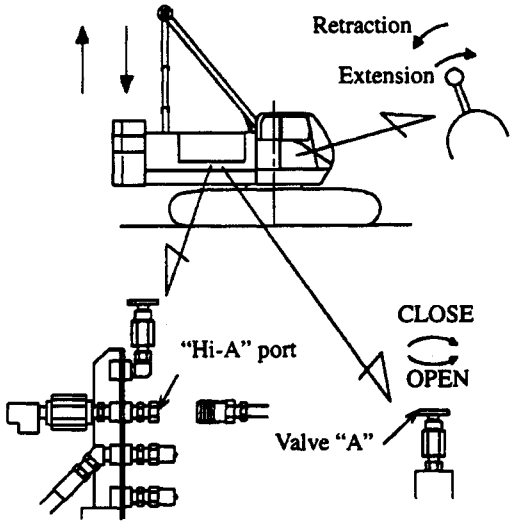


VIEW B-B

NOTICE

Notes to A-frame, crawler and counterweight handling:

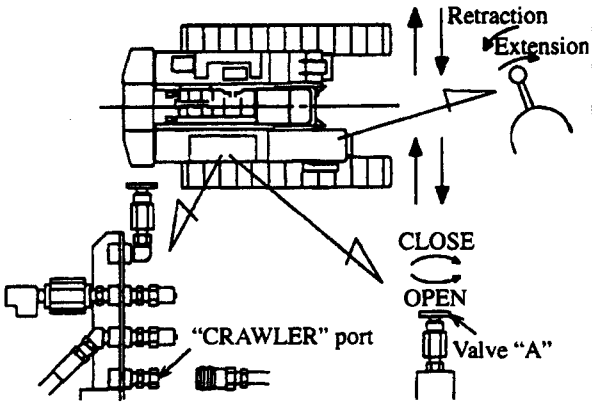
A-FRAME OPERATION



(1) Set up HYD. CIRCUIT CHANGE switch to A-FRAME side on left side box in the operators cab.
(2) The Hose coupling joint to "Hi-A" port after reduced piping pressure by valve "A".
(3) Close the valve "A" after checked the Hose coupling jointed properly.
(4) A-frame is operating by lever in the operators cab.

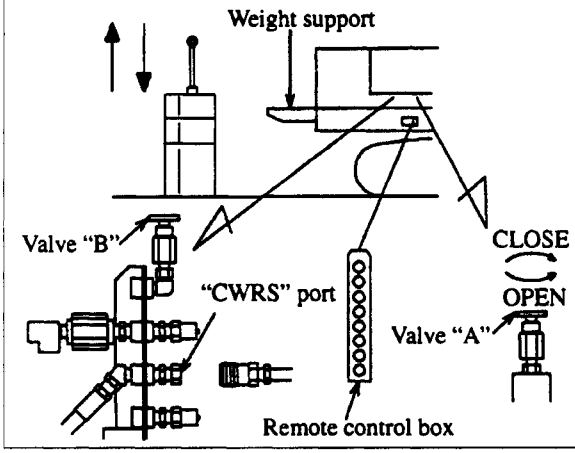
Note:
Make sure to set up the pin on to A-frame tension member, when inert or extract of the Hose coupling.

CRAWLER OPERATION



(1) Set up HYD. CIRCUIT CHANGE switch to CRAWLER side on left side box in the operators cab.
(2) The Hose coupling joint to "CRAWLER" port after reduced piping pressure by valve "A".
(3) Close the valve "A" after checked the Hose coupling jointed properly.
(4) CRAWLER is operating by lever in the operators cab.

COUNTERWEIGHT (CWRS) OPERATION



(1) Set up HYD. CIRCUIT CHANGE switch to CWRS side on left side box in the operators cab.
(2) The Hose coupling joint to "CWRS" port after reduced piping pressure by valve "A".
(3) Close the valve "A" after checked the Hose coupling jointed properly.
(4) Open the valve "B", when operate the weight support, and close valve "B" after operation.
(5) CWRS is operating by remote control box.

Do not change the joint of piping and electric wiring when the engine is running.

Connection of hydraulic hose

When operating the high A-frame, mounting or removing the counterweight and changing the crawler width, you must change the connection of the hydraulic hoses beside the main winch motor.

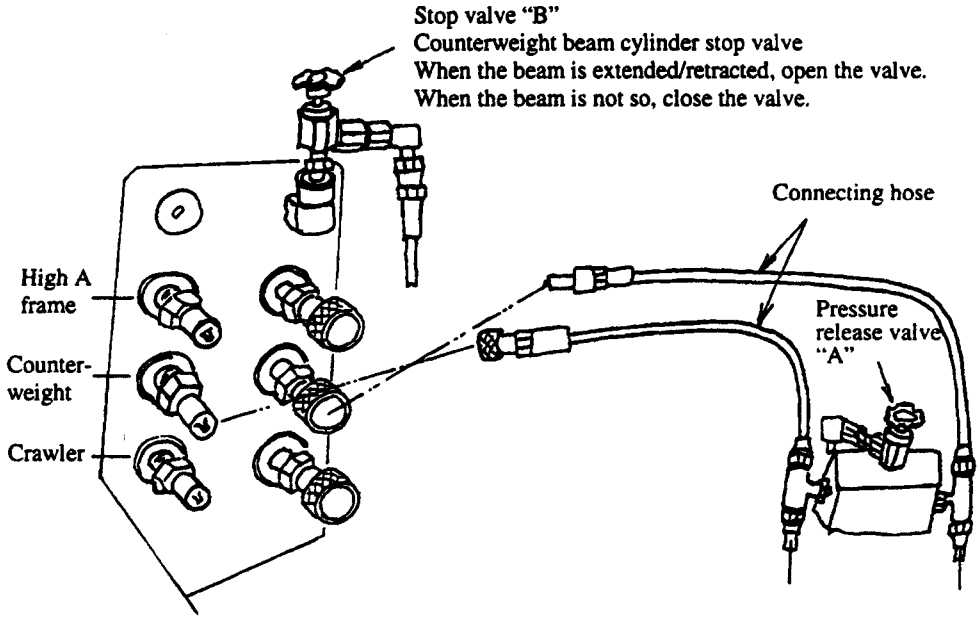
- When operating the high A-frame, connect the hoses to the upper couplers.
- When mounting or removing the counterweight, connect the hoses to the middle couplers.
- When changing the crawler frame width, connect the hoses to the lower couplers.

When there is residual pressure in the hose and so it is difficult connect it to the coupler, open the pressure release valve "A" at the root of the hose to remove the residual pressure from the hose.

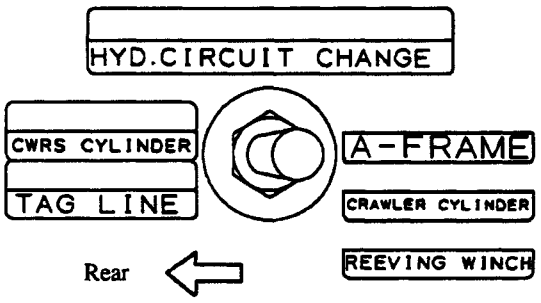
After removing the residual pressure from the hose, close the valve "A". If not, the pressurized oil returns to the tank circuit.

Use the levers at the operator seat to hoist/lower the high A-frame and to extend/retract the crawler width.

Before mounting/removing the counterweight, connect the remote control switch to the skirt unit of the crane.



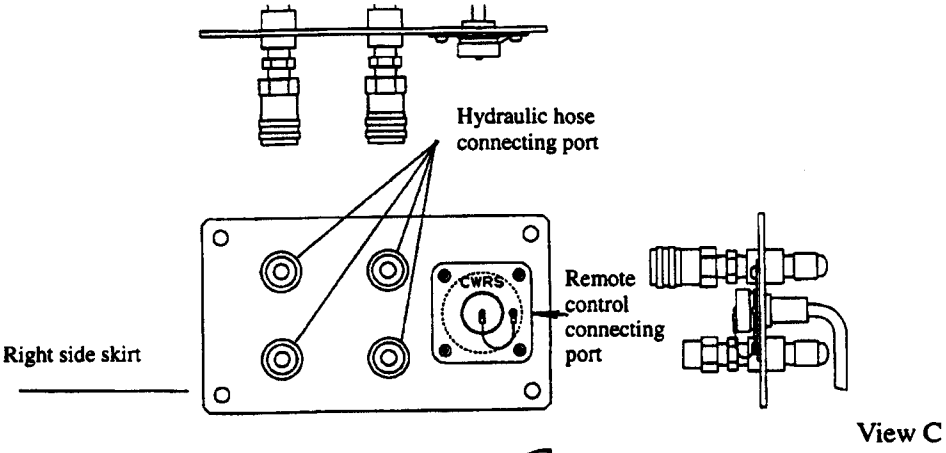
Set the hydraulic circuit selector switch (29) to "CWRS CYLINDER" beforehand. When the switch is in this position, change the hose connection as the above and mount/remove the counterweight. When operating the high A-frame and changing the crawler width, set this selector switch to "A-FRAME".



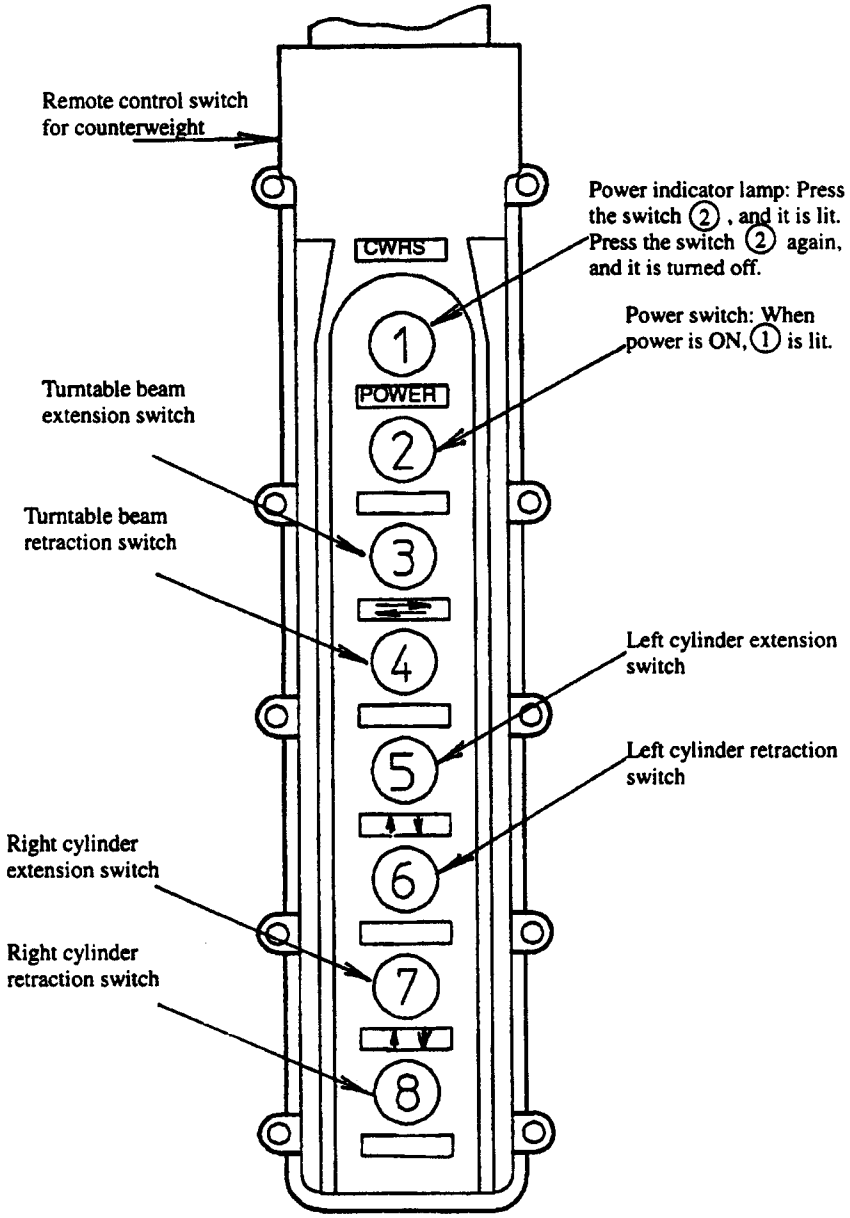
CAUTION

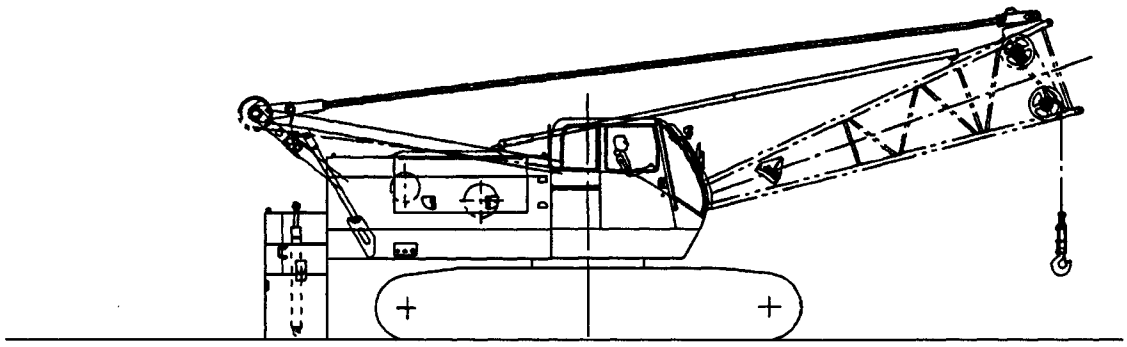
1. **HYDRAULIC CIRCUIT CHANGE SWITCH on left side box must always be in "A-FRAME" position.**
2. **Don't set up HYD. CIRCUIT CHANGE SWITCH on "CWRS" side when the hose coupling joint to "A-FRAME" port.**

Hydraulic hoses and remote control switch connecting unit

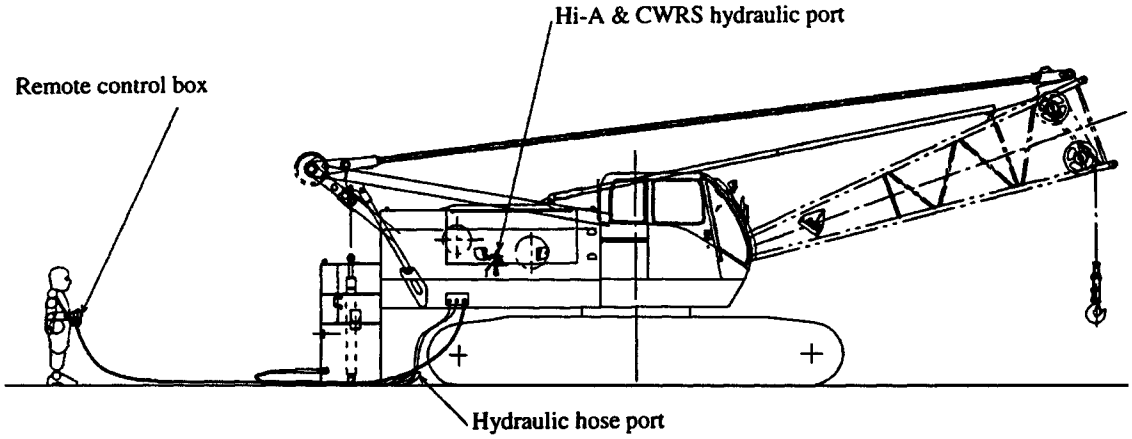


View C



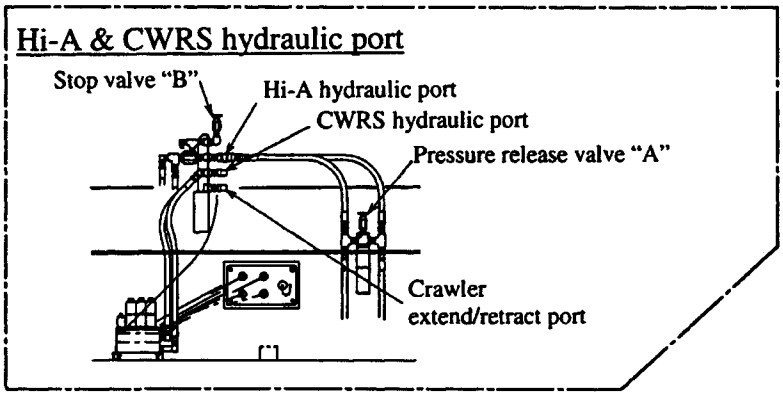


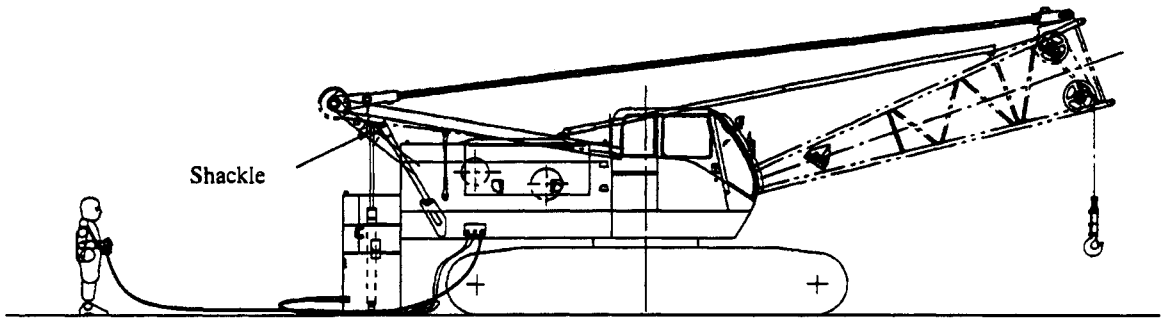
3. Positioning of base machine
   a. Hoist the inner boom from the ground.
   b. Move the base machine to the suitable position matching the center of base machine and counterweight.



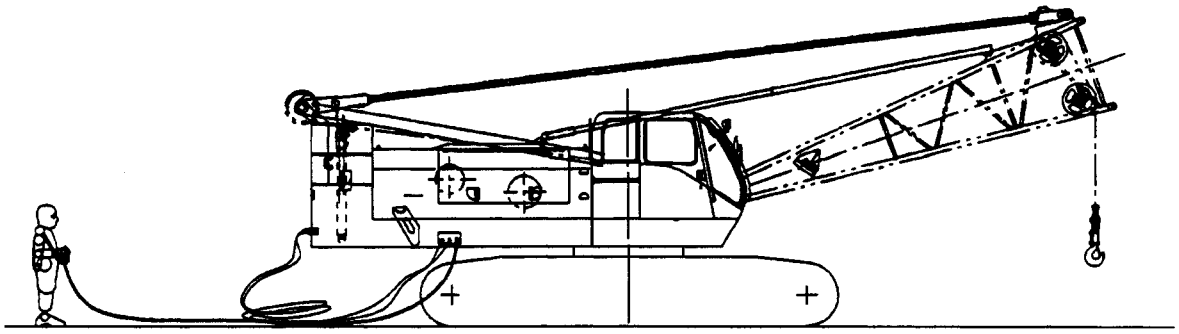
4. Connectng the hydraulic hose of counterweight and connecting the remote control box
   a. Change the coupling of hydraulic port to CWRS side from A-frame side. (Reduce the hydraulic pressure by opening the pressure release valve "A" before doing the above change.)
   b. Connect the hydraulic hose between base machine and counterweight.
   c. Connect the connector of remote control box to base machine.

   Don't change the connection of piping and electric wiring when the engine is running.

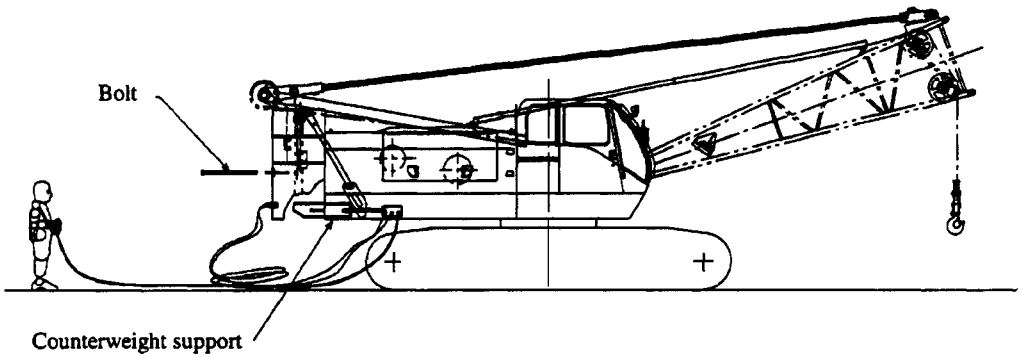




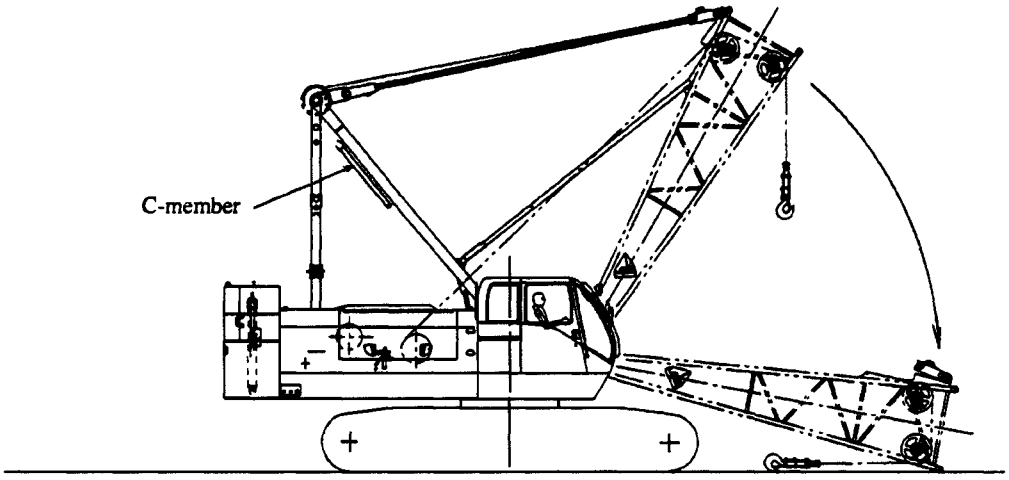
5. Connecting the lift cylinder
   a. Connect the special shackle to A-frame compression member.
   b. Extend the lift cylinders and connect them to the special shackle.



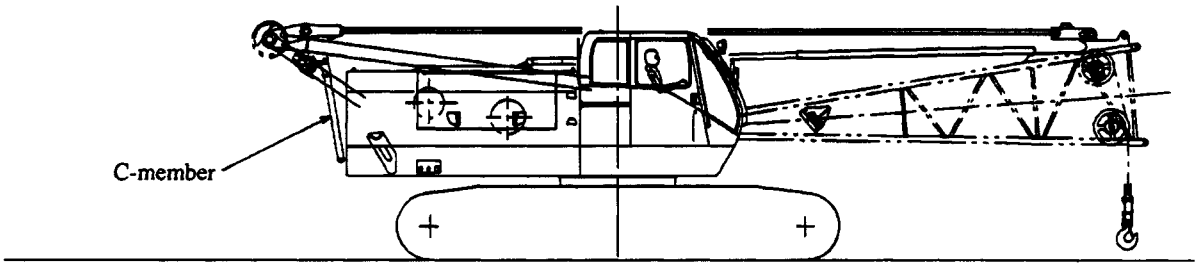
6. Hoisting the counterweight
   a. Hoist the counterweight by retracting the lift cylinder to its end.



7. Pushing out the counterweight support beam
   a. Open the stop valve "B" of the piping for counterweight supporting cylinder after the lifting cylinders are completely retracted to their ends.
   b. Push out the counterweight support cylinders to their ends.
   c. Lower the counterweight until its bolt holes match with the holes of turntable side.
   d. Put the bolts into the counterweight and attach the washers and nuts. Tighten the bolts to fasten the counterweight.
   e. Put the counterweight completely on the counterweight support by extending the lift cylinders. Disconnect the lift cylinders and special shackles from A-frame. Retract the lift cylinder to the end.
   f. Close the stop valve "B" of the piping for counterweight support cylinder.



8. Raising A-frame and preparing for assembly of attachment
   a. Lower the inner boom and put it on the ground.
   b. Change the coupling of hydraulic port to A-frame side (Reduce the hydraulic pressure by opening the pressure release valve "A" before making the above change).
   c. Take the CWRS pins off the tension members.
   d. Raise A-frame by extending the A-frame cylinder.
   e. Lock the C-member onto A-frame before raising A-frame to full extent.
   f. Start the assembly of attachment.



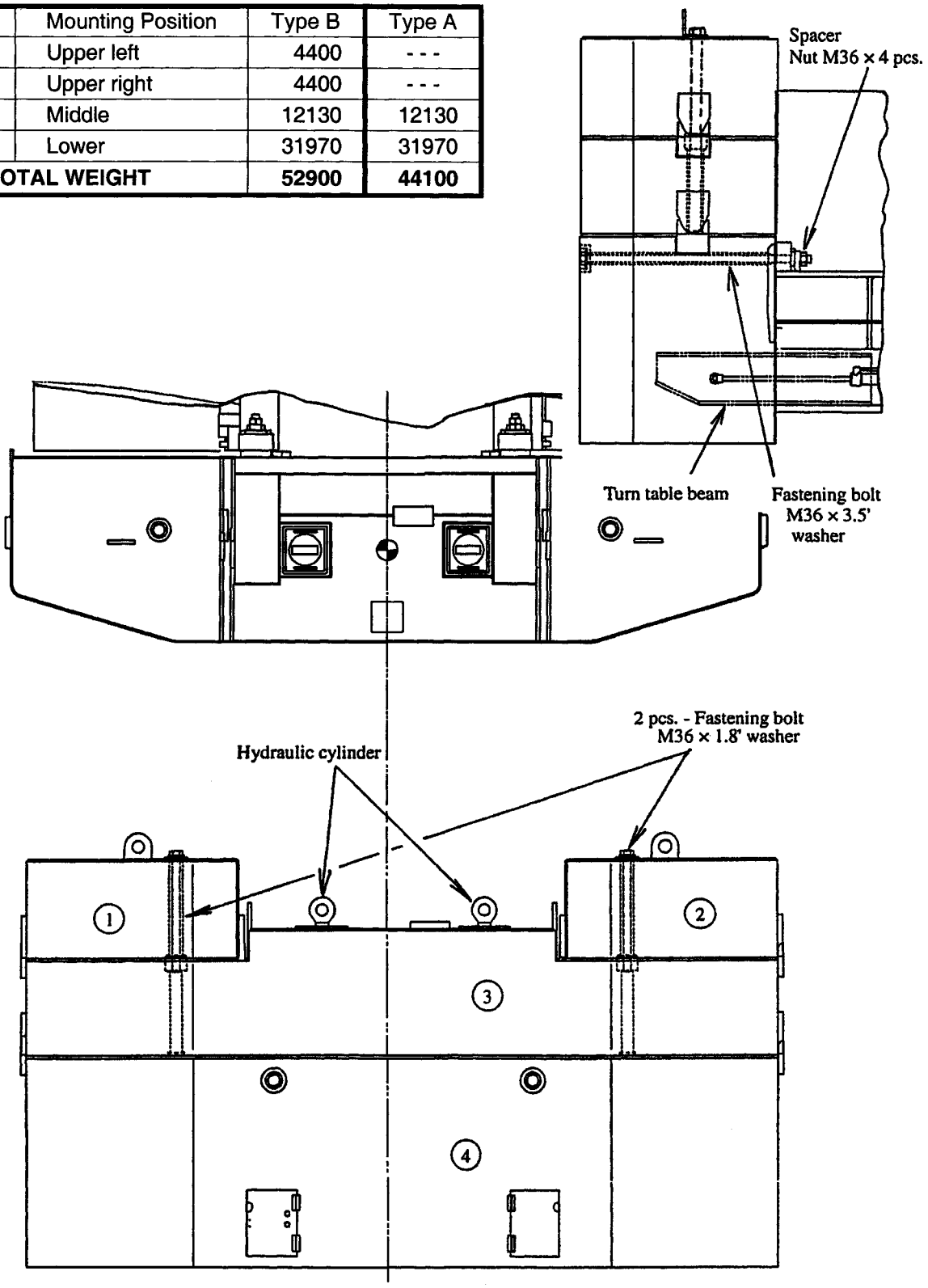
9. Transportation figure
   a. Adjust the angle of C-member out of the receiver pit. Lower the A-frame to its limit and insert the pins to fit the tension member.
   b. Hoist the inner boom to the height of operator's cab.

3. MOUNTING OF COUNTERWEIGHT

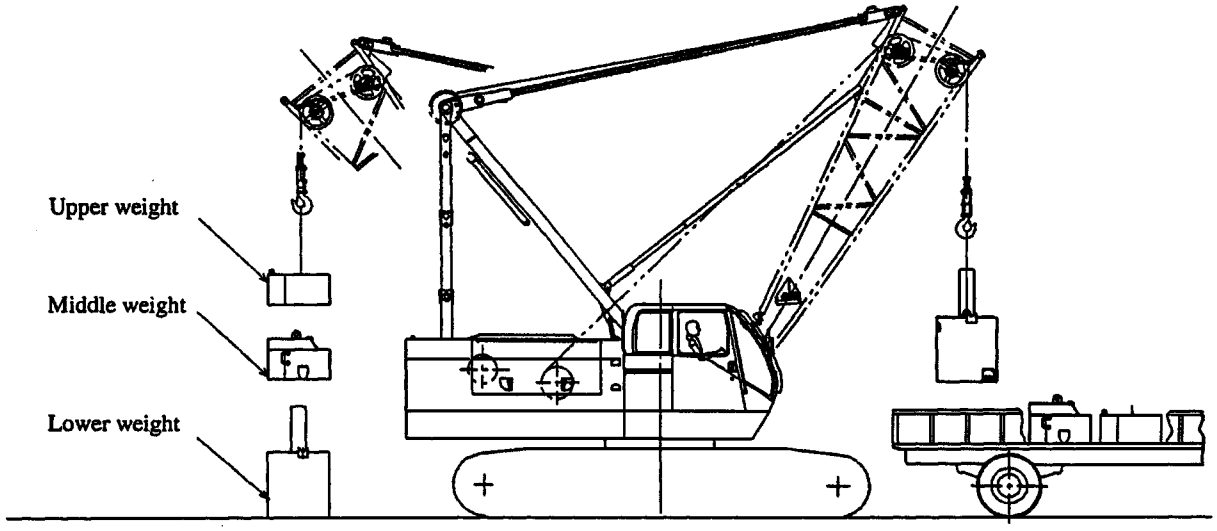
3-1 Weight outline

Unit: Lbs.

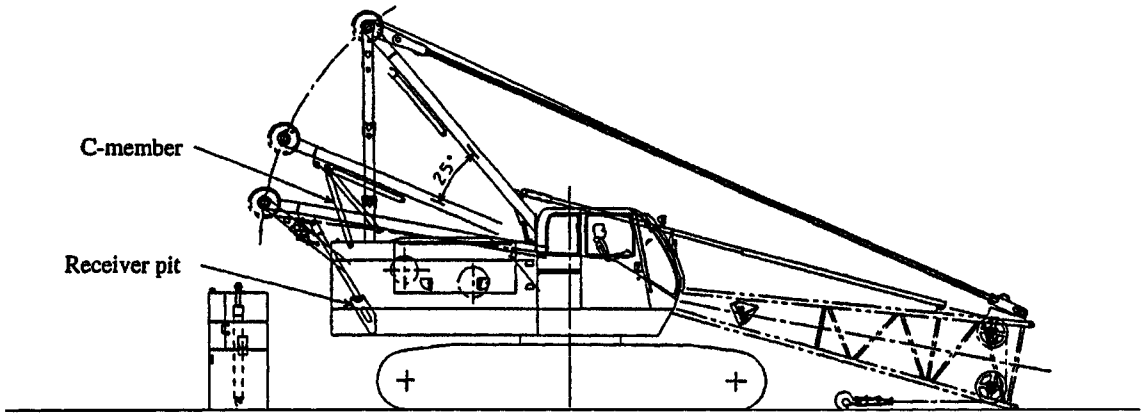
Ref. No.	Mounting Position	Type B	Type A
1	Upper left	4400	- - -
2	Upper right	4400	- - -
3	Middle	12130	12130
4	Lower	31970	31970
TOTAL WEIGHT		**52900**	**44100**



3-2 Counterweight installation method of standard crane



1. Unloading/piling the counterweight (using inner boom)
   a. Unload the counterweight and attachment.
   b. Pile the upper and middle weight on lower weight.



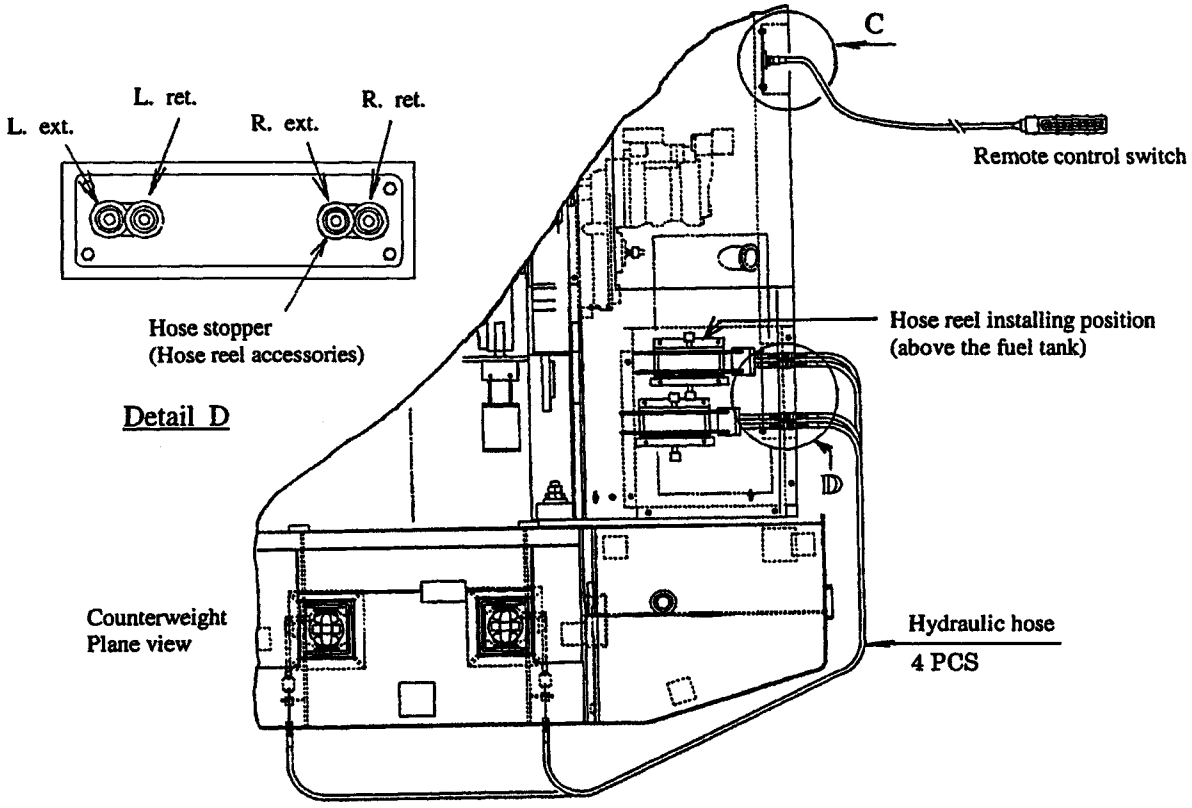
2. Setting the A-frame
   a. Lower the inner boom and put it on the ground.
   b. Remove the C-member housing pins. Make sure that the C-member is hanging from the A-frame.
   c. Lower the A-frame and check that C-member is properly inserted into the receiver pit.
   d. Insert the lock pins to fasten the A-frame tension members.

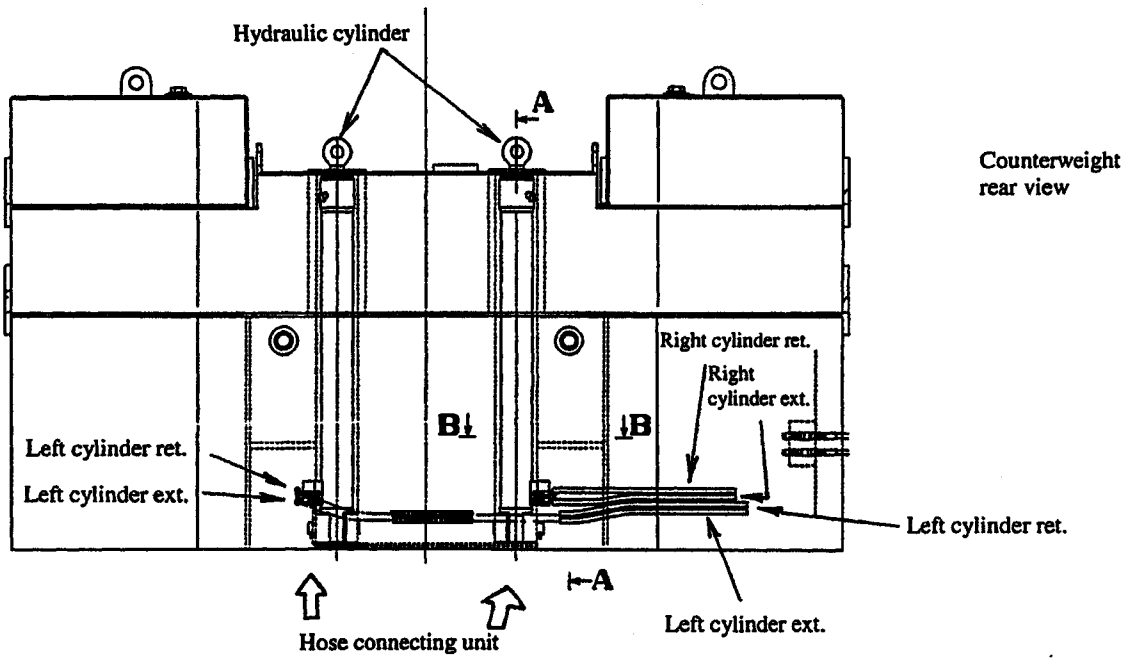
Installation of the counterweight cylinder hydraulic hose and control switch

Install the 4 hydraulic hoses to the 2 hydraulic cylinders. The hose reel of the actuator line should be installed above the fuel tank of the machine.

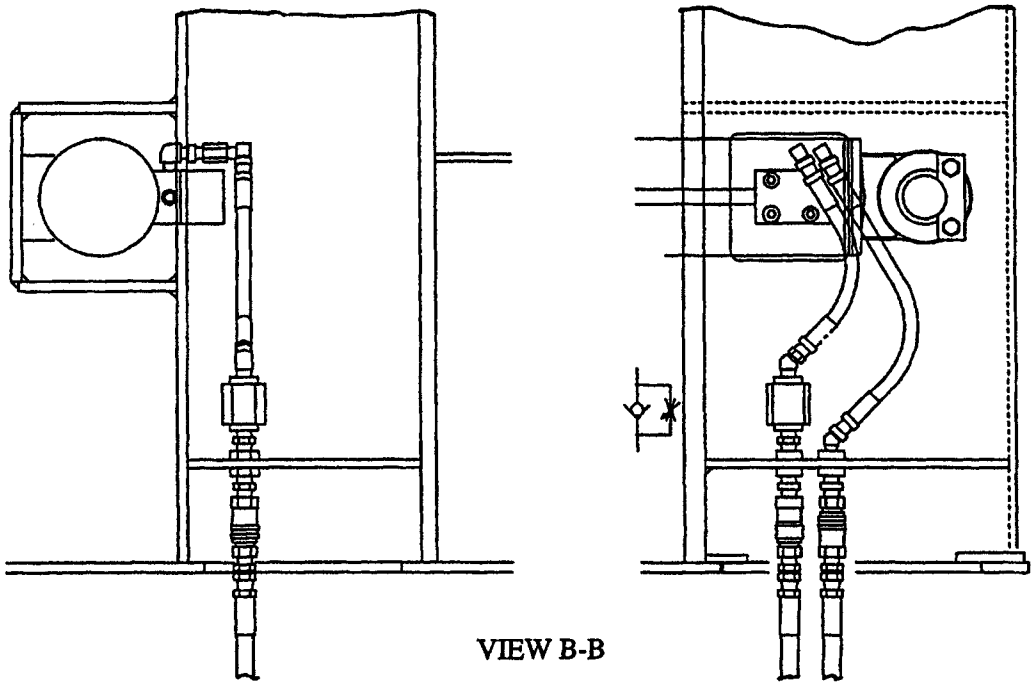
Install the 2 hydraulic hoses to each of the 2 hydraulic cylinders.

Connect the remote control switch to the right of the hydraulic hoses.

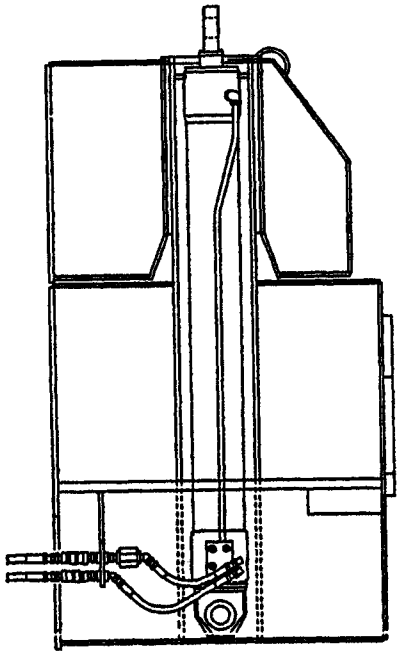




Hose connecting procedure

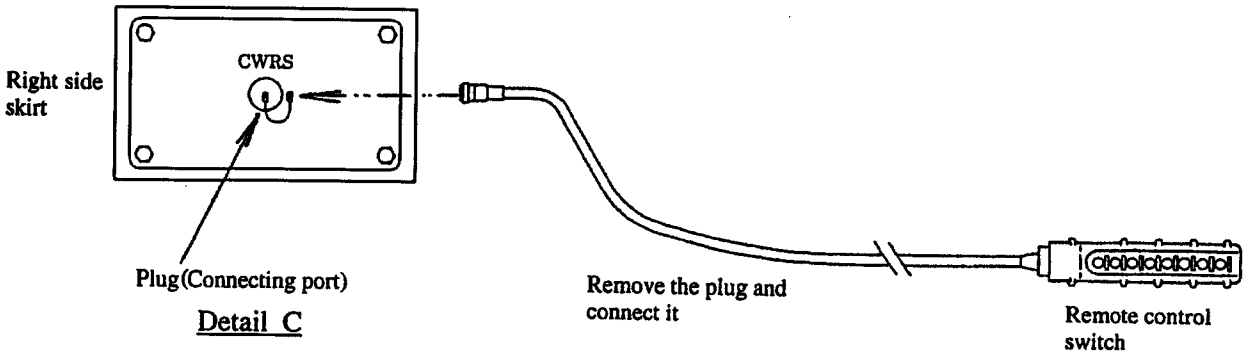


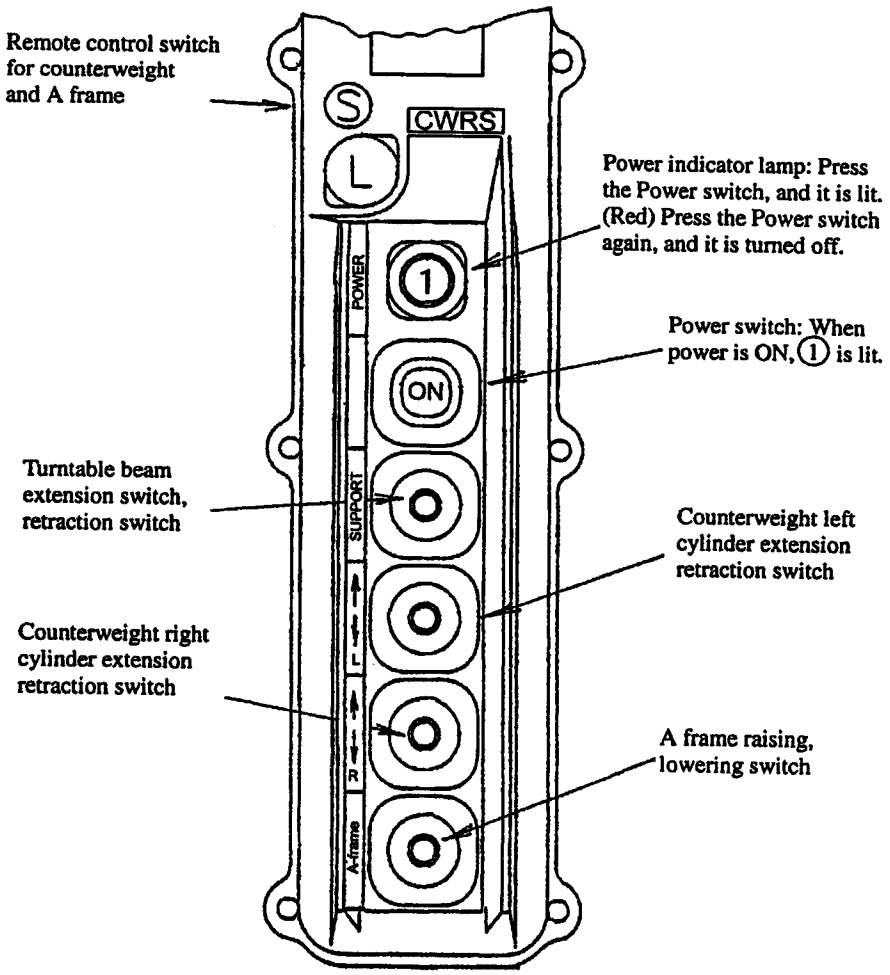
VIEW B-B



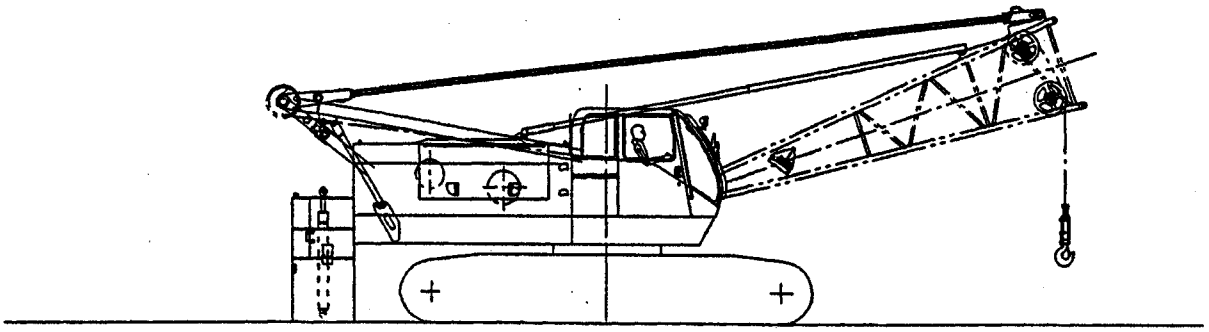
VIEW A-A

Remote control switch connecting unit

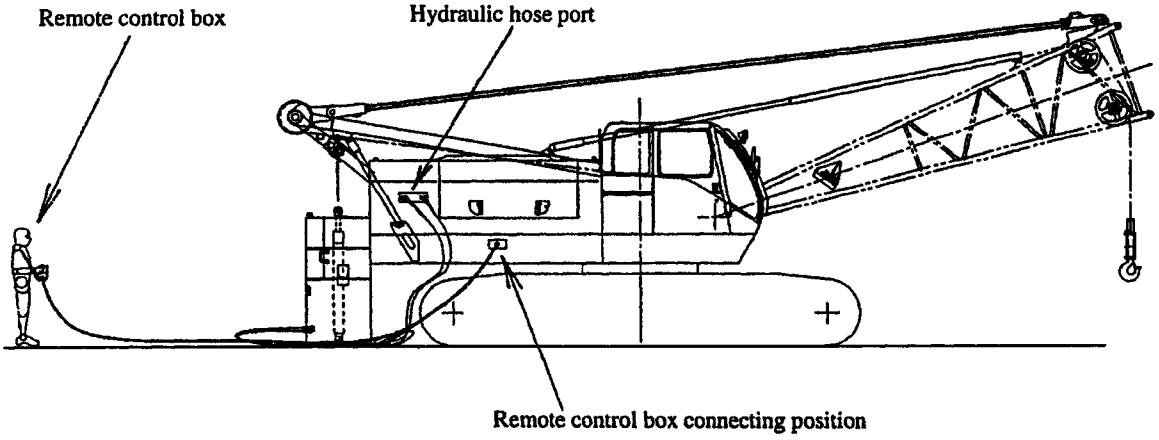




Toggle switch is momentary type switch

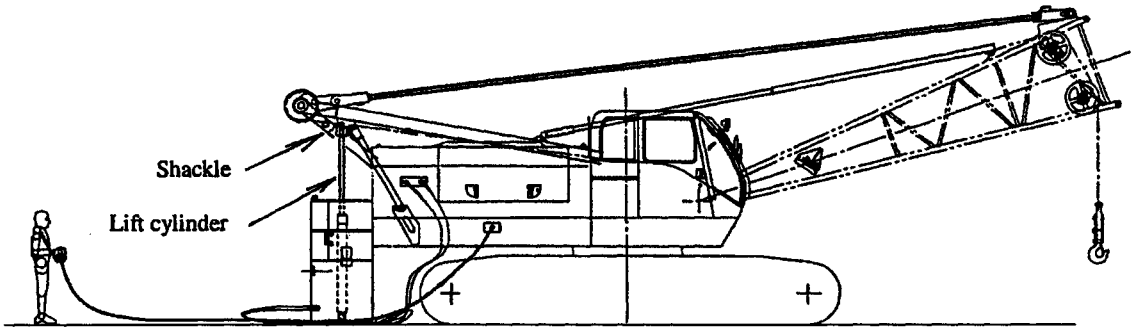


3. Positioning of base machine
   a. Hoist the inner boom from the ground.
   b. Move the base machine to a suitable position matching the center of base machine and counterweight.

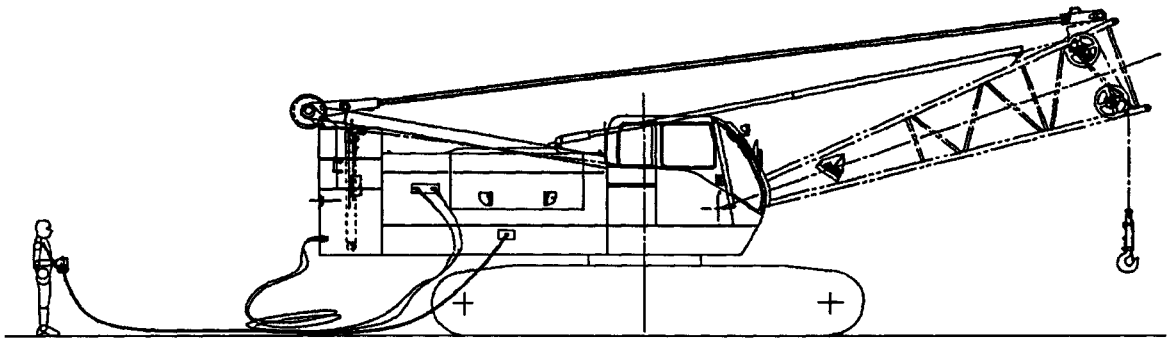


4. Connectng the hydraulic hose of counterweight and connecting the remote control box
   a. Connect the hydraulic hose between base machine and counterweight.
   b. Connect the connector of remote control box to base machine.

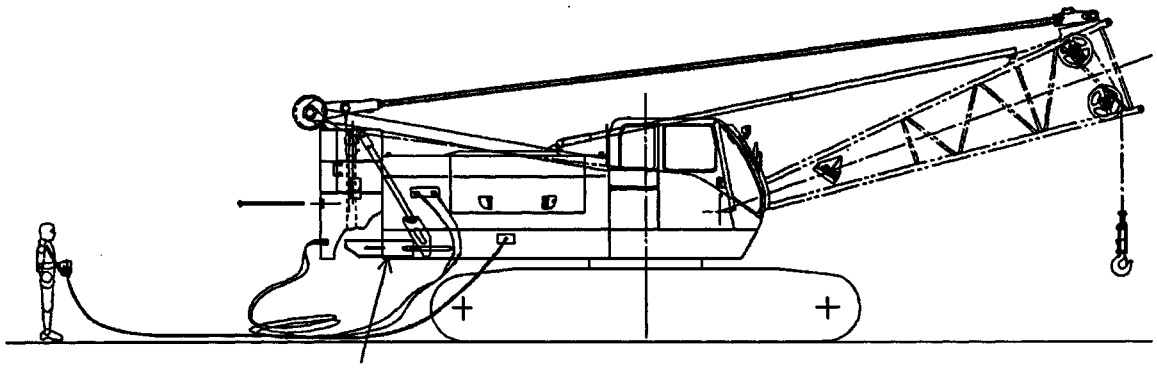
Don't change the connection of piping and electric wiring when the engine is running.



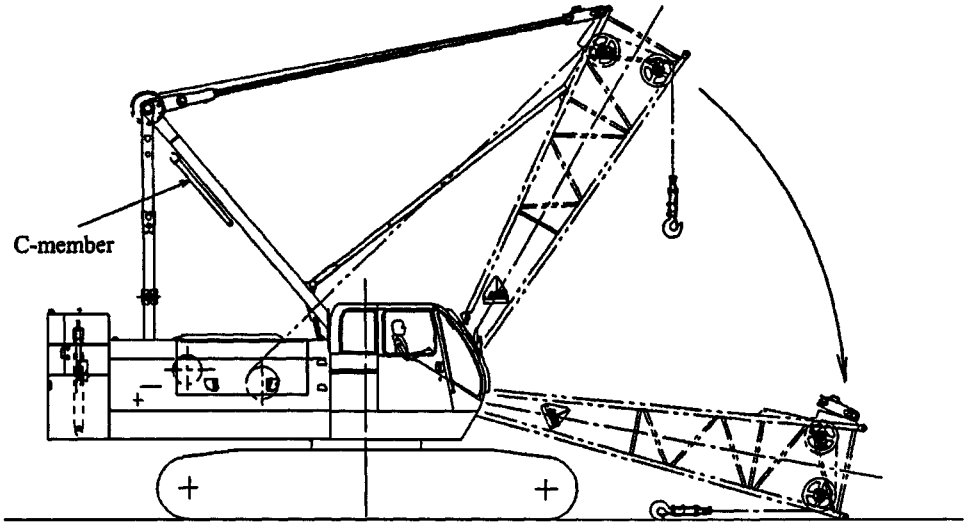
5. Connecting the lift cylinder
   a. Connect the special shackle to A-frame compression member.
   b. Extend the lift cylinders and connect them to the special shackle by pin.



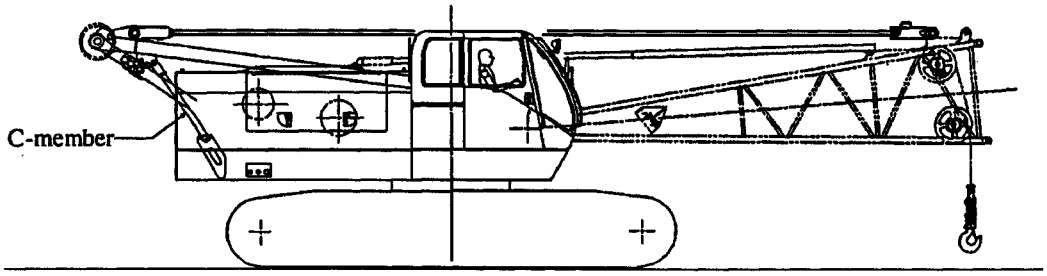
6. Hoisting the counterweight
   a. Hoist the counterweight by retracting the lift cylinder to its end.



7. Pushing out the counterweight support beam
   a. Counterweight lifting cylinders are completely retracted to their ends.
   b. Push out the counterweight support beam cylinders to their ends.
   c. Lower the counterweight until its bolt holes match with the holes of turntable side.
   d. Put the bolts into the counterweight and attach the washers and nuts. Tighten the bolts to fasten the counterweight.
   e. Put the counterweight completely on the counterweight support beam by extending the lift cylinders. Disconnect the lift cylinders and special shackles from A-frame. Retract the lift cylinder to the end.



8. Raising A-frame and preparing for assembly of attachment
   a. Lower the inner boom and put it on the ground.
   b. Take the CWRS pins off the tension members.
   c. Raise A-frame by extending the A-frame cylinder.
   d. Lock the C-member onto A-frame before raising A-frame.
   e. Start the assembly of attachment.

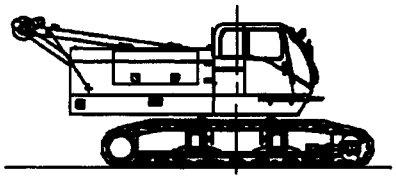
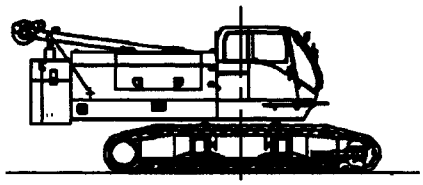
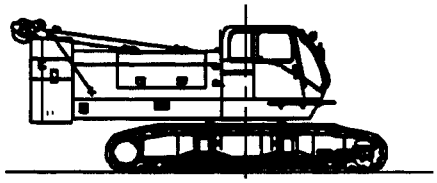
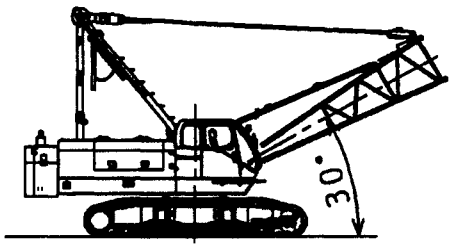


9. Transportation figure
   a. Insert the C-member into the receiver pit, and when the A-frame tension members are retracted to the fullest, set the tension members lock pins.
   b. Hoist the inner boom to the height of operator's cab.

4. ALLOWABLENESS OF SELF-TRAVELING AND ASCENDING/DESCENDING ON TRAILER RAMP BOARD

4-1 Allowableness of self-traveling on level ground

○ = Allowable ▲ = Allowable with EXTREME CAUTION X = Not Allowable

	Self-traveling position		Allowable/ Not allowable
①		Type A, B common Crawler width retract Without counterweight Without crawler weight	○
②		Type A Crawler width extend With counterweight With crawler weight (It is possible to travel at a low speed with extreme caution).	▲
③		Type B Crawler width extend With counterweight With crawler weight (It is possible to travel at a low speed with extreme caution).	▲
④		Type A With counterweight With crawler weight	○

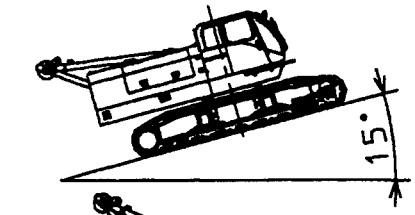
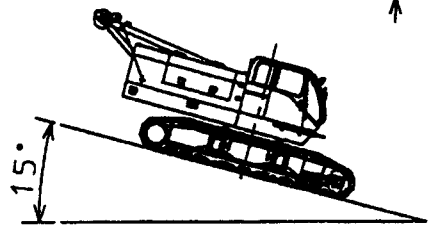
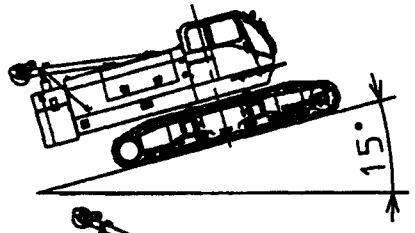
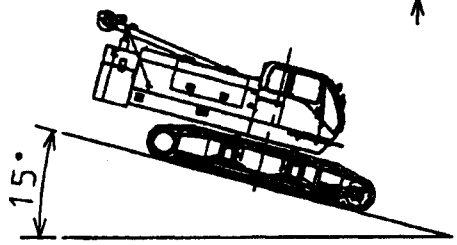
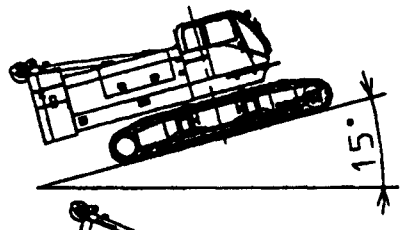
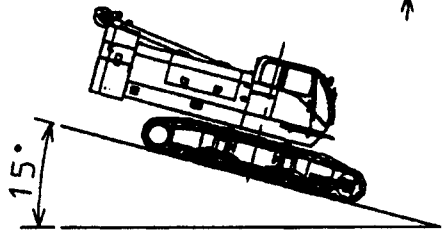
Caution on self-traveling:

1. For traveling, apply the swing brake and engage the swing lock, and select as flat a course as possible.
2. Travel in the forward direction (with travel motor at the rear). Locate the travel motor at the front for ② & ③.
3. Low speed is mandatory for traveling on soft or uneven ground, and for wide steering.
4. Before self-traveling in the crane work position, the hook should be hoisted close to the boom point. For traveling with a boom of 98.5 ft. or longer, the boom angle should be set at about 60°.

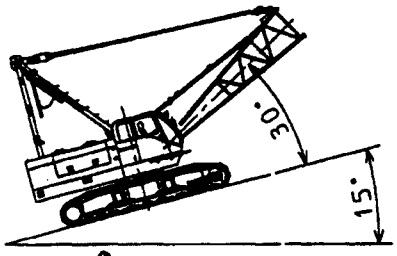
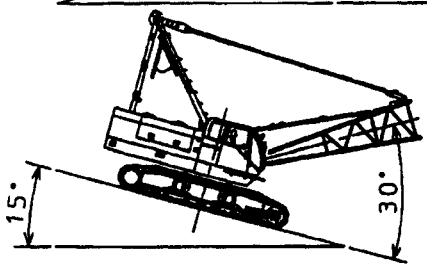
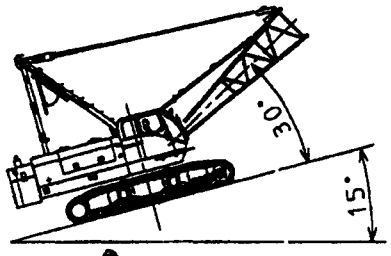
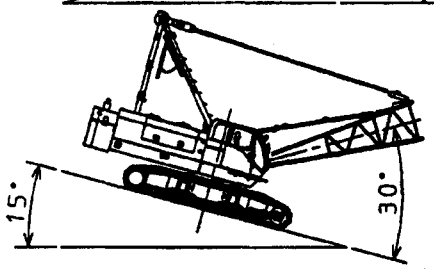
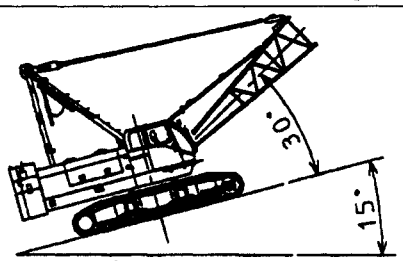
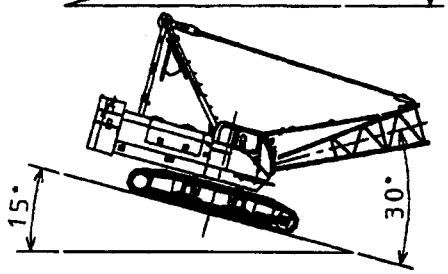
   In the case of a tower crane, set the tower jib at about 50°.
5. When traveling on a slope without the attachment, safety is ensured by removing the counterweight in both uphill and downhill directions. Even when the attachment is mounted, the machine becomes unstable if the attachment (boom length) is short. Adequate attention should be paid.
6. Check the traveling route in advance. When crossing a bridge, its strength should be checked. If the strength is inadequate, reinforcement is necessary.
7. When crossing railways, do not allow the crawlers to touch the rails directly.

4-2 Allowableness of ascending/descending on trailer ramp board, slope

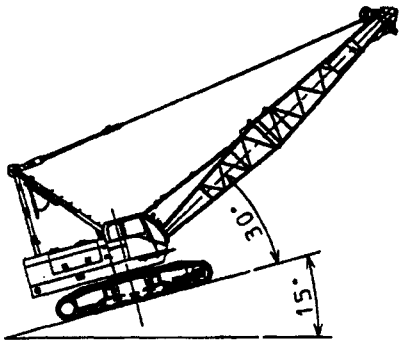
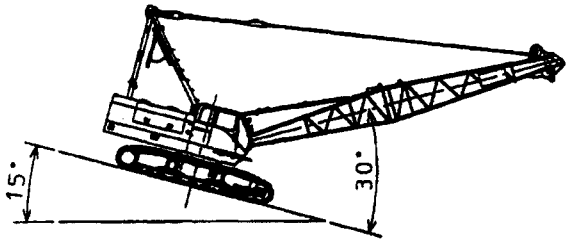
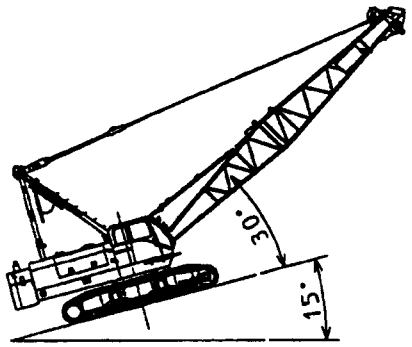
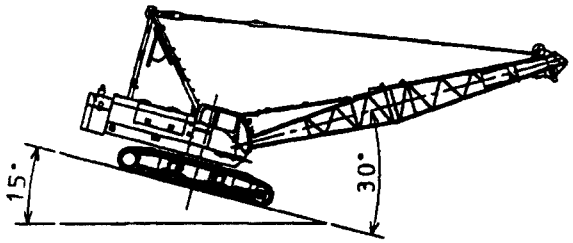
○ = Allowable ▲ = Allowable with EXTREME CAUTION X = Not Allowable

	Machine posture		Allowable/ Not allowable
When ascending/descending on slope		Type A, B common Crawler width retract Without counterweight Without crawler weight	○
			○
		Type A With counterweight With crawler weight	X
			○
		Type B With counterweight With crawler weight	X
			○

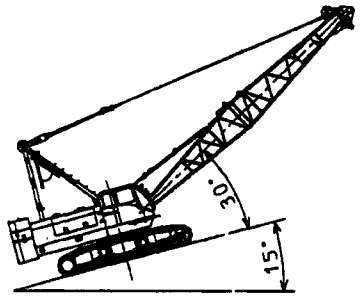
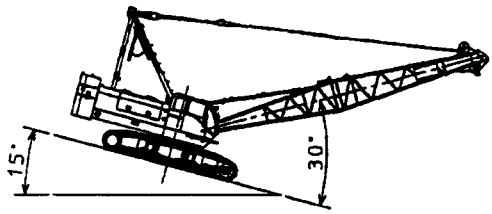
○ = Allowable ▲ = Allowable with EXTREME CAUTION X = Not Allowable

	Machine posture		Allowable/ Not allowable
When ascending/descending on slope		Type A, B common Without counterweight Without crawler weight	○
			○
		Type A With counterweight With crawler weight Ascending possible with extreme caution	▲
			○
		Type B With counterweight With crawler weight	X
			○

○ = Allowable ▲ = Allowable with EXTREME CAUTION X = Not Allowable

	Machine posture		Allowable/ Not allowable
When ascending/descending on slope		Type A, B common Without counterweight Without crawler weight	○
			○
		Type A With counterweight With crawler weight	○
			○

○ = Allowable ▲ = Allowable with EXTREME CAUTION X = Not Allowable

	Machine posture	Allowable/ Not allowable
When ascending/descending on slope	 Type B common Without counterweight Without crawler weight	▲
		○

Allowableness is shown for the machine with counterweight and without counterweight.

When the counterweight is dismounted, ascending and descending are allowed in all machine positions and with or without the attachment.

Transporting the machine by board while the counterweight is still mounted is prohibited.

- In all the illustrations shown above (pages 2-34 to 2-37), the ramp board angle is 15°. The boom angle must not exceed 30°.
- Allowable or unallowable judgement is based on crane stability at ascending and descending.
- The reaction when returning from the inclined state to level state is not considered. Also, the judgement standard may differ depending on the shape of trailer.

⚠ WARNING

When ascending/descending:

1. **Park the trailer on level ground and place chocks behind the wheels.**
2. **Confirm the driving direction in advance so that steering will not be required on the ramp board of the trailer.**
3. **With the swing brake applied and the swing lock engaged, drive the machine at a slow speed.**
4. **Never try the swing operation during ascending or descending.**
5. **If there is a risk of slippage due to rain or snow, the machine should be protected by using sand, mats, etc.**
6. **Keep the allowable posture (with or without counterweight) during ascending/descending on ramp board.**

After loading:

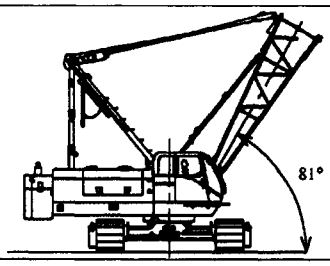
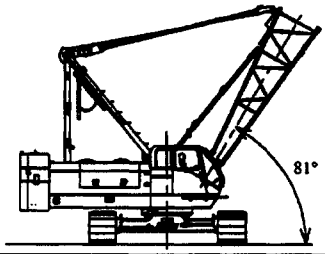
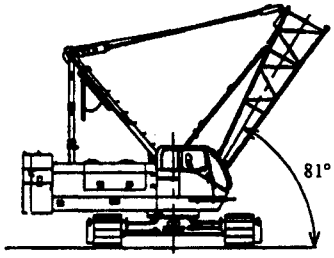
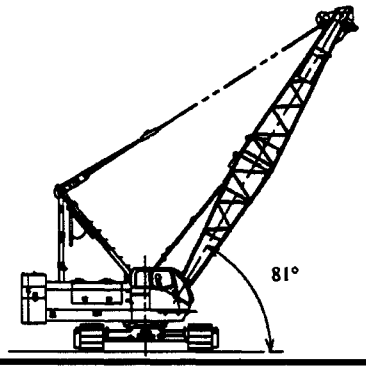
1. **Before swinging on the trailer, support the trailer frame with wood blocks to prevent the trailer from inclining.**
2. **Apply the swing brake and engage the swing lock securely.**
3. **Secure the machine to the trailer by means of wires, chains, etc., to prevent the machine from moving in any direction during transportation.**

Unless the above points are observed, the machine may tip over or fall.

4-3 Allowableness of swing

This table shows the swing allowableness when the machine is stationary on level ground.

○ = Allowable ▲ = Allowable with EXTREME CAUTION X = Not Allowable

Machine posture		Allowable/ Not allowable
	Type A With counterweight With crawler weight With inner boom (Swing is possible with extreme caution)	▲
	Type B With counterweight Without crawler weight With inner boom	X
	Type B With counterweight With crawler weight With inner boom (Swing is possible with extreme caution)	▲
	Type B With counterweight With crawler weight With basic boom	○

⚠ CAUTION

1. **The above illustrations are all based on rear stability when the superstructure is faced in the overside direction on level and firm ground. If swinging the machine in an unallowable posture, it will fall backward.**
2. **The above illustrations show the stability when the machine is stationary. Don't swing the machine during traveling. Before traveling, the superstructure should be aligned in the overend direction of the crawlers.**
3. **Be very careful when changing the crawler width just before loading onto a trailer or just after unloading from a trailer for transportation.**

5. REEVING OF WIRE ROPE

5-1 Precautions for handling the wire rope

⚠ WARNING

Be careful about the following points to prevent your body or hand from being caught by the machine when setting the wire rope on the wire drum or when correcting the rope that has not spooled on the drum properly. Be careful in the same way when reeving the rope on the sheave.

1. **Don't handle a wire rope by bare hands. Always wear leather gloves when handling wire rope.**
2. **Guide the rope in the position approximately 3.5 ft. away from the drum.**
3. **Don't slip the wire rope in your hands. Pass the rope from the left hand to the right and wind it at such a speed as you can stop winding immediately.**
4. **Give the correct signal to start or stop winding.**
5. **Don't touch a rotary section such as a sheave or drum when setting or removing the wire rope. Your hand may be caught by the machine.**
6. **Be careful for the rope reaction when setting or removing the wire rope on the drum. You may be injured.**

⚠ CAUTION

1. **If the wire rope is too long, it may not spool on the drum. The rope will be damaged and its life will be shortened. Use a rope of the specified length.**
2. **If the wire rope is too short, it will be used up before the hook or bucket reaches the destination, and also the drum may be damaged or wire rope may be cut. Leave the rope by two turns or more on the drum for every kind of work.**
3. **A lifting load is specified for one load hoist wire rope. Select a hook capacity and ropes part of line applicable to the load.**

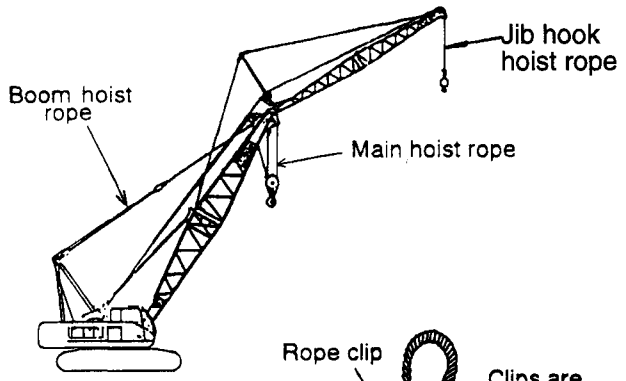
⚠ CAUTION

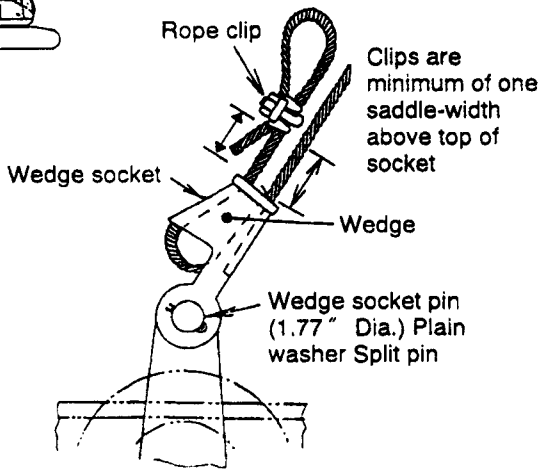
If the end of wire rope comes off from the fixed section, a serious accident may occur. When setting the wire rope on the wire drum or wedge socket, use a wedge (cotter) with the correct size and make sure that the length of the contact between the wedge and wire rope is proper and the tightening allowance is correct. When inserting into the socket, attach a rope clamp accurately.

⚠ WARNING

1. **Insert and attach the split pin (for pendant rope connecting pin) and hairpin (for boom joint pin) correctly. If the pin falls off, an accident resulting in injury or death may occur.**

Precautions for handling the wire rope - Boom Hoist Rope

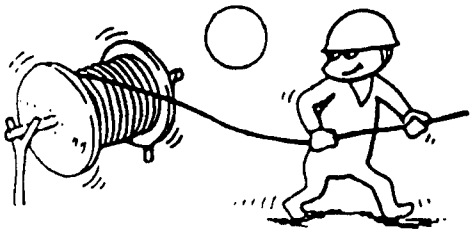




⚠ CAUTION

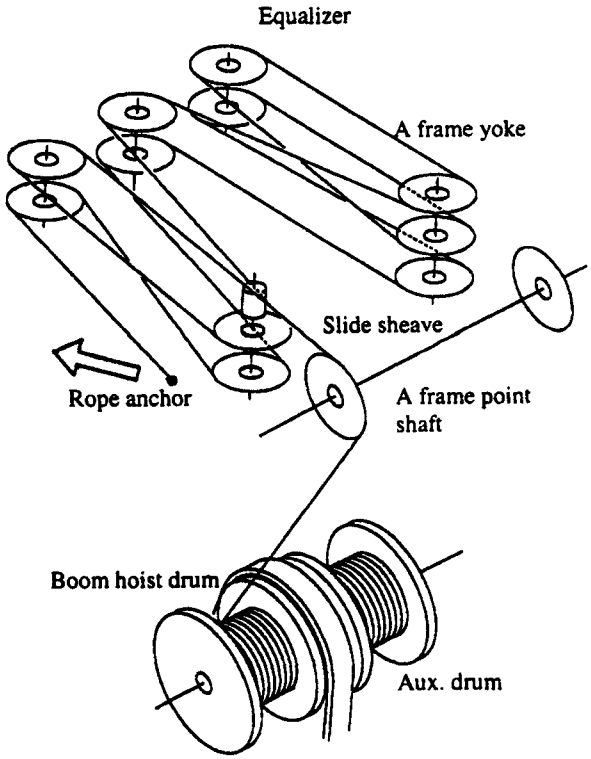
Observe the space and direction as illustrated when mounting the cable clamp.

Insert the wedge socket pin while its head is upside down. Insert and open the split pin accurately. If the clamp position is too far from the socket, the wedge may come off.



⚠ WARNING

Reeve a specified wire rope correctly. If a rope not specified is used or if a rope is reeved incorrectly, it is worn earlier than usual. Check the wire rope periodically.



Spool off the wire rope while turning the reel to prevent twisting. Wind the rope around the sheave without crossing it. When winding the wire rope around the boom hoist drum, give prestress to the rope and wind it correctly for the first layer on the drum.

SECURING THE LOAD LINE DEAD END

Always use an open wedge socket and the correct type of adapter link when securing the dead end of the load line to the boom tip. Figure 1 (right) and Figure 2 (following page) show exploded-view illustrations of both types of adapter links. With these links in place, free movement of the dead end line is possible through two axes of rotation. The pin connection parallel to the boom center line allows lateral stresses to be disseminated safely, while the adapter link pin connection perpendicular to the boom distributes longitudinal stresses. The freedom of movement provided by the wedge socket and adapter link protects the dead end connection from abuse and fatigue much more effectively than a thimble and clips, or other methods.

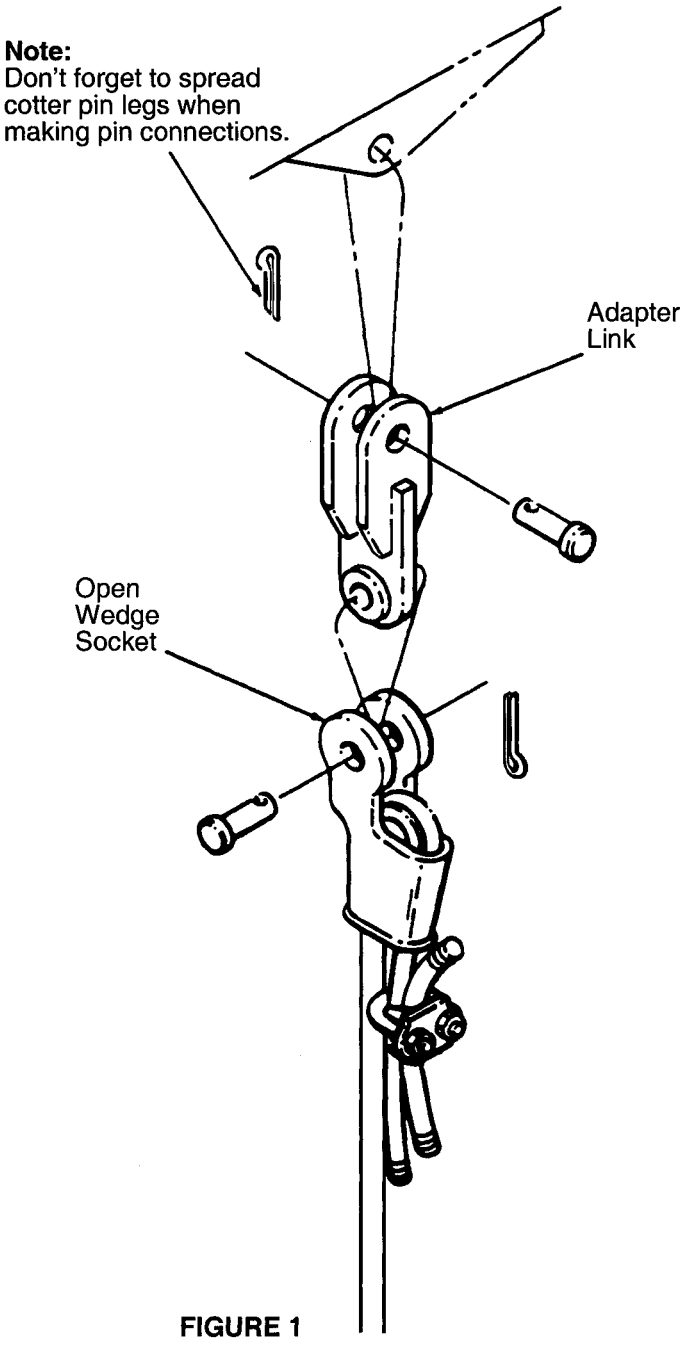


FIGURE 1

CAUTION

REFER TO THE PROCEDURE FOR "SECURING THE DEAD END OF A ROPE WHEN USING A WEDGE SOCKET" IN THIS MANUAL (PAGES 2-43 & 2-44).

SECURING THE LOAD LINE DEAD END

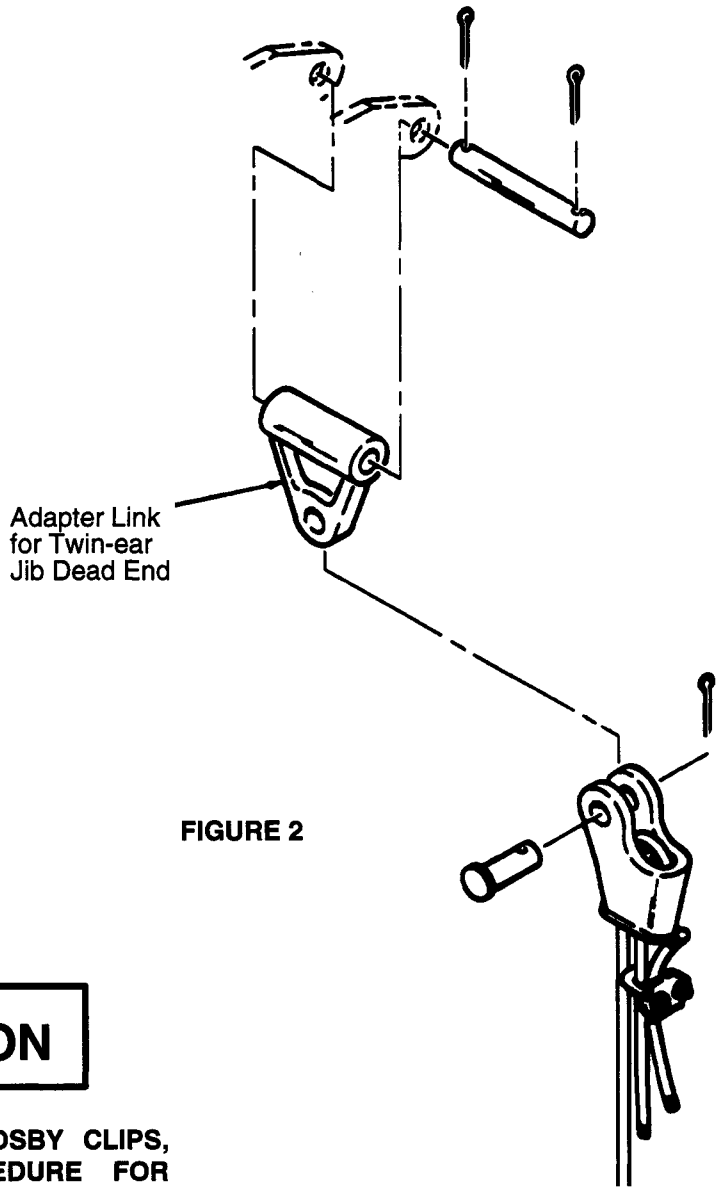


FIGURE 2

CAUTION

BEFORE INSTALLING CROSBY CLIPS, REFER TO THE PROCEDURE FOR "SECURING THE DEAD END OF A ROPE WHEN USING A WEDGE SOCKET" ON THE FOLLOWING THREE PAGES.

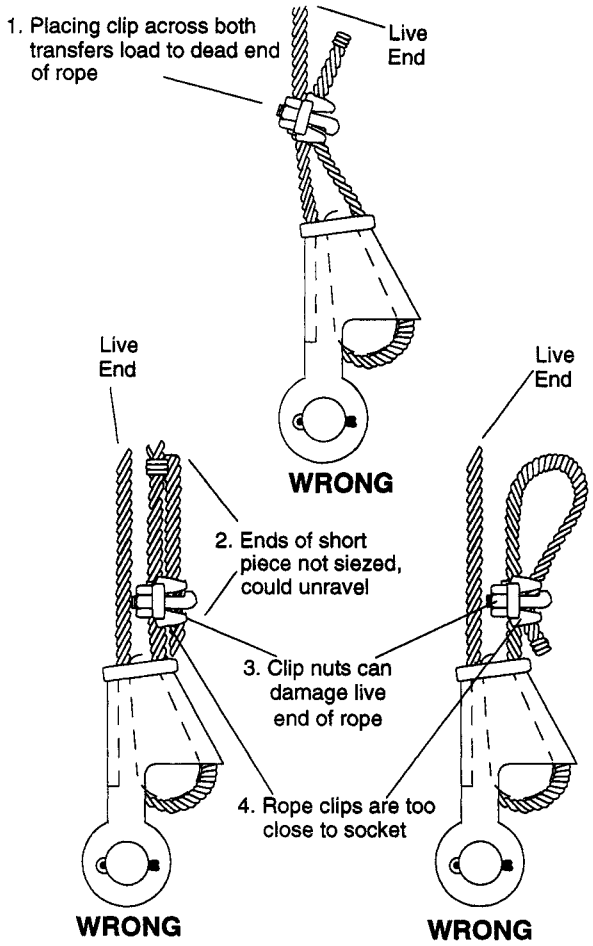
SECURING THE DEAD END OF A ROPE WHEN USING A WEDGE SOCKET

The dead end of a rope is the left-over end, the short piece that comes back out of the wedge socket. The dead end **must** be secured by a wire rope clip. Enough rope should be extended through the socket to allow the end to be doubled back on itself. Then, a rope clip should be attached over the loop with the saddle placed a minimum of one saddle-width above the top of the socket.

WARNING

DO NOT ATTACH THE CLIP ACROSS BOTH ENDS OF THE ROPE AT ONCE. (IT IS THE JOB OF THE WEDGE SOCKET TO HOLD BOTH ENDS OF THE ROPE. THE CROSBY CLIP IS ONLY FOR SECURING THE DEAD END.)

Four **WRONG** ways to secure dead-end.:

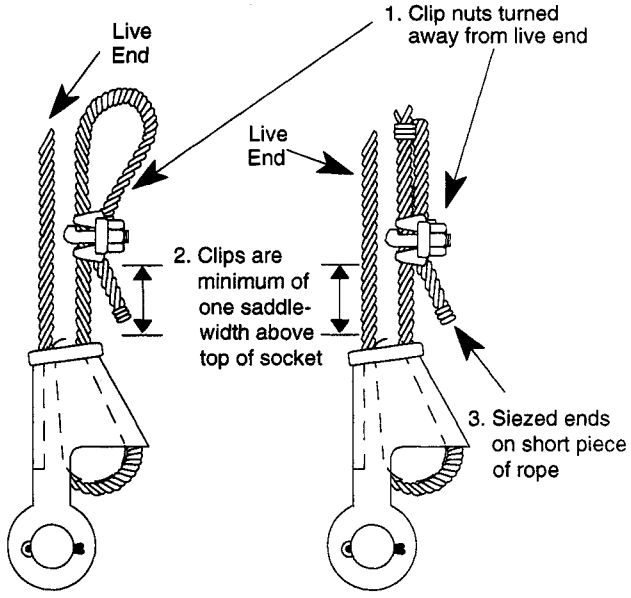


There are two correct ways to dead-end a rope in a socket. Generally, smaller diameter rope, such as 3/4" (19mm) or smaller, can be looped back on itself and clipped as shown in the lower left illustration. Larger diameter rope makes large loops which may foul in use. Therefore, ti is recommended that no loop be formed. Instead, a short piece (4" to 6" long) of tope of the same diameter should be placed against the dead end so that the clip may be drawn up tight as shown in the lower right illustration. Both ends of the short piece of rope should be seized to prevent unraveling. Place the clip at least the width of the clip saddle above the socket.

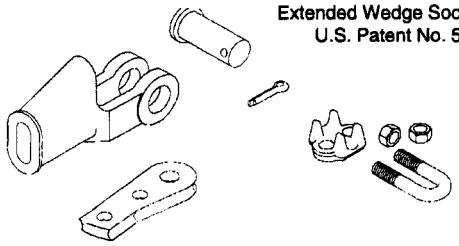
WARNING

NEVER FACE SADDLE END OF CLIP TOWARD LIVE END OF ROPE IN A WEDGE SOCKET. THE CLIP NUTS MAY RUB AGAINST LIVE END OF THE ROPE. THE RESULTING ABRASION COULD EVENTUALLY CUT INTO THE LIVE END OF THE ROPE, SERIOUSLY WEAKENING IT.

RIGHT WAY:



"TERMINATOR" WEDGE SOCKET WARNING & APPLICATION INSTRUCTIONS



Extended Wedge Socket Assembly
U.S. Patent No. 5,553,360

S-421T
"TERMINATOR"™

NOTE: Existing Crosby S-421 Wedge Sockets can be retrofitted with the New Terminator Wedge.

New **QUIC CHECK**™ "Go" and "No-Go" features cast into wedge. The proper size wire rope is determined when the following criteria are met: 1. The wire rope shall pass thru the "Go" hole in the wedge. 2. The wire rope shall NOT pass thru the "No-Go" hole in the wedge.

QUIC-CHECK™

Important Safety Information - Read and Follow

Inspection/Maintenance Safety

- Always inspect socket, wedge and pin before using.
- Do not use part showing cracks.
- Do not use modified or substitute parts.
- Repair minor nicks or gouges to socket or pin by lightly grinding until surfaces are smooth. Do not reduce original dimension more than 10%. Do not repair by welding.
- Inspect permanent assemblies annually, or more often in severe operating conditions.

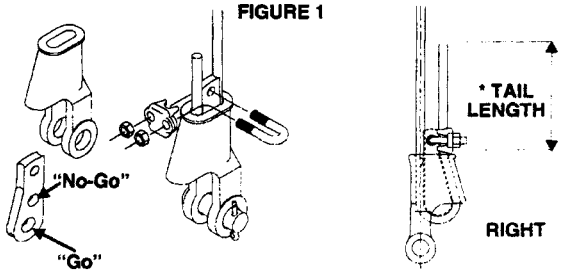
Assembly Safety

- Use only with standard 6 to 8 strand wire rope of designated size. For intermediate size rope, use next larger size socket. For example: When using 9/16" diameter wire rope use a 5/8" size Wedge Socket Assembly. Welding of the tail on standard wire rope is not recommended. The tail length of the dead end should be a minimum of 6 rope diameters but not less than 6" (See Figure 1).
- **To use with Rotation Resistant wire rope** (special wire rope constructions with 8 or more outer strands) ensure that the dead end is welded, brazed or seized before inserting the wire rope into the wedge socket to prevent core slippage or loss of rope lay. The tail length of the dead end should be a minimum of 20 rope diameters but not less than 6" (See Figure 1).
- Properly match socket, wedge and clip (See Table 1) to wire rope size.
- Align live end of rope, with center line of pin. (See Figure 1)
- Secure dead end section of rope. (See Figure 1)
- Tighten nuts on clip to recommended torque. (Table 1)
- Do not attach dead end to live end or install wedge backwards. (See Figure 2)
- **Use a hammer to seat Wedge and Rope as deep into socket as possible before applying first load.**

⚠ WARNING

- **Loads may slip or fall if the Wedge Socket is not properly installed.**
- **A falling load can seriously injure or kill.**
- **Read and understand these instructions before installing the Wedge Socket.**
- **Do not side load the Wedge Socket.**
- **Apply first load to fully seat the Wedge and Wire Rope in the socket. This load should be of equal or greater weight than loads expected in use.**

FIGURE 1



*Tail Length	
Standard 6 to 8 strand wire rope	**Rotation Resistant Wire Rope**
A minimum of 6 rope diameters, but not less than 6"	A minimum of 20 rope diameters, but not less than 6".

TABLE 1

Rope Size	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4
Clip Size	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4
*Torque Ft./lbs.	45	65	65	95	95	130	225	225	225	360

* The tightening torque values shown are based upon the threads being clean, dry, and free of lubrication.

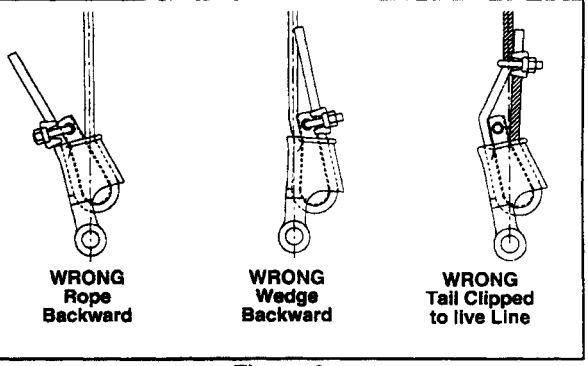


Figure 2

Operating Safety

- Apply first load to fully seat the Wedge and Wire Rope in the socket. This load should be of equal or greater weight than loads expected in use.
- Efficiency rating of the Wedge Socket termination is based upon the catalog breaking strength of Wire Rope. The efficiency of a properly assembled Wedge Socket is 80%.
- During use, do not strike the dead end section with any other elements of the rigging (Called two blocking).

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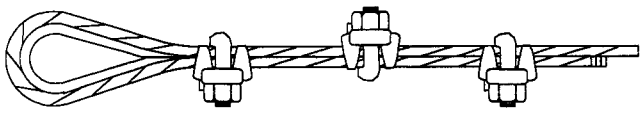
WIRE ROPE CLIP INSTALLATION PROCEDURE

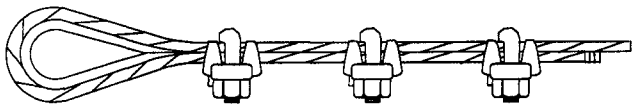
⚠ WARNING

CORRECT INSTALLATION OF ROPE CLIPS IS EXTREMELY IMPORTANT. FAILURE TO INSTALL CLIPS CORRECTLY CAN CAUSE DAMAGE TO THE CRANE AND THE LOAD AND ENDANGER PERSONNEL. TO GET MAXIMUM CLIP HOLDING POWER, CAREFULLY FOLLOW THE INSTALLATION PROCEDURE DESCRIBED BELOW. USE DROP FORGED STEEL TYPE CLIPS ONLY.

WRONG WAYS to clip wire rope

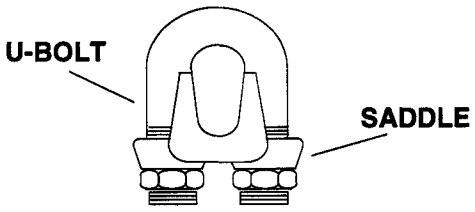


INCORRECT
Do not stagger clips.

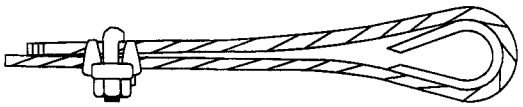


INCORRECT
Do not place U-bolt on live end of rope.

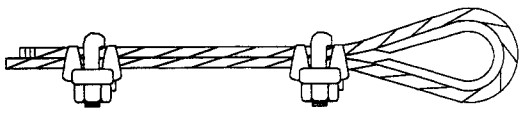
RIGHT WAY to clip wire rope



1. Turn back the specified amount of rope from the thimble. Apply the first clip one base width from the dead end of the wire rope (U-bolt over dead end; live end rests in clip saddle). Tighten nuts evenly to recommended torque



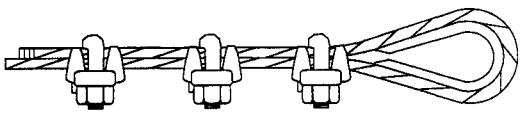
2. Apply the next clip as near the loop as possible. Turn on nuts firmly but do not tighten.



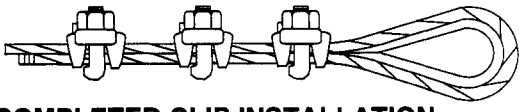
⚠ WARNING

ALL CLIPS MUST BE INSTALLED WITH THE CLIP SADDLE ON THE LIVE END OF THE WIRE ROPE. CUTTING OR KINKING OF THE ROPE MAY OCCUR IF THE "U" OF A CLIP BEARS ON THE LIVE END OF THE ROPE.

3. Space additional clips if required equally between the first two, placing them one base width apart. Turn on nuts - take up rope slack tighten all nuts evenly on all clips to recommended torque.



4. Apply the initial load and retighten nuts to the recommended torque.



COMPLETED CLIP INSTALLATION
U-BOLT OF ALL CLIPS ON DEAD END OF ROPE

NOTE: Rope will stretch and shrink in diameter when loads are applied. Inspect clips periodically and again evenly tighten all nuts on all clips to recommended torque.

A termination made in accordance with the above instructions and using the number of clips shown in the table on the right has an efficiency rating of approximately 80% for 1/8" - 7/8" rope and 90% for 1" - 3" rope.

This rating is based upon the calculated breaking strength of wire rope. If a pulley is used in place of a thimble for turning back the rope, add one additional clip.

The number of clips required is based upon using right regular of Lang lay wire rope, 6 x 19 class or 6 x 37 class, fibre core or IWRC, IPS or XIPS.

If Seale construction or similar large outer wire type construction in the 6 x 19 class is to be used for sizes 1 inch and larger, add one additional clip.

The number of clips shown also applies to right regular lay wire rope, 8 x 19 class, fibre core, IPS sizes 1 1/2 inch and smaller; and right regular lay wire rope, 18 x 7 class, fibre core, IPS or XIPS, sizes 1 3/4 and smaller.

For other classes of wire rope not mentioned above, it may be necessary to add additional clips to the number shown.

If a greater number of clips are used than shown in the table, the amount of rope turnback should be increased proportionately. **Above based on use of Genuine Crosby Clips on new rope.**

Clip Size Inches	Minimum No. of Clips	Amt. of Rope to Turn Back in Inches	Torque in Ft. Lbs.
1/8	2	3 1/4	4.5
3/16	2	3 3/4	7.5
1/4	2	4 3/4	15
5/16	2	5 1/4	30
3/8	2	6 1/2	45
7/16	2	7	65
1/2	3	11 1/2	65
9/16	3	12	95
5/8	3	12	95
3/4	4	18	130
7/8	4	19	225
1	5	26	225
1 1/8	6	34	225
1 1/4	7	44	360
1 3/8	7	44	360
1 1/2	8	54	360
1 5/8	8	58	430
1 3/4	8	61	590
2	8	71	750
2 1/4	8	73	750
2 1/2	9	84	750
2 3/4	10	100	750
3	10	106	1200

⚠ CAUTION

FAILURE TO MAKE A TERMINATION IN ACCORDANCE WITH THE INSTRUCTIONS DETAILED HERE AND ON THE PRECEDING PAGE OR FAILURE TO PERIODICALLY CHECK AND RETIGHTEN CLIPS TO THE RECOMMENDED TORQUE WILL CAUSE A REDUCTION IN THE EFFICIENCY RATING.

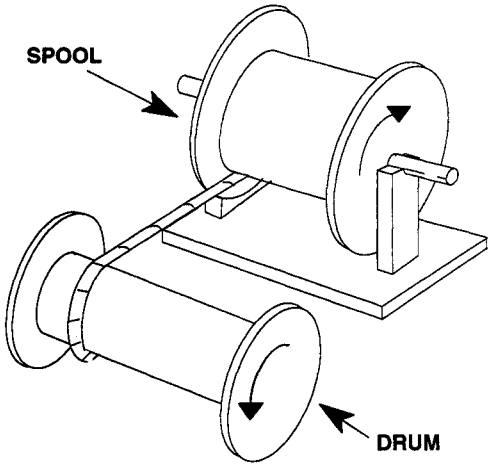
INSTALLING WIRE ROPE ONTO A DRUM

The correct way to remove wire rope from a spool is to mount the spool on a horizontal or vertical axle and rotate the spool in the same direction as drum rotation as the rope is pulled off. The rope should never go through reverse bending when going from the spool to the drum. The Figures illustrate correct and incorrect methods.

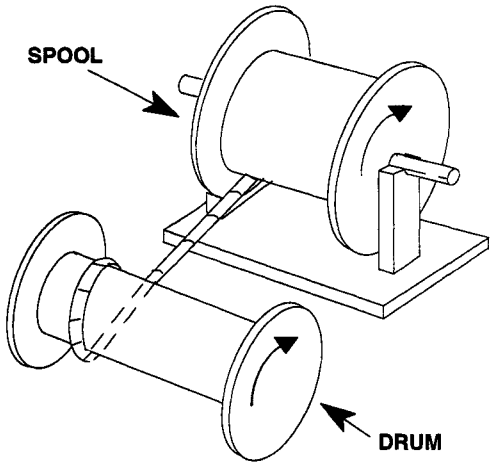
When removing rope from a coil, roll the coil on the ground allowing the rope to trail out behind. Treat it the same as if you were removing it from a rotating spool.

⚠ CAUTION

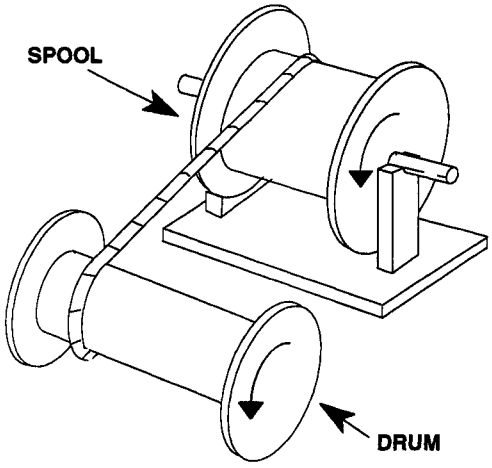
WHEN UNSPOOLING WIRE ROPE IT IS IMPERATIVE THAT THE SPOOL ROTATE AS THE ROPE UNWINDS. IF THE SPOOL DOES NOT ROTATE THE ROPE WILL LOOP AS IT IS UNSPOOLED AND KINKING COULD RESULT. KINKING IS A CONDITION WHERE A LOOP FORMS IN THE ROPE AND THE ROPE IS PULLED TO TRY TO STRAIGHTEN THE ROPE. THE LOOP WILL TIGHTEN AND FORM A KINK. A KINKED ROPE IS DAMAGED BEYOND USE AND MUST BE DISCARDED.



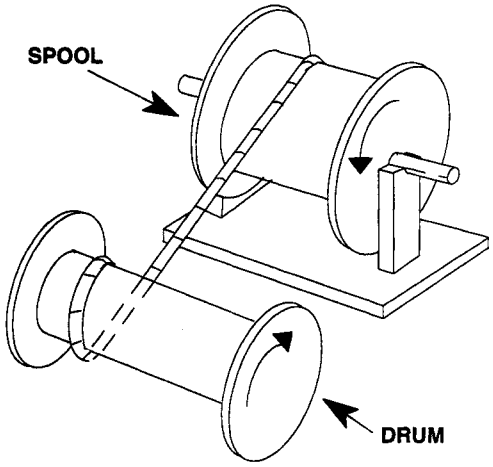
OVERWIND DRUM - INCORRECT



UNDERWIND DRUM - <u>CORRECT</u>



OVERWIND DRUM - <u>CORRECT</u>

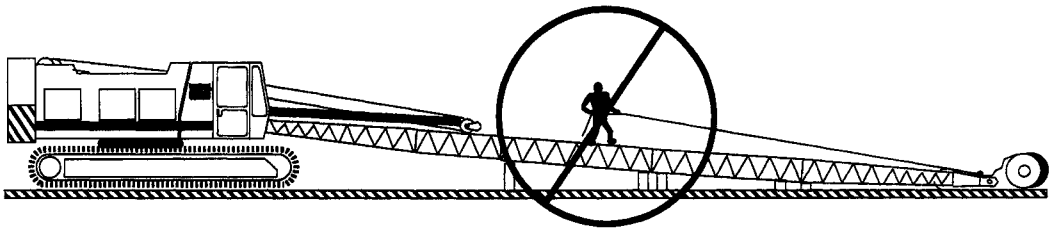


UNDERWIND DRUM - INCORRECT

PULLING THE LOAD LINE FROM THE BOOM TIP TO THE DRUM

CAUTION

DO NOT WALK ON TOP OF BOOM TO REEVE THE LOAD BLOCK OR BALL



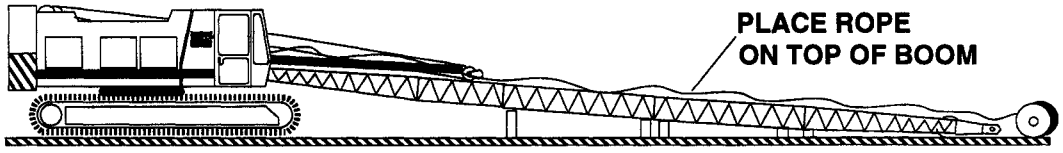
WARNING

USE LEATHER GLOVES TO HANDLE THE ROPE

CAUTION

ALWAYS LOWER THE BOOM AND BLOCK UNDERNEATH THE TIP

1. To reeve the load line from the boom tip to the drum, use a "pulling" rope (manila, nylon, polypropylene) at least 1/2" diameter to reeve from the top of the tip down the boom to the drum.



2. Attach "pulling" rope to wire rope at the boom tip using "Chinese Fingers" (trade name).

WIRE ROPE

3. At the drum, attach the "pulling" rope to the drum. Carefully inhaul the "pulling" rope to bring the wire rope to the drum, Remove the "pulling" rope and "Chinese Fingers". Use the attaching procedure for attaching the wire rope to the drum
4. Reeve the load block or ball to the required specifications found in the rigging section.

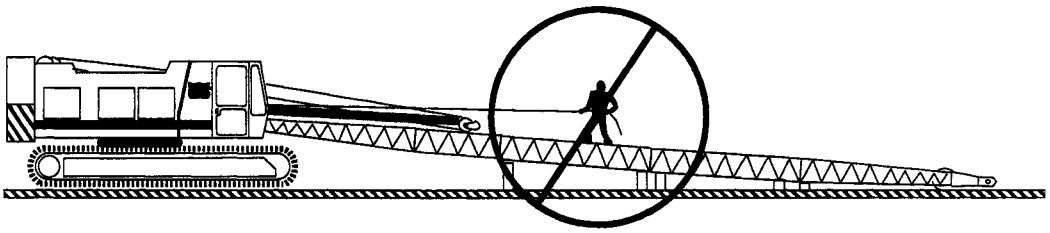
⚠ WARNING

ALWAYS INSURE THE ROPE IS TIGHTLY WRAPPED ON THE DRUM WITH NO GAPS BETWEEN THE WRAPS.

PULLING THE LOAD LINE FROM THE DRUM TO BOOM TIP

⚠ CAUTION

DO NOT WALK ON TOP OF BOOM TO REEVE THE LOAD BLOCK OR BALL



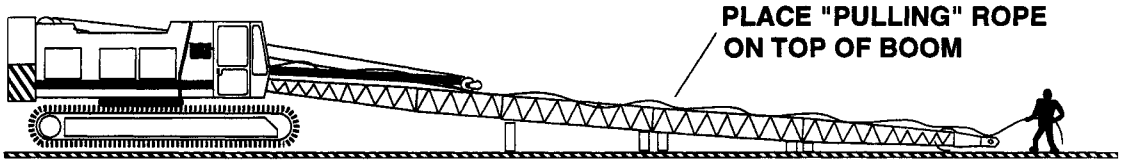
⚠ WARNING

USE LEATHER GLOVES TO HANDLE THE ROPE

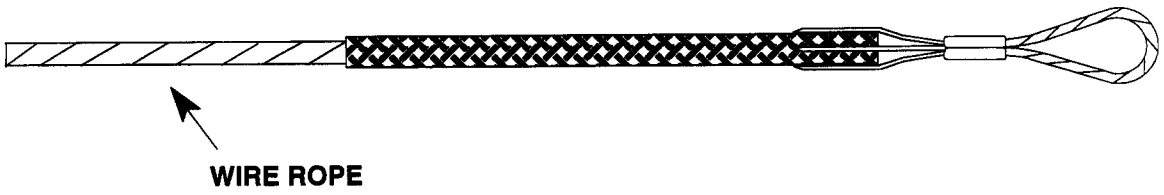
⚠ CAUTION

ALWAYS LOWER THE BOOM AND BLOCK UNDERNEATH THE TIP

1. To reeve the load line from the drum to the boom tip, use a "pulling" rope (manila, nylon, polypropylene) at least 1/2" diameter to reeve from the top of the tip down the boom to the drum.



2. Attach "pulling" rope to wire rope at the drum using "Chinese Fingers" (trade name).



WIRE ROPE

3. Release the park brake and switch the crane to Duty Cycle mode for the drum to freewheel. At the tip of the boom, pull the rope until the wire rope is to the tip.
4. Reeve the load block or ball to the required specifications found in the rigging section.

HC110 HOIST DRUM PERFORMANCE

Main Hoist - 1" Diameter Rope					
Rope Layer	High Range		Low Range		Total Rope Length Feet
	Line Speed Feet per Minute	Single Line Pull Pounds	Line Speed Feet per Minute	Single Line Pull Pounds	
1st*	322	28,210	224	40,640	105
2nd*	350	26,010	243	37,470	212
3rd*	377	24,130	261	34,760	335
4th*	404	22,500	281	32,420	459
5th*	431	21,080	299	30,370	599
6th*	459	19,830	318	28,570	741
7th*	486	18,720	337	26,960	898
8th*	513	17,720	357	25,530	1,056
9th**	540		375		1,232
10th**	568		394		1,407
6x25, RRL, EIPS, IWRC, 103,400 LBS. MBS					

Auxiliary Drum - 7/8" Diameter Rope					
Rope Layer	High Range		Low Range		Total Rope Length Feet
	Line Speed Feet per Minute	Single Line Pull Pounds	Line Speed Feet per Minute	Single Line Pull Pounds	
1st*	348	26,140	241	37,670	64
2nd*	377	24,100	262	34,720	128
3rd*	407	22,360	282	32,210	204
4th*	433	20,860	303	30,040	278
5th*	466	19,540	323	28,150	364
6th*	495	18,380	343	26,450	449
7th*	524	17,350	364	24,990	545
8th*	553	16,430	384	23,670	640
9th**	583		404		747
10th**	612		425		852
6x25, RRL, EIPS, IWRC, 79,600 LBS. MBS					

* = Working Layers
** = Storage Layers

HC110 HOIST DRUM PERFORMANCE

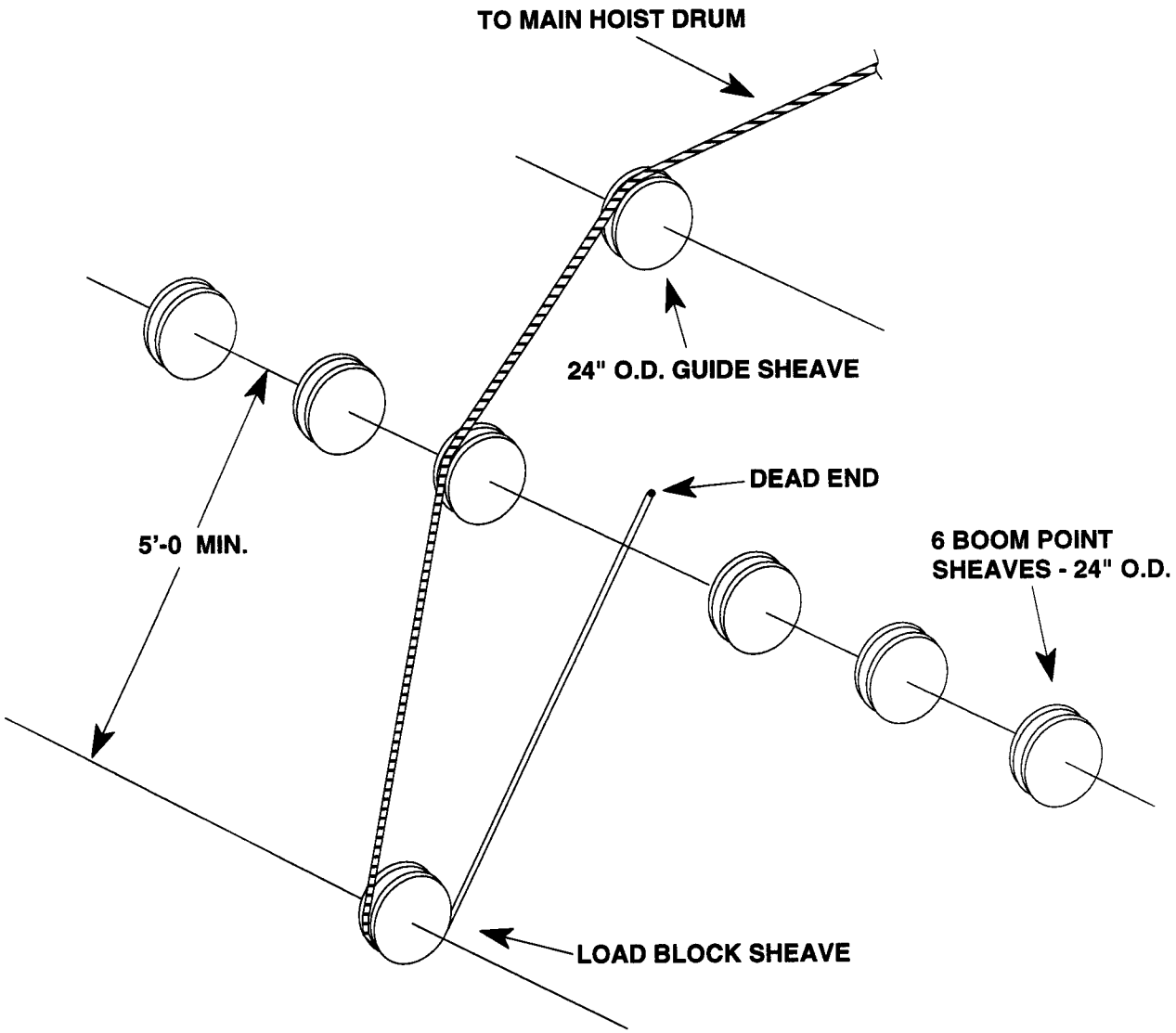
Boom Hoist - 3/4" Diameter Rope			
Rope Layer	Line Speed Feet per Minute	Single Line Pull Pounds	Total Rope Length
1st*	174	18,220	65
2nd*	188	16,840	131
3rd*	202	15,660	207
4th*	216	14,640	283
5th*	230	13,740	369
6th*	244	12,940	455
7th*	258	12,240	552
8th*	272	11,600	648
9th**	286		755
10th**	300		862
530 FT. - 6x26, RAL, EIPS, IWRC, 58,800 LBS. MBS			

Third Drum - 3/4" Diameter Rope			
Rope Layer	Line Speed Feet per Minute	Single Line Pull Pounds	Total Rope Length
1st*	225	18,000	108
2nd*	245	17,222	224
3rd*	262	16,094	348
4th*	279	15,104	480
5th*	296	14,230	620
6th**	314		769
7th**	331		925
6x25, RRL, EIPS, IWRC, 58,800 LBS. MBS			

* = Working Layers ** = Storage Layers

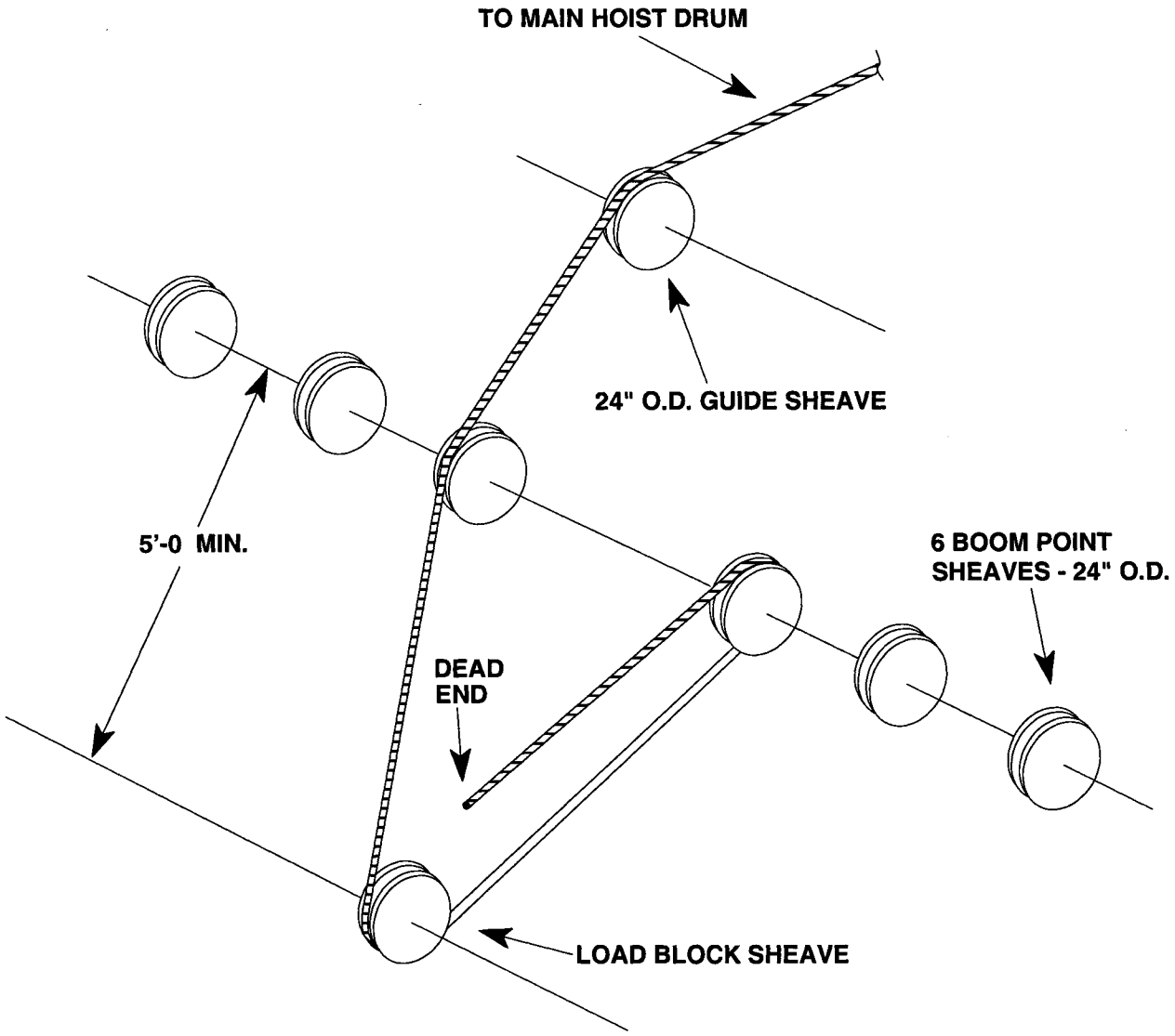
REEVING DIAGRAM

59" BOOM WITH 6 SHEAVE OFFSET TIP
2 PART LINE



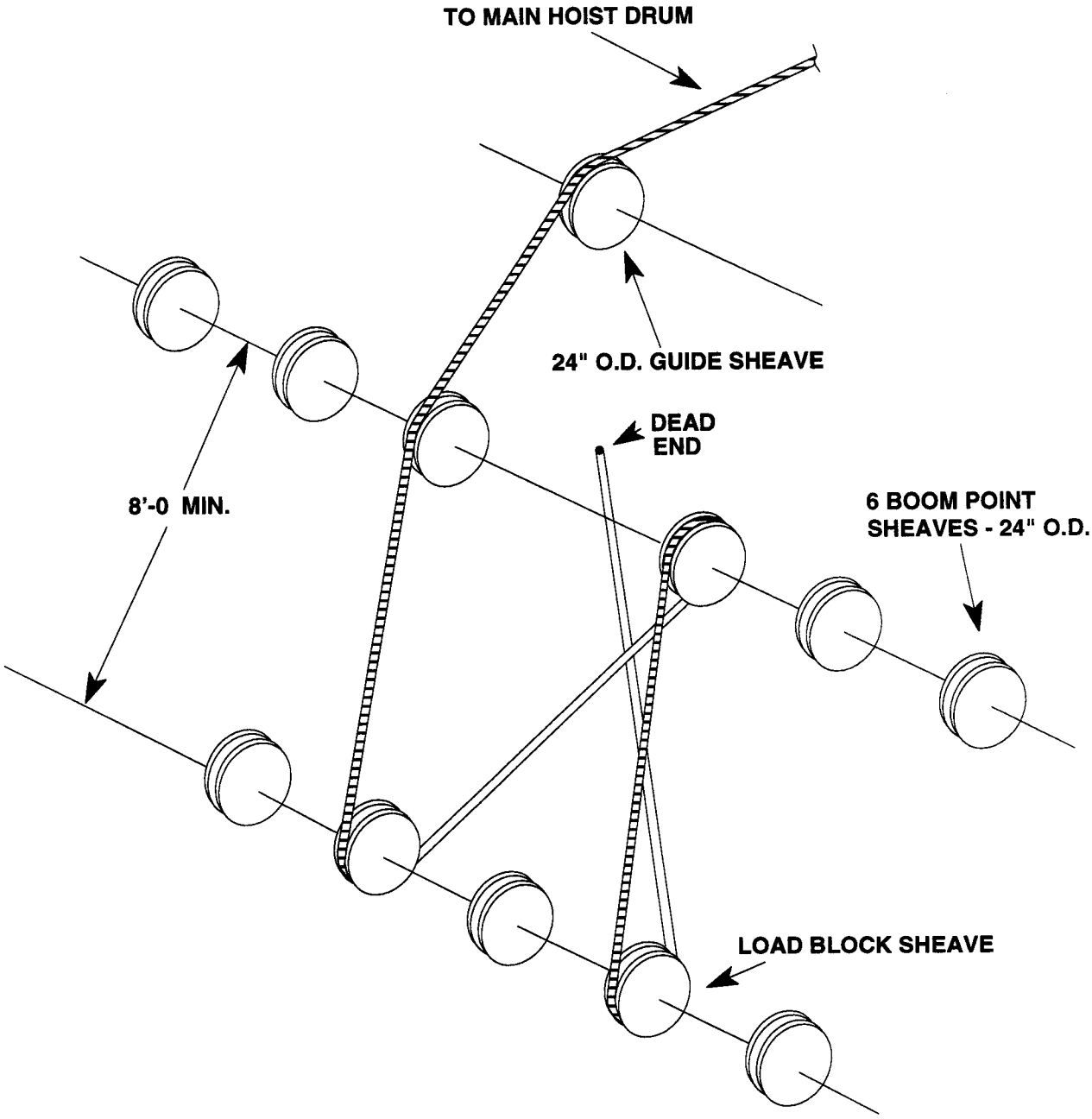
REEVING DIAGRAM

59" BOOM WITH 6 SHEAVE OFFSET TIP
3 PART LINE



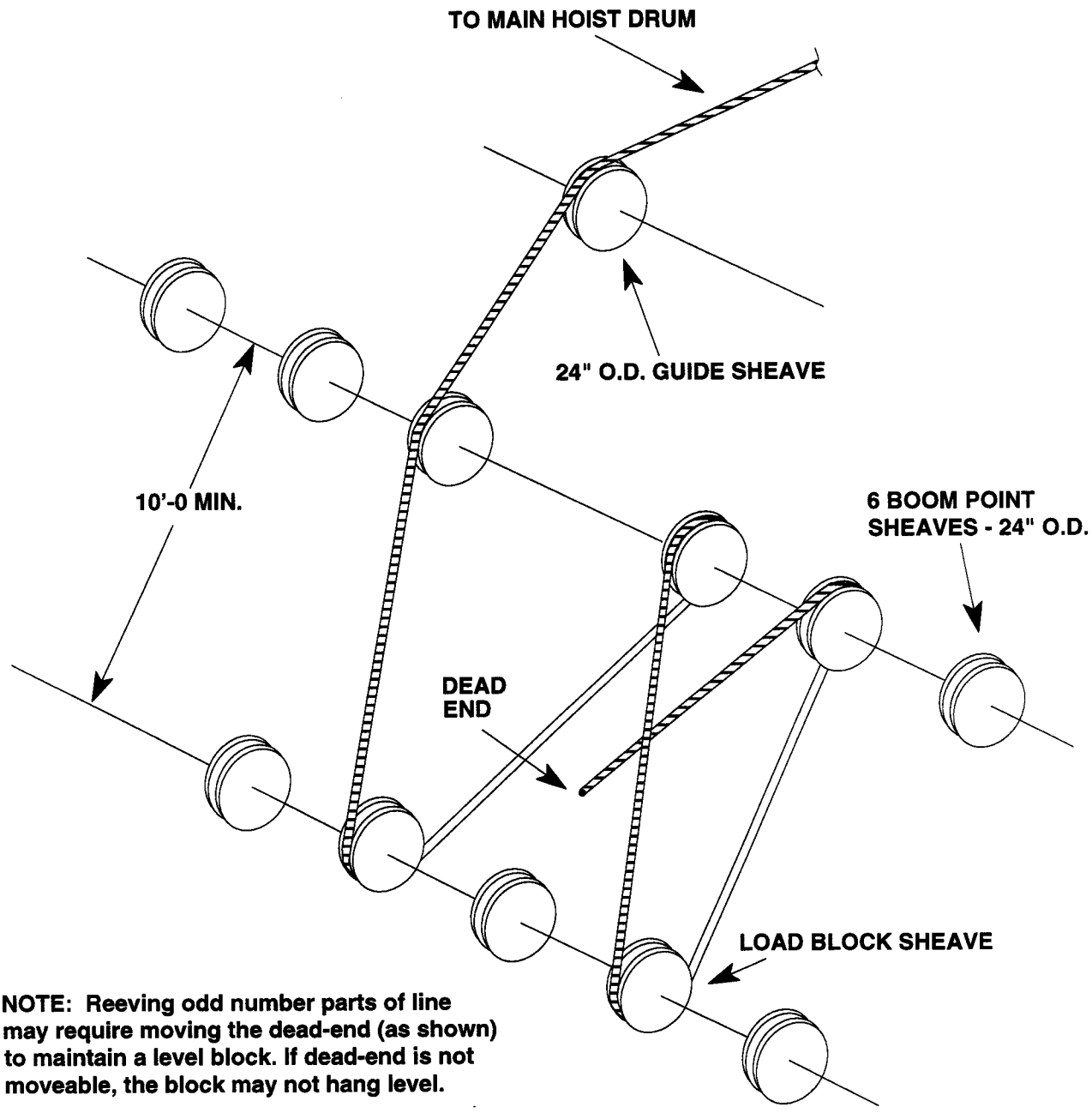
REEVING DIAGRAM

59" BOOM WITH 6 SHEAVE OFFSET TIP
4 PART LINE



REEVING DIAGRAM

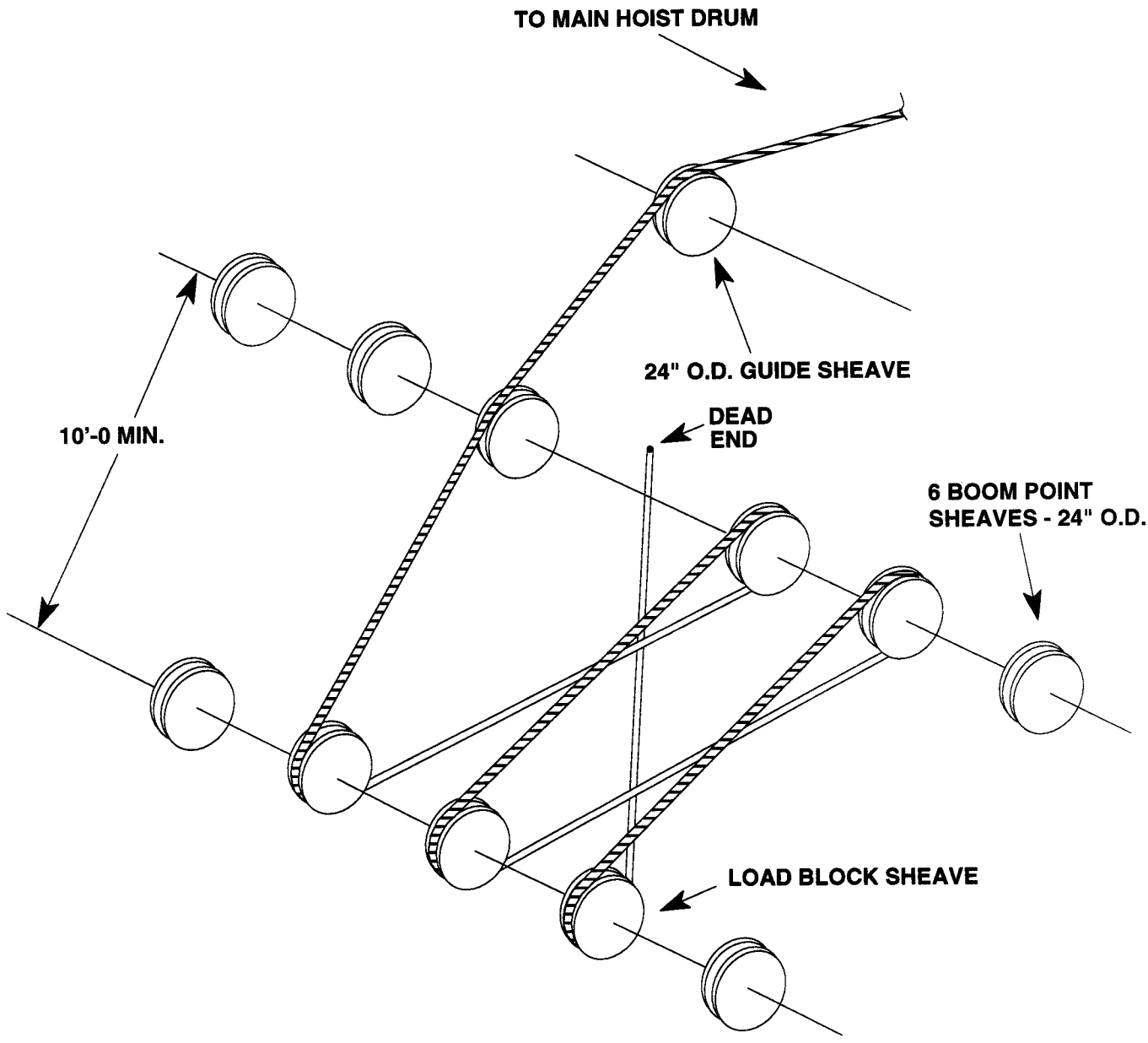
59" BOOM WITH 6 SHEAVE OFFSET TIP
5 PART LINE



NOTE: Reeving odd number parts of line may require moving the dead-end (as shown) to maintain a level block. If dead-end is not moveable, the block may not hang level.

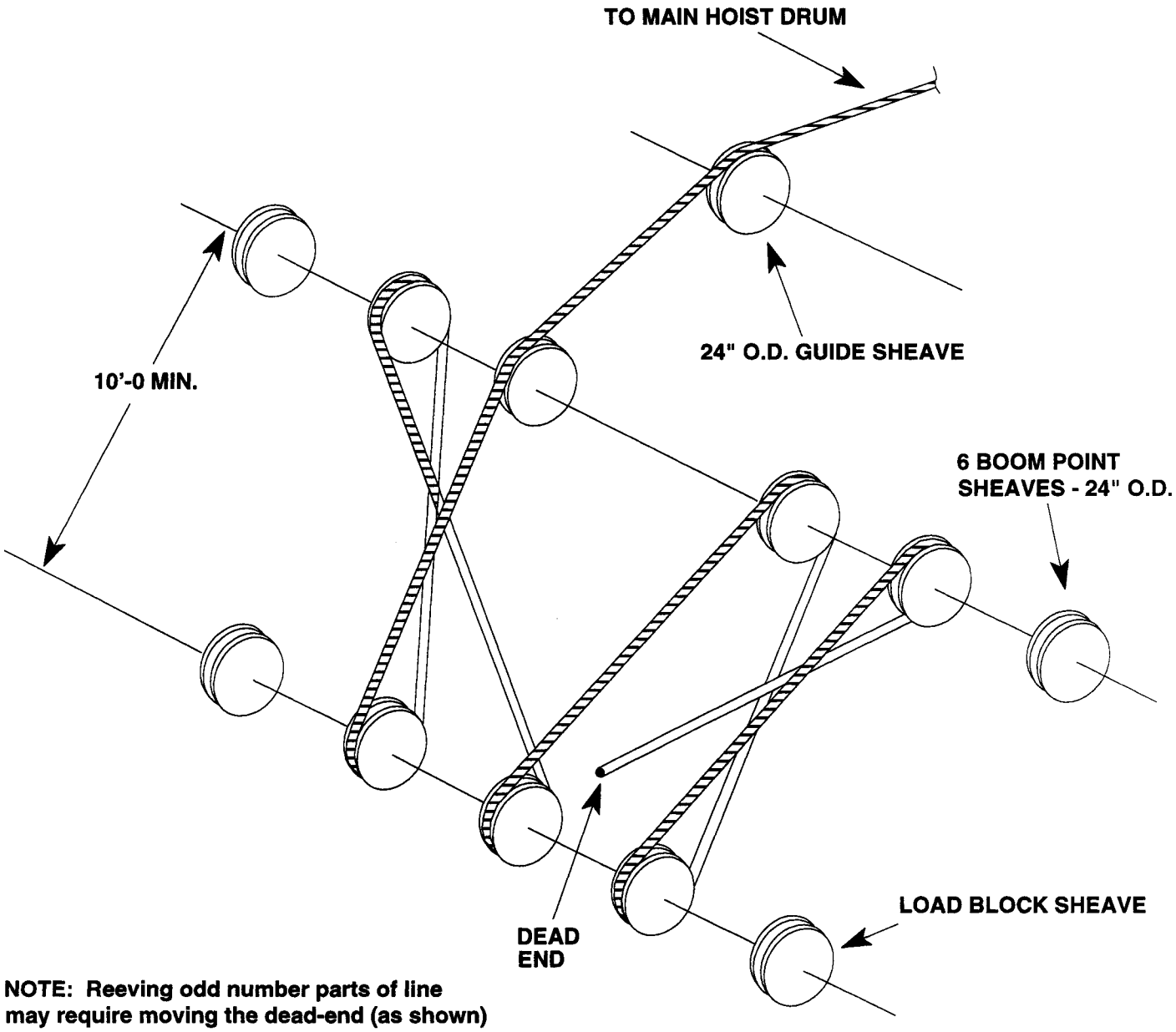
REEVING DIAGRAM

59" BOOM WITH 6 SHEAVE OFFSET TIP
6 PART LINE



REEVING DIAGRAM

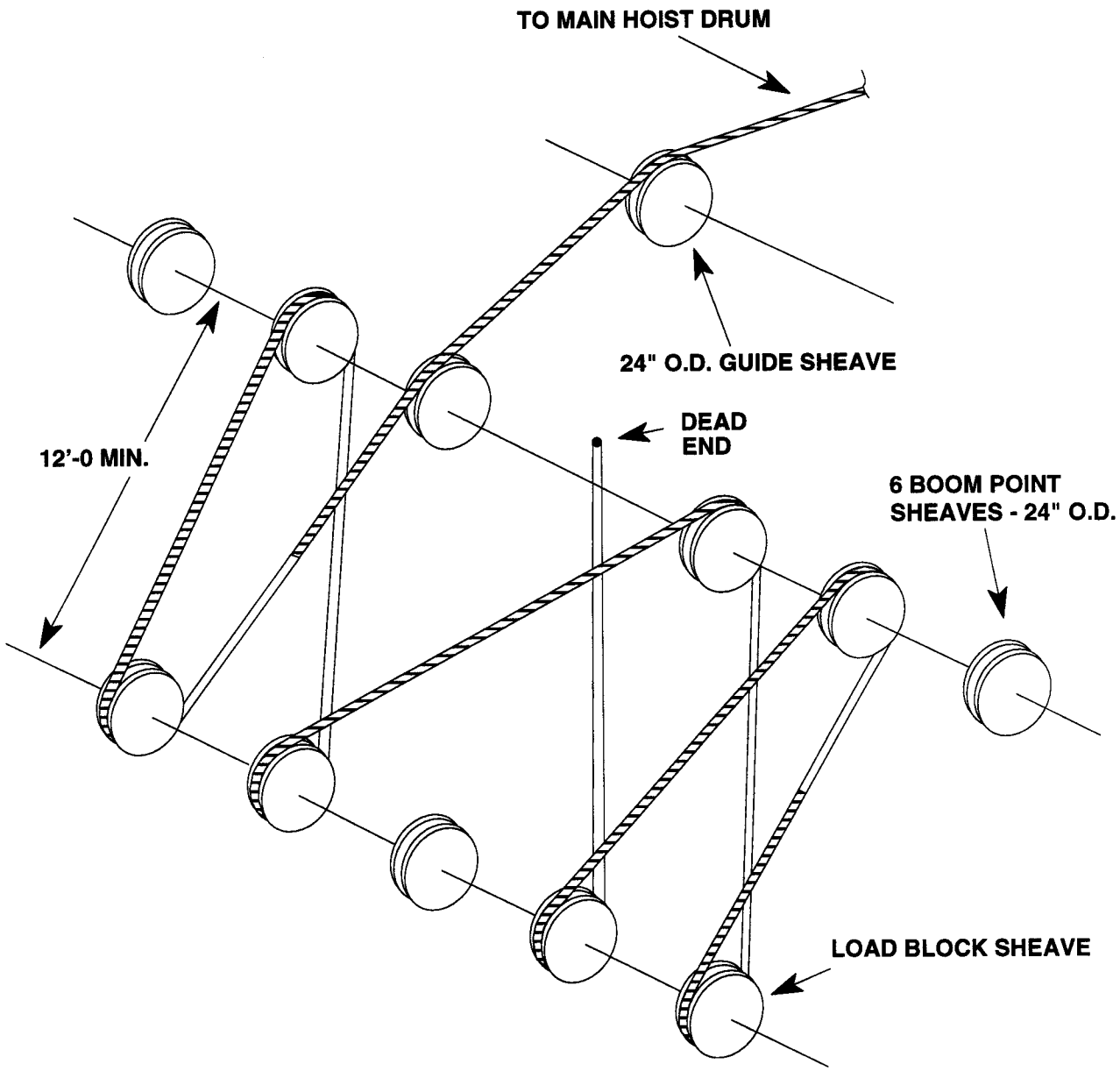
59" BOOM WITH 6 SHEAVE OFFSET TIP
7 PART LINE



NOTE: Reeving odd number parts of line may require moving the dead-end (as shown) to maintain a level block. If dead-end is not moveable, the block may not hang level.

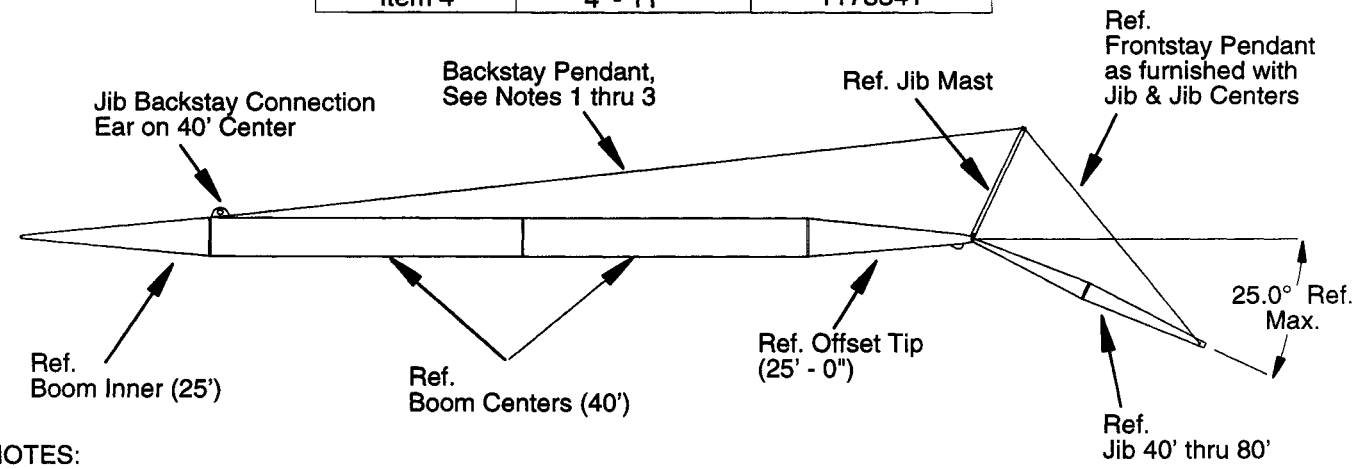
REEVING DIAGRAM

59" BOOM WITH 6 SHEAVE OFFSET TIP
8 PART LINE



BACKSTAY PENDANT INSTALLATION, OFFSET TIP & JIB FOR BOOMS 130 FT. THRU 230 FT., AND JIBS 40 FT. THRU 80 FT.

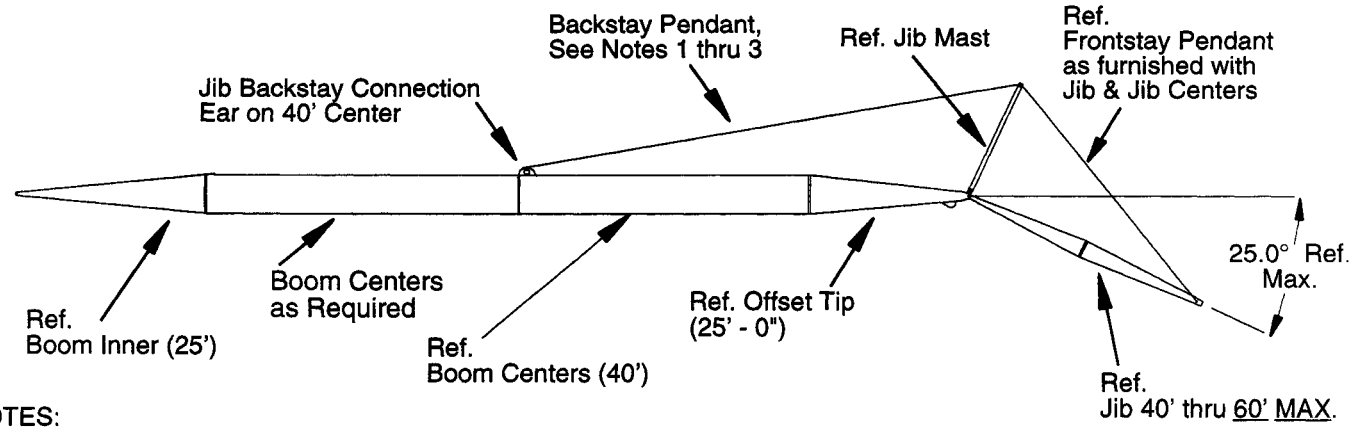
ITEM NUMBER	PENDANT LENGTH	ACC PART NUMBER
Item 1	133' - 8"	1178338
Item 2	78' - 8"	1178339
Item 3	4' - 1"	1178340
Item 4	4' - 11"	1178341



NOTES:
1. To obtain a 5° Jib Angle, use Items 1 and 2
2. To obtain a 15° Jib Angle, use Items 1, 2 and 3
3. To obtain a 25° Jib Angle, use Items 1, 2, 3 and 4

For ordering purposes,
use ACC P/N 1178337

BACKSTAY PENDANT INSTALLATION, OFFSET TIP & JIB FOR BOOMS 100 FT. THRU 230 FT., AND JIBS 40 FT. THRU 60 FT. MAX.



NOTES:
1. To obtain a 5° Jib Angle, use Item 1
2. To obtain a 15° Jib Angle, use Items 1 and 3
3. To obtain a 25° Jib Angle, use Items 1, 3, and 4

} See chart above for items

For ordering purposes,
use ACC P/N 1178071

AMERICAN CRANE BOOM COMPOSITION

⚠ WARNING

IF ANY OF THE FOLLOWING SUBSTITUTIONS ARE GOING TO BE USED, THE INSTRUCTIONS MUST BE FOLLOWED EXACTLY. NEVER USE MORE THAN ONE SUBSTITUTION IN A SPECIFIC BOOM COMBINATION. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN AN ACCIDENT WITH PERSONAL INJURY, DEATH, OR SEVERE PROPERTY DAMAGE.

Each Rating Chart issued by American Crane has a Boom Composition Chart at the back of the Rating Chart. A Boom Composition tabulation on the back pages of the rating chart lists the type and location of each boom section for all legitimate boom lengths from minimum to maximum boom. In most cases the shortest center boom sections are placed closest to the bottom of the boom and the longest center sections are placed closest to the tip.

Individual boom sections are labeled "L", "S" or "H" to designate "light", "standard" or "heavy" sections. The substitution of a boom section heavier than one specified will reduce the crane's stability for both erection and operating conditions. The substitution of a boom section lighter than one specified reduces the strength of the boom and is never allowed.

⚠ WARNING

THE SUBSTITUTION OF BOOM SECTIONS OTHER THAN THOSE SPECIFIED OR THE USE OF ANY SECTIONS AT LOCATIONS OTHER THAN THOSE SPECIFIED, MAY RESULT IN AN ACCIDENT WITH SEVERE PROPERTY DAMAGE, PERSONNEL INJURY, OR DEATH.

Limited deviation from the boom composition sequence specified on the crane's assigned rating chart is allowable provided the following rules are strictly enforced.

1) No boom section can ever be replaced by a lighter section of the same length, e.g. a 40 ft. "H" section CANNOT be replaced by a 40 ft. "S" section.
2) A maximum of one center section can be replaced by a combination of shorter center sections of the same designation, e.g. a 40 ft. "S" section can be replaced by two 20 ft. "S" sections.
3) No more than three shorter sections can be used to replace a longer section of the same designation, e.g. a 40 ft. "S" section CANNOT be replaced by four 10 ft. "S" sections.
4) A maximum of one lighter center section can be replaced by a heavier section of the same length e.g. a 40 ft. "S" section can be replaced by a 40 ft. "H" section.
5) No more than three shorter sections of any designation can be used to replace a longer, lighter section, e.g. one 10 ft. "S" plus two 20 ft. "H" sections can be used to replace one 50 ft. "S" section. The same three sections CANNOT be used to replace one 50 ft. "H" section.
6) Absolutely no substitutions are allowed for boom or boom plus jib combinations within 50 ft. of maximum self-erectable length combinations.
7) Any time a substitution is used 2,000 pounds must be subtracted from each load chart rating.
8) No more than one of the above substitutions can be made in any given boom length.

If any of the allowed substitutions are to be made, the following rules must be followed in determining the new boom assembly sequence.

A) Heavier sections must always be placed below lighter sections.
B) Subject to Rule A), shorter sections must always be placed below longer sections.

If there are any questions concerning whether or not a particular substitution can be made, contact American Crane Service Department before proceeding.

NOTE: You cannot substitute an Angle Boom Section into a Tubular Boom, or a Tubular Boom Section into an Angular Boom even if they pin together.

BOOM INSPECTION

Inspect all boom structure which includes all the chords, lacings, and plated areas for damage, corrosion and cracks. If any area is damaged or cracked, do not operate the crane until the boom is repaired. Always keep the boom well painted and touch up any paint scratches or chips to prevent corrosion.

Check the boom tip sheaves. Look for excessive wear, cracked or broken flanges and see that the proper size rope is being used in the sheaves. An undersized rope will flatten out on the bottom of the sheave groove and will wear out quickly because the sheave groove can't support the rope as it should. If a rope is too big for the sheave, the rope will pinch in the sheave groove and will not be free to roll in the sheave groove as the sheave turns. This will cause accelerated sheave wear and drastically shorten the rope life.

All sheaves should be checked to make sure they are greased and that they rotate freely.

We also provide boom timbers on the top of the boom. These timbers clamp across the boom from chord to chord. These timbers protect the lacings against being scraped as a lightly loaded load line is hoisted or lowered. These timbers also protect the lacings against load line slaps in the event an operator drops a bucket without braking the hoist line as the bucket impacts the ground. If a rope slaps the top of the boom and breaks a timber or damages a lacing, the broken timber or damaged lacing must be repaired or replaced before using the crane.

Boom timbers are held on with clamps around the chord. There must be an annual inspection to check the chord under these clamps for corrosion. If corrosion is starting, remove all the timbers, re-prime and paint as required.

We also use "rope rubs" on some of our booms. Rope rubs are sections of heavy duty hose that are split lengthwise. These hose sections are then pushed over the lacing and secured with hose clamps. These rope rubs also protect the lacing from load line scrubs. When these rope rubs are used, there must be an annual inspection to check the condition of the lacing under the rope rub. To inspect the lacing under the rope rub, loosen up the hose clamps and open at the hose split. If the lacing has lost its protective coat of paint and is starting to corrode, remove all the rope rubs, re-prime and paint the lacings, and then replace the rope rubs.

All the sheaves on our booms have a guard to keep the rope from jumping off of the sheave.

⚠ CAUTION

DO NOT OPERATE THE CRANE IF A ROPE GUARD IS MISSING OR DAMAGED. A ROPE GUARD IS A SAFETY DEVICE TO KEEP THE ROPE ON THE SHEAVE. OPERATION WITHOUT SAFETY DEVICES CAN LEAD TO ACCIDENTS RESULTING IN PERSONNEL INJURY OR PROPERTY DAMAGE.

If the boom section has pockets that collect water, consult American Crane Service Department for possible corrective action.

Boom sections can also be damaged by transportation and handling. Always use non-metallic straps around the chords while lifting the boom sections or when securing the section to the bed of a truck.

- Never cinch a chain around a boom chord or lacing as damage will surely result.
- Never pick up a boom section by the tongues of a forklift truck
  - Always store boom sections flat on blocking to keep the boom section off of the ground and out of any water, mud, etc.

59HI BOOM AND 9HL JIB
HC 110 MAIN & JIB HOIST ROPE REQUIREMENTS

TOTAL OF BOOM & JIB LENGTH	PARTS OF LINE AND CORRESPONDING ROPE LENGTHS (FEET)							
	1	2	3	4	5	6	7	8
50	122	178	234	290	346	402	458	514
60	142	208	274	340	406	472	538	
70	162	238	314	390	466	542		
80	182	268	354	440	526			
90	202	298	394	490				
100	222	328	434	540				
110	242	358	474	590				
120	262	388	514					
130	282	418	554					
140	302	448						
150	322	478						
160	342	508						
170	362	538						
180	382	568						
190	402	598						
200	422							
210	442							
220	462							
230	482							
240	502							
250	522							
260	542							
270	562							

MAIN HOIST LOAD LINE (8 PARTS MAXIMUM)

1" EIPS, RRL, IWRC, 103,400 LBS. (46,902kg) Minimum Breaking Strength

	NUMBER PARTS OF LOAD HOIST							
	1	2	3	4	5	6	7	8
MAX. LIFTING CAPACITY	29,540	59,080	88,620	118,160	147,700	177,240	206,780	220,000

The rope lengths calculated for load lines allow working at ground level with the boom at its minimum radius. For rope length adjustments when working at a different level, multiply the parts of line used times the difference in level from the ground. [8 parts of line x 10' (3.05m) below ground level = 80' (24.38m) extra added.] Add this adjustment for below ground level work, or subtract it for above ground level work.

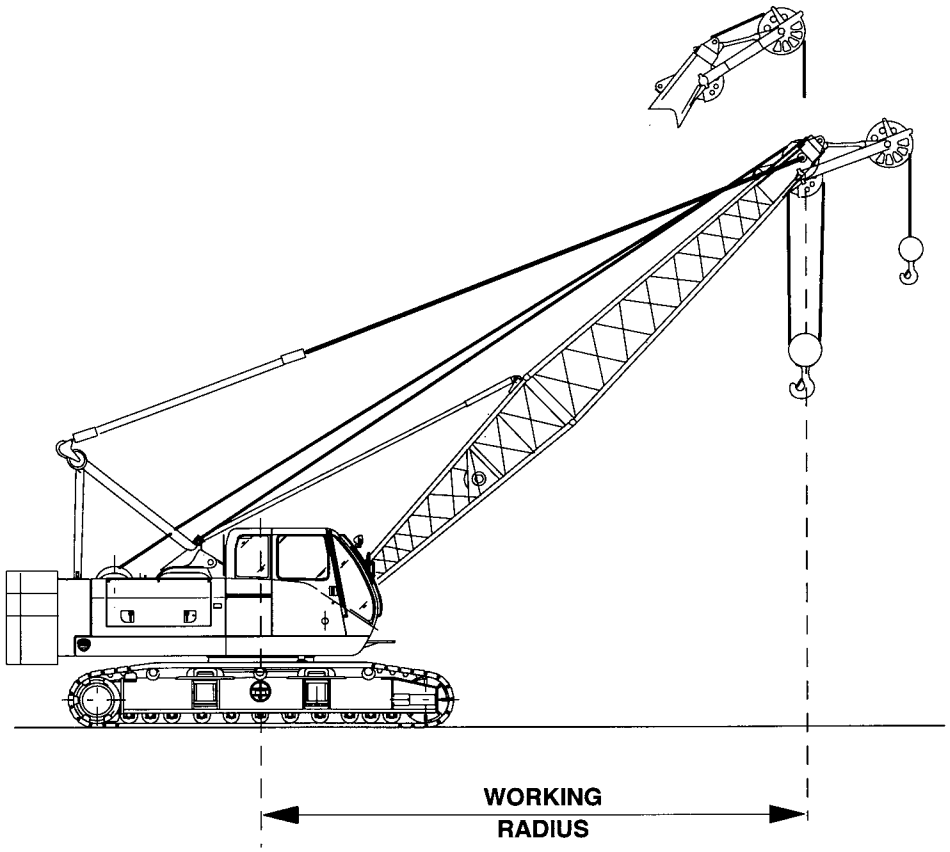
JIB WHIP LINE

7/8" EIPS, RRL, IWRC, 79,600 LBS. Minimum Breaking Strength

BOOM COMPOSITION CHART
59HI OPEN THROAT

BOOM LENGTH	25' (7.625m) 59HI (1.50M) INNER	10' (3.05m) 59H (1.50M) CENTER	20' (6.10m) 59H (1.50M) CENTER	40' (12.19m) 59H (1.50M) CENTER	25' (7.625m) 59 (1.50M) OUTER
50' (15.24m)	1	0	0	0	1
60' (18.29m)	1	1	0	0	1
70' (21.34m)	1	0	1	0	1
80' (24.38m)	1	1	1	0	1
90' (27.43m)	1	0	0	1	1
100' (30.48m)	1	1	0	1	1
110' (33.53m)	1	0	1	1	1
120' (36.58m)	1	1	1	1	1
130' (39.62m)	1	0	0	2	1
140' (42.67m)	1	1	0	2	1
150' (45.72m)	1	0	1	2	1
160' (48.77m)	1	1	1	2	1
170' (51.82m)	1	0	0	3	1
180' (54.86m)	1	1	0	3	1
190' (57.91m)	1	0	1	3	1
200' (60.96m)	1	1	1	3	1
210' (64.01m)	1	0	0	4	1
220' (67.06m)	1	1	0	4	1
230' (70.11m)	1	0	1	4	1
240' (73.16m)	1	1	1	4	1

BOOM TIP EXTENSION RATED CAPACITY



The Boom Tip Extension Capacity is the lesser of:

1. The maximum rated capacity of the Boom Tip Extension (40,000 pounds)
2. The hoisting drum's maximum rated single line pull multiplied by the allowable parts of line used. (Refer to Operator's Manual Page 2-55)
3. The allowable rope load multiplied by the allowable parts of line used (Refer to appropriate rating chart)
4. The mainfall capacity at the same working radius less the weight of the main fall tackle. (Refer to appropriate rating chart)

Please note the following:

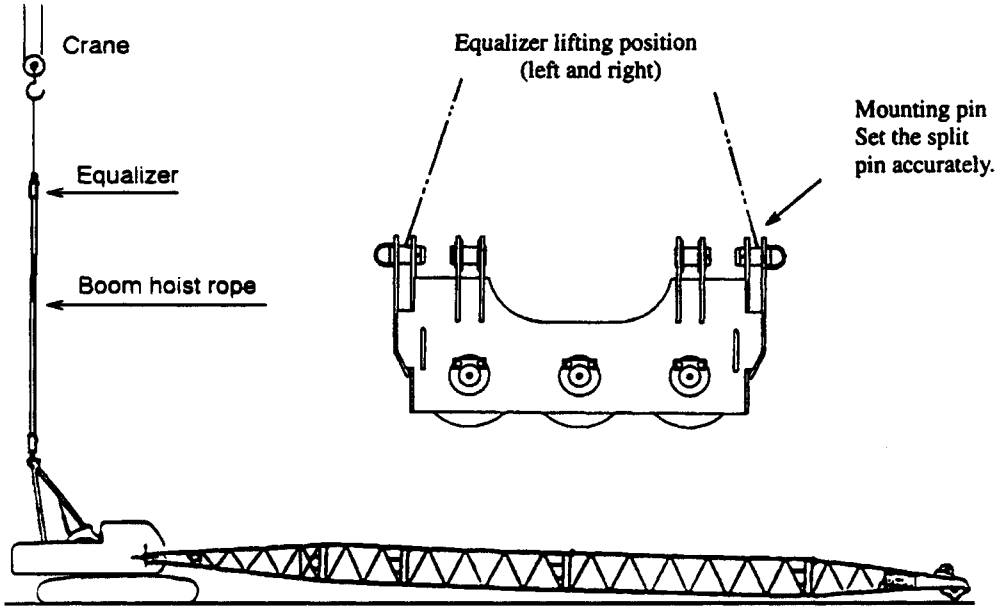
- Simultaneous lifting from both falls is not permitted. Panel tilt-up applications are an exception to this rule. Contact American Crane Service Department for additional information.
- When lifting from the main boom, with this boom tip extension in place, the LMI will automatically account for the weight of the boom tip extension.
- When lifting from the main boom, with this boom tip extension in place without the LMI, deduct 700 pounds from all ratings on the Load Chart.

How to apply pre-tension to the boom hoist wire rope

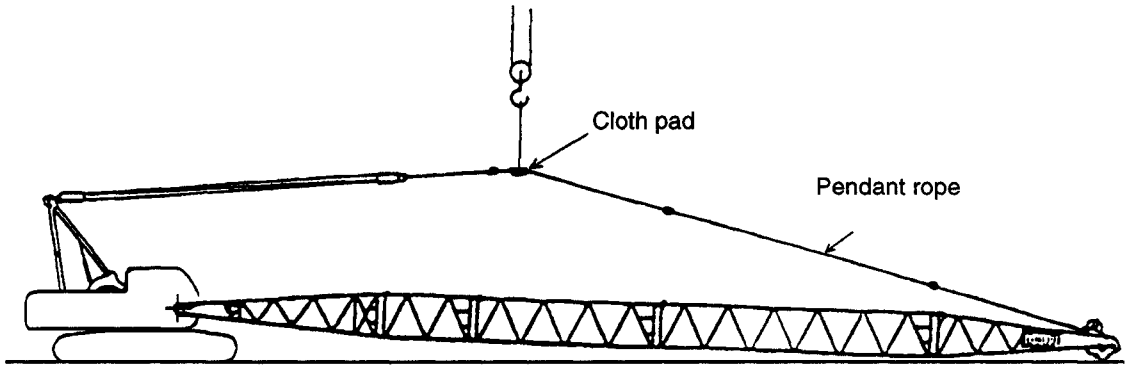
CAUTION

When replacing the boom hoist wire rope or when loosening the first layer of rope on the drum for repair, wind the first layer tightly while applying pretension and then wind the rope correctly while applying force to prevent the wire rope from not spooling. If not, the life of the wire rope will be shortened by the wire rope not spooling.

1. When replacing the boom hoist wire or when loosening the first layer of the rope on the drum:

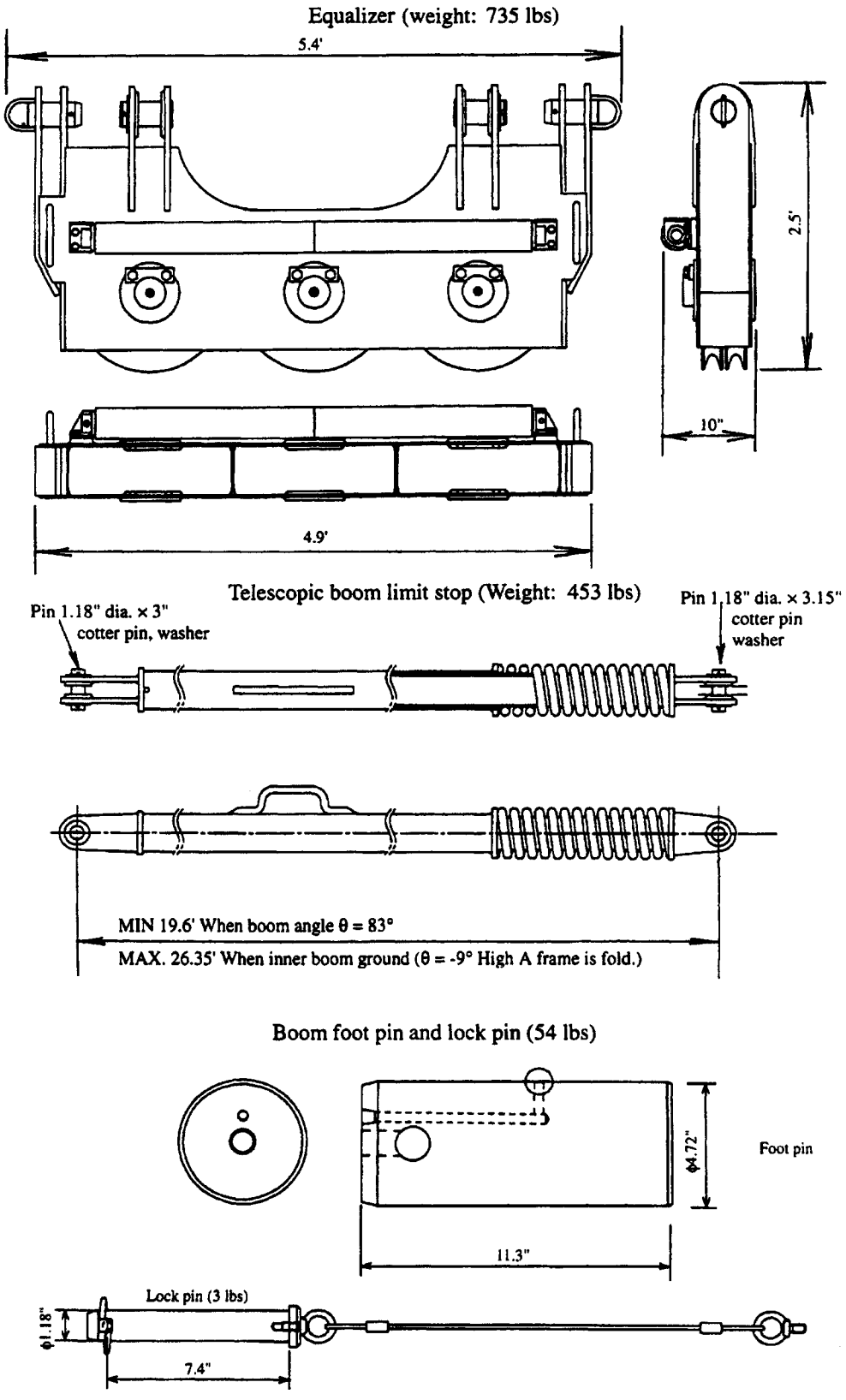


   a. Mount the pendant connecting pin to the equalizer, lift the equalizer with a crane and apply tension to the boom hoist rope. While applying tension, wind the boom hoist rope. Keep the proper length of the rope to be able to connect with the pendant rope.
   b. Connect the equalizer with the pendant rope.
   c. Lift the pendant rope with a crane and wind the boom hoist rope around the drum while applying the boom weight.



   Use a pad for the lifted section of the pendant rope so as not to make an extreme bend in the rope. Gradually lift the next pendant rope in addition to the first one. For the tower crane, carry out the above procedure if necessary.

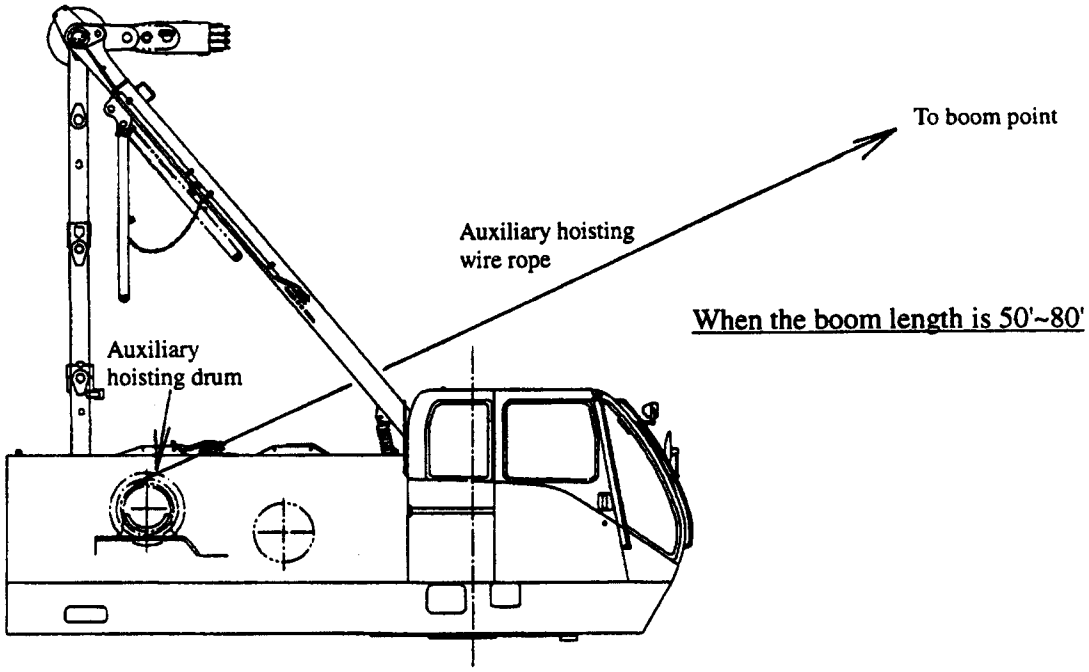
5-3 Dimension of equalizer and boom limit stop



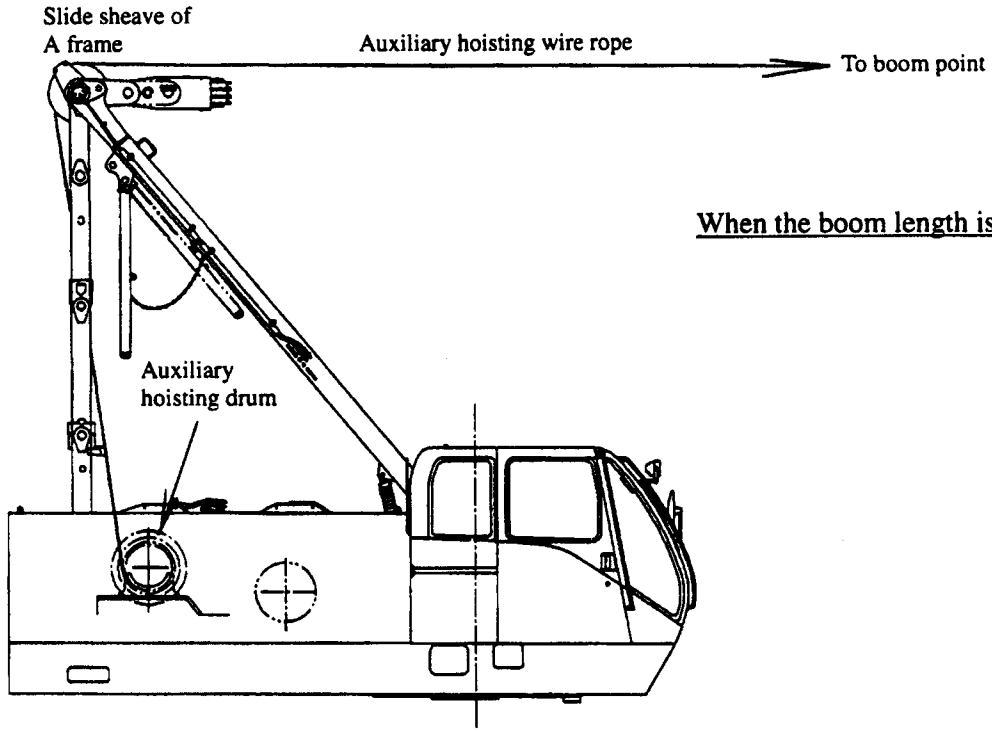
5-4 Cautions when setting the auxiliary hoisting drum rope

When the boom length is 50'~80', guide the wire rope directly from the auxiliary hoisting drum to the boom point and then set the hook.

When the boom length is 90'~200', guide the wire rope to the boom point through the slide sheave of the A-frame and then set the hook.



When the boom length is 50'~80'



When the boom length is 90'~200'

a. Insert the inner member into the outer member initially on the ground.
b. Lift the limit stop assembly with a crane. Set the inner member to the hole under the bracket at the end of the inner boom, and the outer member to the low A-frame with pins.
c. Open the split pin correctly to set the mounting pin.

NOTICE

1. **This is a prevention device against falling backward. It is used when the load is released during the operation with the boom high angle or when the boom is turned reversely by the vibration during swinging or traveling.**
2. **When the boom angle is 81° or more, the upper limit stop functions of the boom throw-out and moment limiter work and the boom hoist winch stops automatically. When the boom angle is approximately 80°, it is safe and efficient to perform operation as far as the limit stop or the upper limit stop of the boom throw-out or moment limiter does not work.**

6. ASSEMBLY OF CRANE ATTACHMENT

6-1 Precautions for disassembly, assembly

1. Directions of operation:

⚠ DANGER

The Regulations on Safety of Cranes provides that a director should be selected for disassembly/assembly of attachment (boom and jib). Observe the regulations. Moreover, be careful about the following points.

1. **Don't enter under the boom during working process. Insert or remove the boom joint pin from the side.**
2. **If the joint pin is removed from the boom bottom while the pendant rope is tensed, the boom will drop. Put the boom point on the ground, mount the equalizer to the inner boom, stretch the boom hoist rope, remove the lower pin of the inner boom and then lower the boom to the ground.**
3. **When the equalizer is separated from the pendant rope, the equalizer is sometimes pulled toward the base machine. Be careful of the body position.**
4. **Use the double taper pin on bottom of crane for an inner boom lower pin. If this is done, the lower pin can be inserted or removed without entering under the boom.**
5. **Don't put your finger or hand into the pin hole when aligning the pin holes.**

2. Precautions for operation in a high place:

⚠ WARNING

When operating in a high place, the worker must use a safety belt to prevent an accidental fall. When working on the boom, use a footing plate.

3. Precautions for assembly order:

⚠ CAUTION

Be careful not to make a mistake with the crane assembly order and the usage of parts. Otherwise, the attachment may be damaged or fall down.

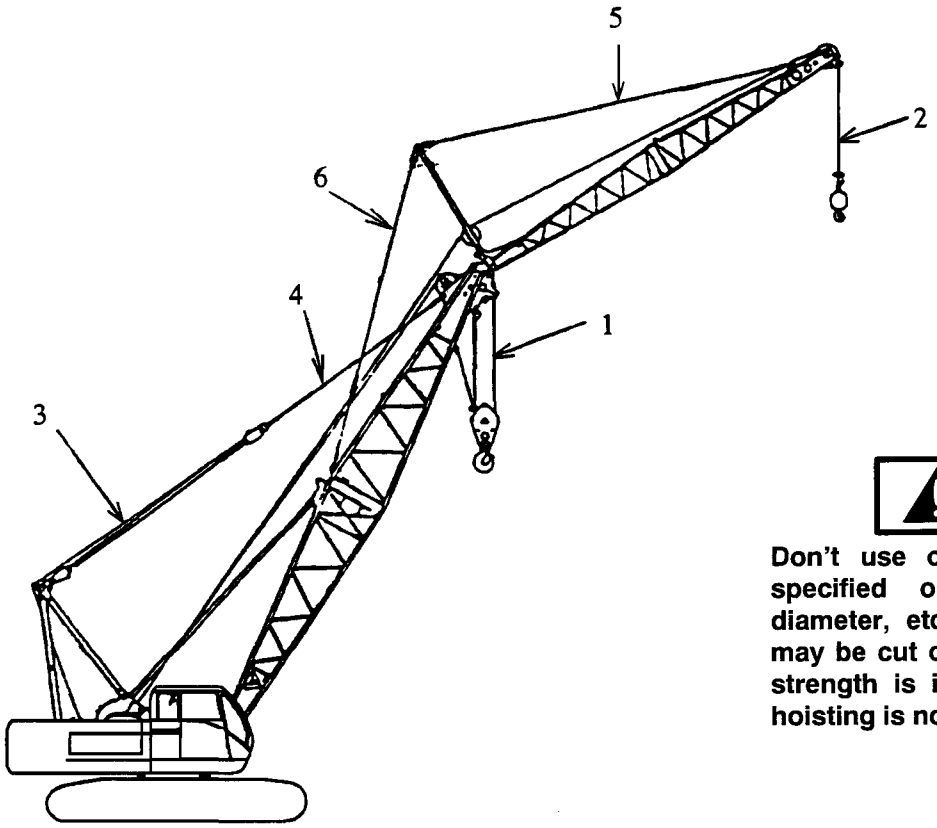
4. Precautions for handling electrical wires:

⚠ CAUTION

Be careful about the following points for handling the power supply and connectors when connecting or disconnecting the electrical wires of attachment. If the wires are damaged or splashed with water, the moment limiter and other safety devices will not operate correctly.

1. **Turn off the power before joining or separating the connector. If not, the devices may be burned or may malfunction.**
2. **Don't let water or mud adhere to the connector joints.**
3. **When the connector is separated, attach a cap to prevent water from entering.**
4. **Don't nip, step on or pull forcibly on the connectors and electric wires.**

7. SPECIFICATIONS OF WIRE ROPE (STANDARD CRANE)



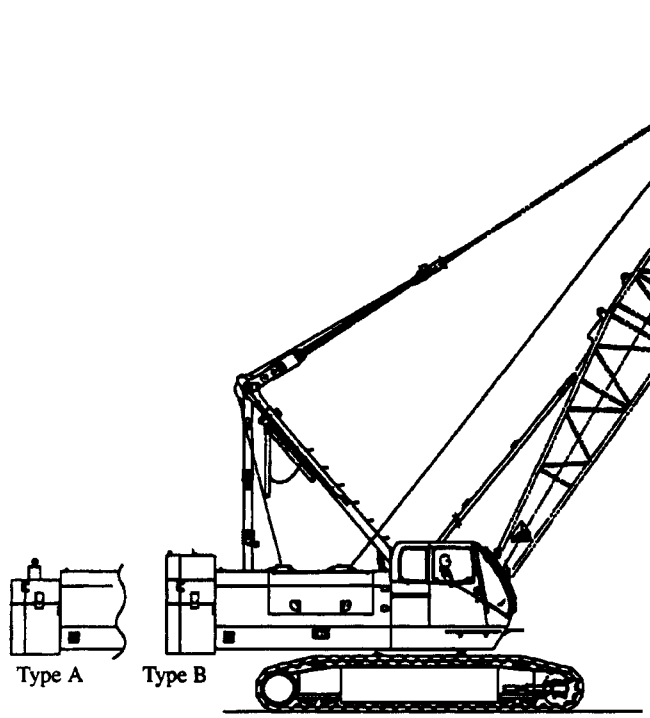
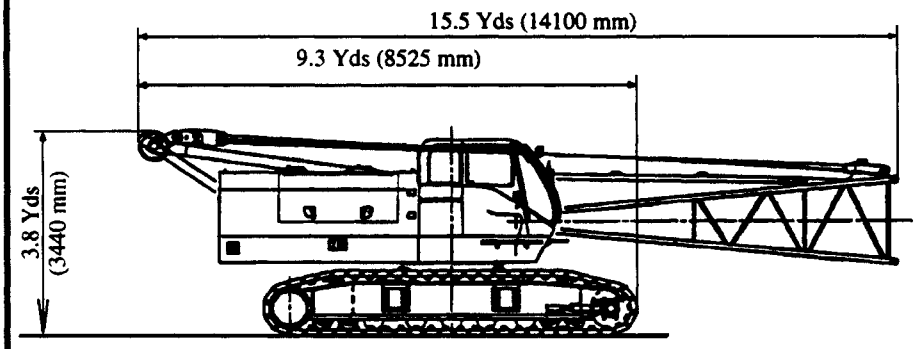
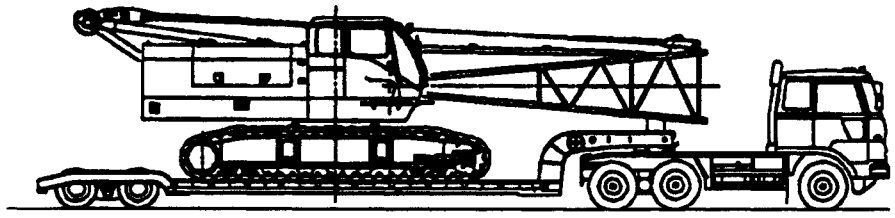
⚠ WARNING

Don't use other ropes except the specified one (rope type, rope diameter, etc.). Otherwise, the rope may be cut or damaged because the strength is inadequate or the drum hoisting is not good.

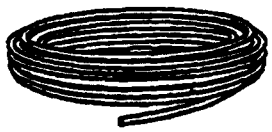
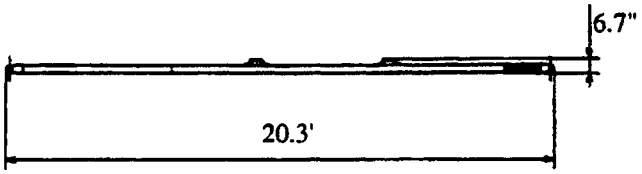
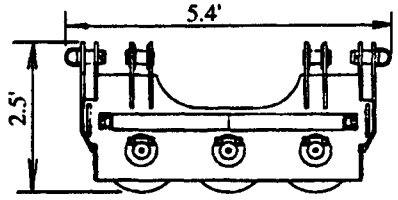
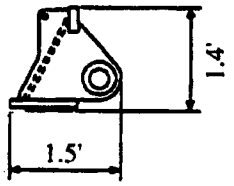
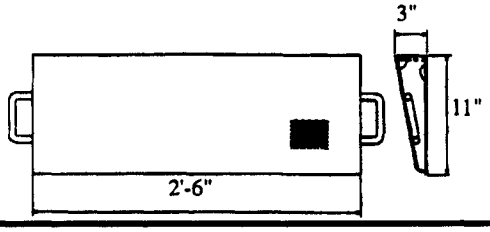
Ref. No.	Wire Rope	Type	Diameter (In.)	Length (Ft.))	Breaking Strengh (Lbs.)	Remarks
1	Main Hoist		1" (25.4 mm)	705 (215 m)	103,400 (46.8 metric tons)	
2	Aux. Hoist		0.875" (22.2 mm)	502 (153 m)	79,600 (36.1 metric tons)	
3	Boom Hoisting		0.75" (19.1 mm)	531 (162 m)	51,200 (23.2 metric tons)	
4	Boom Suspension		1.375" (34.9 mm)		208,000 (94.3 metric tons)	
5	Fly Jib Suspension		0.875" (22.2 mm)		69,200 (31.4 metric tons)	
6	Jib Strut Suspension		0.875" (22.2 mm)		69,200 (31.4 metric tons)	

8. WEIGHT AND DIMENSIONS AT THE TIME OF DISASSEMBLY (STANDARD CRANE)

8-1 Base Machine

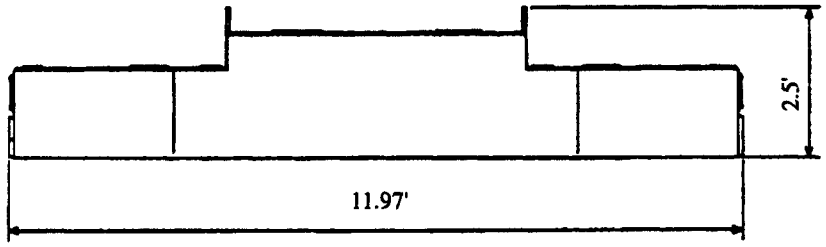
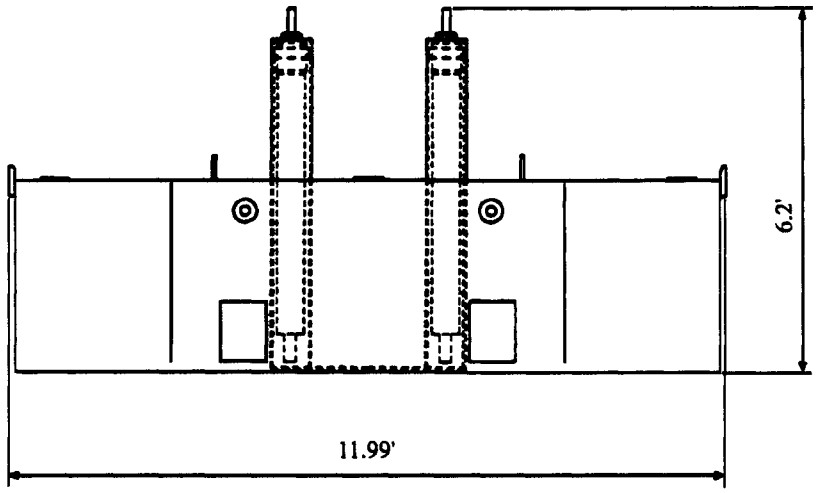
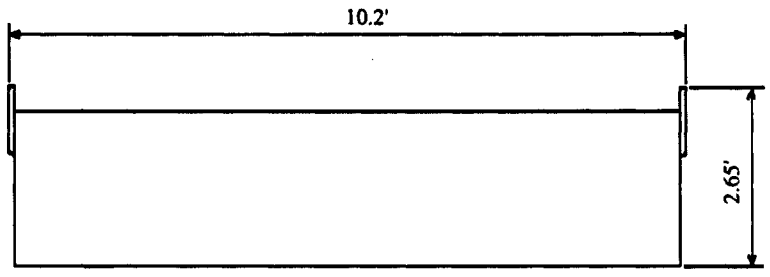
Outline and Posture	Weight, etc.
	Type A Weight: Approx. 175,000 lbs. Type B Weight: Approx. 185,000 lbs.
	Weight: Approx. 99,500 lbs. (without counterweight, outer boom hook)
	

8-2 Standard crane attachment

	Outer drawing	Dimension and weight
Main Hoist	 Main hoist wire rope	1" dia. x 235 yards 1,300 lbs.
Aux. Hoist	 Boom hoist wire rope	0.87" dia. x 167 yards 710 lbs.
Boom Hoist	 Boom hoist wire rope	0.75" dia. x 178 yards 550 lbs.
Telescopic boom limit stop		20.3' 6.7" 450 lbs. Right and left
Equalizer		5.4' 2.5' 735 lbs.
Extend axle		1.4' 1.5' 9" 255 lbs.
		3" 11" 2'-6" 58 lbs.

8-3 Counterweight

(Each value is approximate)

Outer Drawing	Dimension & Weight
	Upper left and right 1.95' x 3.3' x 3.08' Weight: 4,400 lbs. (each)
	Middle weight 2.5' x 11.97' x 30.08' Weight: 12,130 lbs.
	Lower Weight: 6.2' x 11.99' x 3.08' Weight: 31,970 lbs.
	Crawler weight left and right 2.65' x 10.2' x 1.5' Weight: 11,540 lbs. (each)

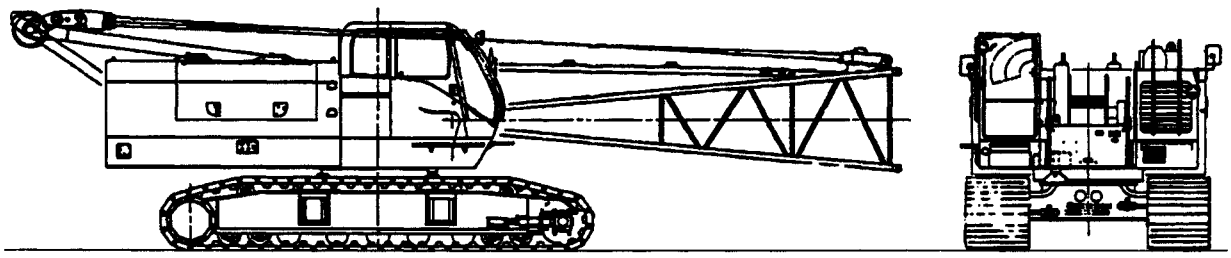
9. PRECAUTIONS FOR TRAILER TRANSPORTATION

9-1 Precautions and posture before loading on a trailer

1. Remove the front attachment.
2. Remove the counterweight and crawler weight.
3. Lower the high A-frame. Wind the boom hoist rope around the drum to some extent and set the equalizer on the gantry.
4. Wind the main hoist rope around the jib hook hoist drum or remove it toward the equalizer side to bundle on the inner boom beforehand.
5. Retract the crawler to set the proper posture for loading on a trailer.
6. Prepare a trailer with more capacity than the machine weight.

⚠ WARNING

1. **Remove the counterweight and crawler weight when loading on a trailer. If equipped with a counterweight, the machine may tip over on a ramp board because the center of gravity is on the rear.**
2. **If the trailer with the machine exceeds the allowable loading weight, it cannot drive on public ways.**
3. **Change the crawler width (by extension or retraction) without counterweight.**
4. **After retracting the crawler, carefully perform swinging or traveling in a low speed.**



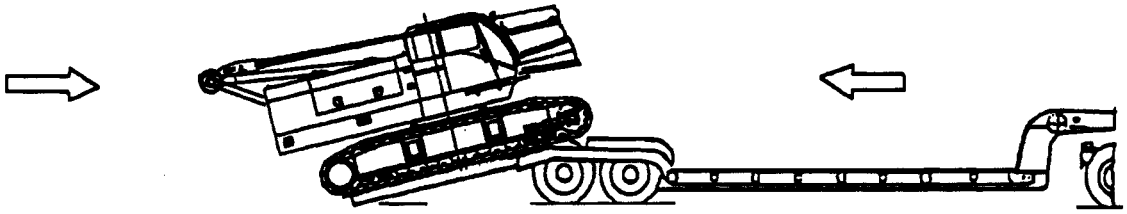
Weight without counterweight: approx. 99,500 lbs

9-2 Trailer operations for going up or down on ramp board

Set the trailer on level ground, apply the parking brake and set the stopper for the tires. The ramp board angle should be approximately 15°. If the angle is too low, the ramp board length is too long. If the angle is too large, it is dangerous when the center of gravity for the crane is moved.

Set the machine in the forward direction and apply the swing lock accurately. The traveling speed should be low, but not enough to hinder the machine from going up or down.

Don't steer the machine while on the trailer or the ramp board. Center the machine and trailer on the ground before going on the ramp board.



Weight: approx. 99500 lbs

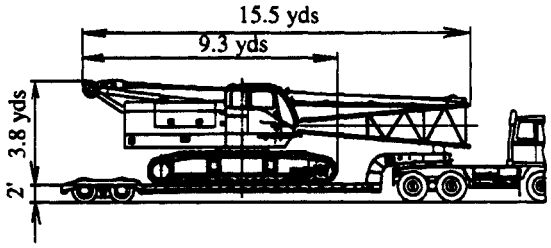
When steering while going up on the ramp board, get off the board, change the direction on the ground and get on the board again. Fix the machine on the trailer with a wire rope or chain to prevent its shift during transportation. Make sure that the swing lock is applied.

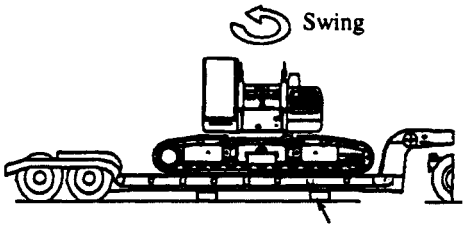
Check the lock condition so that the operator's cab, rear door or side door may not open. When swinging the machine on the trailer, set the wood plates between the trailer frame and road to prevent the trailer from being inclined.

⚠ WARNING

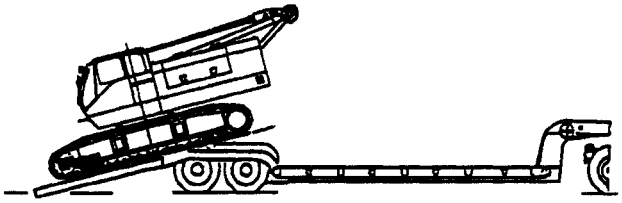
Don't change the direction of or swing the machine while going up or down on the ramp board. The machine may tip over or drop.

When unloading from the trailer, set the superstructure to the front side. If the rear side is unloaded first, the machine may tip over when going to the inclined surface.





Support the tail swing side with wooden blocks.



Sideframe Removal Procedure.

The following components are provided for the Transport Option and are required for removing and installing sideframes:

1.	1182533	Sideframe Handling Sling, Short	1 Each
2.	1182534	Sideframe Handling Sling, Long	1 Each
2.	813120	Shackles, 8.5 Ton	4 each
3.	1182400	Hook, Sideframe Handling, L.H.	1 Each
4.	1182401	Hook, Sideframe Handling, R.H.	1 Each
5.	1182516	Sideframe Extension Plates	4 Each
6.	1182517	Headed Pins	4 Each
7.	804910	Cotter Pins	4 Each
8.	1188094	Alternate Dead End Installation	1 Each

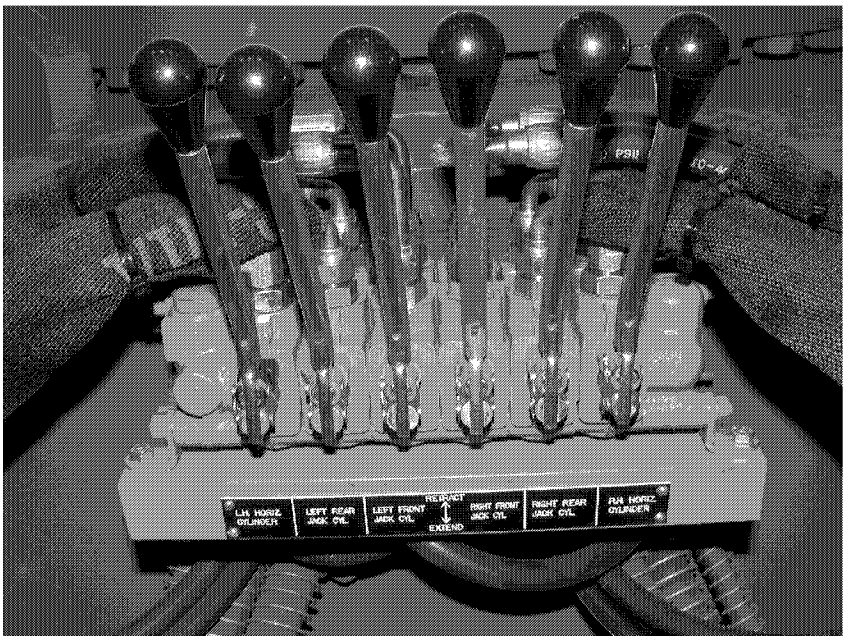
Machine configuration for removing/installing sideframes:

Basic boom inner installed. Alternate dead end installed. Sideframe axle extensions installed. All counterweights removed from machine. Gantry (Retract. "A"-Frame) must be fully raised and pinned. Third drum or front hoist load line reeved through counterweight handling sheaves and rigged for two parts of line through a 30 ton single sheave block. Note: The load line must be spooled tight on the drum. If the load line is spooled loosely on the drum, the rope will pull down into the lower layers of the spooling and be damaged.

Controls For Removing Sideframes:

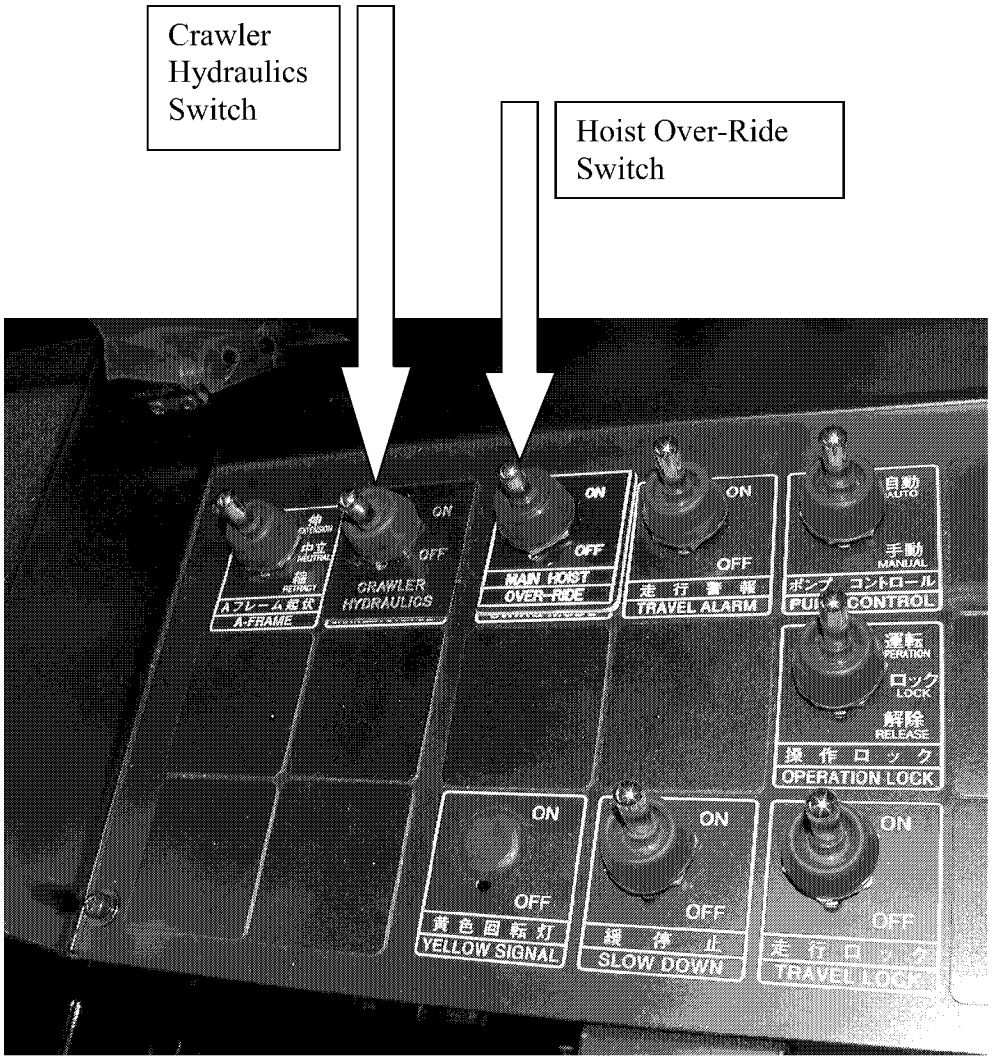
Carbody Controls

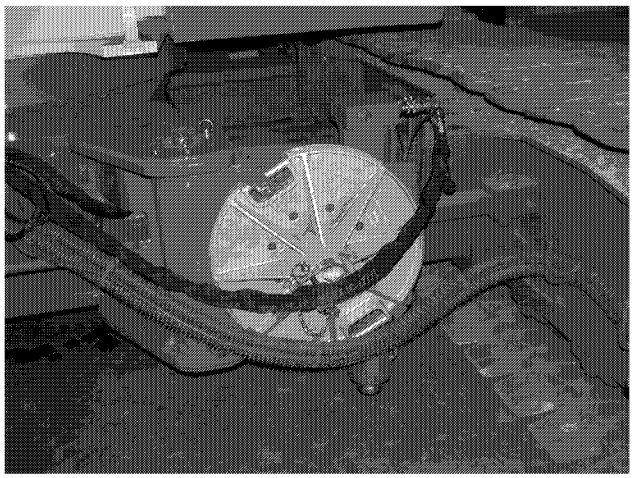
Directional control valve w/6 manually operated spools. Is used for operating 4 vertical jack cylinders and both horizontal sideframe cylinders. Levers are labeled to identify each function that they operate. For all levers, pulling the lever to you will extend the cylinder being controlled, and pushing the lever away from you will retract the cylinder.



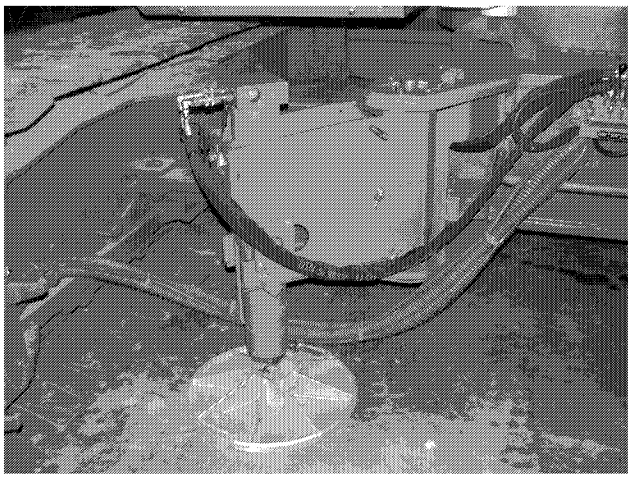
Operator's Cab Controls

Located against the left hand side wall inside the operator's cab are two new switches which are required for the sideframe removal procedure. On the upper row of switches, The second switch from the left is for "Crawler Hydraulics" It turns the power on or off for the solenoid valve which supplies oil to the sideframe handling cylinders. It should only be in the "On" position when the cylinders need to be operated. The third switch from the left is for "Main Hoist Over-Ride". It is only used when at maximum boom angle and will be discussed further in the procedure, when removing the sideframes.

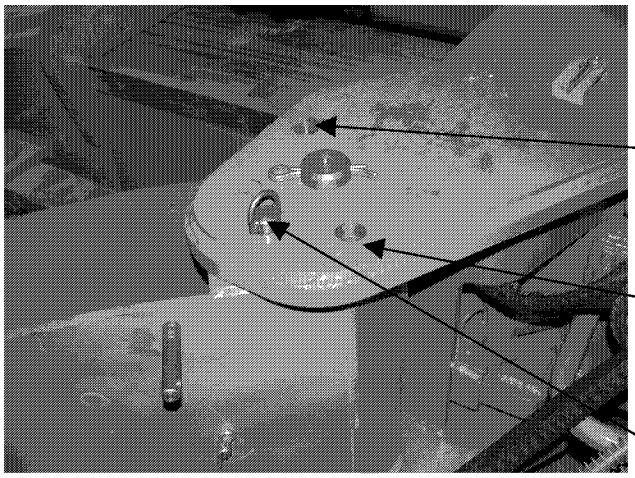




Right rear cylinder mount arm shown in the stored position. Vertical Cylinder has been pivoted into the working position and secured with the screw provided. Hydraulic hoses for the cylinder have been connected.



Left rear cylinder mount arm is rotated into the working position and pinned in place. Float pad has been installed and pinned into working position.
Some ground conditions may require cribbing under the float pad.
The ground bearing pressure under the pad is approx. 86 PSI when lifting the sideframe at a 14.5' radius over the side.



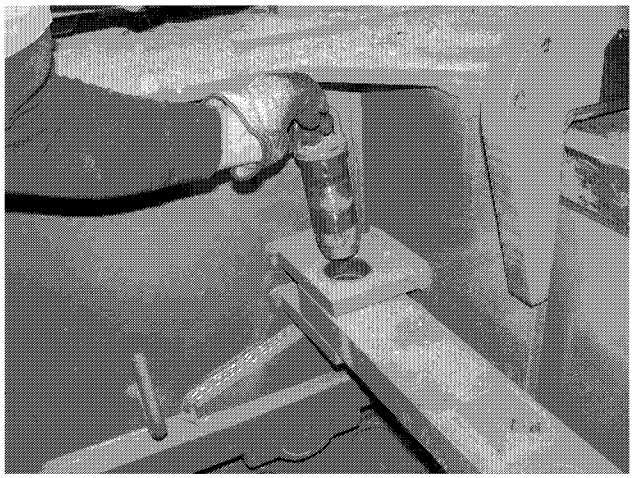
Three possible pin positions for the cylinder mount arm are shown.

Number 1 pin hole is for storing the arms in the sideframe fully extended condition.

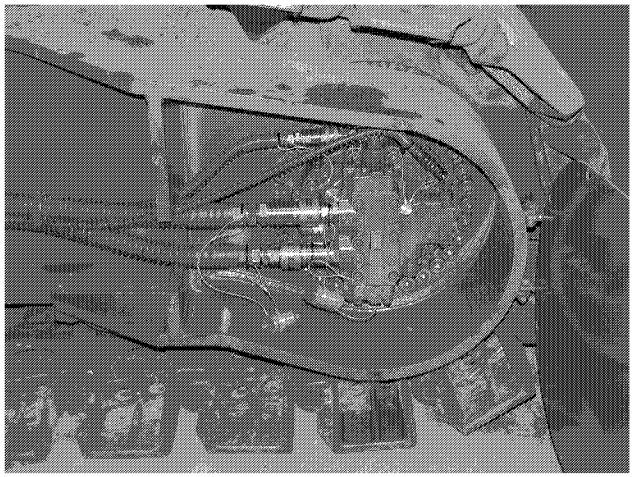
Number 2 pin hole to the right of the lock pin is for storing the arms in the sideframe fully retracted condition.

Number 3 Pin hole is for the working position.

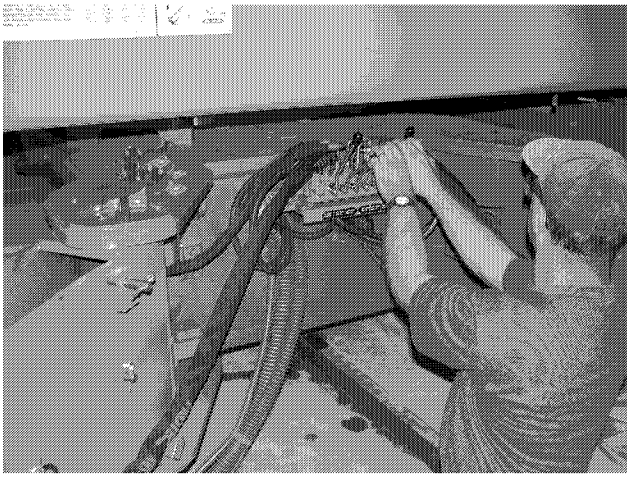
Remove shim fixing bolts, 2 bolts per shim, 2 shims per sideframe. Remove shims from between sideframe and axles. It may be necessary to swing machine to assist in removing shims.



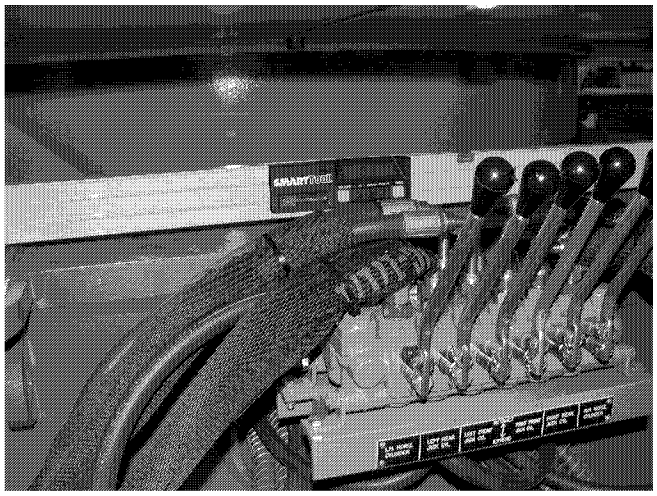
Remove locking pin and pin from crawler fixing link. Horizontal cylinders may need to be slightly extended or retracted to loosen the pins for removal. After removing pin, link should be slid into storage position and pinned.



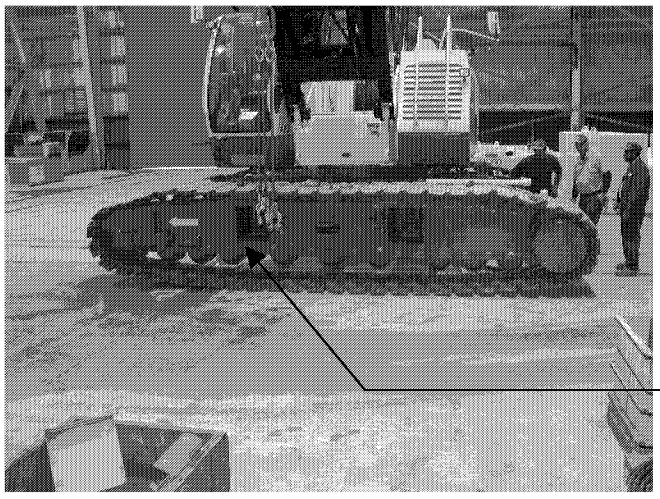
Disconnect all QD couplings from the propel motors and install plugs and caps provided in the ends of the hoses and on the couplings at the motors. Keep the hoses clean and out of the dirt. Secure hose to carbody for transporting.



Using the cylinder control valve, extend the vertical cylinders evenly, until the bottom surface of sideframe roller mount rail is approximately 18" off of the ground. (Approximately 8.0" of vertical cylinder extension) Note, the carbody hydraulics switch in the operator's cab must be in the "On" position to operate any of the cylinders on the carbody.

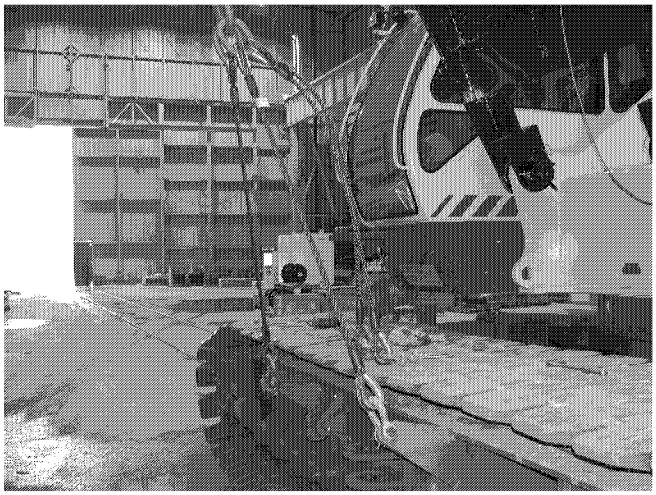


A level can be used on the top surface of the carbody to confirm the level condition of the machine.



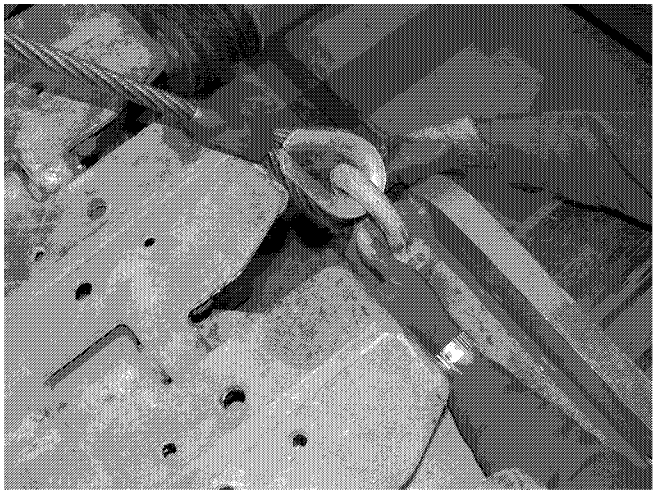
Approximate machine elevation to begin the removal process. Amount of sag in the crawler track will vary, depending on the adjustment. Not all shoes are likely to clear the ground.

Install sideframe handling hooks on the outside of the side frame. Note that there is a left hand and a right hand handling hook. They are not interchangeable. The bent portion of the hook legs should point toward the center of the sideframe.



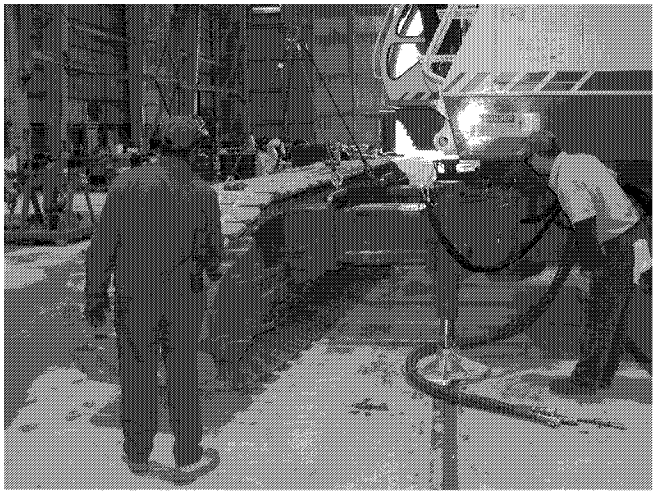
Raise boom to approximately 68 degree angle. Using the shackles provided, connect the sling to the hooks on the outside of the sideframes. Short legged sling should be connected to the propel transmission end of sideframe, and the long legged sling to idler end of carbody.

Boom can now be hoisted to maximum angle of 84 degrees. Hoist drum is used to maintain tension on the boom hoist suspension, while boom is raised. Alternately hoist boom, and lower the load line to keep boom suspension from getting slack. As soon as the boom begins to compress springs on boom stops, the load line can be relaxed.

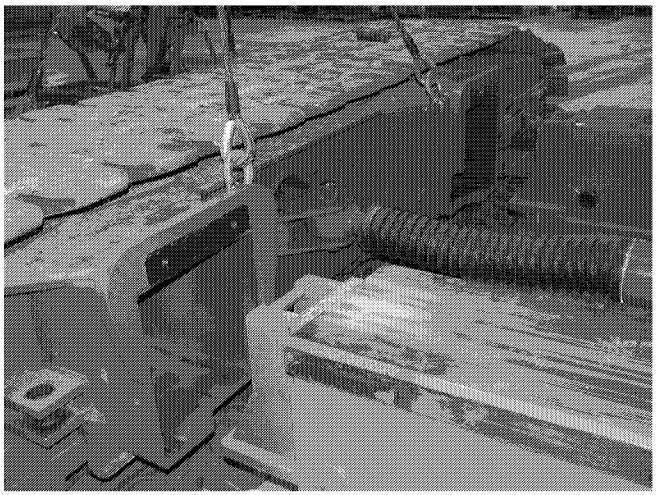


The two remaining sling legs can now be shackled to the inside lifting lugs on the sideframe. Again, the short sling leg should be connected to the propel transmission end of the sideframe.

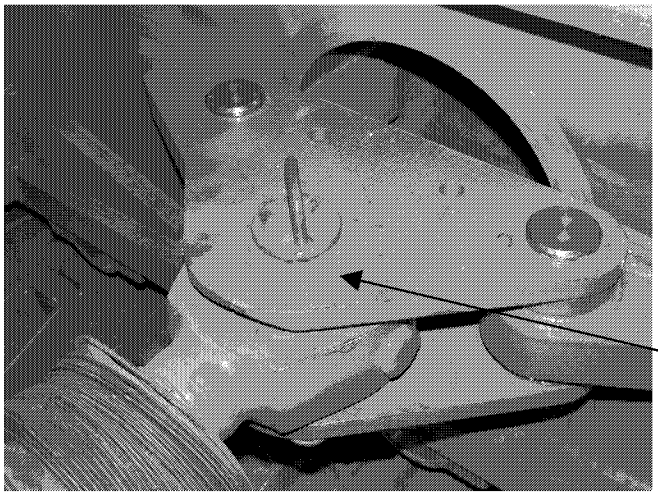
With sideframe connected to sling at all four points, sideframe can now be hoisted with load line until clearance is achieved between top of axles and sideframe. When maximum boom angle has been achieved, hoist over-ride switch will be required to hoist sideframe.
(unless 3rd drum is being used.)



Sideframe can now be pushed away from machine and clear of axles, using the horizontal cylinders. Operator will have to follow the sideframe by alternately booming down and inhauling with the load line.

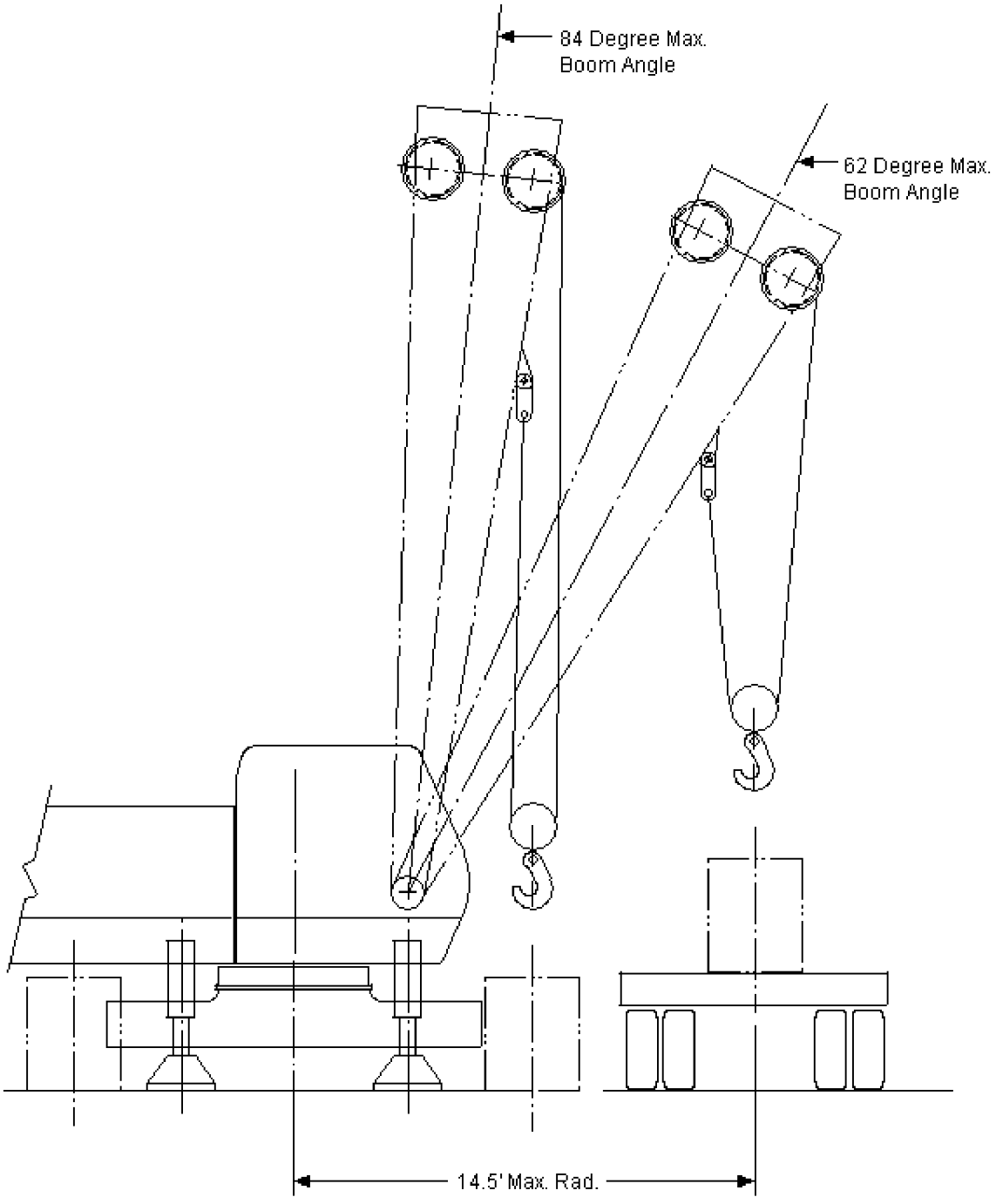


With sideframe clear of axles and horizontal cylinder at maximum stroke, rod end of cylinder can be unpinned from sideframe. Horizontal and vertical cylinder controls can be used to loosen pin, as well as hoist load line.



Remove pin from rod end of horizontal cylinder, and fully retract rod into the cylinder.

Operator can now boom out and load the sideframe onto truck. Maximum boom angle of 62 degrees (load radius of 14.7') should not be exceeded. Do not swing machine more than 3 degrees to either side of center with the load on the boom.


84 Degree Max.
Boom Angle
62 Degree Max.
Boom Angle
14.5' Max. Rad.

Section 3

MAINTENANCE

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12/00

1. GENERAL CAUTION ON MAINTENANCE

1. **Precautions for handling battery**

⚠ WARNING

The battery electrolyte is diluted sulfuric acid. If it is adhered to the skin, it will cause a burn. If the eye is splashed with it, eyesight may be lost. Moreover, nitrogen gas is generated during or right after the engine revolution. If fire is near the electrolyte, an explosion may occur. Be careful about the following items:

1. **Attach the battery cable or booster cable from the positive terminal and remove it from the negative terminal to avoid sparking.**
2. **If your eye is splashed with the battery electrolyte, wash the eye at once and then see a doctor.**
3. **Don't set a fire near the electrolyte and don't perform charging or start with other power supply while the electrolyte is frozen. The generated gas cannot be discharged and an explosion is caused.**
4. **When handling the battery, wear protective glasses, protective gloves, etc. Don't put a tool or other item on the battery so as to prevent spark.**
5. **The charging current must be 1/10 or less of the battery rated capacity.**

2. **Check of wire ropes and sheaves**

⚠ WARNING

Inspect the boom hoist rope, load hoist rope and slings and replace them if any of the following deficiencies are found. Inspect before starting and monthly. If the boom hoist rope is broken and the boom falls, a serious accident will occur. If the load hoist rope or sling rope is broken, a load falling accident will occur.

1. **Check if the connection is proper at the rope end, if the rope is spooled and if the rope is worn or damaged before starting.**
2. **Check the rope for specification, length and oil shortage in the monthly check. Check if the rope is in the following status:**
   a. **The diameter is reduced by 7% or more of the nominal diameter.**
   b. **More than 10% of the wires (except fillers) are broken within one lay of the rope.**
   c. **The rope has kinked.**
   d. **The rope has been significantly deformed or corroded.**

CAUTION

Check if the sheave and hook block are damaged or worn. If the sheave is broken, the wire rope will be cut. If the hook is broken a serious accident such as load dropping will occur.

1. **Sheave**

   Check if the sheave is damaged or cracked, if the groove and flange are excessively worn, if the bearing is normal when turning the sheave, if the suspension is good, if the protective metal is damaged, deformed or loosened.

   - **When the rope diameter is 1" or more, the sheave groove must be within "standard bottom dia. - (rope dia. x 0.2)". When the rope diameter is less than 1", it must be within "standard bottom dia. - (rope dia. x 0.3)".**
   - **The sheave should not be cracked, worn or deformed excessively.**
   - **The wear of the bearing or pin should be within 0.15% of the original dimension, that of the bushing hole should be within 2.0% of the original diameter, and that of the bushing or pin should be within 0.6% of the original diameter.**
   - **The oil supply should be sufficient and done properly.**

2. **Hook block**

   - **Check if the hook block is damaged, if the rope stopper is deformed or damaged and if the contact section with rope is worn excessively.**
   - **Check if the bolts, nuts or pins are loosened or lost. The wear of the hook wire contact section should be within 3%. The hook opening should be within 5% of the original dimension. The bolts, nuts and pins should not be worn, deformed or damaged. The bearing should not be damaged, and oil should be supplied to the bearing sufficiently.**

3. **Engine stop for check**

WARNING

Stop the engine before checking the fan belt or fan to prevent your hand from being caught. Stop the engine before checking the rotary sections.

4. **Maintenance of operator aids**

CAUTION

The following shows the causes for the malfunction of the hook overhoisting prevention device, boom overhoisting prevention device and other operational aids.

1. **The electric current is not good due to the deterioration of electric cables. The cables are disconnected. The cables are imbued with water.**
2. **The electric equipment such as the limit switch is bad. Other components are deteriorated. The voltage drops.**
3. **Improper check or adjustment.**

When removing the electric cables, set the waterproof cap to prevent water through the terminals. Measure the electric current and insulation resistance periodically. Replace the cables if necessary. Overhaul the overhoisting prevention devices every 2 years. Replace them if necessary.

CAUTION

5. **Parts requiring periodic replacement**

   Replace the hydraulic hose for hoisting clutch and brake system periodically.

   1. **Clutch and hydraulic hose of the brake system ..... Replace every 2 years**
   2. **Rotary joint, clutch cylinder and master cylinder..... Replace every 2 years**
   3. **Sheave and pendant wire rope..... Replace if it reaches the allowable limit or every 4 years**
   4. **Limit switches of operator aids and electric cables..... Replace every 2 years**

   The parts which may cause a serious accident when deteriorated must be replaced periodically. Immediate replacement is necessary if any abnormality is found on these parts, even before the periodic replacement time.

6. **Prevention of falling and other precautions**

WARNING

Use a safety belt to prevent a fall accident when working in a high place. Use a footing plate when working on the boom.

CAUTION

1. **If grease or oil remains on the cab, crawler or boom after greasing, a slip or fall accident may occur. Wipe off the residual grease or oil.**
2. **When adjusting or repairing the brake and clutch, lower the load and hook block on the ground and stop the engine. Lower the boom if necessary.**

7. **Precautions for handling radiator and others**

CAUTION

1. **The coolant temperature is high and pressure is applied in the radiator during engine revolution or right after engine stop. If the radiator cap is removed carelessly in such status, hot water will spout out and cause a burn. Stop the engine and wait until the coolant temperature is lowered properly. Then, discharge the inner pressure by turning the radiator cap slowly and remove the cap. Check and supply the coolant in the reservoir tank.**
2. **Don't touch the muffler or engine main unit during engine revolution or right after engine stop. You will be scalded by the high temperature.**
3. **Stop the engine before supplying the fuel to prevent fire.**

⚠ CAUTION

8. **Management of hydraulic fluid**

   Keep the contamination of the hydraulic oil within the specified value, NAS Class 12, to operate the solenoid valve and other hydraulic devices smoothly and to prolong their lives. Replace the elements such as the line filter or return filter periodically.

   1. **For a new machine, replace the elements after first 50 hours operation. When they are used for 50 hours, all the contaminants adhere to them in the circuit.**
   2. **Replace the elements every 250 hours after the first replacement.**
   3. **Don't let dust enter the circuit when repairing the machine, supplying the oil or replacing the elements.**
   4. **Drain away from the bottom of the hydraulic oil tank.**

9. **Precautions for handling electric cables**

⚠ CAUTION

When installing or removing the electric cables for the attachment or others, be careful about the following points for handling the power supply and connectors. If the cables are damaged or imbued with water, the moment limiter and other operational aids do not operate correctly.

1. **Before plugging or unplugging a connector, turn off the power switch. If not, the devices may burn out or malfunction.**
2. **Prevent the joining section of a connector from touching water or mud.**
3. **Attach a cap to prevent water from touching connector when unplugging.**
4. **Don't stamp, pull or catch forcibly a connector or cable.**

10. **Others**

⚠ CAUTION

Check the switches and the electric sections of the operator aids for corrosion, mounting status and operating status periodically. Replace them if necessary.

NOTICE

Use genuine American Crane Corporation parts when replacing parts or repairing a machine.

11. **Relationship between hour meter reading and calendar**

    The hour meter reading should be related to the calendar time span with reference to the table below.

Hour meter reading (hour)	Calendar time span	Hour meter reading (hour)	Calendar time span
4	Half day	250	1 month
8	1 day	500	2 months
50	1 week	1000	4 months
100	2 weeks	1500~2000	6 to 12 months

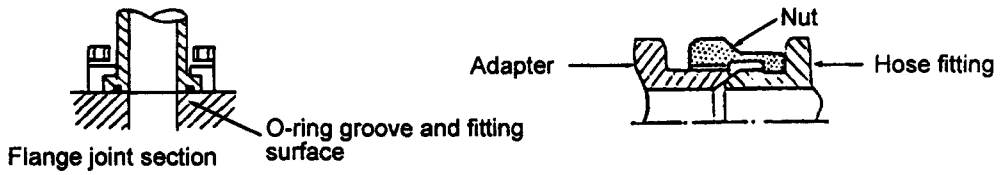
12. Handling of hydraulic equipment

⚠ WARNING

Before disassembling the hydraulic hoses or equipment, remove the residual pressure from the circuit. If not, you may be injured by the spouting oil or scattered part.

⚠ CAUTION

1. **Never disassemble the hydraulic pump, hydraulic motor, control valve, or relief valve. Do not tamper with the adjusting parts of hydraulic equipment.**
2. **Carefully handle the hydraulic equipment so that foreign materials such as dust will not enter inside.**
   a. **Clean the equipment and surrounding area.**
   b. **Do not remove the dust preventative plug of the joint section before assembly.**
   c. **Be sure to wash the tube and hose before connecting them.**
3. **Carefully handle the connections of hydraulic equipment parts so as not to damage them.**



4. **Do not fit the high-pressure hose in a twisted state. Otherwise, its service life will be shortened significantly.**
5. **If the union nut of the high-pressure hose is tightened beyond the specified torque, the caulking portion may be deformed and disabled for use. So, observe the specified torque.**
6. **Tighten the four split flange fastening bolts of hydraulic piping to the same torque for preventing oil leakage.**
7. **If you determine a repair to be too difficult, contact American Crane Service Department.**

13. Retightening

To prevent accidents due to loosened bolts, tighten the bolts of principal sections to the specified torque.

14. Lubrication

1. For lubrication, it is important to use clean oil and grease and take care not to allow the entrance of dust during injection.
2. When the machine is used under severe conditions, lubrication frequency should be increased.
3. Carry out lubrication on safe and level ground.
4. Use oil and grease of the same brands, avoiding mixture of different brand lubricants where possible.

2. PERIODIC MAINTENANCE TABLE

Periodic checking is most important to operate the machine safely and demonstrate its performance fully. Take special care when using the machine under severe conditions.

▲ = First time ❑ = Periodic time
❋ = See "Remarks" column

Maintenance Position		Maintenance/ Inspection	Daily	50h (1 week)	250 h (1 month)	1000h (4 months)	1500~ 2000h (6~12 months)	Remarks
Operation Device	Lamp, meter, moment limit	Indication	❑					
	Switch	Operation	❑					
	Lever, pedal	Operation	❑					
Clutch	Main hoist, auxiliary hoist Third drum (option)	Oil or water adhere check	❑					
		Operation	❑					
		Adjusting		▲	❋			Adjustment according to clutch force
		Lining				❋		Replacement according to wear condition
		Hydraulic cylinder					❋	Replacement as required
Brake	Main hoist, auxiliary hoist, Swing (disk) Third drum (option) Traveling (disk)	Oil or water adhere check	❑					
		Operation	❑					
		Adjusting		▲	❋			• Adjustment according to brake force • Excluding the travel/swing brakes
		Lining				❋		Replacement according to wear condition
		Hydraulic cylinder				❋		Excluding swing brake
Lock	Main hoist drum	Operation	❑					
	Auxiliary hoist drum							
	Third drum, boom drum	Hydraulic cylinder					❋	Replacement as required
	Swing	Operation	❑					
Hydraulic Equipment	Hydraulic fluid tank	Oil quantity and cleanliness	❑					
		Tank water removal			❑			
		Oil replacement & tank cleaning					❋	Replace regardless of specified time when oil is contaminated
	Master cylinder	Inspection				❑		For third drum
	Return filter, line filter	Element replacement		▲	❑			
	Air breather	Filter cleaning		▲	❑			
	Accumulator	Gas pressure check				❑ 500h		
		Gas charging					❋	Replace or recharge as required
Reduction	Main drum, aux. drum Third drum (option) Boom, Swing, Travel	Oil replacement			▲	❑		
Tightening Bolt	Swing bearing	Tightening bolt check	❑					
		Retightening		▲	❑			
	❋Main tightening bolt	Retightening		▲	❑			See periodic tightening points in this chapter

Maintenance Position		Maintenance/ Inspection	Daily	50h (1 week)	250 h (1 month)	1000h (4 months)	1500~ 2000h (6~12 months)	Remarks
Safety devices	Over-loading prevention device	Operation	❑					
		Actual load adjustment			❑			
	Boom or tower jib overwind prevention device (boom hoist throwout)	Operation	❑					
		Operating angle adjustment			❑			
		Limit switch					❋	Replace as required
	Boom (or tower jib) back fall stopper	Set condition check	❑					
	Hook overhoist prevention device	Operation	❑					
		Limit switch					❋	Replace as required
	Boom (or tower jib) over-hoisting prevention device, Max. working radius stop device	Operation check			❑			
Engine	Fuel tank	Residual fuel check, supply	❑					
		Water drain			❋			Drain water as needed
	Oil pan	Oil quantity check, supply	❑					
		Oil replacement			❑			
	Battery	Liquid quantity check	❑					
		Liquid density check			❑			
		Terminal cleaning, oil supplying					❑	
	Radiator	Cooling water quantity and dirt check	❑				❋	Replace as required
Travel unit	Crawler belt	Shoe pin pulling out check	❑					
		Belt adjustment		▲	❋			Adjust according to soil condition
	Upper/lower rollers, front idler	Oil leak check	❑				❋	Oil replacement as required
Hydraulic Equipment	Hydraulic equipment	Oil leak check	❑					
	Hydraulic pipe	Oil leak check	❑					
		Hose crack & rubbing check	❑					
Grease supply point								See lubrication
Attachment	Boom, auxiliary jib, tower boom, tower jib	Connection pin & lock pin check	❑					Report damage to Dealer/ Factory
		Lacing bending & crack check	❑					Report damage to Dealer/ Factory
	Hook, sheave, grab bucket	Deformation & crack check	❑					Sheave must not exceed wear limit given in inspection guideline
	Wire rope Pendant rope	Socket, wedge, clamp, joint pin check	❑					
		Wear, corrosion & lub. check	❑					
		Wire rope replacement					❋	Replace as required
	Electric wiring	Wiring damage check	❑					
		Checking connectors for water	❑					

1. Maintenance should be carried out with reference to the total operation time read on the hour meter in the cab.
2. Lubrication:

   Check frequency should be increased when the machine is used under difficult conditions. Shortening the maintenance interval may be required.
3. Handling of hydraulic equipment:

   Never disassemble the hydraulic pump, motor, control valve, or relief valve. When disconnecting and reconnecting a hydraulic pipe, clean the pipe and its surrounding area in order to prevent foreign materials from entering the joint and pipe.
4. Retightening:

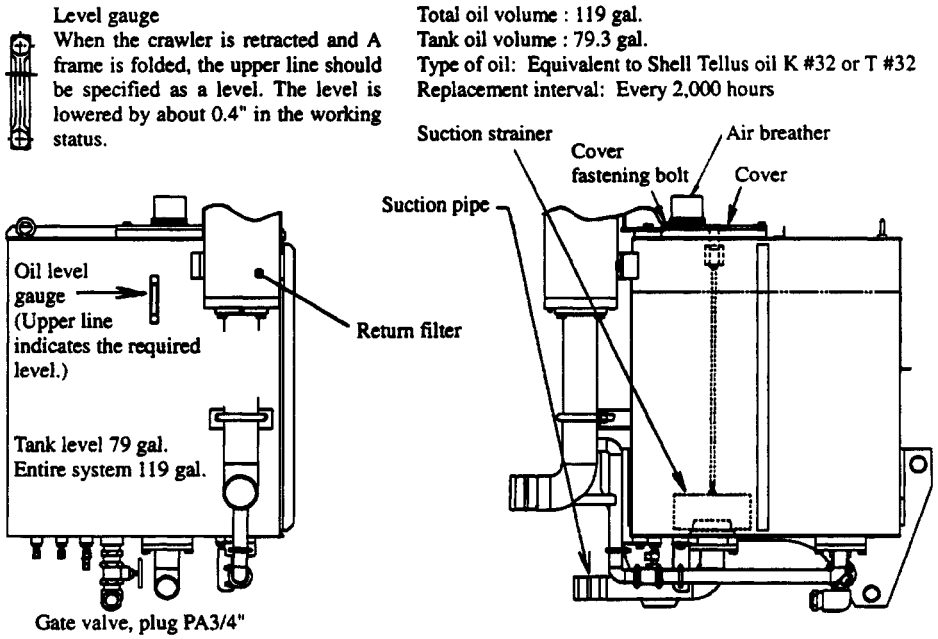
   To prevent an accident due to loose bolts in any principal section, the bolts should be retightened to the specified torque periodically.

⚠ CAUTION

1. **Set the machine on level ground, lower the attachments to the ground, stop the engine and then check or repair the machine in a safe manner.**
2. **When checking the operator aids, set the engine revolution at a low speed and keep a safe speed so as to be able to stop the machine as required.**

3. HANDLING OF HYDRAULIC EQUIPMENT

3-1 Hydraulic oil tank



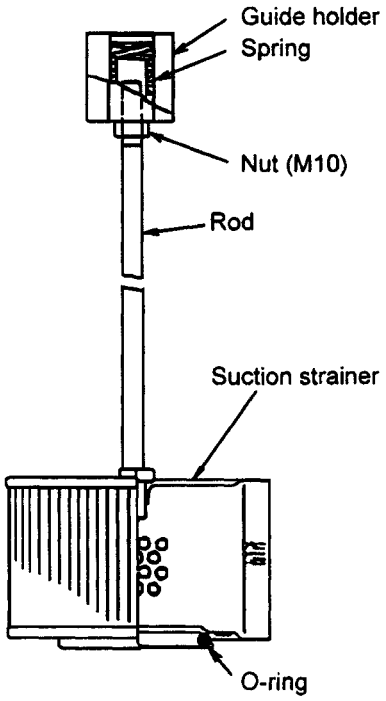
WARNING

A pressure of 850 to 1,210 psi is built up in the control hydraulic circuit. After the engine has stopped, the circuit has a residual pressure for some time. If a hose, line filter or similar part is disconnected under a residual pressure, great danger may be caused. So, relieve the residual pressureby depressing the brake pedal a few times. After the control circuit pressure gauge reads zero, disconnection is allowed.

1. Water draining from the tank should be done before start of operation when water has settled down at the bottom. Loosen each plug of the lower cover and gate valve to discharge a little volume of water.

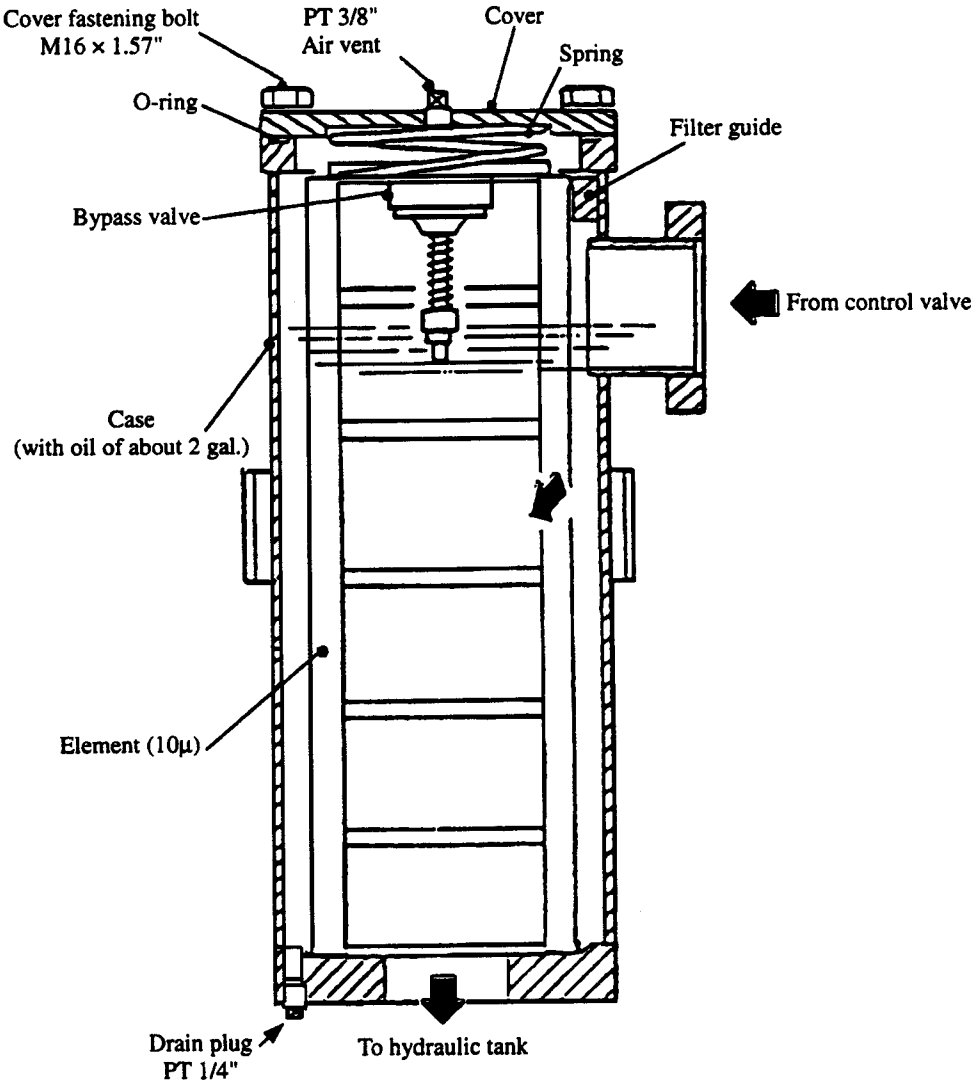
3-2 Suction strainer

1. Remove the cover fastening bolt at the top of tank and remove the cover.
2. Grip the guide holder and pull it out straight. Don't wash the O-ring with a volatile oil. Take care not to let the spring in the guide holder drop into the tank.
3. Mount the cleaned strainer in the tank. Fit the strainer to the suction pipe, paying attention to the O-ring.
4. Put the spring in the guide holder and fix the holder with the cover.



3-3 Return filter

Part No. of Filter Element: 535043203

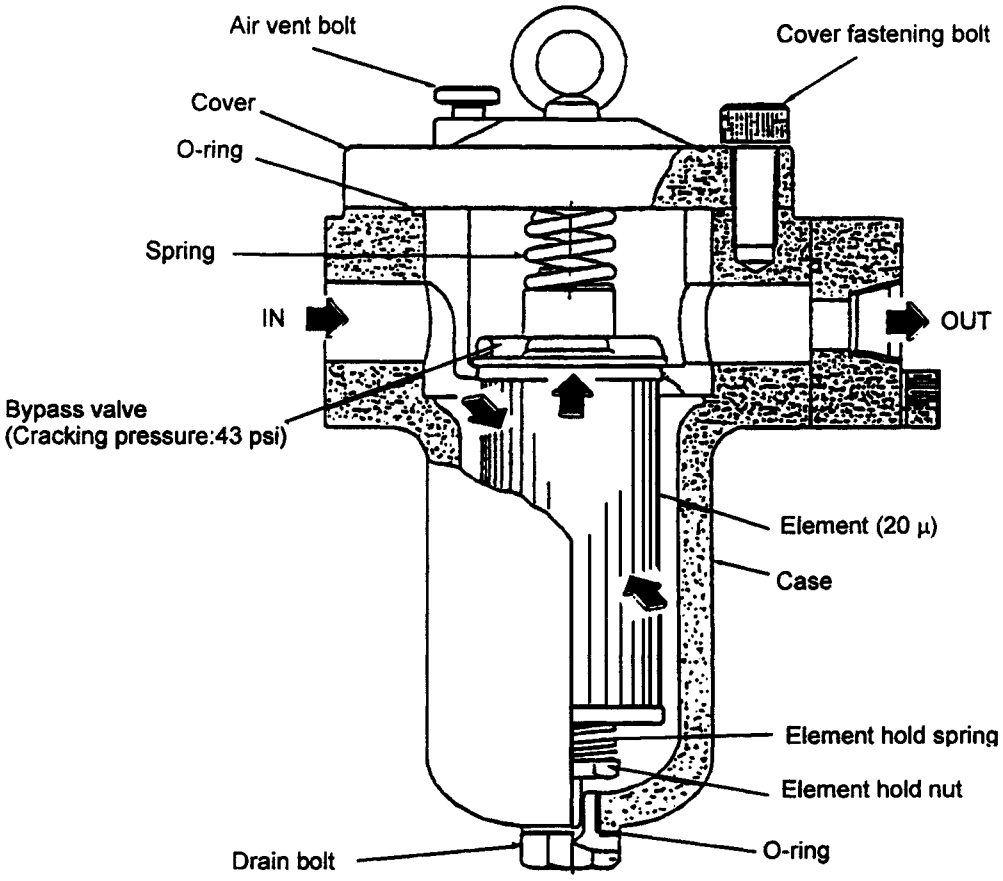


How to replace filter element:

1. Stop the engine.
2. Loosen the air vent plug at the top. Then, tighten the plug.
3. Remove the cover fastening bolts and detach the cover.
4. Pull out the spring and bypass valve, and lift out the element. Remove dust from the case bottom.
5. Install a new element.
6. Mount the bypass valve and spring above the element.
7. Reattach the cover.
8. Start the engine and let the oil circulate at an idling speed.

3-4 Line filter (mounted beside the gear pump)

Part No. of filter element: 075513091



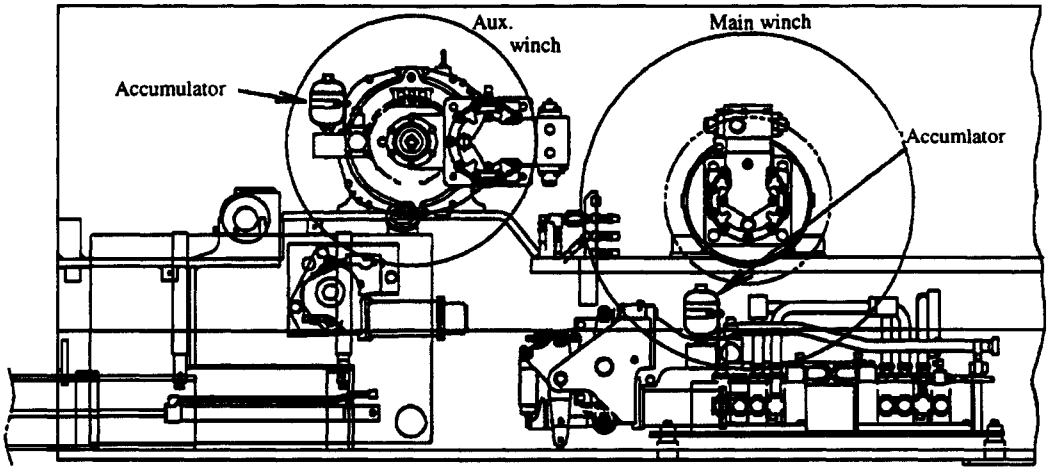
⚠ DANGER

After the engine has stopped, the pressure remains in the control (operation) circuit for a while. Operate the brake pedal or control levers until the pressure gauge of the control circuit shows "0" and then disassemble the machine. If the pressure remains, the oil will spout out and injure you during disassembly.

How to replace element:

1. Stop the engine and fully relieve the residual pressure from the circuit.
2. Clean the cover and case area.
3. Remove the cover fastening bolts and detach the cover.
4. Loosen the drain bolt at the bottom of case to discharge oil from the case.
5. Take out the spring, bypass valve, element, hold spring and nut in this order.
6. Clean the inside of case.
7. Replace the old element with a new one and reverse the above steps. The old O-ring should be replaced with a new one.
8. Start the engine and let the oil circulate at an idling speed.

3-5 Accumulator

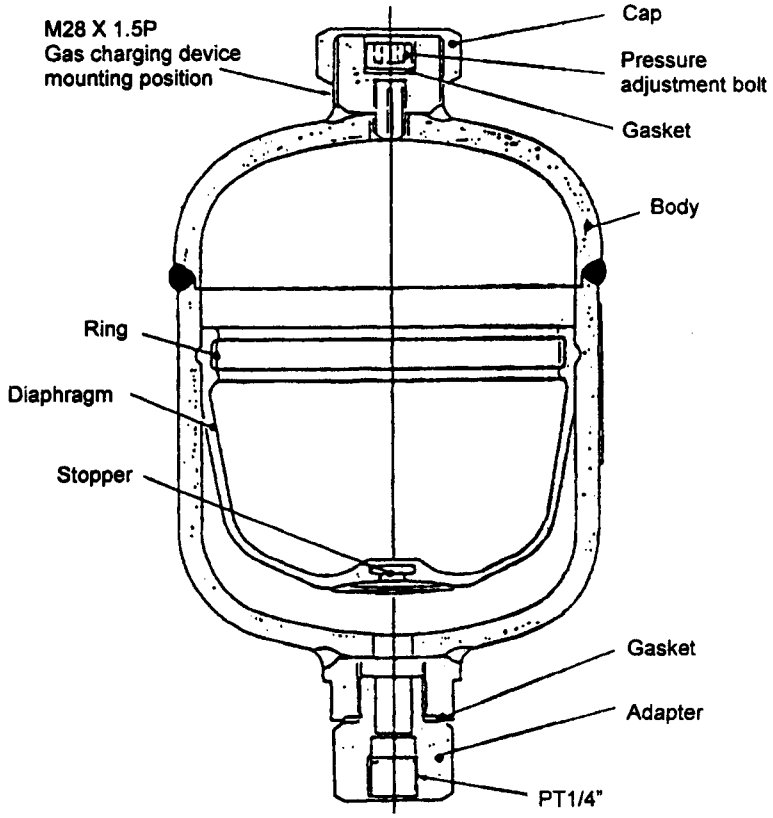


Left winch (auxiliary hoisting) Right winch (main hoisting) ⇨ Front

Line filter and accumulator mounting positions

Gas is charged in the accumulator at a pressure of 780 psi. When the gas pressure drops to about 650 psi, the nitrogen needs to be recharged. Ask your local service shop for gas pressure measurement and recharging.

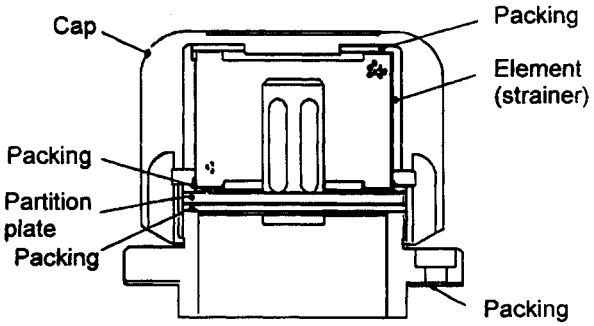
Nitrogen gas charging pressure	780 psi
Capacity	0.19 gal.



3-6 Air breather (mounted on the hydraulic oil tank)

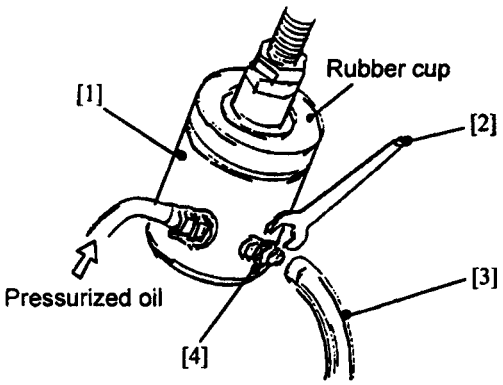
Air flows into and out of the tank through the strainer. When the strainer is clogged, a negative pressure is built up in the tank when the tank oil level falls. Once a negative pressure has built up in the tank, the suction performance of the hydraulic pump is degraded.

Clean the element every 500 hours.



Air breather

3-7 Clutch and brake cylinders



① Cylinder
② Wrench (size 0.4")
③ Vinyl hose (dia. 1/4" x 40")
④ Air bleeder

Air bleeding procedure:

1. Start the engine and set it at an idling speed.
2. Operate the clutch or brake to deliver oil to the selected cylinder ①.
3. Insert the transparent vinyl hose ③ into the air bleeder ④ and loosen the air bleeder gradually with the wrench ②.

   Bleed air until white bubbles are no longer discharged.
4. After completion of air bleeding, tighten the air bleeder firmly with the wrench.

NOTICE

1. **If the bleeder ④ is loosened suddenly. The vinyl hose ③ will be ejected, causing oil to be splashed. To prevent this, the bleeder should be loosened gradually while holding the inserted vinyl hose with the hand. In particular, exercise maximum care when bleeding air from clutches.**
2. **If oil leaks and sticks to the clutch lining, the clutch will slip. Therefore, if oil leakage is detected cylinder replacement or a similar measure is required.**

Oil leak check (monthly)

1. Locate the clutch spider so that the cylinder rod faces upward.
2. Remove the rubber cup shown above and check if hydraulic oil is collected.

3-8 Manual operation of solenoid valve

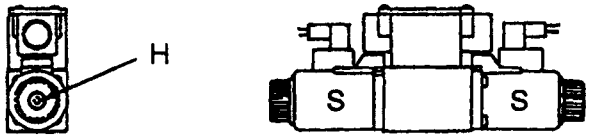
Measures to be taken when the solenoid valve fails to operate normally due to an electric problem, etc.

Resetting method:

1. Push the manual operation pin if there is one.
2. If there is a pin hole for manual operation, push the pin inside the hole with a thin rod.
3. Turn the manual adjustment screw if there is one.

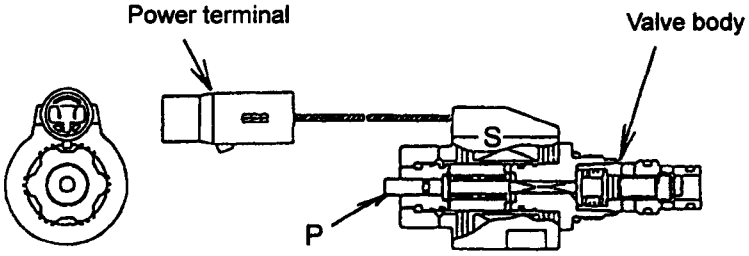
As a result, the same status as after power-on is set.

- Direction selecting solenoid valve

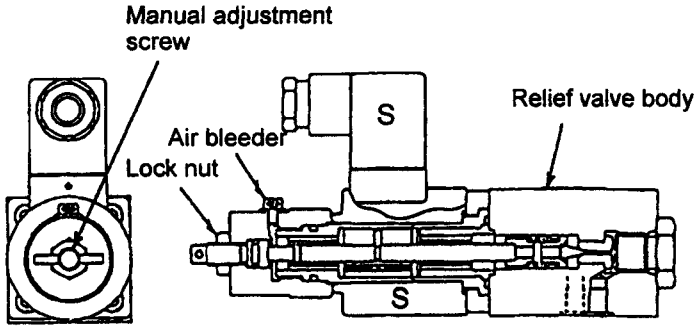


Note:
S = Solenoid valve
P = Manual operation pin
H = Manual operation pin hole

- Cartridge solenoid valve controlling hydraulic pump (flow regulation)

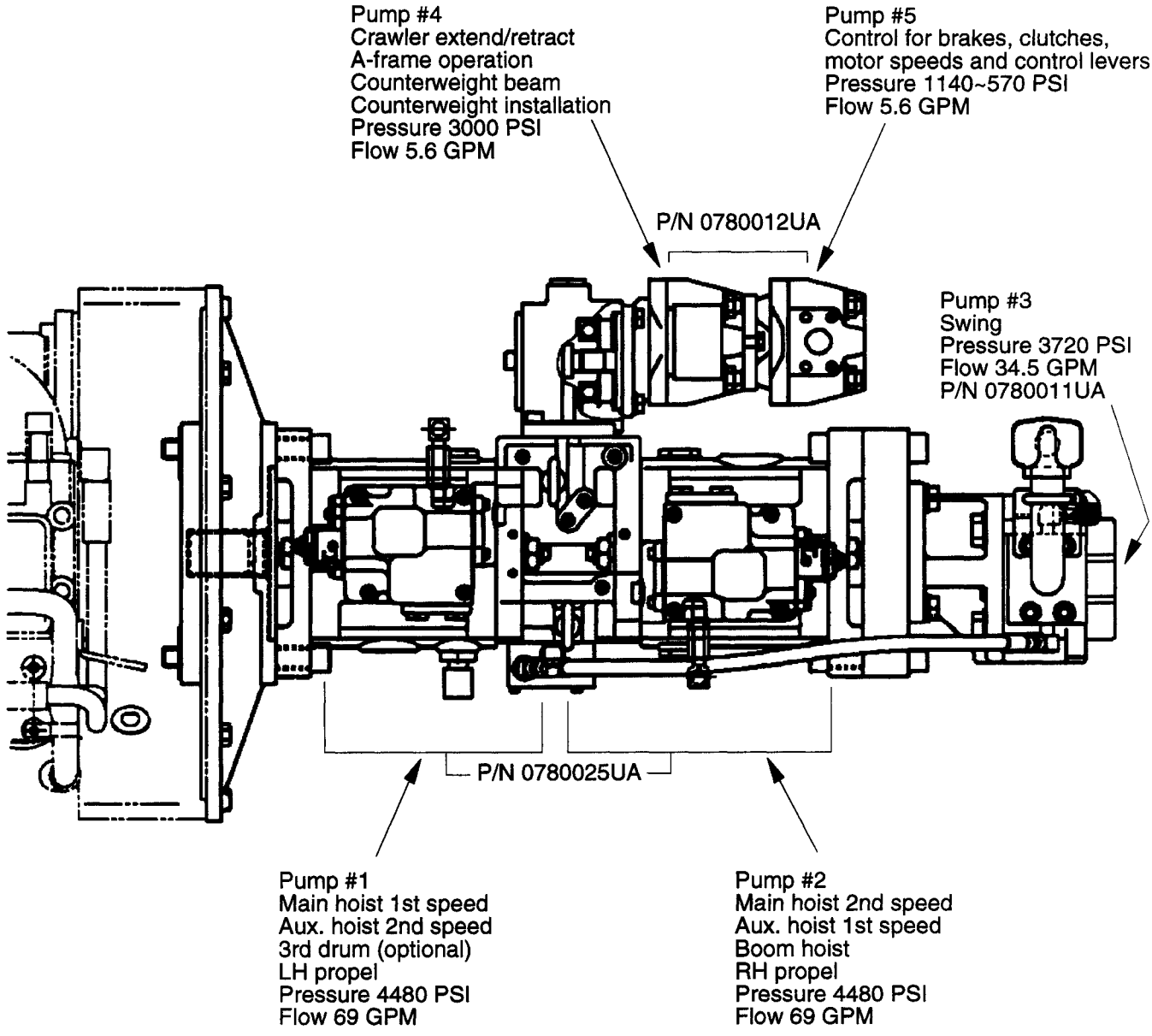


- Electromagnetic proportional relief valve controlling hydraulic pump



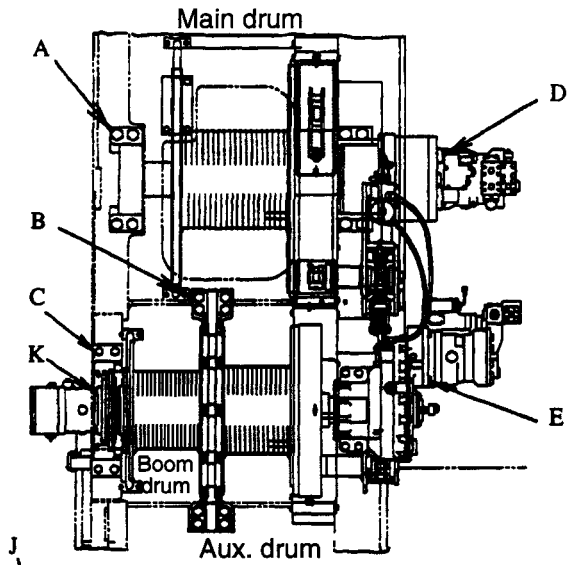
Pressure is set by turning the adjustment screw with the lock nut loosened. Normally, return the screw completely and be sure to tighten the lock nut.

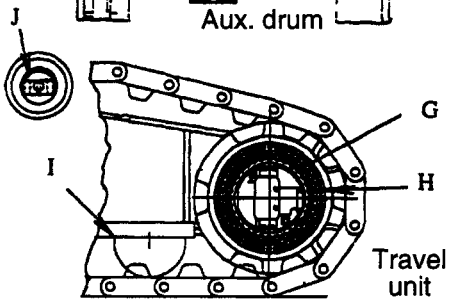
HYDRAULIC PUMPS

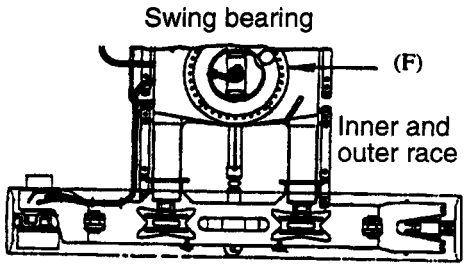


4. PERIODIC RETIGHTENING POSITIONS AND TORQUES

4-1 Wire drum, swing bearing, travel reduction, hydraulic motor







⚠ CAUTION

Check every 250 operation hours if the swing bearing mounting bolts are loosened or fell off. If a bolt is loosened, remove and check it. If damaged, replace it. If using a new bolt, clean it and then tighten it with specified torque. Retighten all bolts with specified torque.

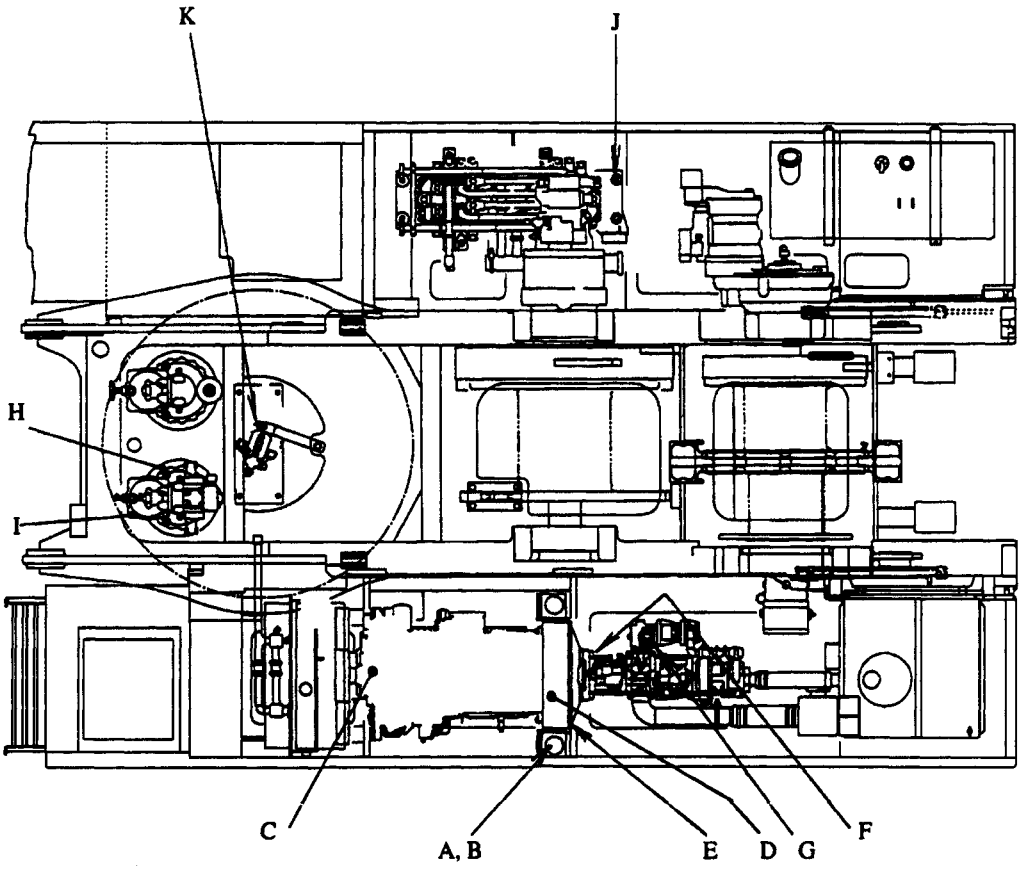
Unit: ft-lbs

Symbol	Position	Bolt Size	Wrench Size (mm)	Q'ty.	Tightening Torque
A	Main drum mounting bolt	M36	55	8	1873
B	Aux. drum middle suspension	M30	46	8	730
C	Aux. boom drum mounting	M24	36	8	530
D	Hyd. motor and reduction	M20	30	4	330
E	Hyd. motor and reduction	M20	30	4	330
(F)	Swing bearing mounting	M30	46	72	1340
G	Travel reduction & crawler frame	M24	Bar	64	594
H	Travel reduction & drive tumbler	M20	Bar	76	330
I	Lower roller and frame	M24	36	72	526
J	Upper roller and frame	M20	30	36	302
K	Boom motor and reduction	M16	24	4	152

1. At the positions shown above, retightening is first required when 50 hours are on the hour meter after the new machine is delivered (or overhauled).

   Subsequently, retightening is required every 250 hours.
2. Check item (F) routinely. If loose, retightening is required to the specified torque.

4-2 Upper machine



Unit: ft-lbs

Symbol	Position	Bolt Size	Wrench Size (mm)	Q'ty.	Tightening Torque
A	Engine bed and bracket	M20	30	2	403
B	Engine bed and bracket	M16	24	4	140
C	Engine and engine bed	M12	19	4	67
D	Fly wheel and flange	(UNC 1/2")		8	70
E	Fly wheel housing mounting	(UNC 7/16")		12	33
F	Fly wheel housing and pump	M20	Bar	4	340
G	Gear pump mounting	M12	19	4	137
H	Swing reduction and turntable	M16	24	18	152
I	Swing reduction and motor	M16	24	4	152
J	Control valve and base plate	M16	24	4	60
K	Rotary joint and car body	M12	19	8	23

1. At the positions shown above, retightening is first required when 50 hours are on the hour meter after the new machine is delivered (or overhauled).

   Subsequently, retightening is required every 250 hours.
2. For the bolts and nuts other than in this figure, refer to the"Tightening torque table."

4-3 General tightening torque value (10T bolt)

Bolt Size	Spanner Size (mm)	Tightening Torque (ft-lbs)	
		Metric, coarse-thread, heat treated bolt	Metric, fine-thread, heat treated bolt
M8	13	16.6	18
M10	17	34.7	37
M12	19	61.5	67
M16	24	152.0	163
M20	30	304.0	333
M24	36	528.0	600
M30	46	1070.0	1172
M36	55	1873.0	2098
M48	71	4542.0	4940
M64	95	10890.0	11550

High-pressure hose union nut	
Hose size (inch)	Tightening torque (ft-lbs)
1/4"	18
3/8"	36
1/2"	43
3/4"	86
1"	101
1 1/4"	123

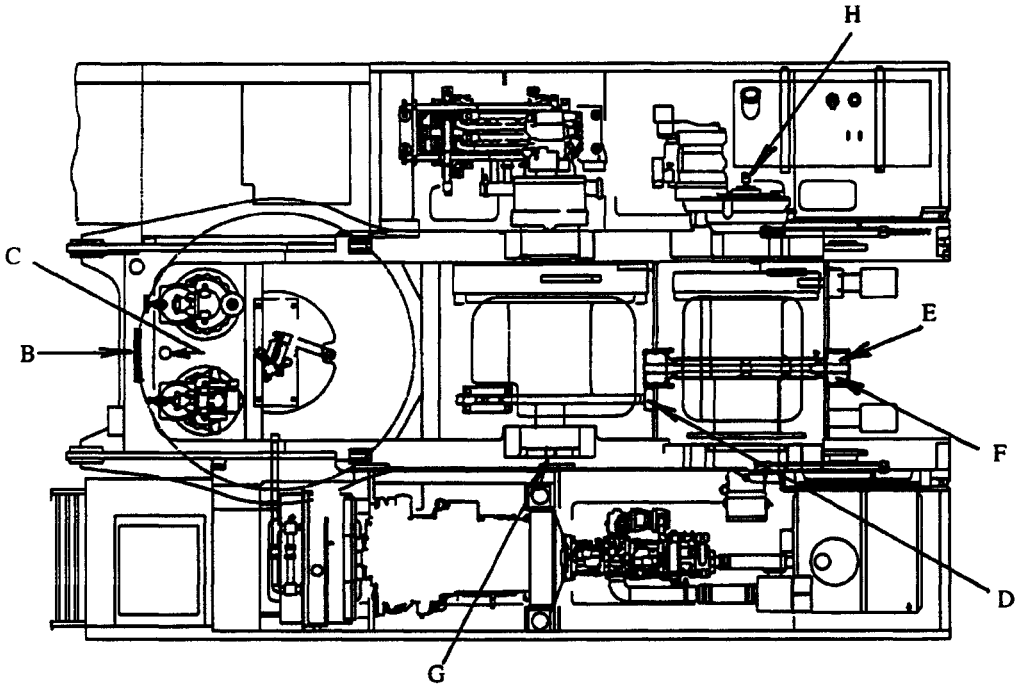
Pay attention not to damage the tapered area of the union nut.

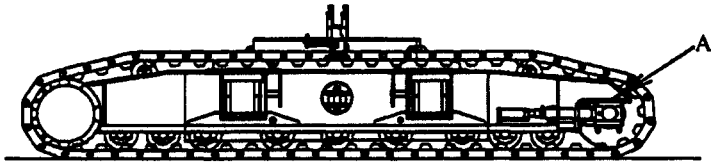
In case any heat-treated bolt does not have torque specification, refer to the above table. For the bolt of SS400, about 30% of the above torque for the coarse-thread bolt should be a reference.

The tightening torque of bolts is specified to maintain the clamping force (bolt tension) for connecting two or more substances. Clean bolts and nuts and then tighten them. If the threaded part or washer is damaged, corroded or soiled, the torque will be decreased. When there are such problems, the necessary torque is not demonstrated even if tightening as specified, resulting in the bolt looseness.

5. GREASING POINTS AND OTHERS

5-1 Base machine greasing points, etc.



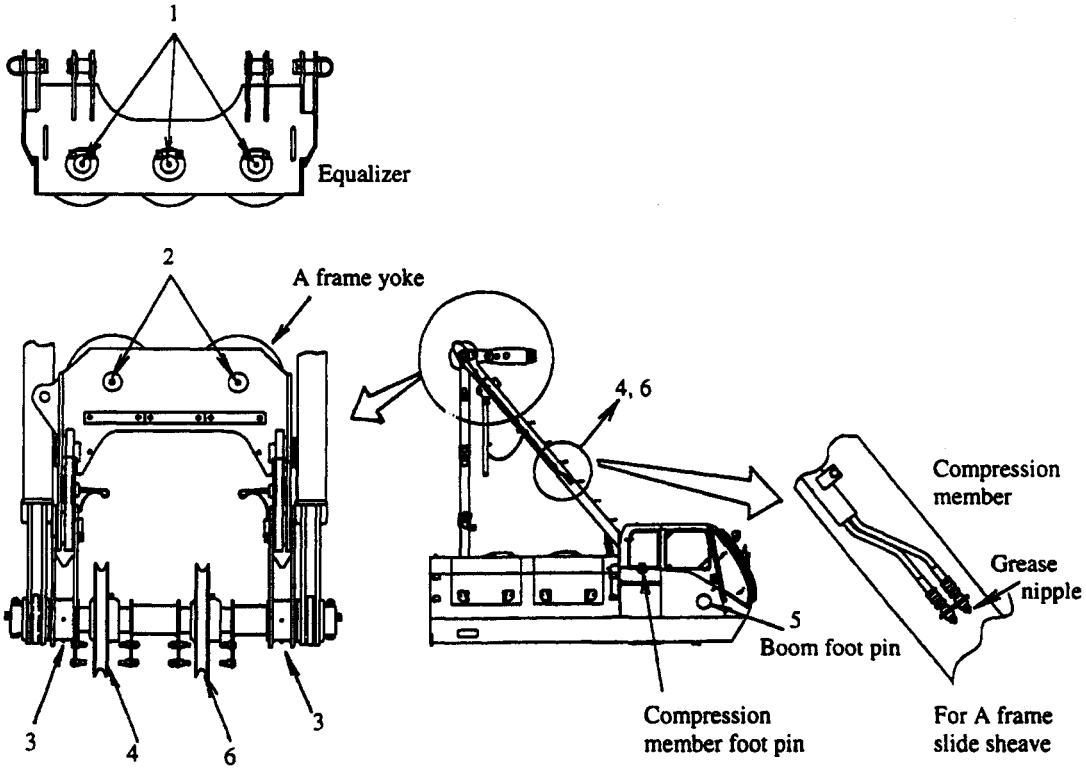


NOTICE

Carry out greasing until the old grease is pushed out. Wipe off the spilled grease.

Symbol	Position	Q'ty.	Interval	Remarks
A	Slide bearing	4	When shoe adjusting	Small amount of grease
B	Swing bearing	4	250 hours or 1 month	Collective lubrication
C	Swing ring gear (grease bath)	1	1000 hours (grease change)	About 5.3 gallons
D	Main drum locks	1	1000 hours	Small amount of grease
E	Aux. drum lock	1		
F	Boom drum lock	1		
G	Main drum clutch rotor	1		
H	Auxiliary drum clutch rotor	1		

5-2 Crane attachment



The yoke shaft and connection link should be greased through the above grease pipe.

NOTICE

Sheaves are of either lubrication-type or non-lubrication-type. The lubrication-type sheave requires greasing every 500 hours.

The non-lubrication-type sheave requires replacement of the grease in the bearing every 2,000 hours through sheave disassembly.

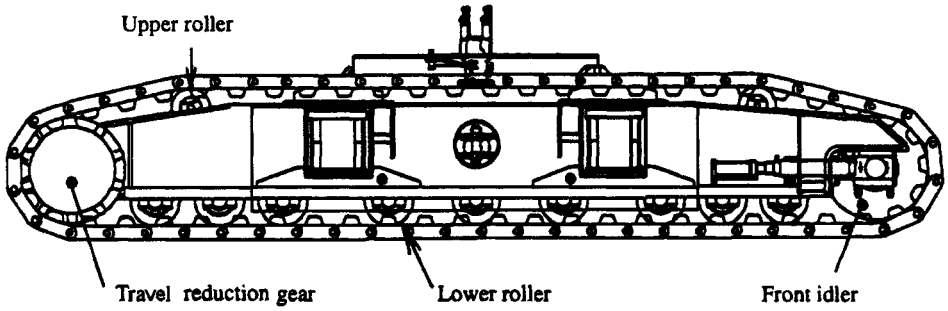
Grease used: EP #2

Symbol	Name	Greasing Point	Interval
1	Equalizer sheave	3	Lubrication type:
2	High A-frame yoke sheave	4	Greasing every 500 hours
			Non-lubrication type:
			Grease replacement through
			disassembly every 2,000 hours
3	Yoke link bushing	4	
4	Boom hoist slide sheave	1	8 hours or
5	Boom foot pin	2	1 day at maximum
6	Aux. hoist slide sheave	1	
6	Guide sheave	1	250 hours
7	Pendant sheave	2	or 1 month

6. REPLACEMENT OF REDUCTION GEAR OIL AND OTHERS

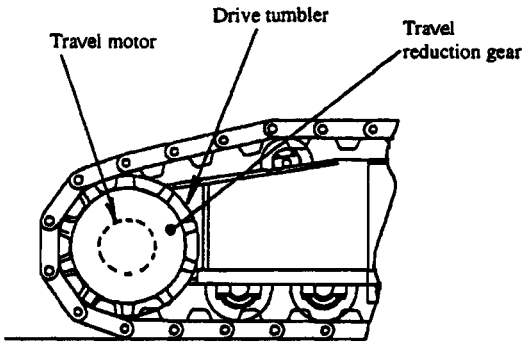
6-1 Travel equipment

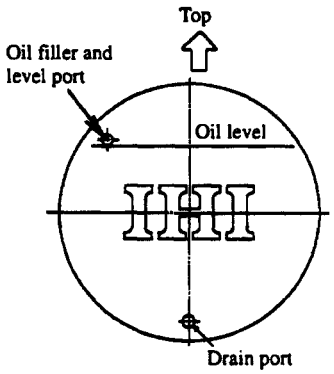
Before oil replacement, move the machine onto level ground so that the exact quantity of oil can be known.



Description	Type of oil	Capacity (Gal.)	Replacement interval (hours)		Remarks
			First time	Thereafter	
Travel reduction gear	Gear oil SAE 90 API GL-5	6.6 (one side)	250	1,000	
Front idler bearing	Engine oil SAE 30 API CD	0.18 (one side)		3,000 to 4,000	
Lower roller		0.14 (per roller)			
Upper roller		0.05 (per roller)			

6-1-1 Travel reduction gear





Park the machine on level ground so that each port is positioned as shown at left, and then discharge the old oil and fill with new oil.

Oil can be discharged easily when it is still hot, shortly after operation.

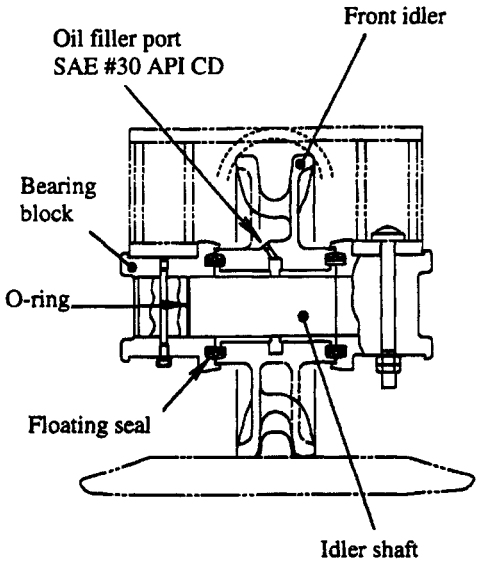
1. Move the machine onto level ground so that the oil filler and drain ports are positioned as shown above.
2. Remove the oil filler and level port and drain ports to discharge the old oil.
3. After fitting the drain port plug, fill gear oil through the oil filler port. When the oil overflows the level port, filling should be stopped.
4. Fit the oil filler port plug.

NOTICE

When the inside of the reduction gear needs to be cleaned, fill hydraulic oil or the like and turn the gear a few minutes under no load. After cleaning, fill gear oil. Never fill volatile oil. The volatile oil damages the seals and shortens the lives of other parts.

6-1-2 Front idler (left/right)

1. Position the two plugs of the idler vertically.



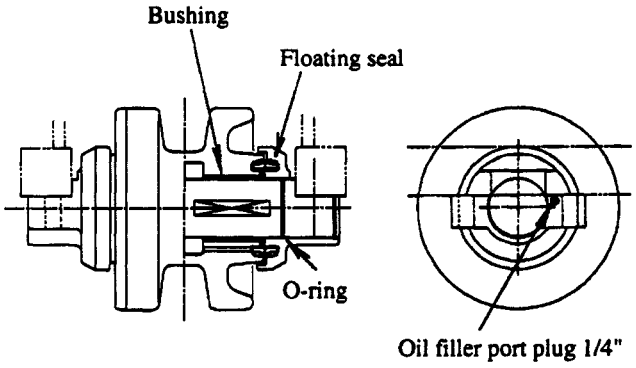
Front idler

2. Remove the two plugs and discharge the old oil.
3. After discharging the oil, position the two plugs horizontally and fill new oil. Stop filling when oil flows out through the opposite plug hole.
4. Fit the two plugs securely.

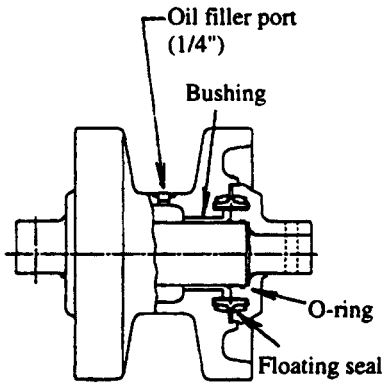
NOTICE

After oil injection, revolve the front idler by 5 turns and confirm the absence of oil leakage. If oil leaks, the floating seal must be replaced.

6-1-3 Upper roller and lower roller (upper x 4, lower x 18)



Lower roller



Upper roller

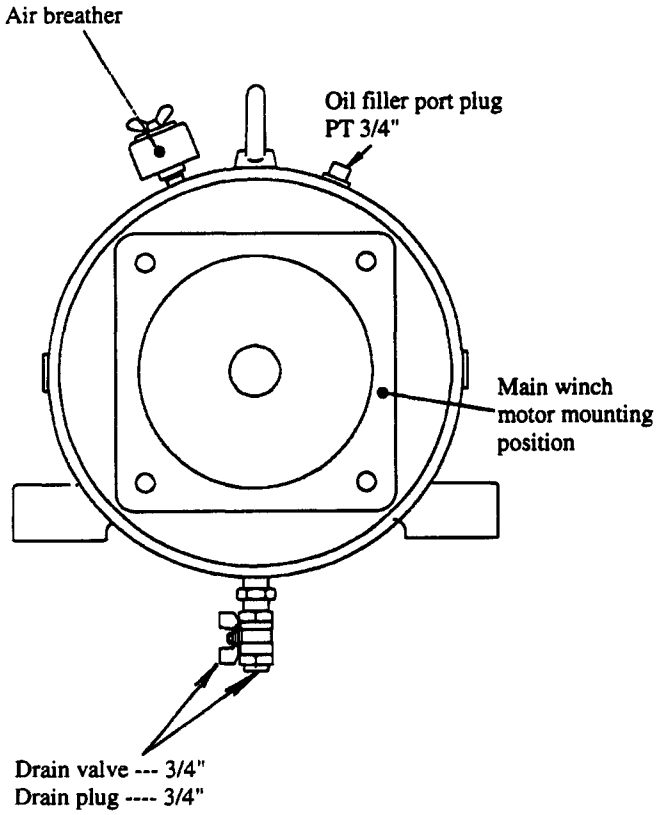
1. Remove the filler port plug.
2. Fill oil through the oil filler plug hole. (If oil cannot be filled smoothly, disassemble the roller, then fill oil again.)
3. Fill with 0.14 gal. (0.57 quart) of new oil.
4. Fit the plug.

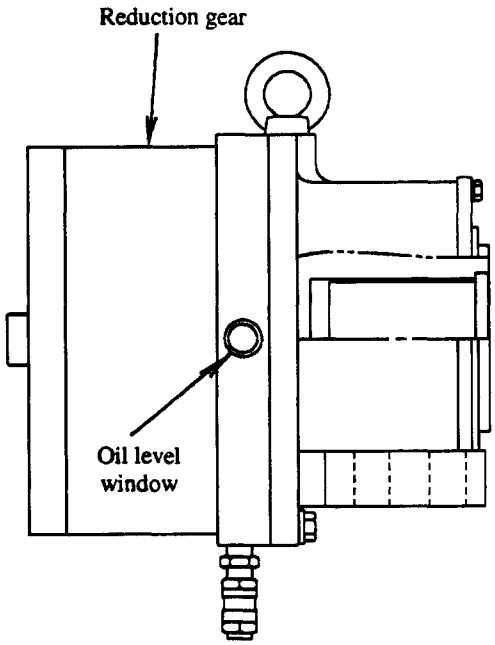
1. Remove the plug from the oil filler port.
2. Fill oil. Stop filling when oil overflows. (Oil amount of 0.2 quart)
3. Fit the plug.

NOTICE

After oil injection, revolve the front idler by 5 turns and confirm the absence of oil leakage. If oil leaks, the floating seal must be replaced.

6-2 Winch reduction gear





Oil used, etc.

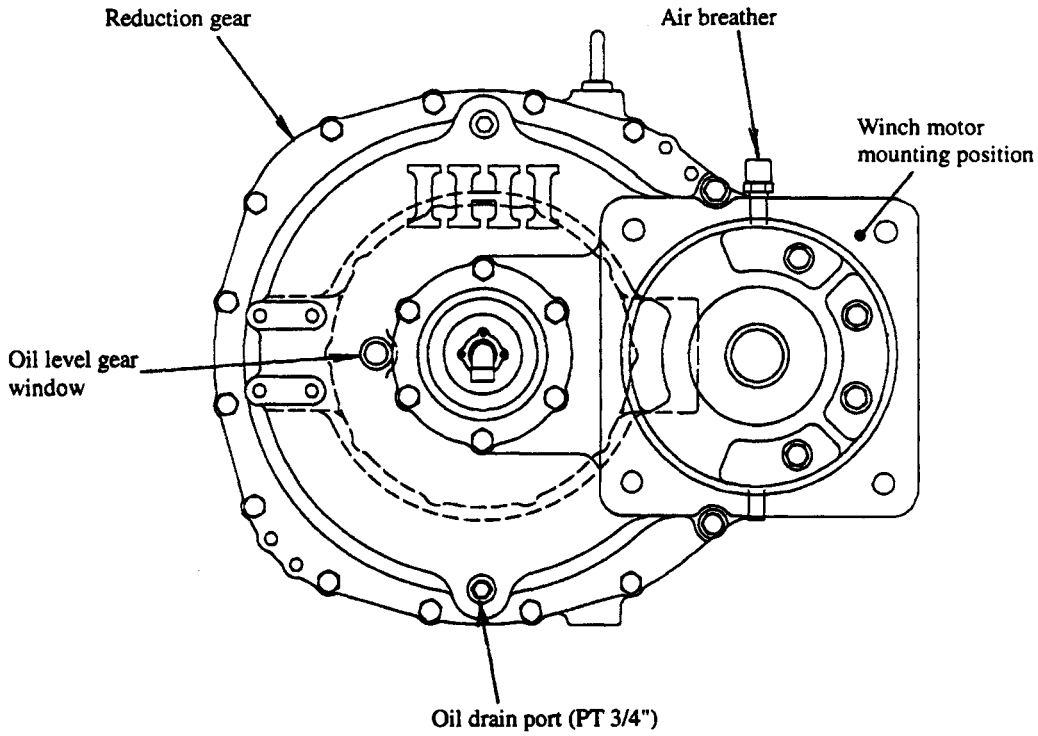
Type of oil	SAE #90, API GL - 4 or 5
Oil volume	5.3 gallons
Replacement interval	Initially at 250 hours, subsequently every 1000 hours

Oil replacement

1. Remove each plug from the oil drain port and oil filler port and allow the old oil to flow out by opening drain valve.
2. Fit the oil drain port plug and close drain valve.
3. Fill oil through the filler port. When the oil level has risen up to the center of the oil level window, filling should be stopped.
4. Fit the oil filler port plug.

- Make sure the air flow through the air breather is satisfactory.

6-3 Aux. winch reduction gear



Oil used, etc.

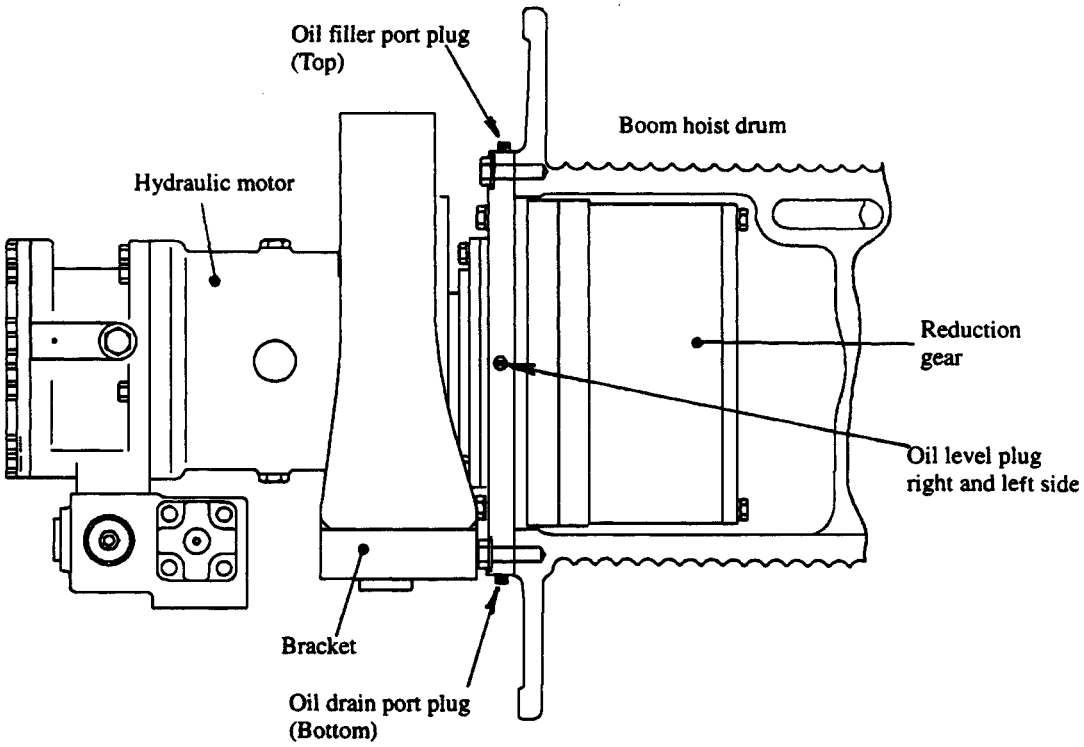
Type of oil	SAE #90, API GL - 4 of 5
Oil volume	1.85 gallons
Replacement interval	Initially at 250 hours, subsequently every 1000 hours

Oil replacement

1. Remove each plug from the oil drain port and oil filler port and allow the old oil to flow out.
2. Fit the oil drain port plug.
3. Inject oil through the injection port.
   When the oil level has risen up to the center of the oil level gauge, injection should be stopped.
4. Fit the oil injection port plug.

- Make sure the air flow through the air breather is satisfactory.

6-4 Boom reduction gear



Type of oil	SAE #90, API GL - 4 or 5
Oil volume	0.53 gallons
Replacement interval	Initially at 250 hours, subsequently every 1000 hours

Oil replacement

1. Remove each plug from the oil filler port, oil drain port, and level port to discharge the old oil.
2. Fit the oil drain port plug.
3. Fill oil through the oil filler port. When the oil flows out through the level port, stop filling.
4. Fit the oil filler and level port plugs.

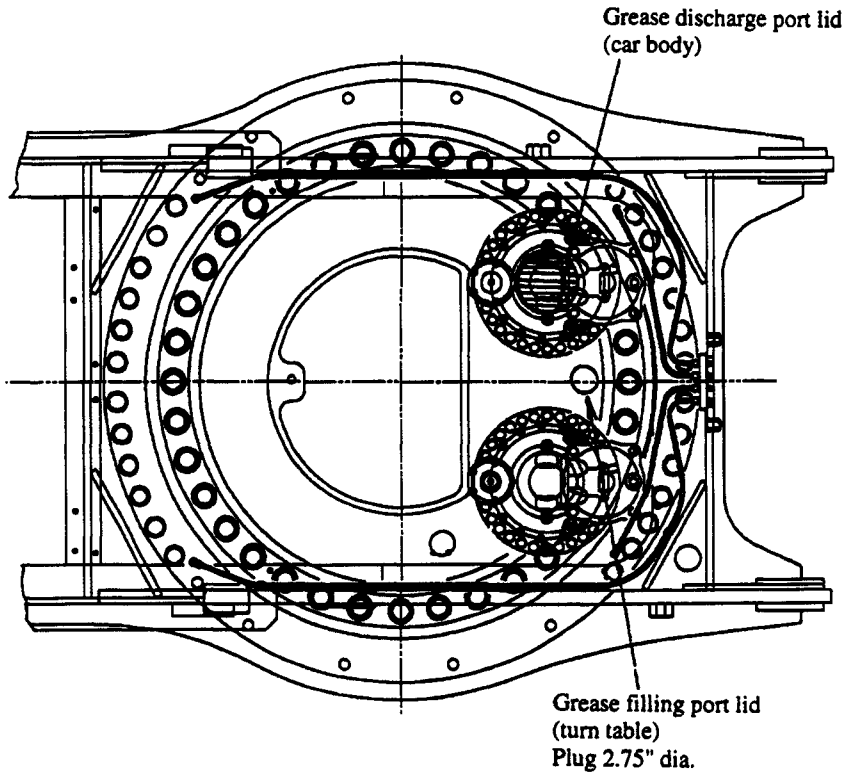
⚠ CAUTION

1. **When replacing the oil or performing other repairs, put the load on the ground, and lower the attachment to the ground if necessary. Then, stop the engine and show a label of "REPAIR" on the operator's cab.**
2. **Be careful not to spill the old oil when discharging it from the reduction gear. Wipe off the spilled oil to maintain the safety on footing and to prevent fire.**

NOTICE

1. **Use the specified oil when replacing at specified interval. If the drained oil has metallic powder which is different from the normal worn powder, the reduction gear must be checked.**
2. **Ask the industrial waste disposal expert to manage the drained oil.**

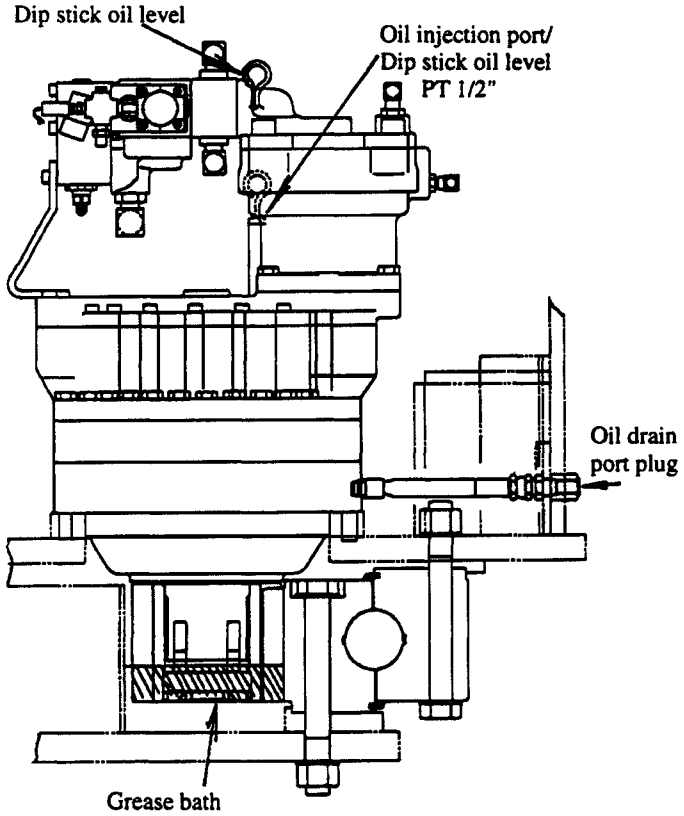
6-5 Swing grease bath



Grease	EP #2
Volume	9.5 gal.

1. Remove the grease discharge port lid to discharge the old grease. If the grease is not discharged smoothly, insert a rod or the like into the hole of the turntable and manipulate it so as to facilitate discharge.
2. Attach the discharge port lid and fill grease through the hole at the top of the turntable.
3. Inject grease in the determined quantity. Be careful not to inject excessively.
4. Perform a swing operation to make sure the grease is distributed to the ring gear and pinion.
5. Attach the filling port lid.

6-6 Swing reduction gear



Type of oil	SAE #90, API GL 4 or 5
Oil volume	2.1 gallons each
Replacement interval	Initially at 250 hours, subsequently every 1000 hours

1. Remove the oil drain port plug and oil level gauge to discharge the old oil.
2. Fit the oil drain port plug and inject oil through the oil injection port. Although an oil injection of 2.1 gallons is needed, oil will overflow before reaching 2.1 gallons of the old oil is not discharged completely. Inject oil up to the specified level with the aid of the level gauge.

7. LUBRICATION OIL TABLE

	Lubricating point	Required Volume	Replacing & Supplying time	Application	Designation	Shell	Esso Std. Oil	Mobil Oil
	Engine Cummins 6CTA	5.0 gal. (6.3 gal. system)	250 hours (Inspection every day)	For severe cold, less than 14°F	API CF/CF-4	Rimula X 15W-40	Exxon D-3 10W	Delbac 1310
				For general 14°~104°F			Exxon D-3 30	Delbac 1330
	Hydraulic oil (tank only: 79.3 gal)	Total oil Volume 119 gal.	1500 hours ~ 2000 hours	Ambient temperature more than 26°F	ISO VG32, 46 Wear resistance	Tellus oil K32. T32 Tellus oil ✶K46	Nuto HP 32 ✶HP 46	Mobil DTE oil 24 ✶DTE oil 25
Reduction Gear	Boom	0.53 gal.	1000 hours or every 6 months	For winter	API GL-5 SAE-80	Gelco oil 5080	Esso gear oil GX-80W 90	Mobilube HD 80W 90
	Main hoist	5.3 gal.						
	Travel	6.6 gal.		In general	API GL-5 SAE-90	Gelco oil 5090	Standard super gear oil 90	
	Swing	2.1 gal.						
	Wire rope	- -	100 hours ~ 150 hours	For winter	Gear Compound	Cardium Compound A	Surett fluid	Mobiltac MM.QQ.4
				In general		Cardium Compound D	N5K	
	Swing grease bath	5.3 gal.	1000 hours	- -	EP-2 Lithium	Alvania EP grease 2	Lithtan EP2	Mobilux EP2
	Greasing point	- -	- -					

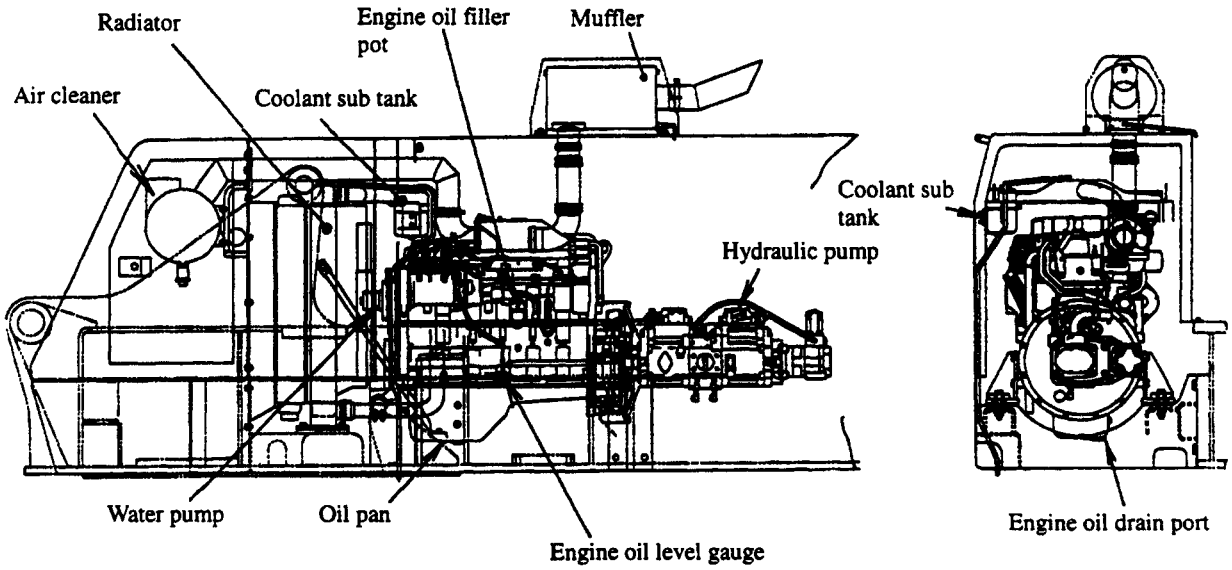
Inject 0.74 quart, 0.57 quart and 0.2 quart of No. 30 engine oil into the front idler, lower roller and upper roller, respectively.

Note:

1. For the oil marked ✶ in the Hydraulic Oil section of chart should be used above 32°F.
2. If oil is contaminated or degraded excessively, it should be replaced even before the regular replacement time point.
3. The lubricants listed inside the ☐ are the ones used at the time of shipment from the factory.
4. Use of oil and grease of the same brands ... avoid mixing lubricants of different brands.
5. We recommend Shell Tellus oil K46 for tropical countries such as Taiwan, the Philippines, Hong Kong, Singapore, Malaysia, Indonesia, Thailand and China (south of Shanghai).
6. We recommend Shell Tellus T32 oil to cranes working in cold weather or frigid countries.

8. CHECK AND MAINTENANCE OF ENGINE

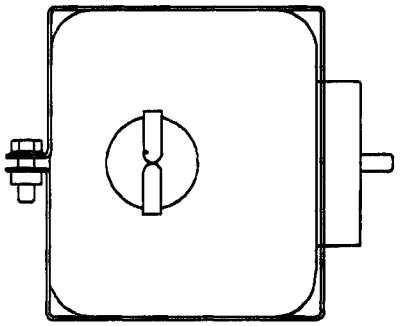
For details of engine handling, refer to the instruction manual of the engine.



8-1 Maintenance table

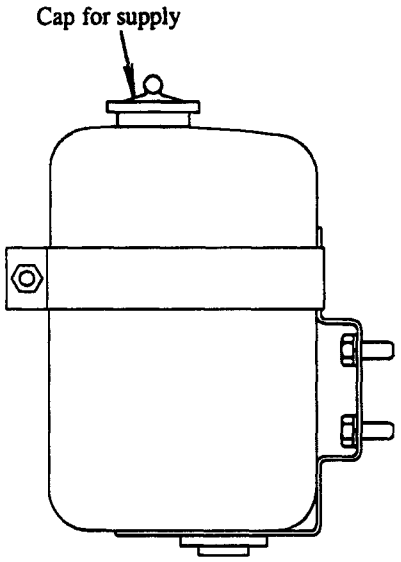
Name	Capacity (gallons)	Check and Replacement Interval (hours)						Remarks
		Daily	30	120	250	500	1000	
Engine oil	H level: 5.0 L level: 4.0 Total volume: 58	❑						Oil level check & replenishment
			❑					Initial oil replacement
				❑				Fuel & water mix - in check
					❑			Oil & water filter element replacement
Fuel line (light oil)	Tank Capacity: 105			❑				Water & dust mix - in check
						❑		Filter element replacement
Air cleaner					❑			Element check & cleaning
							❑	Element replacement
		Monthly operation condition check						Operation of dust indicator
Coolant	Engine alone: 6.0 Total volume: 7.9	Yearly cleaning and replacement						The interval of replacement can be widened by using a long-life coolant
		Mixing ratio of antifreeze						
		Min. temperature		14°F	5°F	- 13°F	- 31°F	
		Mixing ratio		20%	30%	40%	50%	
		Antifreeze volume		1.6 gal.	2.4 gal.	3.2 gal.	4.0 gal.	
		Coolant volume		6.3 gal.	5.5 gal.	4.7 gal.	4.0 gal.	
Water pump	Small amt. grease	Monthly (Not easy to see, take care not to omit greasing.)						

8-2 Replacement of oil filter element



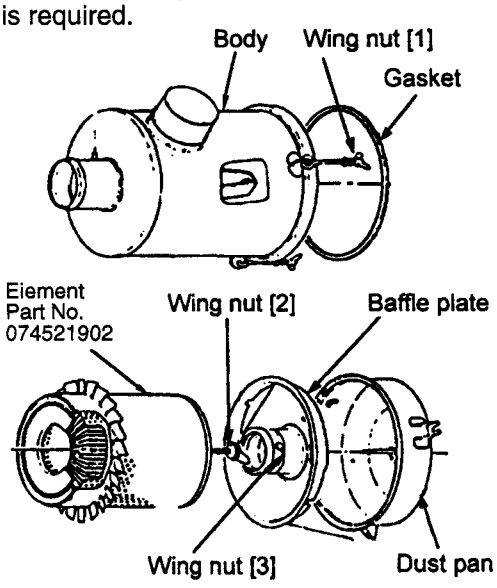
When checking the coolant level of the engine, check the coolant level of the sub tank,

If the coolant is not full, supply the coolant to the upper limit of the sub tank. The capacity of the sub tank is approximately 1.1 gallons.



8-3 Cleaning of air cleaner and replacement of element

When the clogging indicator lamp flickers on the OK monitor, the element is clogged. Cleaning or replacement is required.



1. Loosen wing nut ① and remove the dust pan.
2. Loosen wing nut ③ and remove the baffle plate and eliminate dust from inside the dust pan.
3. Loosen wing nut ② and remove the element.
4. Clean the element. If the element is dry, blow compressed air, or wash it with a neutral detergent if stained with oil.
5. Replace with the new element and assemble the air cleaner. Carry out assembly by reversing the disassembling procedure.

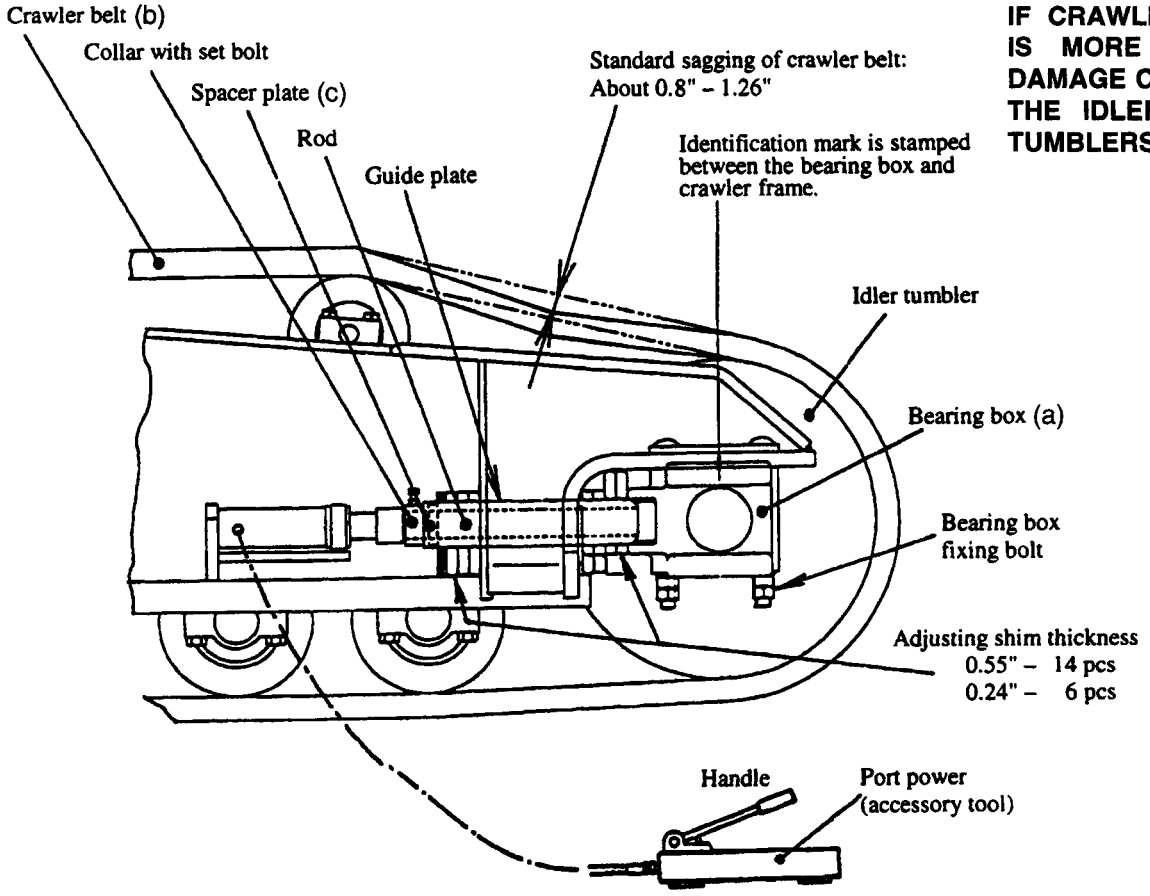
   *Clean the pre-cleaner dust, together with air cleaner.

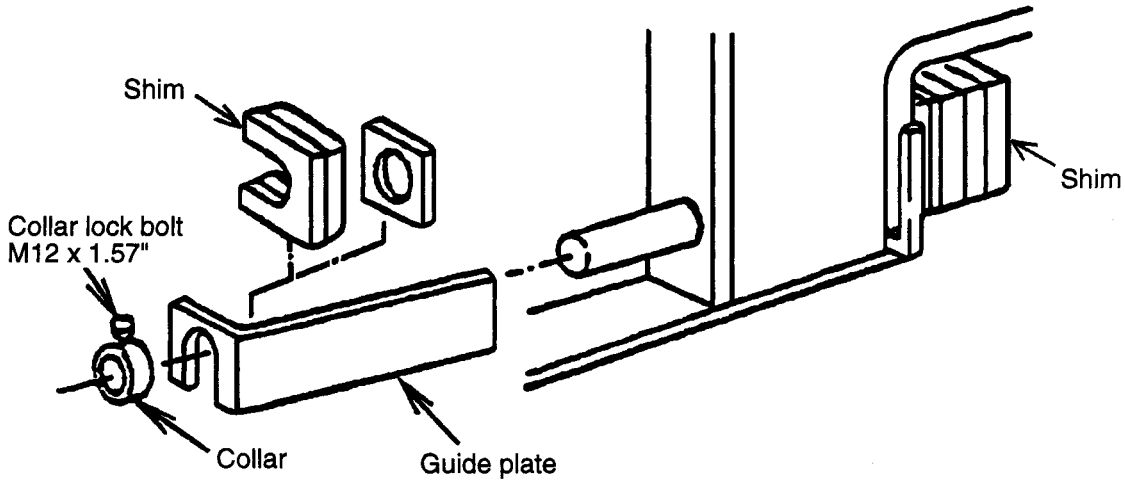
9. ADJUSTMENT OF CRAWLER BELT

9-1 Part name and structure

WARNING

IF CRAWLER BELT SAG IS MORE THAN 1.50", DAMAGE CAN OCCUR TO THE IDLER AND DRIVE TUMBLERS.





Install the port powers to the right and left of the crawler and operate them at the same time.

Insert the shims of same quantity to each of the right and left so that the idler may be perpendicular to the crawler frame.

9-2 Adjustment procedure

Adjustment is to be performed by moving the bearing box (a) of the idler tumbler shaft on level ground.

1. Drive the machine forward by a distance equal to the length of crawler belt (b) to bring the sagging of the belt to the top.
2. Loosen the fixing bolt of the bearing box.
3. Under no port power status, loosen the lock bolt of the collar and remove the collar from the rod. Next, remove the spacer plate (c).
4. Remove the guide plate from the rod.
5. Put the port power at the rod end, push the port power so that the illustrated sagging of the crawler belt may be 0.8"~1.26" and move the bearing box forward.
6. Combine the adjusting shims of two kinds with each other and set them on a clearance between the bearing box and frame. Support the force of the bearing box with the frame.
7. Remove the port power. Insert the residual adjusting shim, guide plate and spacer plate into the rod rear end in this order, set the collar last and fix it with the lock bolt.
8. Tighten the bearing box mounting bolt and fix the tumbler.
9. Adjust the crawler belt of the opposite side in the same way.

Note: Shorten the port power and store it in the tool box. Be sure to remove the port power. If the port power receives the force of the bearing box, the port power will be broken.

⚠ CAUTION

1. **Don't carry out travelling while the bearing box is being pushed out by the port power. The hydraulic jack may be broken.**
2. **Make sure that the tumbler does not apply a load to the head of the port power after adjusting the crawler belt. Remove the port power if necessary.**

NOTICE

1. **For adjustment, the quantity of shim should be the same between the inside and outside. If the tumbler shaft is not perpendicular to the crawler belt, the adjustment bearing seal, shaft tumbler, etc., may be damaged. After the last adjustment, make sure that the left right identification mark are the same.**
2. **Once the machine has been adjusted, drive it back and forth a few times and make sure belt sag is even between the two crawlers. This is essential for distributing the load uniformly on both sides and for ensuring exact straight travelling.**
3. **When travelling in deep sand or on other soft ground, increase the belt sag. This prevents sand and dirt from being trapped.**
4. **Remove one shoe before adjustment if the center of the tumbler must be 3" or more forward from the identification mark.**

9-3 How to loosen crawler belt

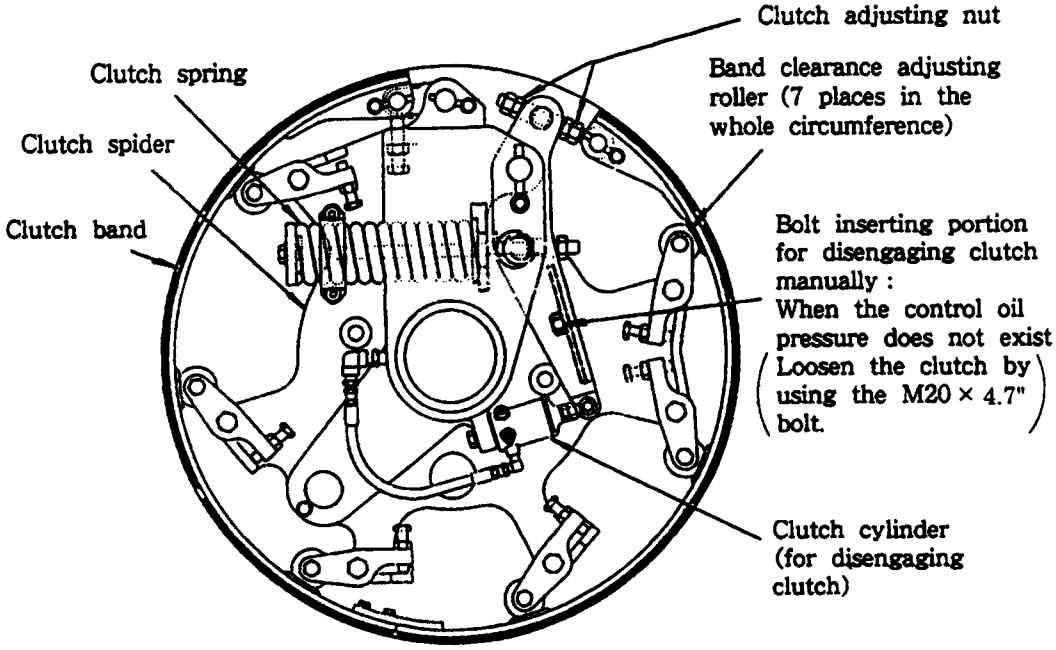
The crawler belt is loosened by removing the adjusting shims and moving the bearing box to the rear.

1. Remove the cover, set the port power to its inside and outside and connect it to the couplers.
2. Loosen the collar fastening bolt, remove the support plate and loosen the bearing box fixing bolts.
3. Remove the force which is applied to the adjusting shims by pushing the port power cylinder until the adjusting shims are loosened on the bearing box.
4. Remove the adjusting shims according to the looseness of the crawler belt. Make sure that the port power is not in contact with the rod. If not, the port power may be broken. This danger is avoided by removing the spacer.
5. Tighten the bearing box fixing bolts.
6. For the subsequent procedure, follow the steps of "How to adjust the crawler extension".

10. ADJUSTMENT OF MAIN HOIST CLUTCH

10-1 Outline

Minimum thickness of lining
.236" (6.0mm)



⚠ CAUTION

Before adjusting or repairing the brake or clutch, the hook block and suspension load must be lowered to the ground. Lower the boom if necessary for safety.

NOTICE

Clutch slippage affects the crane work. Check the following points to prevent the clutch from slipping. Replace, repair, or clean the lining if necessary.

1. **Is the thickness of the clutch lining over the allowable limit?**
2. **Is the spring tension of the clutch adjusted properly?**
3. **Is water or oil adhered to the clutch lining?**
4. **Does oil leak from the clutch cylinder? Is the piston of the clutch cylinder in contact with the cylinder bottom?**

1. In the case of this clutch, the band is always expanded by the tension of the clutch spring (clutch is engaged). The clutch cylinder serves to disengage the clutch. When setting the winch lever to neutral with the winch set in foot mode, oil is supplied to the clutch cylinder and the clutch is disengaged. As a result, the drum and spider are disengaged to allow free fall of the load.
2. To rotate the clutch spider independently for adjustment, etc., depress the brake pedal, then set the winch mode selector switch to the foot mode. Next, turn the clutch switch to the "OFF" position. The clutch spider can now be rotated to the desired position by the winch lever. This clutch switch is explained as "(45) clutch switch" in Chapter 1, Pages 1-5 and 1-15, "Arrangement of switches, meters, etc."

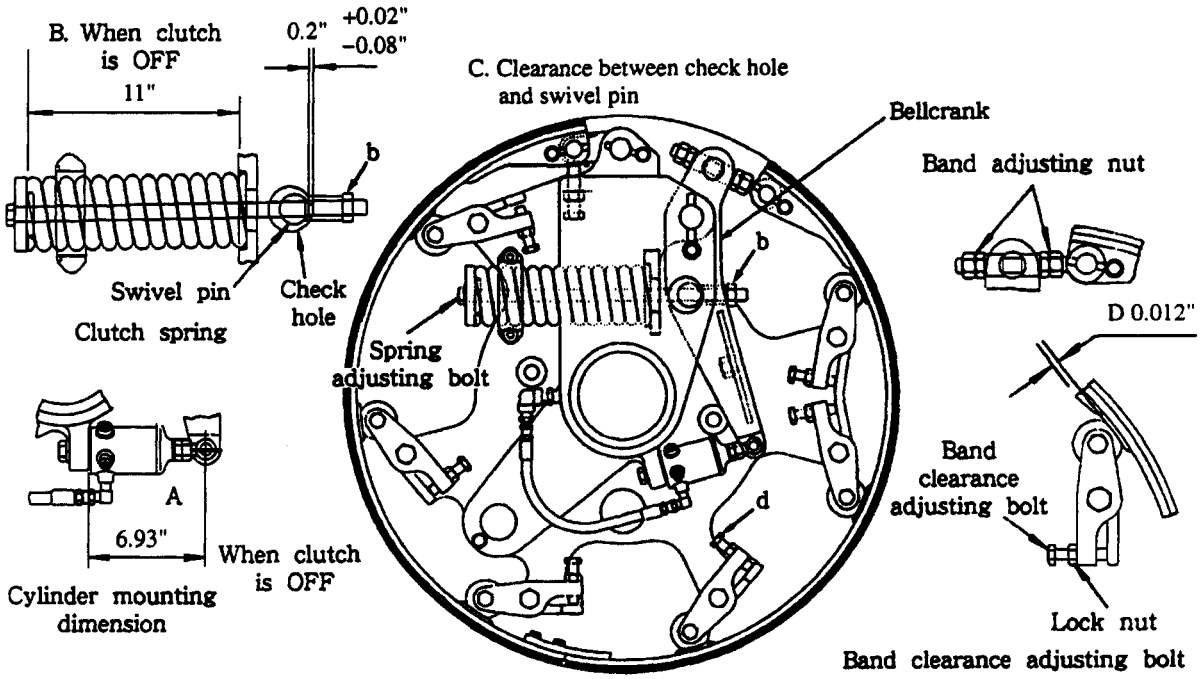
10-2 Adjustment

The tension of the band is usually adjusted due to the wear of the lining.

If the clutch has been disassembled for overhaul, obtain the initial adjustment dimensions in the following procedure. The clutch must not usually be touched.

Initial adjustment dimensions

A	Clutch OFF	6.93 in.
B	Clutch OFF	11.0 in.
C	Clutch ON	About 0.2 in.
D	Clutch ON	0.012 in.



Initial adjustment

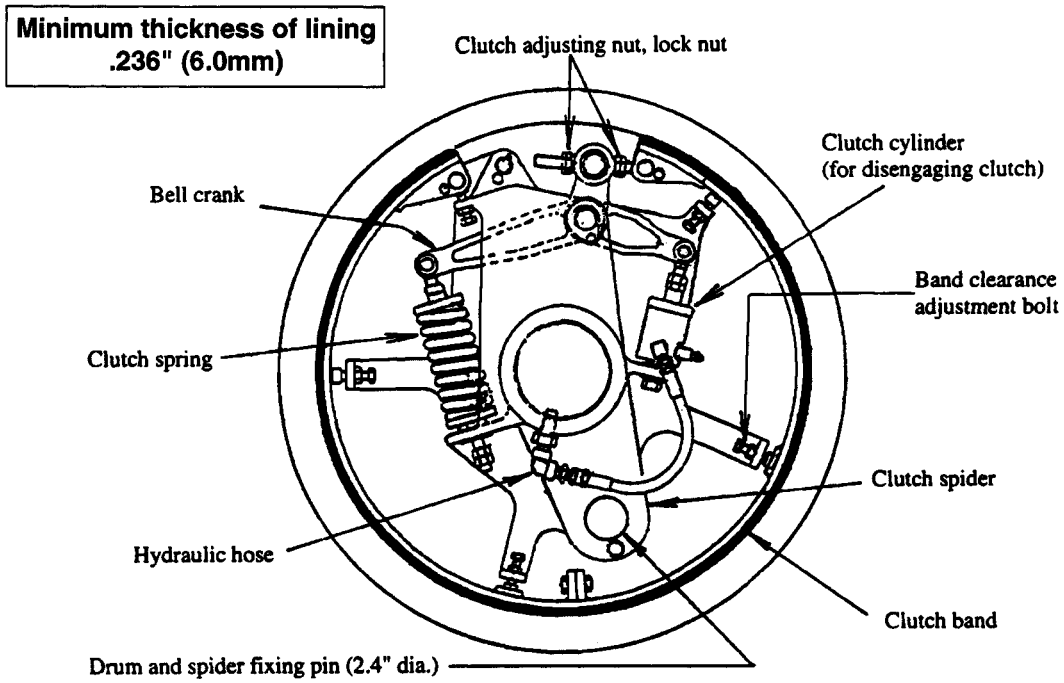
1. Assemble the clutch as illustrated above. Contact the band with the housing lightly.
2. Set the bolt (M20 x 4.72") into the clutch manual disengaging unit to turn the clutch OFF. Screw in the bolt until the swivel pin contacts with the clutch spider lightly.
3. Ensure the cylinder mounting dimension, 6.93".
4. Turn the nut "b" to ensure the spring length of 11".
5. Turn the band clearance adjusting bolt "d" and adjust the band clearance of 7 places to 0.012". The clearance between the lining and housing is 0.012" when the clutch is OFF.
6. Remove the clutch manual disengaging bolt.
7. Adjust the band with the band adjusting bolt so that there may be 0.2" at the left end of the swivel pin and check hole.
8. After adjustment, lock the band adjusting nut and clearance adjusting nut.

⚠ CAUTION

When the clutch is worn, the spring is loosened and the dimension "C" is increased. If the dimension "C" is 0.315", adjust the band with the band adjusting nut to make "C" 0.2". Normally, carry out this adjustment. Use the band adjusting nut.

11. ADJUSTMENT OF AUXILIARY HOIST CLUTCH

11-1 Outline



CAUTION

1. **This pin is used to lock the clutch spider and hoist drum. For standard crane operation, the pin should be removed. Operation is allowed with the pin in place if free fall of the hook and load is unnecessary.**
2. **For the tower crane, the left drum (for tower jib hoisting) must be locked with this pin to secure the clutch spider to the wire drum.**
3. **Before adjusting or repairing the brake or clutch, the hook block and suspension load must be lowered to the ground. Lower the boom if necessary for safety.**

NOTICE

Clutch slippage affects the crane work. Check the following points to prevent the clutch from slipping. Replace, repair, or clean the lining if necessary.

1. **Is the thickness of the clutch lining over the allowable limit?**
2. **Is the spring tension of the clutch adjusted properly?**
3. **Is water or oil adhered to the clutch lining?**
4. **Does oil leak from the clutch cylinder? Is the piston of the clutch cylinder in contact with the cylinder bottom?**

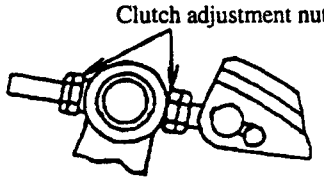
1. In the case of this clutch, the band is always expanded by the tension of the clutch spring (clutch is engaged). The clutch cylinder serves to disengage the clutch. When setting the winch lever to neutral with the winch set in foot mode, oil is supplied to the clutch cylinder and the clutch is disengaged. As a result, the drum and spider are disengaged to allow free fall of the load.
2. To rotate the clutch spider independently for adjustment, etc., depress the brake pedal, then set the winch mode selector switch to the foot mode. Next, turn the clutch switch to the "OFF" position. The clutch spider can now be rotated to the desired position by the winch lever.

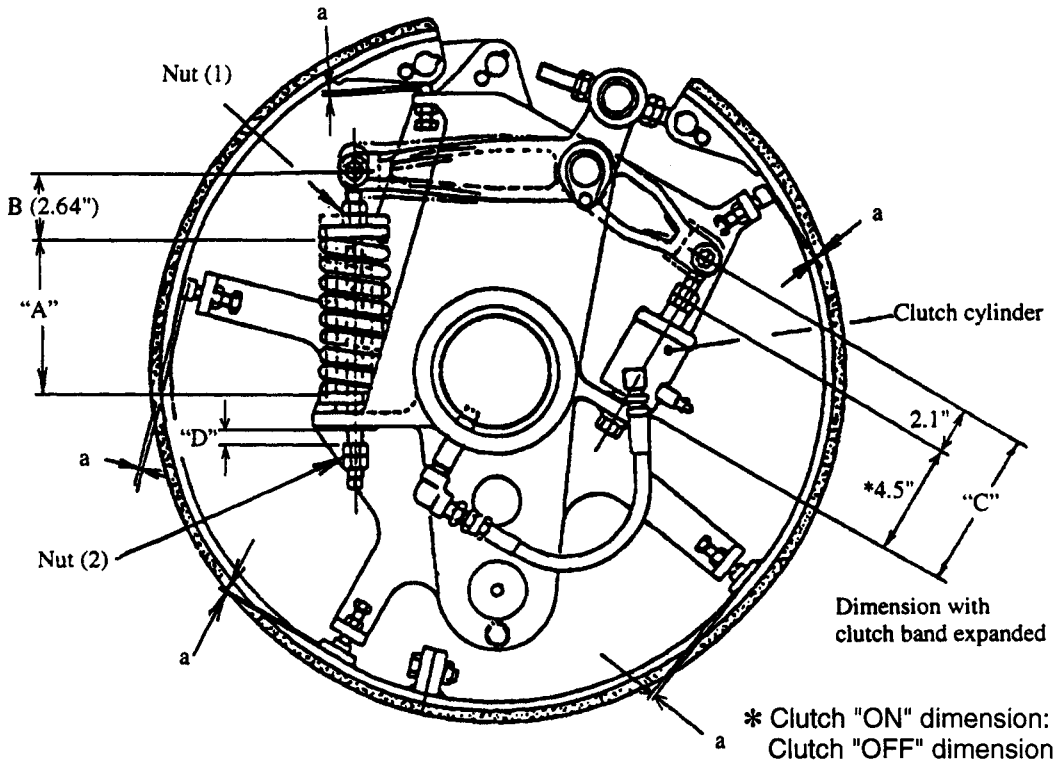
11-2 Adjustment

Dimensions for initial adjustment

(With clutch engaged)

A	Set length of spring	5.96 in.
B	Distance between spring & pin	2.64 in.
C	Set length of cylinder	6.57 in.
a	Band gap	.024 in.





* Clutch "ON" dimension: 4.5 in.
Clutch "OFF" dimension: 4.7 in.
In the clutch "ON" status, a gap of 0.43 in. is obtained between the clutch cylinder bottom and piston.

Usually, the clutch is adjusted for wear of the lining. If the clutch has been disassembled for repair, etc., the above dimensions for initial adjustment should be obtained. Follow the procedure given below.

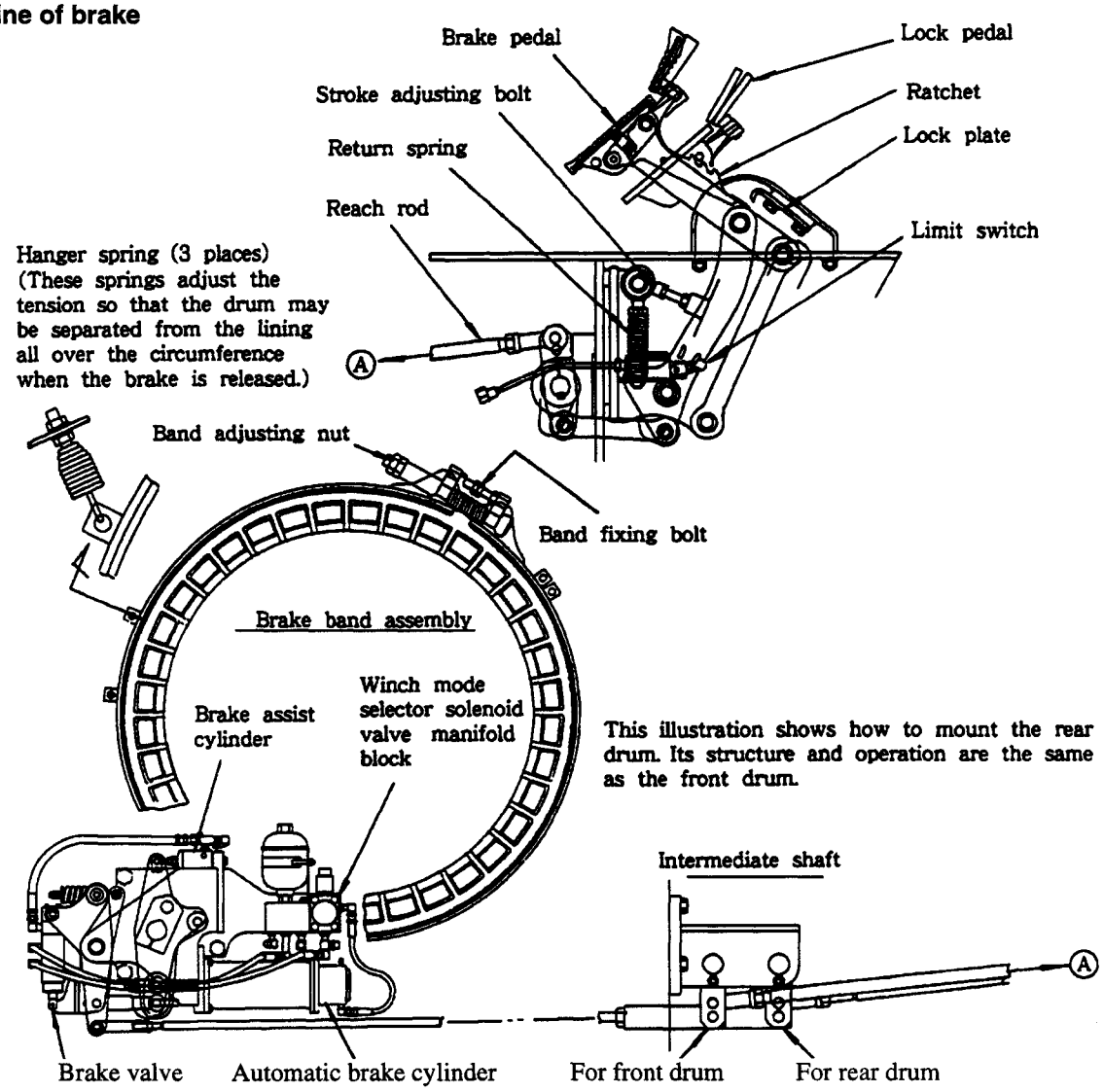
1. Tighten nut (1) so that the set length of spring becomes 5.96 in.
2. Adjust the tension of the clutch band by turning the clutch band adjustment nut.
3. Adjust gap "D" to .59 in. by turning nut (2).
4. Obtain set length "C" of the clutch cylinder so as not to change the present conditions.
5. Adjust gap "a" between each thimble and clutch band to 0.024 in. (0.6mm) at 5 points.
6. Lift a rated load and make sure that the clutch transmission is as specified.

⚠ CAUTION

If dimension "D" is reduced to 0.47 in. or less due to wear of the lining, be sure to return it to .59 in. by readjusting the band. If the lining is used despite significant wear, the bottom of the clutch cylinder will contact with the piston, disabling expansion of the clutch. As a result, the clutch fails to hold and the load may fall.

12. ADJUSTMENT OF MAIN HOIST BRAKE

12-1 Outline of brake



CAUTION **The limit switch must operate where the second ratchet is applied to the lock plate and the braking force must hold the rated load safely. Adjust the brake to keep such a condition.**

Brake assist device assembly

This brake mechanism consists of two systems: Foot mode, dependent on pedal operation, and one for Automatic mode, in which the brake is controlled with the automatic brake cylinder.

Foot mode: Although this mode is basically the same as a mechanical brake, in which the brake band is controlled by the pedal force, a hydraulic assist mechanism is designed to boost the pedal force.

Automatic mode: Returning the winch control lever to neutral, the automatic brake cylinder activates to engage the brake band, thereby applying the brake.

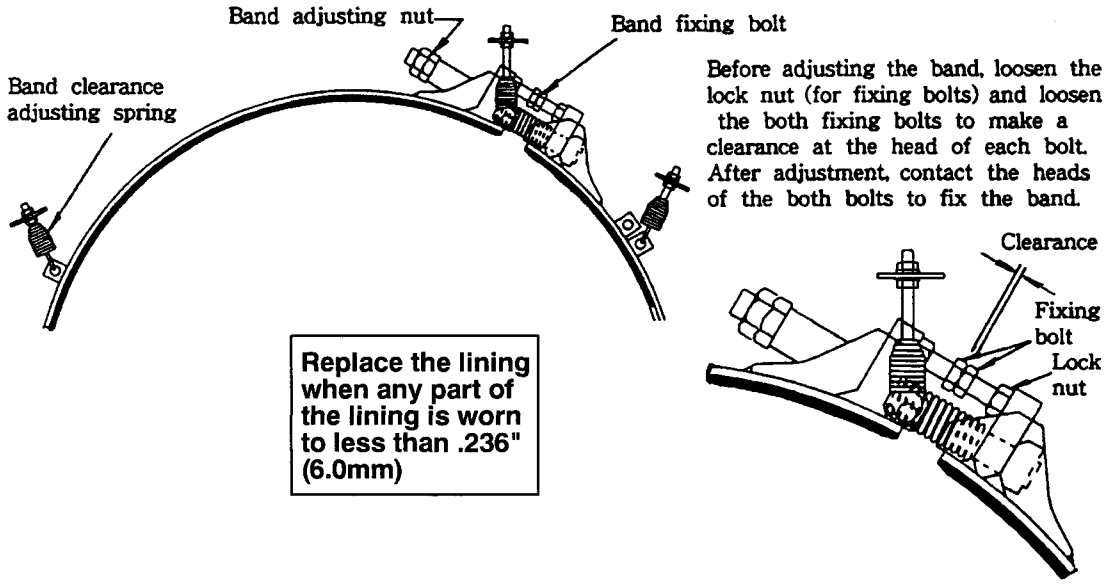
The automatic brake cylinder functions as an emergency brake to keep the brake engaged in an emergency such as a drop in control hydraulic pressure. The brake is spring applied hydraulic release.

12-2 Adjustment of brake band

CAUTION

Adjust the brake to hold a rated load. If the brake is not operating properly, the load may be dropped. Check the following points. Replace the lining, adjust the band tension or clean the lining if necessary.

1. **Is the thickness of the brake lining over the allowable limit?**
2. **Is the tension of the brake band adjusted properly?**
3. **Is water or oil adhered to the brake lining?**
4. **Is the band clearance maintained over the entire drum circumference? Is the brake pedal force proper?**
5. **Is the lag of the brake band deformed? Is the brake rod or linkage normal?**



CAUTION

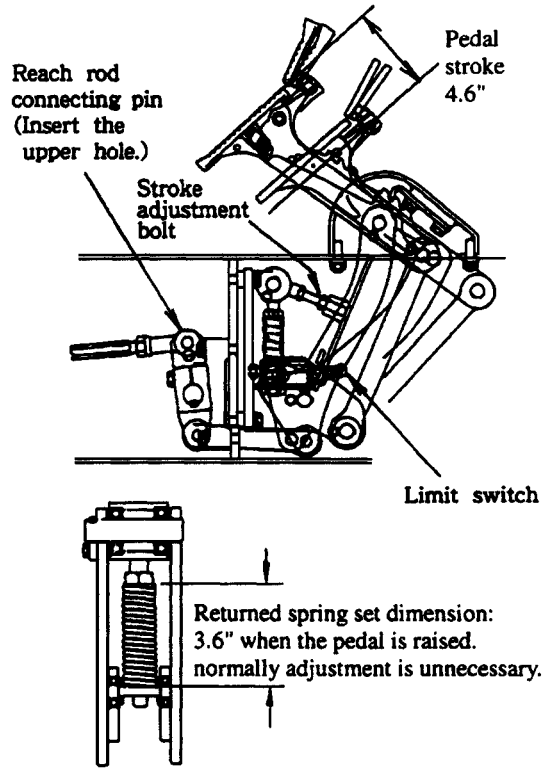
As the lining is wearing, the effect of the brake pedal weakens and the pedal comes closer to the floor so that the braking force is reduced. To compensate for lining wear, adjust the brake band in the following procedure.

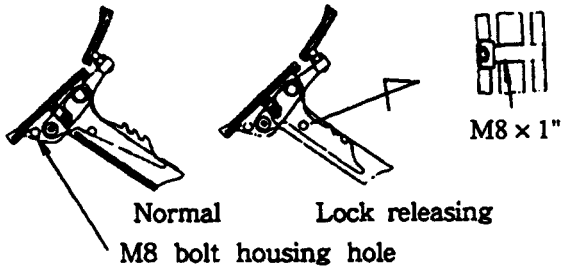
1. Lower the load and the hook to the ground.
2. Raise the brake pedal to release the brake, after brake "FOOT MODE" is selected.
3. Loosen the nut of the band adjusting bolt and back out the bolts to provide a gap between the heads of the two bolts.
4. Tighten the band adjustment nut to adjust the brake band. For adjustment, make sure that the rated load can be held when the brake pedal has a proper force and the second ratchet is hooked on the lock plate while the pedal is being depressed. Adjust the brake band so that the limit switch can operate when the second pawl is hooked on the lock plate. Make sure that the third pawl is hooked on the lock plate when the pedal is depressed further.
5. When brake is engaged, move the band fixing bolts until their heads come in contact with each other.
6. Adjust the tension of the band clearance adjustment springs to provide clearance. Adjustment is satisfactory when the lining and brake drum are separated over the entire circumference when the brake is released.

12-3 Adjustment of pedal stroke

If an adequate pedal stroke in not ensured, the hydraulic assist device will not operate satisfactorily, which may cause dragging of the band. Make sure that the pedal moves 3.8 " with the rod connecting pin pulled out. Insert the connecting pin.

1. Depress the pedal down to second ratchet pawl as a reference.
2. Allow the pedal to rise by 4.6 ". At this position, bring the stroke adjustment bolt into contact with the stop.
3. Confirm that the limit switch is activated at the position where the pedal is depressed to the second ratchet pawl.
   At this state pedal stroke is 3.8 ".



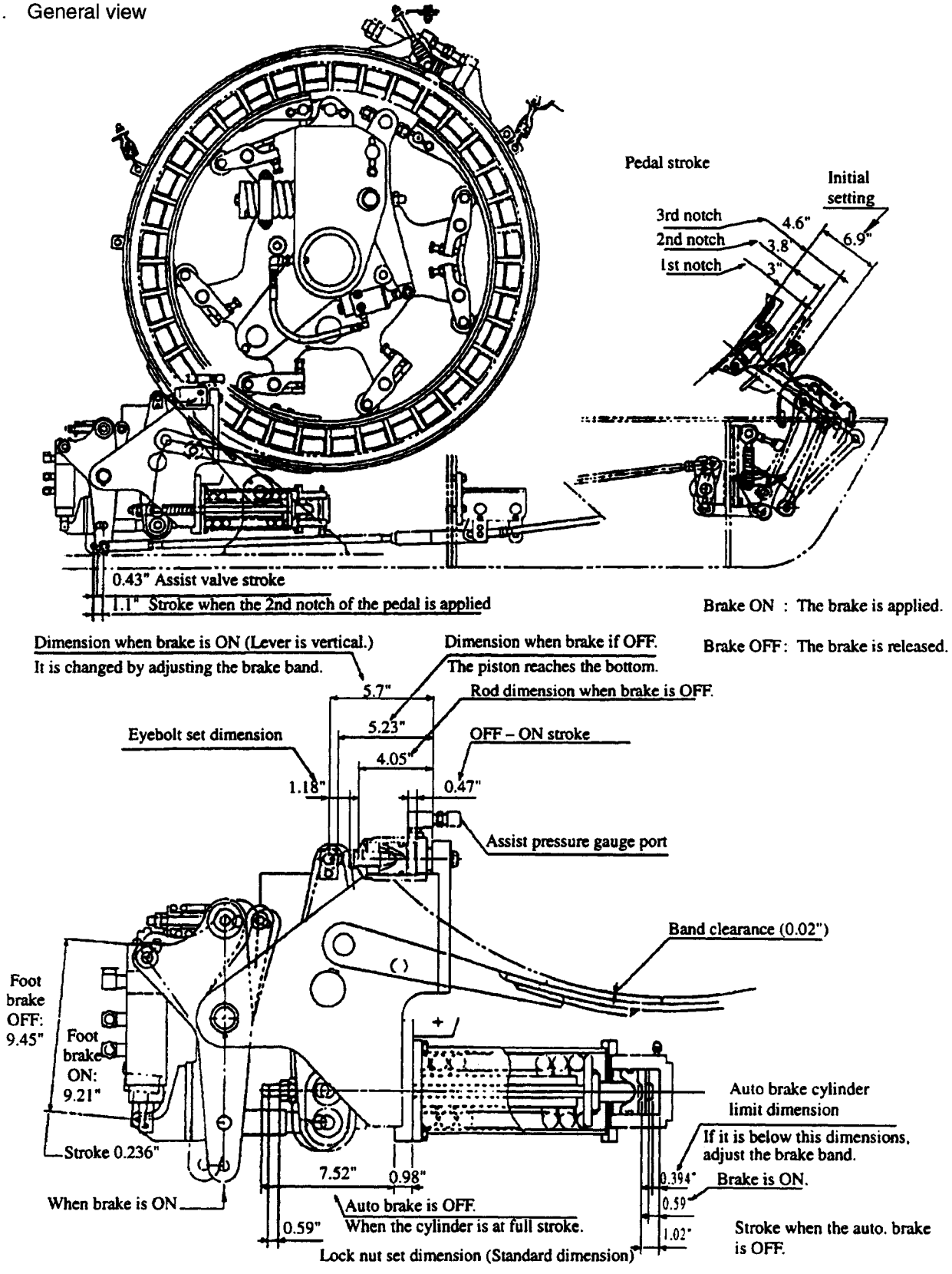


Releasing pedal lock

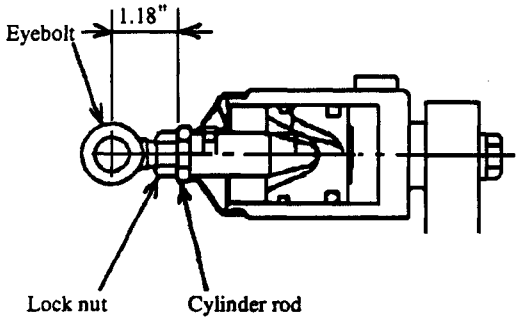
If the pedal lock function is not required with clamshell operation, etc., the ratchet can be locked by tightening the bolt (shown above) so that the pedal lock cannot be engaged. (For normal operation, the bolt should be in the housing hole.)

12-4 Adjustment of brake

1. General view



2. Adjustment

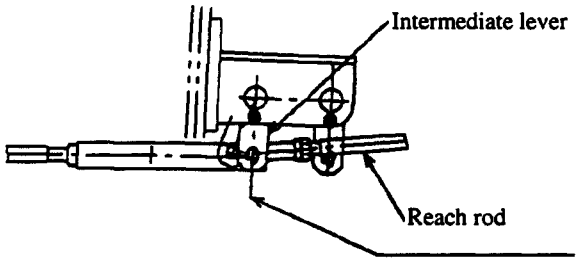


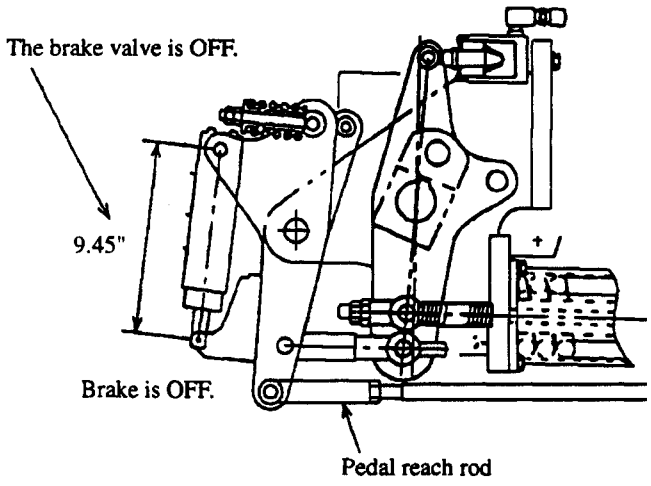
2. Adjustment of the auto brake cylinder

Remove the reach rod from the pedal beforehand.

Extend the auto brake cylinder (foot brake side) to set the brake OFF. (The piston of the assist cylinder reaches the bottom.)

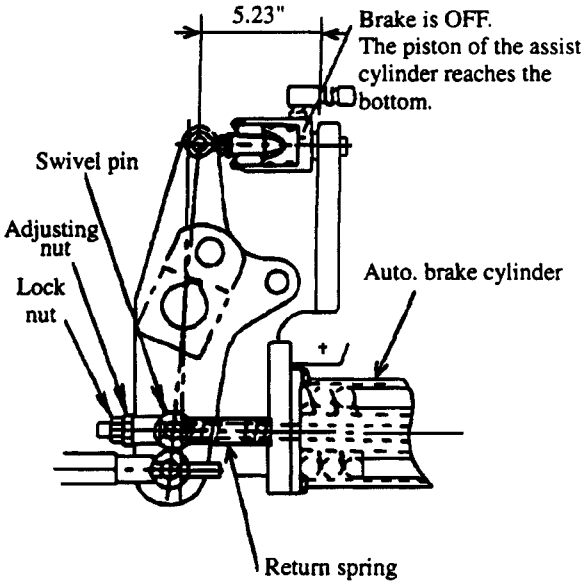
Under the above condition, tighten the adjusting nut, loosen it by half a turn from the position where it contacts with the swivel pin (clearance of 0.04") and fix it with the lock nut.





1. First, adjust the assist cylinder

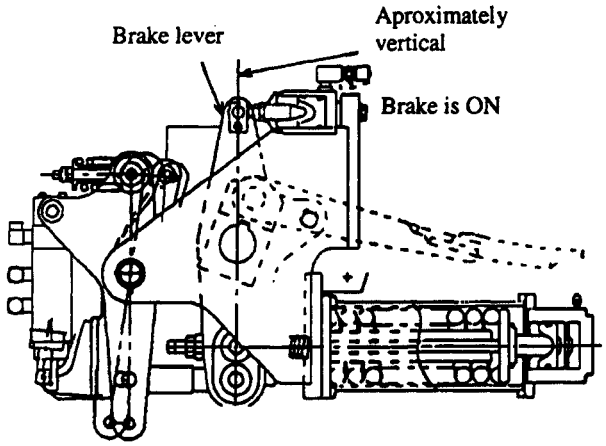
Set the dimension of the eyebolt and cylinder rod to 1.18" and fix them with the lock nut.



3. Mounting of the pedal reach rod

Mount the reach rod while the brake is OFF and the foot pedal is released fully. (Make sure that the brake valve is OFF).

Mount the reach rod while the brake is OFF and the foot pedal is released fully. (Make sure that the brake valve is OFF).



4. Adjustment of the brake band tension

Tighten the band tension adjusting nut so that the brake lever may be approximately vertical (standard) when the auto brake is ON.

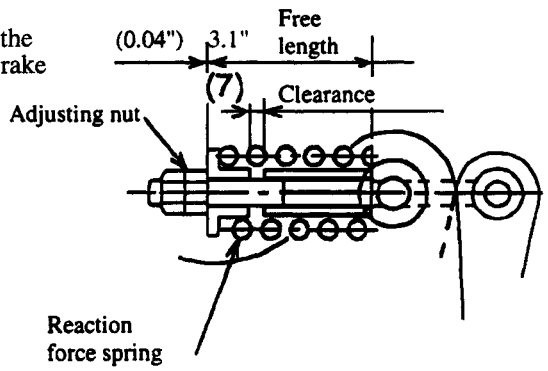
Under this condition, change to the foot brake side, effect a free condition and make sure that the drum is turned by hand (33-44 lbs. with the drum lock notch).

If the drum does not turn smoothly, adjust the band lifting spring and check the contact of the clutch band with the drum.

If the drum still does not turn smoothly because of the initial fit of the band, loosen the band tension adjusting nut. (Nut: M30-P3.5 0.14" by one turn)

5. Adjustment of depress force

Standard set dimension at the foot brake side when the brake is OFF.

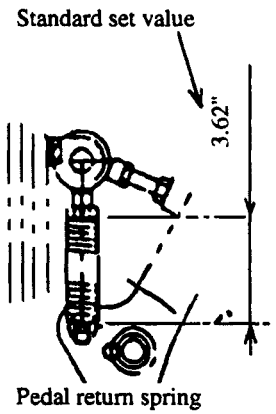


Tighten the adjusting nut → The pedal reaction force is increased. (The pedal is heavier).

If the adjusting nut is loosened excessively, the pedal is lightened, the assist pressure is increased rapidly, the brake feeling is lost and the brake is ineffective.

When depressing the pedal fully, make sure that the assist cylinder pressure is 853 psi or more.

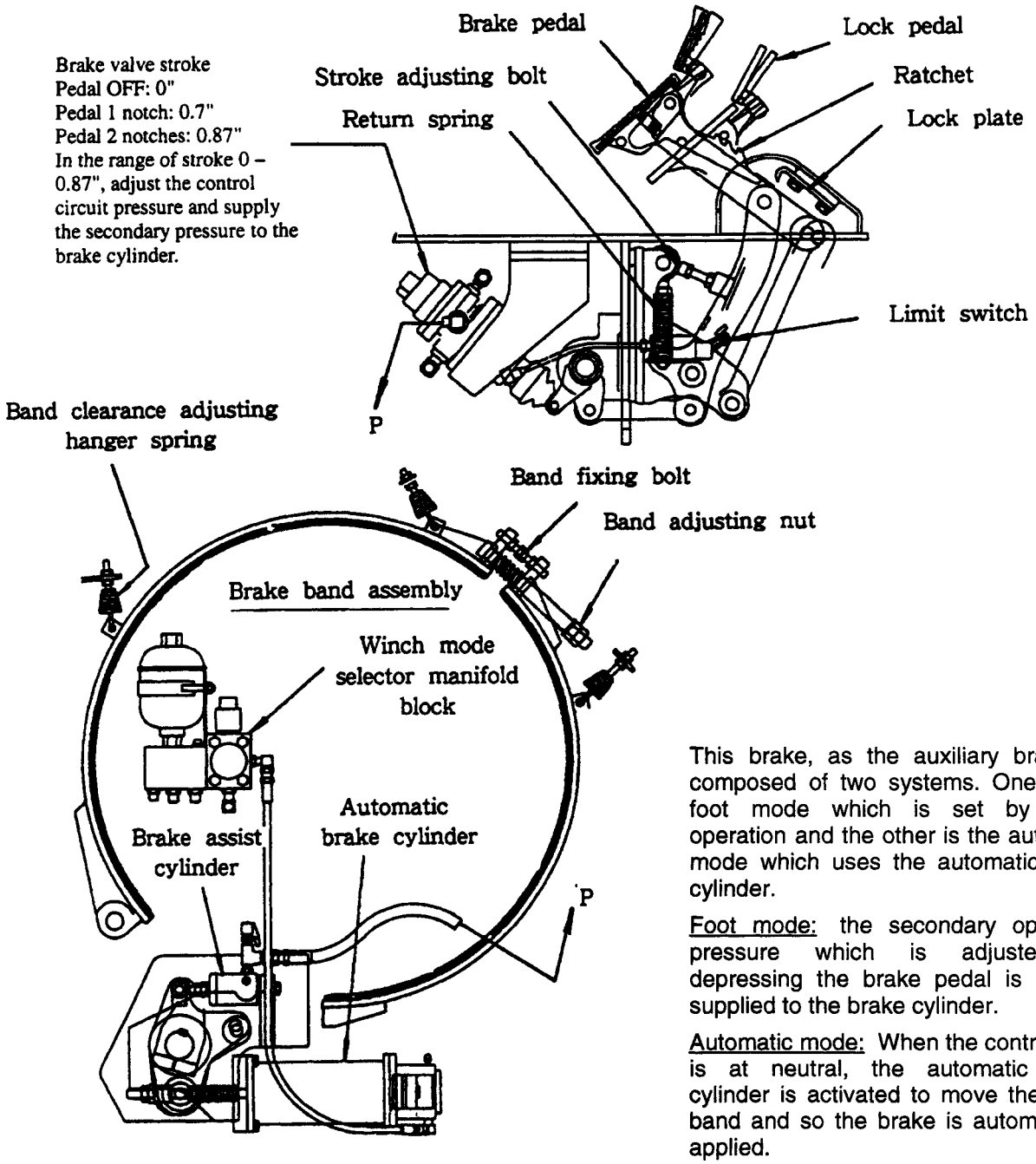
6. Return spring of pedal



If treading force of a pedal is heavy, lengthen the set dimension. (Spring free length: 4")

13. ADJUSTMENT OF AUXILIARY DRUM BRAKE

13-1 Outline



This brake, as the auxiliary brake, is composed of two systems. One is the foot mode which is set by pedal operation and the other is the automatic mode which uses the automatic brake cylinder.

Foot mode: the secondary operating pressure which is adjusted by depressing the brake pedal is directly supplied to the brake cylinder.

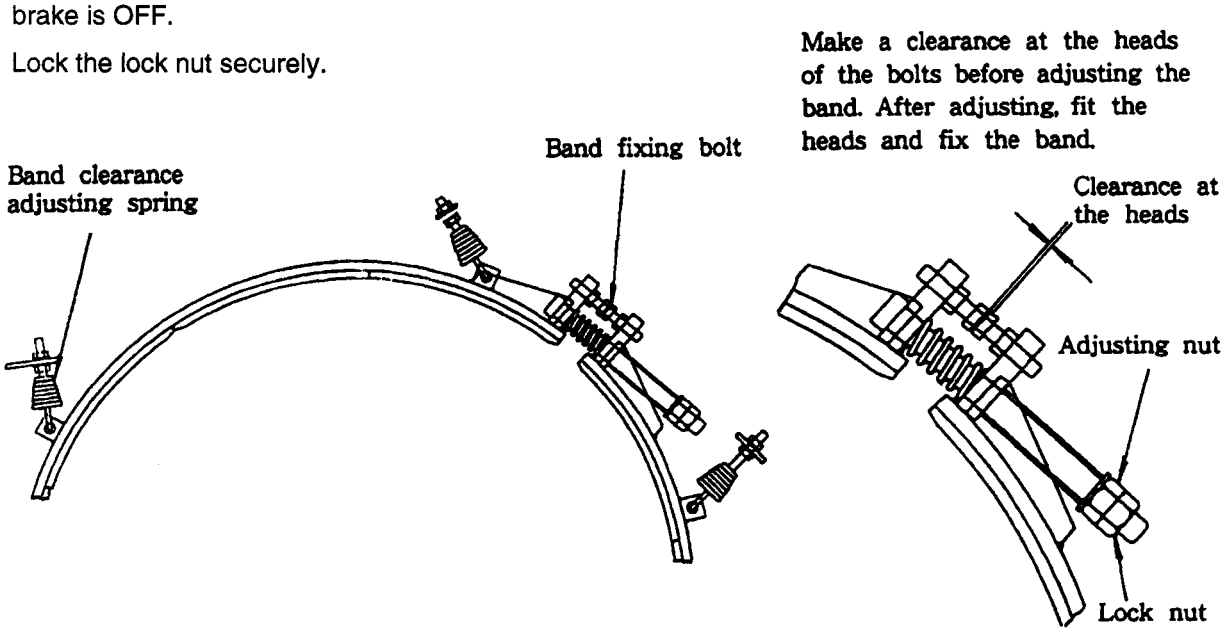
Automatic mode: When the control level is at neutral, the automatic brake cylinder is activated to move the brake band and so the brake is automatically applied.

13-2 Adjustment of brake

1. Normally, the band is adjusted to compensate for the wear of the brake band lining.
2. After the band lining is replaced, adjust the clearance all over the band. This is necessary to separate the lining from the drum all over the circumference when the brake is released.
3. When the brake band linkage has been disassembled, check the operating stroke of the brake pedal and brake valve and then carry out the initial adjustment.

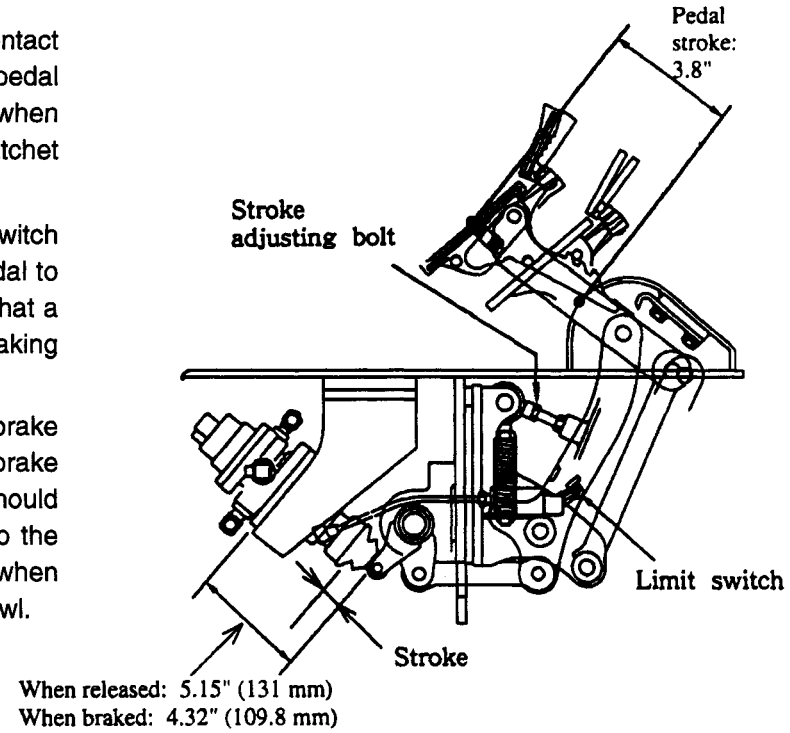
13-3 Adjustment of brake band

1. Turn the band fixing bolts to make a clearance at the heads.
2. Tighten the adjusting nut by depressing or releasing the pedal to obtain a proper depressing force and braking force.
3. Tighten the fixing bolts while the pedal is completely depressed and lock the band.
4. Adjust the hanger spring so that the band clearance may be 0.04" all over the circumference when the brake is OFF.
5. Lock the lock nut securely.



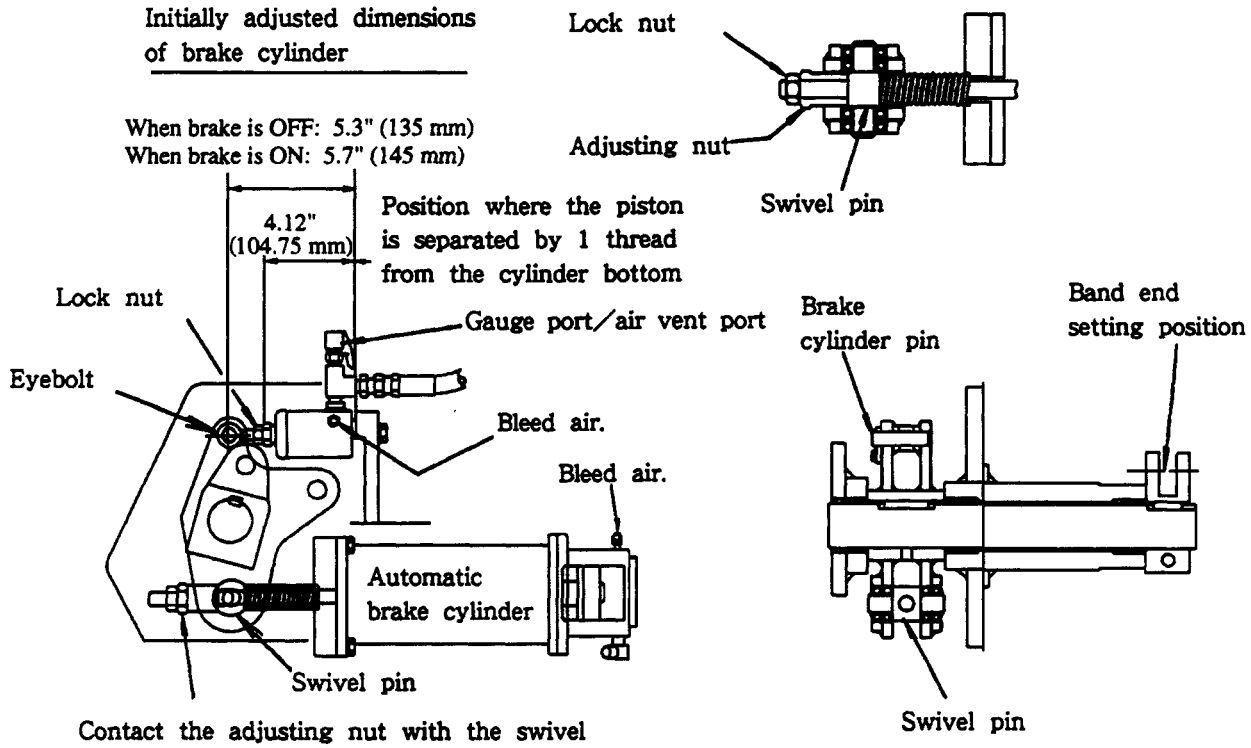
13-4 Adjustment of pedal stroke

1. Adjust the stroke adjusting bolt to contact with the stopper where the released pedal is moved by 3.8". The stroke is 3.8" when depressing the pedal to the second ratchet pawl.
2. Make adjustment so that the limit switch can operate when depressing the pedal to the second ratchet pawl. Make sure that a rated load can be held by the braking force.
3. Check the operating stroke of the brake valve. The stroke is "0" when the brake pedal is fully released. The stroke should be 0.7" when depressing the pedal to the first ratchet pawl and 0.866" when depressing it to the second ratchet pawl.



13-5 Adjustment of brake band linkage

1. Adjust the dimension against the brake cylinder pin to 5.3" (135mm) when the brake is OFF with the brake pedal released. At this position, screw in the eyebolt by 1 turn to separate the piston from the cylinder bottom.
2. Adjust the brake band by depressing or releasing the pedal so that the dimension against the pin may be 5.7" (145mm) when the brake is ON.

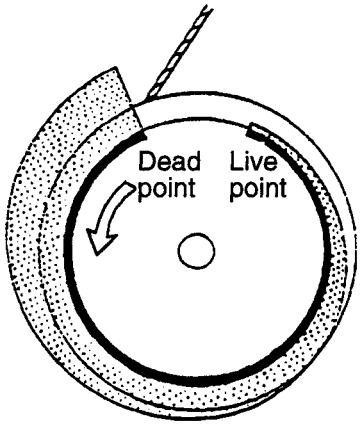


3. Set the automatic brake cylinder after adjusting the pedal brake. Contact the adjusting nut with the swivel pin tightly when the rod is extended to the maximum by supplying the pressurized oil to the cylinder. Turn the nut by half a thread and then tighten the lock nut securely.
4. Bleed the air from both cylinders by depressing or releasing the brake pedal lightly.
5. After adjusting the brake, lift a load and carry out the brake test. Make sure that the machine can hold the rated load safely.

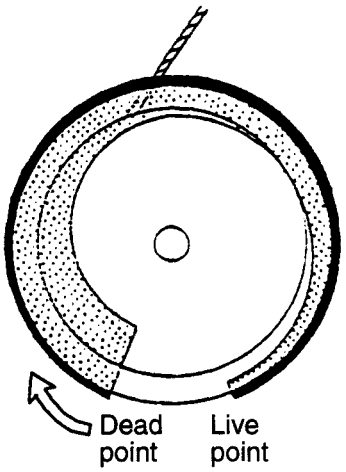
14. SERVICE LIFE OF LINING AND SHEAVE

The band type lining usually begins wearing from the dead point side (clutch/brake band fixed end). However, it may wear at different places, depending on how the lining contacts. Measure the most worn point of the lining and replace it if worn beyond the minimum thickness.

14-1 Figures for one-way characteristic (band type)



Clutch transmission force



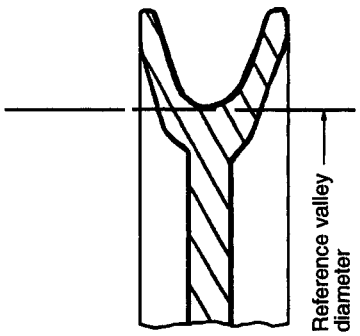
Braking force

14-2 Lining service life

Position		Thickness of New Lining	Minimum Thickness
Clutch	Main and aux. hoist	0.4 inch	0.24 inch
	Third drum		
Brake	Main and aux. hoist	0.4 inch	0.24 inch
	Third drum		

Replace linings if any portion of lining is worn below the minimum thickness.

14-3 Service limit of sheave (Japanese alone)



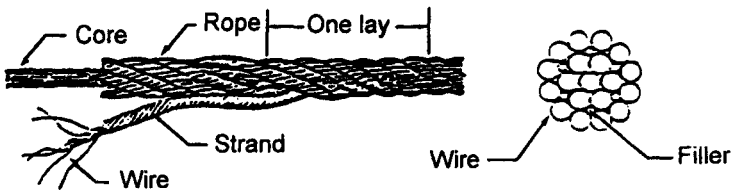
1. Wear of the sheave groove must meet the following conditions:
   a. Must be within the difference of the reference valley diameter minus (rope diameter x 0.2) if the rope used has a diameter of 1" or more.
   b. Must be within the difference of the reference valley diameter minus (rope diameter x 0.3) if the rope used has a diameter of less than 1".
2. Check for excessive wear or deformation. Wear or deformation into the groove or groove sides must not be worn or deformed so that it does not uniformly support the rope or it has sharp edges which would damage the rope. If this type of wear or deformation is present - replace the sheave.
3. If bearing or shaft is worn less than 15% of the original dimension, replace the worn part.

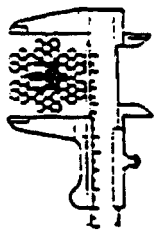
   (For other details, refer to the periodic self-inspection guide for mobile cranes).

14-4 Service limit of wire rope (Japanese alone)

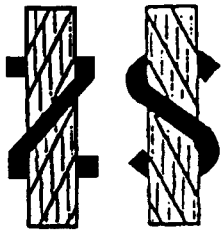
Wire rope should be inspected regularly and with particular care regarding the parts where wear and corrosion are apt to occur, and should be replaced before reaching the service limit.

The following standards are based on the general regulations for operational safety of cranes, etc. The pendant rope should also be inspected carefully.

<table>
<tr><th>Service Limit</th><th>Remarks</th></tr>
<tr><td>When more than 10% of the wires (except fillers) are broken within one lay of the rope</td><td> 

Example: Wire rope of 6 x Fi (29) has 22 wires per strand. Thus, we obtain:
$6 \times 22 \times \frac{10}{100} = 13.2$ Therefore, if 14 wires are broken within 1 lay, it can no longer be used.</td></tr>
<tr><td>When the rope diameter has been reduced by more than 7% of its nominal diameter</td><td> 
The diameter should be measured in three different directions without a load to work out an average for comparison within the nominal diameter.
Example: In the case of wire rope having a nominal diameter of 0.787" (20mm)
$0.787" \times (1 - \frac{7}{100}) = 0.732"$ (18.6mm) Therefore, this wire rope must be replaced when the average diameter has been reduced to less than 0.732" (18.6mm).</td></tr>
<tr><td>When the rope has kinked</td><td> 
The remaining breaking strength of kinked wire rope differs depending on how the rope was kinked. However, once the rope is kinked, loss of its strength is inevitable. So, immediate replacement is essential.
Decrease in breaking strength due to kinking
<table>
<tr><th>Rope condition</th><th>Remaining strength</th></tr>
<tr><td>Original rope</td><td>100%</td></tr>
<tr><td>Kinked but corrected</td><td>83 to 80%</td></tr>
<tr><td>Kinked in twisting direction</td><td>60 to 55%</td></tr>
<tr><td>Kinked in untwisting direction</td><td>45 to 40%</td></tr>
</table></td></tr>
<tr><td>When the rope has been significantly deformed or corroded</td><td>Significant deformation: Dents in the strands, exposed core or more than one loose strand
Significant corrosion: Pits on wire surfaces or corrosion reaching the inside of the rope</td></tr>
</table>

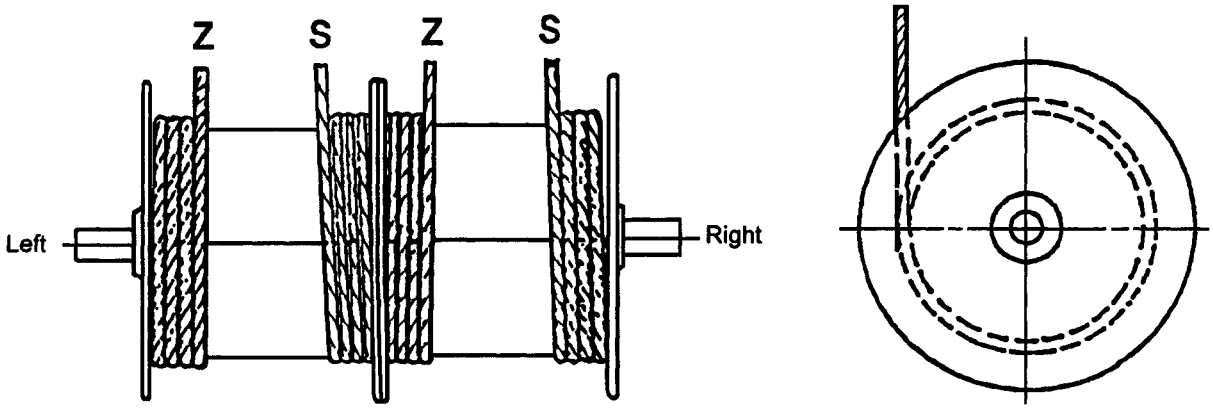
Rope twisting direction and winding onto drum (reference)



For "Z" lay, rope is wound from left to right.

For "S" lay, rope is wound from right to left.

Therefore, when winding the rope from the inside of each drum, use the "Z" lay for the right drum, and the "S" lay for the left drum. When winding the rope from the outside of each drum, use the "Z" lay for the left drum, and the "S" lay for the right drum.

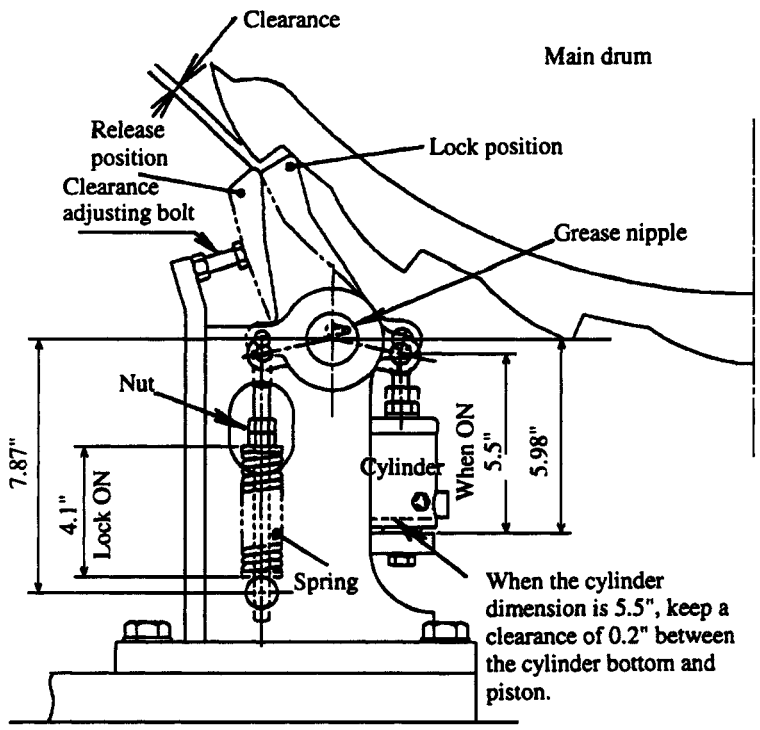


The wire rope tends to turn in the untwisting direction when it is tensed. When winding the first layer of rope evenly by pulling strongly as shown above, it serves as a basis for subsequent correct winding. If the rope is wound roughly on the first layer, it is overlaid one-sidedly or bitten between adjacent ropes, causing excessive wear or crushing. As a result, the rope will reach the end of its service life earlier.

The standards for the structure of the crane, etc., stipulate that at least 2 rope windings should always be left on each drum.

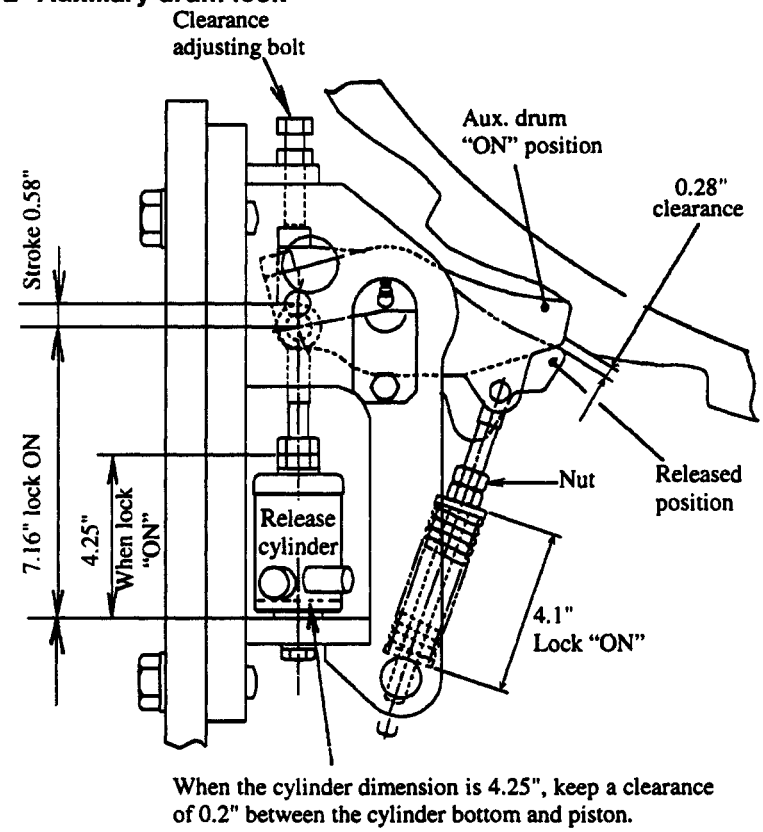
15. ADJUSTMENT OF DRUM LOCK AND SWING LOCK

15-1 Main drum lock



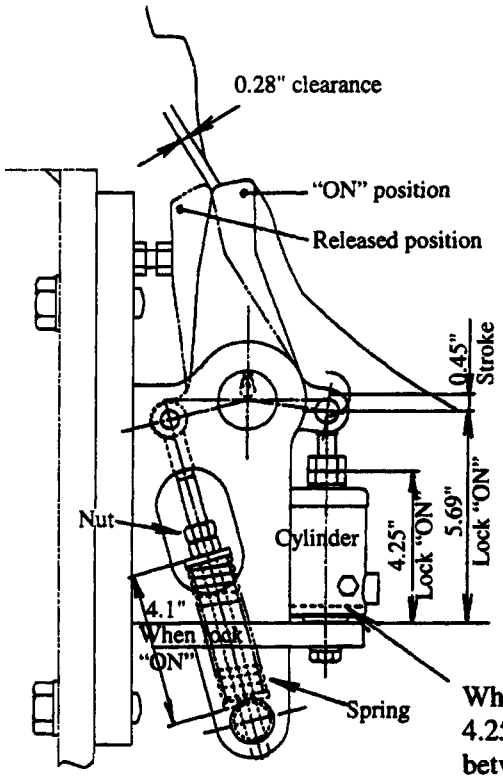
1. Adjust the spring length with the nut to be 4.1" when the lock is "ON".
2. When the lock is "ON", the hydraulic cylinder mounting dimension is 5.5". When the lock is released, the hydraulic cylinder mounting dimension is 5.98". Keep a clearance of 0.2" at the bottom of the cylinder.
3. Use the clearance adjusting bolt to adjust the clearance between the pawl and drum teeth.

15-2 Auxiliary drum lock



1. When the lock is "ON", the cylinder mounting dimension is 4.25". In such a case, make sure that there is a clearance of 0.2" between the piston and cylinder bottom.
2. When the lock is "ON", the spring dimension is 4.1". Adjust the spring length with the nut.
3. The cylinder stroke is 0.58". When the lock is released, a clearance between the drum and pawl is 0.28". Make adjustment with the clearance adjusting bolt.

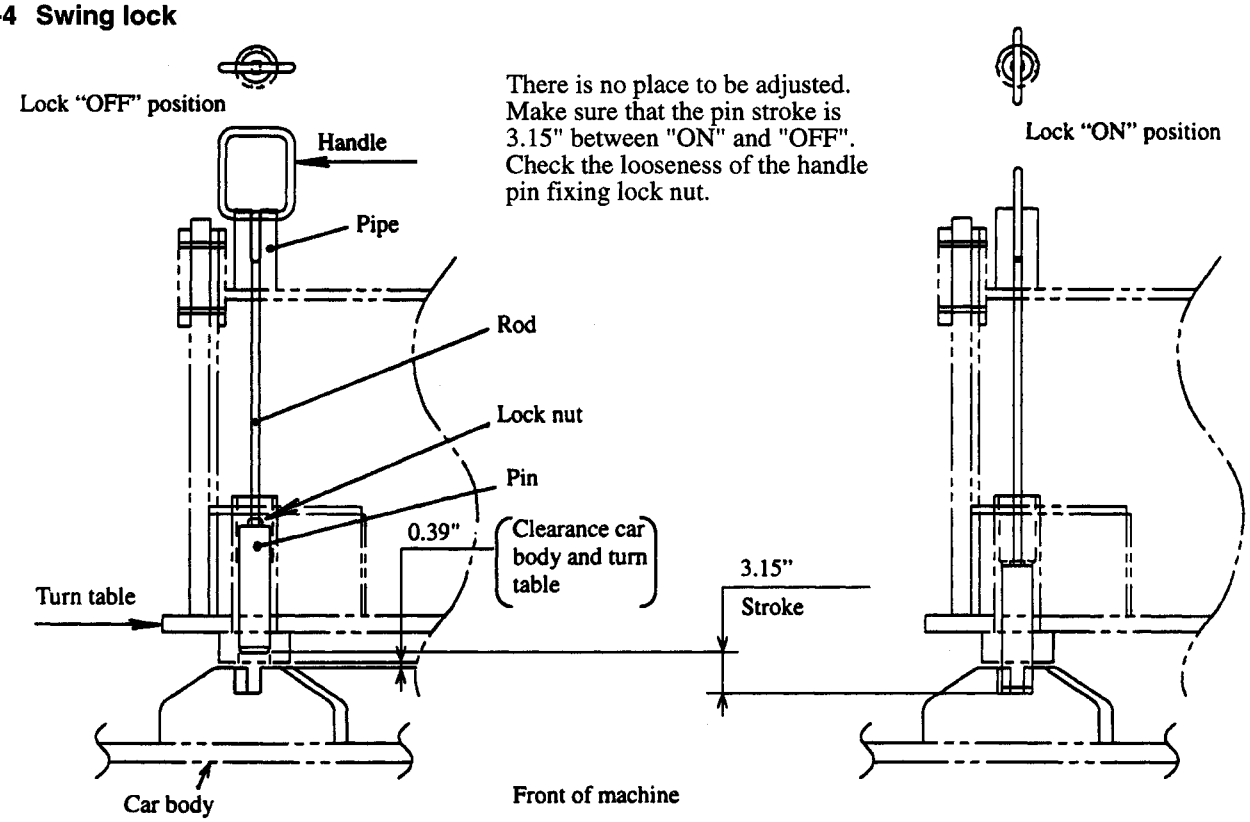
15-3 Boom drum lock



1. When the lock is "ON", the cylinder mounting dimension is 4.25". Make sure that there is a clearance of 0.2" between the piston and cylinder bottom.
2. When the lock is "ON", the spring set dimension is 4.1". Adjust the spring length with the nut.
3. The cylinder stroke is 0.45". When the lock is released, a clearance between the drum and pawl is 0.28". Make adjustment with the clearance adjusting bolt.

When the cylinder dimension is 4.25", keep a clearance of 0.2" between the cylinder bottom and piston.

15-4 Swing lock



16. MAINTENANCE UNDER SPECIAL CONDITIONS

16-1 Operation in water

(Maximum depth of water should be one half the crawler height for operation in water)

- Before operation:
  1. Adjust the tension of the crawler belts according to the condition of the river bed, etc.
  2. Confirm that the crawler shoe pins, lock bolts and pins are firmly tightened.
  3. Confirm that the plugs of the travel reduction gear, front idler, etc., are properly clamped. Retighten reduction gear clamp bolts.
- After operation:
  1. Wash undercarriage with fresh water.
  2. Apply grease to the slides of the idler tumbler adjustment bearings, and waste oil on shoe pins.
  3. Discharge a slight amount of the oil by loosening the plug of travel reduction gear and check if water is mixed in.
     a. For operation in water, the depth must not exceed 1/2 the crawler height.
     b. Do not steer the machine in water without checking the bed condition.
     c. The place for refuge in the event of flooding or some other emergency should be determined before operation and a passage to the place should be secured. After operation, the machine should be moved to this place for refuge.

Note: The instructions on operation in water are also applicable to operation on muddy ground.

16-2 Operation on a beach

- Before operation:
  1. Moving parts, even if not provided with a grease fitting, should always be coated with adequate oil or grease.
  2. Be sure to use soft water for the cooling system.
  3. Apply grease to the necessary positions of electrical parts as a corrosion prevention measure, since problems with these parts are often caused by rust and moisture.
- After operation:
  1. Wash the machine thoroughly to eliminate salty substances and wipe with a cloth soaked in oil when necessary.
  2. Retouch the areas where paint has peeled off.

16-3 Operation in a dusty or windy place

1. Clean the air cleaner element earlier than usual.
2. Earlier maintenance is required for the oil cooler and radiator core in order to prevent clogging.

16-4 Operation at a rocky site

1. Carefully check that the crawlers are free from cracks, wear, damage, etc.

16-5 Operation in cold weather

1. Check the level and specific gravity of the battery electrolyte, and recharge the battery earlier than in mild weather.
2. Use the lubricating oil and hydraulic oil recommended for cold weather.
3. Be sure to discharge the engine coolant if antifreeze is not used.
4. Drain water completely from the fuel tank. Replenish fuel after operation and drain precipitated water from the tank before operation.
5. When stowing away the machine, place planks under the crawlers to prevent freezing. In addition, avoid a location exposed to strong wind, and cover the machine with canvas or the like.

17. STOWAGE OF MACHINE

Take the following measures when stowing away the machine for a long time.

17-1 Preparation for stowage

1. Select a place where no damage can be caused by wind or water, and park the machine on level ground.
2. When the machine is not intended to be used for 10 days or longer, lower the front attachment to the ground regardless of its type, length, etc.

   This measure should also be taken before stowage for less than 10 days if strong winds, an earthquake, etc., is anticipated.
3. All parts required to be greased in the lubrication chart should be greased. All reduction gears, the hydraulic oil tank, and engine oil pan should be supplied with the determined oil up to the specified level.
4. All control levers should be set in neutral. All brakes and locks should be applied and engaged.
5. All control switches should be turned off. Any disconnected electric terminal of the front attachment should be completely sealed with vinyl tape.
6. When the ambient temperature is expected to fall below 32° F, drain the radiator coolant completely unless antifreeze is added. Attach a tag stating that water has been drained. Water for the cab heater should also be drained.
7. Disconnect battery terminals and cover the battery, or dismount and stow it away.
8. Close every machine door completely and engage the lock key when provided.
9. When stowing the machine for over a month, clean each section and cover the base machine with canvas or the like.

17-2 Maintenance during stowage

1. Run the engine under no load for 30 to 60 minutes once a month. When the crane boom is lowered on the ground, hoist the boom every other month up to the working position and perform no-load operation for about one hour.
2. During no-load operation, check to see if each device (particularly, safety devices in the case of the crane configuration) operates normally. If any device does not operate normally, it must be repaired immediately.
3. Recharge the battery every month.

17-3 Preparation for operation after stowage

1. Before starting the engine, carry out the general appearance check.
   - Confirm that oil is not leaking from the engine, hydraulic equipment, piping, etc.
   - Confirm that the front attachment does not have an ejected joint pin or loose bolt.
   - Confirm that wire ropes are in normal condition and they are not caught by the joint pin, etc.

17-3 Preparation for operation after stowage (cont'd)

2. Drain water from:
   - Engine oil pan
   - Hydraulic oil tank
   - All reduction gear cases
   - Fuel tank

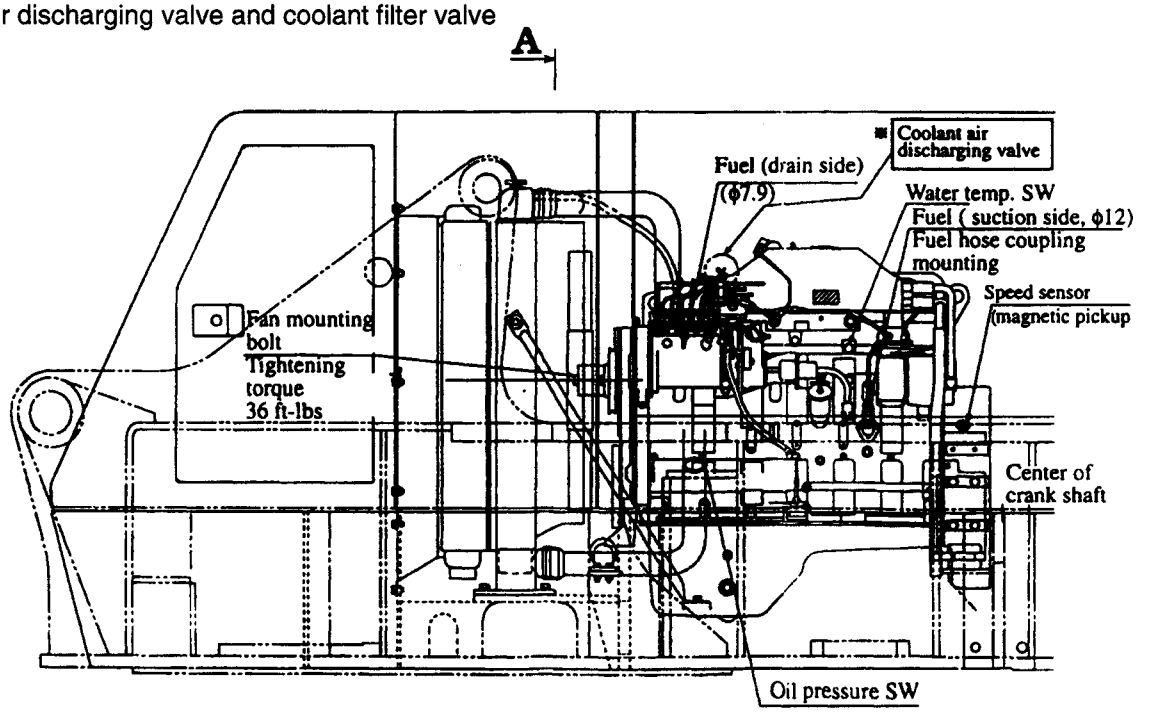
     Confirm that oil is contained up to the specified level.
   - Check that radiator coolant is contained up to the specified level.
3. Grease all points specified in the lubrication chart.
4. After starting the engine, run it at idling speed for about 5 minutes. During idling, perform the following confirmations:
   - Confirm that oil is not leaking.
   - Confirm that no abnormal sound is emitted.
   - Confirm that the clutch and brake of the main drum function satisfactorily.
   - Confirm that drum locks and brakes function normally. Particularly, normal functioning of the auxiliary drum in the crane configuration must be confirmed with utmost care.
5. After setting the machine in the working position, avoid starting crane work immediately. Instead, carry out the following:
   - Perform no-load operation for about 10 minutes in order to confirm that each device (particularly, safety devices) operate normally.
   - Confirm that the same operability as before stowage is available.

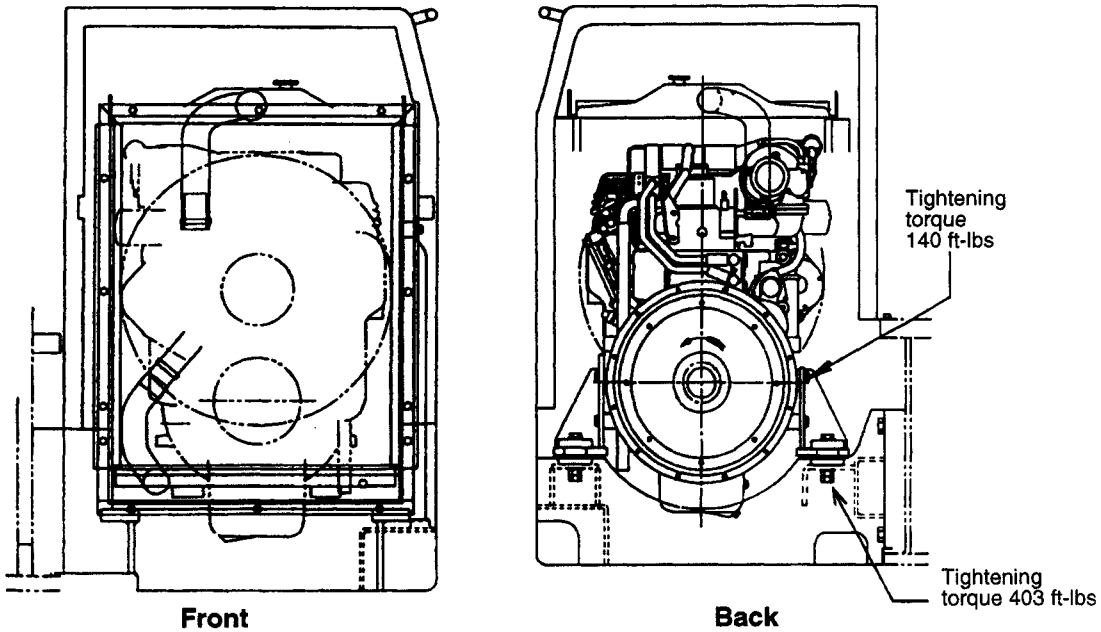
18. ENGINE

Engine mounting bolt tightening torque

Hot water heater cock

Coolant air discharging valve and coolant filter valve

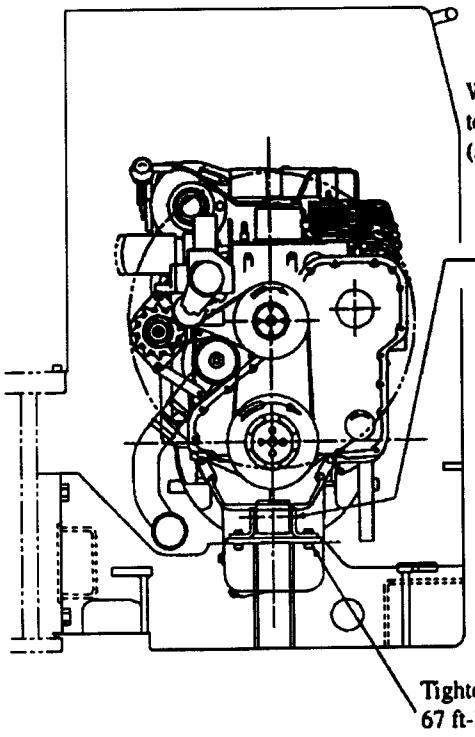




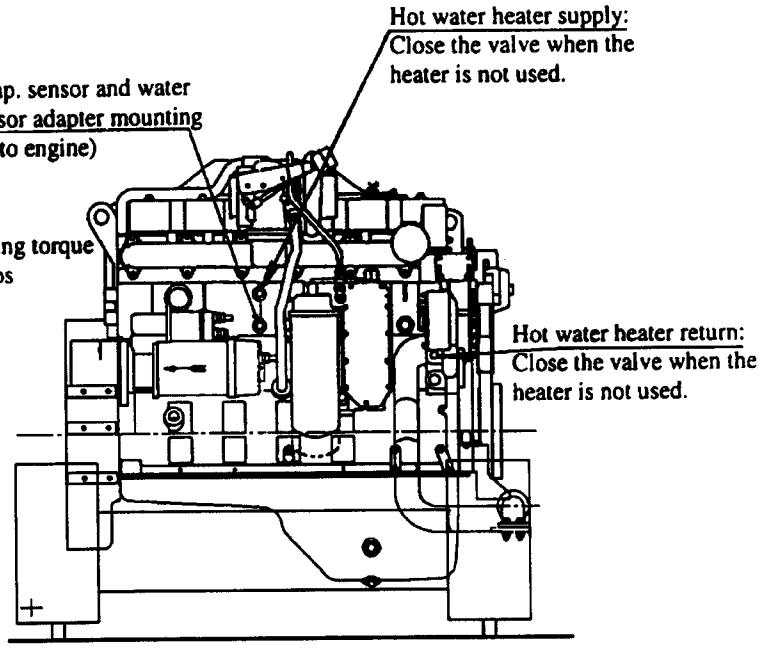
Notes:

1. When mounting the fan, set its character written side at the front (radiator side) and fix it with the above tightening torqe. Put one fan spacer upon the other and then mount the two.
2. Make sure that the valve in Detail "C" (on next page) is opened. (It is closed only when the filter is replaced.)

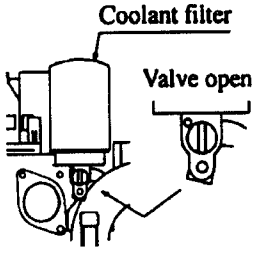
ENGINE (Continued)



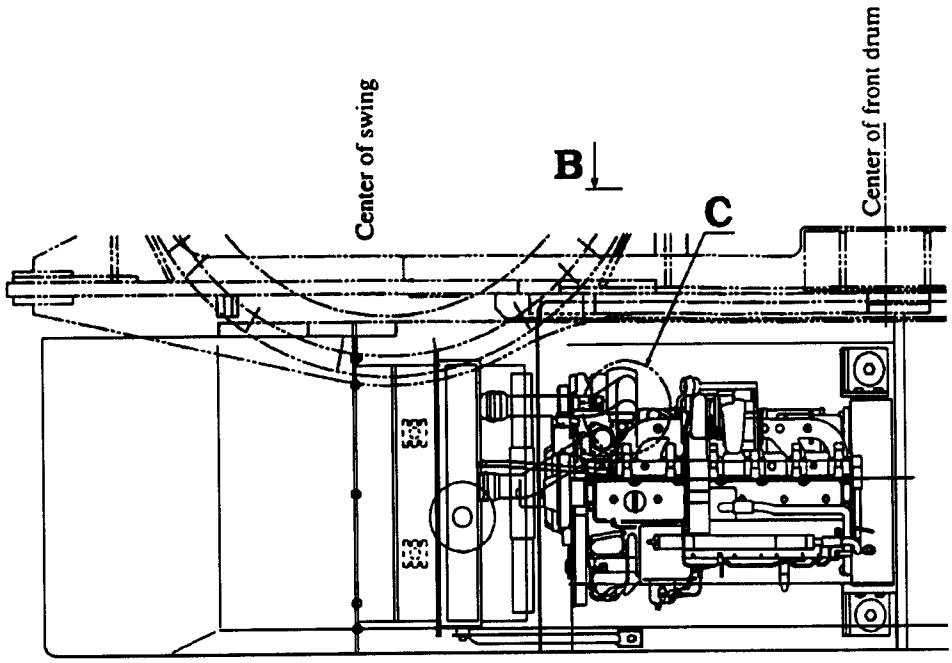
VIEW A



VIEW B



DETAIL C



19. BOOM GUIDELINES & REPAIR PROCEDURES

WARNING

THE STRUCTURAL AND MECHANICAL PARTS OF AMERICAN CRANES ARE BUILT FROM A VARIETY OF STEELS, MANY OF WHICH ARE HEAT TREATED OR CONTAIN SPECIAL ALLOYS. BECAUSE OF THIS, WELDING IN MOST CASES IS EXTREMELY CRITICAL AND MUST BE PERFORMED WITH THE CORRECT PROCEDURE, OR DAMAGE WILL RESULT. THIS DAMAGE IS NOT ALWAYS READILY VISIBLE BUT NONE THE LESS CAN BE QUITE SERIOUS.

Therefore, for all welding procedures not specifically covered in your service parts manual, it is imperative that you contact the Customer Service Department at American Crane for detailed welding instructions.

Failure to use the proper welding procedures will result in weakened and/or damaged portions of the crane.

Do not weld on any structural element of the crane without first consulting the Service Manual or American Crane Customer Service Department.

When welding, attach the ground cable directly to the piece or area you are welding. This will prevent arc and current from traveling through bearings, bushings, and spacers.

American Crane Corporation does not authorize any type of repair in the field or shop on tubular high lift jibs. If it becomes necessary to replace lacings, the replacement must be performed by a welder supplied by American Crane Corporation.

TUBULAR CHORD BOOM GUIDELINES FOR FIELD EVALUATION

WARNING

DO NOT USE any Boom Sections that do not meet ALL of the following conditions. Any conditions which are not met must be corrected prior to use.

TUBULAR CHORD BOOM SECTIONS

1.0 SCOPE

This procedure provides the guidelines and essential requirements in the determination, feasibility, methods and limitations of field repair of tubular boom sections, excluding tubular chord high lift jibs. The replacement of specific boom section components shall be governed by procedures that identify that particular repair.

2.0 POLICY

2.1 The evaluation and/or subsequent repairs to any tubular boom section shall be performed by qualified personnel. The materials used in American boom construction include quenched and tempered carbon and alloy steels that require conformance to the applicable procedure to avoid any irreversible damage. **American assumes no liability for repairs performed by personnel not employed by American Crane.**

2.2 Damage to the lacing or to the chords (four [4] corner members) may render that boom section unfit for use in its damaged condition. A complete examination of the entire section is required to determine the type and extent of the damage incurred. Visual and magnetic particle (yoke) method examinations must be utilized in the determination of repair feasibility.

2.3 This procedure applies to all tubular boom sections wherein the boom section size is forty-seven inches (47") or larger. Boom sections used in jib applications shall be included in this procedure providing the section size is equal to or greater than forty-seven inches (47")

2.4 Definitions

2.4.1 To provide a common understanding and consistent interpretation of the terms used within this procedure, the following definitions will apply:

2.4.1.1 "Unrestrained Chord"

Area of chord in which connecting lacings have been cut free of the chord.

2.4.1.2 "Gouge"

A condition of the chord surface wherein material has been removed or displaced resulting in reduced chord wall thickness. The reduced wall thickness may have been caused by being struck by a sharp instrument or object, or wear due to an abrasive action, and it is generally fairly sharp and/or severe.

2.4.1.3 "Dent"

A condition wherein the chord surface has been deformed from its normal rounded shape, and is without any noticeable removal of the material itself. The dent shall be considered as having no effect on the overall straightness of the chord. A dent may be the result of being struck by or striking a flat or rounded object.

2.4.1.4 "Bend"/"Bow"

A condition of a chord wherein deformation of the chord results in a permanent change of direction to the centerline straightness of that chord. A bent chord may be the result of hitting or being hit by another object severely enough to cause the directional change of the chord centerline straightness, within a relatively short distance, and is usually noticeable on both sides of the chord.

Bent or buckled chords shall not be repaired and that boom section shall be rendered unfit for further use.

3.0 REFERENCES

This procedure provides the guidelines and essential requirements in the determination, feasibility, methods and limitations of field repair of tubular boom sections, excluding tubular chord high lift jibs. The replacement of specific boom section components shall be governed by procedures that identify that particular repair.

3.1 American Welding Standard WEL-2000 (Reference: Pages 715.1 thru 715.3, American Operating and Maintenance Manual) - Welding Procedure for Lacing Replacement in High Strength Tubular Booms.

4.0 CLASSIFICATION OF BOOM REPAIR

4.1 Lacing Replacement: American Welding Standard WEL-2000 designates the procedure to successfully remove and replace lacing in a boom section. Acceptability of any given boom section for lacing replacement shall be contingent on the chord condition defined in this procedure

4.2 Boom Splice Replacement: Contact American Customer Service Department for boom splice replacement.

SEE TABLE VI FOR BOOM SPLICE JOINT INSPECTION CRITERIA

4.3 Chord Examination

4.3.1 Chord Straightness

4.3.1.1 The method used to determine chord straigtness shall be by positioning two

(2) blocks of equal dimensions, one at each end of the chord, drawing a wire or line taut over the two blocks, and measuring the variations to the chord surface.

4.3.1.2 Chord straightness measurements must be taken to determine the maximum out of straight condition, both planes (horizontal and vertical) prior to lacing removal. Assessment of the length and location of an out of straight condition of the chord shall be included in this examination.

4.3.1.3 Damaged lacing may affect the chord straightness in any segment of the total length of that boom section. Damaged lacings in these areas must be cut free from the chord to determine their effect on that one particular cord. Re-examine chord for straightness when free of lacings in the location of the acceptable out of straight condition. In the event the lacings removed may affect the end plane squareness, a squaring fixture or boom section must be used to hold the affected end.

4.3.1.4 The maximum variation from straight in an unrestrained chord (reference 2.4.1.1) that will permit a straightness repair may not exceed the values in Table I. Specific restrictions on the minimum length allowing a straightening repair, and the number of chords affected in a given boom section are stated in Table II (see next page).

TABLE I

CHORD VARIATIONS FROM STRAIGHT (UNRESTRAINED) ALLOWING REPAIR

CHORD DIAMETER (INCHES)	Length of Section (Feet)				
	10	20	30	40	50
3	1/4"	1/4"	5/16"	3/8"	-
3½	1/4	1/4	5/16	3/8	-
4	1/4	1/4	5/16	3/8	-
4½	1/4	1/4	5/16	3/8	7/16
5	1/4	5/16	3/8	7/16	1/2
5½	1/4	5/16	3/8	7/16	1/2
6	1/4	5/16	3/8	7/16	1/2

See 4.3.1.5 for Straightness Requirement after repairs

4.3.1.5 With the boom section ends secured to other boom sections, or squaring fixtures, and with all restraining lacings removed, straighten the chord to within 1/8" (one eighth inch) of absolute straight. This may be accomplished by pulling or pushing the chord straight by applying a load at the location of bow. The load applied may be by use of a come-along, load binder, or other device. **Do not use heat** to straighten the chord. Care must be exercised to avoid additional damage to chord surface when applying load to straighten. Protect surfaces by using belting, partial sleeves, etc.

Position and tack weld the lacings in place and complete the welding in accordance with American WEL-2000. Weld discontinuities or nonconformances shall be removed and repaired, and the welds re-examined in the same manner as specified for the original welding.

Remove the reworked boom section from the fixtures used and re-examine for chord straightness, lacing to chord welds for soundness, and the total section for possible twist within that section.

4.3.2 Chord Surface

4.3.2.1 Boom section chords (four [4] corner members) that receive damage by whatever the cause, must receive a thorough examination to determine the acceptability of that boom section for possible future use. the four (4) chords are the main load carrying members of a boom section, and, depending on the type and severity of the damage, may render that section unfit for use.

4.3.2.2 To determine the type of damage incurred, refer to Section 2.4, "Definitions", of this procedure to identify the type of damage. Two types of chord damage (gouge and dent) may allow a repair, while a bent chord will not allow a repair.

4.3.2.3 Gouged Chord Surface

4.3.2.3.1 Chords wherein a "gouge" type damage condition exists must meet the requirements in Table III. The minimum wall thickness shall control the maximum depth limit of any gouge. Chord wall thicknesses vary, even somewhat within the same chord, making it critical that the actual chord wall thickness be known. An ultrasonic thickness measuring instrument is required to determine the actual wall thickness at the location of the gouge and the areas adjacent to the gouge. **The minimum wall thickness requirement is absolute and a chord with wall thickness below that value shown in Table III will not be repaired or used**. Chords with wall thicknesses greater than nominal shall be allowed up to the maximum depth shown in Table III, but never reducing wall thickness below the minimum value shown.

TABLE II

CHORD STRAIGHTNESS RESTRICTIONS ALLOWING REPAIR

MINIMUM LENGTH FOR MAXIMUM VARIATION FROM STRAIGHT (TABLE I) - 8 FEET NUMBER OF CHORDS REQUIRING STRAIGHTENING MAY NOT EXCEED - 2

TABLE III

CHORD SURFACE - GOUGE TYPE CONDITION

Nominal Wall Thickness (Inches)	Minimum Wall Thickness (Inches)	Maximum Depth of Gouge (Inches)
.188	.174	.025
.250	.230	.035
.375	.345	.050
.500	.462	.060
.625	.587	.070
1.000	.940	.125

4.3.2.3.2 The maximum length and width of a gouge is also a consideration affecting the feasibility of repair. The maximum length shall not exceed one (1) times the chord diameter. The maximum width shall not exceed twenty five percent (25%) of the chord diameter. The **length** of gouge should run with length of chord and not across chord.

4.3.2.3.3 Repair of a gouge shall only be accomplished by the tapering of the surface adjacent to the gouge by grinding, filing, etc., to avoid any abrupt change on the surface contour. Care must be exercised to control heat created in blending; the temperature shall not exceed 200° F. The tapered length and width of the gouge shall be equal to or greater than twenty (20) times the actual depth of the depression.

4.3.4.3.4 Surface damage identified as dents, but which are smaller in length and width than the material thickness shall be regarded as gouges.

4.3.2.4 Dented Chord Surfaces

4.3.2.4.1 Chord wherein a "dent" type damage condition exists must meet the requirement specified in Table IV. There shall be no abrupt (sharp) change in chord surface at the edges of a dent. Abrupt changes will require minimum wall thickness determination and must be judged at that point or points the same as a gouge. An ultrasonic thickness measuring instrument is required to insure the minimum wall thickness (Table III) is maintained.

TABLE IV

CHORD SURFACE - DENT TYPE CONDITION

Nominal Wall Thickness (Inches)	Depth (Inches)	Maximum Allowable Length (Inches)	Width (Inches)
.188	.030	3.0	.500
.250	.050	4.0	1.00
.375	.065	4.5	1.00
.500	.080	5.0	1.00
.625	.100	6.0	1.50
1.000	.125	10.0	2.00

4.3.2.5 Other Limitations

4.3.2.5.2 The minimum distance between dents, gouges, or dent and gouges shall be three (3) times the chord tube diameter. Example: A four (4) inch diameter chord tube will require a minimum distance of twelve (12) inches between these types of surface damage.

4.3.2.5.3 Surface deterioration by corrosion shall be governed by the minimum wall thickness specified in Table III.

The chord must be sand blasted to remove all corrosion and an ultrasonic thickness measuring instrument is required to measure the minimum wall thickness that remains.

When inspecting booms for corrosion, particular attention should be paid to areas of the chords or lacings that are wrapped or clamped. Corrosion can occur under the boom timber clamps, rope rub wraps, and other places that could conceal moisture.

Before placing boom section back into service, it should be re-primered and finish painted to protect against future corrosion.

4.4 Repaired Boom Section Examination

4.4.1 Each repaired boom section shall be examined for chord straightness, chord surface condition, lacing to chord weld conformance, and boom section twist after the removal from other boom sections or fixtures. These examinations shall be in conformance with the table and/or the instructions included within this procedure, or their own governing procedure.

4.4.2 Twist is the measured difference of one end of the boom section to the other end of that section on the same plane. Twist shall not exceed the dimensional tolerance specified in Table V.

TABLE V

BOOM SECTION TWIST TOLERANCE

	Boom Section Length (Feet)				
	10	20	30	40	50
Maximum Tolerance (Inches)	.065	.080	.120	.160	.200

TABLE VI

AMERICAN CRANE
BOOM SPLICE JOINT INSPECTION CRITERIA

Boom Size	Boom Connecting Pin Minimum	Boom Connecting Bore Maximum*	Maximum Difference Pin to Bore
47"	1.8636	1.879	.012
59"	1.8636	1.879	.012
77"	2.3626	2.380	.015
92"	2.3626	2.380	.015
94"	2.9886	3.006	.015

***Elongation of bore is a maximum of .002 difference at 90 degree readings**

AMERICAN CRANE
ANGLE CHORD BOOM SPLICE JOINT INSPECTION CRITERIA

Boom Size	Boom Connecting Pin Minimum	Boom Connecting Bore Maximum*	Maximum Difference Pin to Bore
37"	1.3636	1.379	.012
46"	1.8636	1.879	.012
58"	2.3626	2.380	.015

Angle chord boom splice joint inspection criteria supplied for your reference

⚠ CAUTION

FOR ANY INSPECTIONS THAT ARE NOT WITHIN THESE GUIDELINES, CONSULT AMERICAN CRANE SERVICE DEPARTMENT. DO NOT ATTEMPT ANY REPAIRS WITHOUT APPROVAL OF AMERICAN CRANE.

ANGLE CHORD BOOM GUIDELINES FOR FIELD EVALUATION

⚠ WARNING

DO NOT USE any Boom Sections that do not meet ALL of the following conditions. Any conditions which are not met must be corrected prior to use.

ANGLE CHORD BOOM SECTIONS

1.0 SCOPE

This procedure provides the guidelines and essential requirements in the determination, feasibility, methods and limitations for field repair of angle chord boom sections, including angle chord jibs. The replacement of specific boom section components shall be governed by procedures that identify that particular repair.

2.0 POLICY

2.1 The evaluation and/or subsequent repairs to any angle boom section shall be performed by qualified personnel. The materials used in American boom construction include quenched and tempered carbon and alloy steels that require conformance to the applicable procedure to avoid any irreversible damage. **American assumes no liability for repairs performed by personnel not employed by American Crane.**

2.2 Damage to the lacing or to the chords (four [4] corner members) may render that boom section unfit for use in its damaged condition. A complete examination of the entire section is required to determine the type and extent of the damage incurred. Visual and magnetic particle (yoke) method examinations must be utilized in the determination of repair feasibility.

2.3 This procedure applies to all angle chord boom and jib sections

2.4 Definitions

2.4.1 To provide a common understanding and consistent interpretation of the terms used within this procedure, the following definitions will apply:

2.4.1.1 "Unrestrained Chord"

Area of chord in which connecting lacings have been cut free of the chord.

2.4.1.2 "Gouge"

A condition of the chord surface wherein material has been removed or displaced resulting in reduced chord thickness. The reduced thickness may have been caused by being struck by a sharp instrument or object, or wear due to an abrasive action, and it is generally fairly sharp and/or severe.

2.4.1.3 "Dent"

A condition wherein the chord surface has been deformed from its normal shape, and is without any noticeable removal of the material itself. The dent shall be considered as having no effect on the overall straightness of the chord. A dent may be the result of being struck by or striking a flat or rounded object.

2.4.1.4 "Bend"

A condition of a chord wherein deformation of the chord results in a permanent change of direction to the centerline straightness of that chord. A bent chord may be the result of hitting or being hit by another object severely enough to cause the directional change of the chord centerline straightness, within a relatively short distance, and is usually noticeable on both legs of the chord.

Bent or buckled chords shall not be repaired and that boom section shall be rendered unfit for further use.

3.0 REFERENCES

3.1 American Welding Standard WEL-2013 or 2012 (Reference: Pages 715.6 thru 715.9 or 715.12 thru 715.14 and 716-717, American Operating and Maintenance Manual) - Welding Procedure for Lacing Replacement in Angle Chord Tubular Booms.

4.0 CLASSIFICATION OF BOOM REPAIR

4.1 Lacing Replacement: American Welding Standard WEL-2013 or 2012 disignates the procedure to successfully remove and replace lacing in a boom section. Acceptability of any given boom section for lacing replacement shall be contingent on the chord condition defined in this procedure.

4.2 Boom Splice Replacement: **Contact American Customer Service Department for boom splice replacement.**

SEE TABLE VI FOR BOOM SPLICE JOINT INSPECTION CRITERIA

4.3 Chord Examination

4.3.1 Chord Straightness

4.3.1.1 The method used to determine chord straightness shall be by positioning two (2) blocks of equal dimensions, one at each end of the chord, drawing a wire or line taut over the two blocks, and measuring the variations to the chord surface.

4.3.1.2 Chord straightness measurements must be taken to determine the maximum out of straight condition, both planes (horizontal and vertical) prior to lacing removal. Assessment of the length and location of an out of straight condition of the chord shall be included in this examination.

4.3.1.3 Damaged lacing may affect the chord straightness in any segment of the total length of that boom section. Damaged lacings in these areas must be cut free from the chord to determine their effect on that one particular cord. Re-examine chord for straightness when free of lacings in the location of the unacceptable out of straight condition. In the event the lacings removed may affect the end plane squareness, a squaring fixture or boom section must be used to hold the affected end.

4.3.1.4 The maximum variation from straight in an unrestrained chord (reference 2.4.1.1) that will permit a straightness repair may not exceed the values in Table I. Specific restrictions on the minimum length allowing a straightening repair, and the number of chords affected in a given boom section are stated in Table II (see next page).

TABLE I

CHORD VARIATIONS FROM STRAIGHT (UNRESTRAINED) ALLOWING REPAIR

CHORD ANGLE (Inches)	LENGTH OF SECTION (Feet) 10	20	30	40
2"	1/4"	-	-	-
2 1/2"	1/4"	1/4"	-	-
3"	1/4"	1/4"	-	-
3 1/2"	1/4"	1/4"	5/16"	3/8"
4"	1/4"	1/4"	5/16"	3/8"
5"	1/4"	5/16"	3/8"	7/16"
6"	1/4"	5/16"	3/8"	7/16"

See 4.3.1.5 for Straightness Requirement after repairs.

4.3.1.5 With the boom section ends secured to other boom sections, or squaring fixtures, and with all restraining lacings removed, straighten the chord to within **1/8"** (one eighth inch) of absolute straight. This may be accomplished by pulling or pushing the chord straight by applying a load at the location of bow. The load applied may be by use of a come-along, load binder, or other device. **Do not use heat** to straighten the chord. Care must be exercised to avoid additional damage to chord surface when applying load to straighten. Protect surfaces by using belting, wood blocking, etc.

Position and tack weld the lacings in place and complete the welding in accordance with American WEL-2013 or 2012. Weld discontinuities or nonconformances shall be removed and repaired, and the welds re-examined in the same manner as specified for the original welding.

Remove the reworked boom section from the fixtures used and re-examine for chord straightness, lacing to chord welds for soundness, and the total section for possible twist within that section.

4.3.2 Chord Surface

4.3.2.1 Boom section chords (four [4] corner members) that receive damage by whatever the cause, must receive a thorough examination to determine the acceptability of that boom section for possible future use. The four (4) chords are the main load carrying members of a boom section, and, depending on the type and severity of the damage, may render that section unfit for use.

4.3.2.2 To determine the type of damage incurred, refer to Section 2.4, "Definitions", of this procedure to identify the type of damage.

4.3.2.3 Gouged Chord Surface

4.3.2.3.1 Chords wherein a "gouge" type damage condition exists must meet the requirements in Table III. The minimum thickness shall control the maximum depth limit of any gouge. Chord wall thicknesses vary, even somewhat within the same chord, making it critical that the actual chord thickness be known. **The minimum thickness requirement is absolute and a chord with thickness below that value shown in Table III will not be repaired or used**. Chords with thicknesses greater than nominal shall be allowed up to the maximum depth shown in Table III, but never reducing thickness below the minimum value shown.

TABLE II

CHORD STRAIGHTNESS RESTRICTIONS ALLOWING REPAIR

MINIMUM LENGTH FOR MAXIMUM VARIATION FROM STRAIGHT (TABLE I) - 8 FEET NUMBER OF CHORDS REQUIRING STRAIGHTENING MAY NOT EXCEED - 2

TABLE III

CHORD SURFACE - GOUGE TYPE CONDITION

Nominal Angle Thickness (Inches)	Minimum Angle Thickness (Inches)	Maximum Depth of Gouge (Inches)
.188	.176	.025
.312	.300	.040
.375	.360	.050
.500	.485	.065
.562	.547	.075

4.3.2.3.2 The maximum length and width of a gouge is also a consideration affecting the feasibility of repair. The maximum length shall not exceed one **(1) times** the chord width. The maximum width shall not exceed twenty five percent (25%) of the chord width. The **length** of gouge should run with length of chord and not across chord.

4.3.2.3.3 Repair of a gouge shall only be accomplished by the tapering of the surface adjacent to the gouge by grinding, filing, etc., to avoid any abrupt change on the surface contour. Care must be exercised to control heat created in blending; the temperature shall not exceed 200° F. The tapered length and width of the gouge shall be equal to or greater than twenty (20) times the actual depth of the depression.

4.3.4.3.4 Surface damage identified as dents, but which are smaller in length and width than the material thickness shall be regarded as gouges.

4.3.2.4 Dented Chord Surfaces

4.3.2.4.1 Chord wherein a "dent" type damage condition exists must meet the requirement specified in Table IV. There shall be no abrupt (sharp) change in chord surface at the edges of a dent. Abrupt changes will require minimum thickness determination and must be judged at that point or points the same as a gouge. A micrometer or vernier is required to insure the minimum thickness (Table III) is maintained.

The "square" of the angle must also be maintained. Maximum allowable out of square is .025 x (times) length of angle leg.

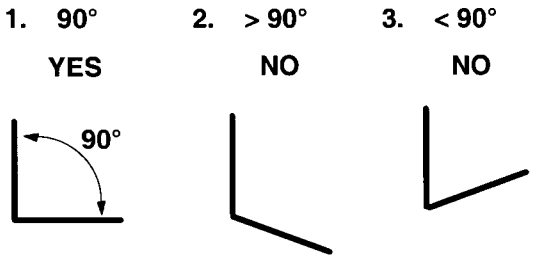


TABLE IV

CHORD SURFACE - DENT TYPE CONDITION

Nominal Thickness (Inches)	Depth (Inches)	Maximum Allowable Length (Inches)	Width (Inches)
.188 = 3/16	.030	3.0	0.50
.312 = 5/16	.050	4.0	1.00
.375 = 3/8	.065	4.5	1.00
.500 = 1/2	.080	5.0	1.00
.562 = 9/16	.100	6.0	1.50

4.3.2.5 Other Limitations

4.3.2.5.2 The minimum distance between dents, gouges, or dent and gouges shall be three (3) times the chord width. Example: A four (4) inch chord will require a minimum distance of twelve (12) inches between these types of surface damage.

4.3.2.5.3 Surface deterioration by corrosion shall be governed by the minimum thickness specified in Table III.

The chord must be sand blasted to remove all corrosion and using a caliper measure the minimum thickness that remains.

When inspecting booms for corrosion, particular attention should be paid to areas of the chords or lacings that are wrapped or clamped. Corrosion can occur under the boom timber clamps, rope rub wraps, and other places that could conceal moisture.

Before placing boom section back into service, it should be re-primered and finish painted to protect against future corrosion.

4.4 Repaired Boom Section Examination

4.4.1 Each repaired boom section shall be examined for chord straightness, chord surface condition, lacing to chord weld conformance, and boom section twist after the removal from other boom sections or fixtures. These examinations shall be in conformance with the table and/or the instructions included within this procedure, or their own governing procedure.

4.4.2 Twist is the measured difference of one end of the boom section to the other end of that section on the same plane. Twist shall not exceed the dimensional tolerance specified in Table V.

TABLE V

BOOM SECTION TWIST TOLERANCE

	Boom Section Length (Feet)			
	10	20	30	40
Maximum Tolerance (Inches)	.065	.080	.120	.160

TABLE VI

AMERICAN CRANE
ANGLE BOOM SPLICE JOINT INSPECTION CRITERIA

Boom Size	Boom Connecting Pin Minimum	Boom Connecting Bore Maximum*	Maximum Difference Pin to Bore
26"	1.3636	1.379	.012
30"	1.3636	1.379	.012
37"	1.3636	1.379	.012
46"	1.8636	1.879	.012
58"	2.3626	2.380	.015

***Elongation of bore is a maximum of .002 difference at 90 degree readings**

AMERICAN CRANE
ANGLE JIB SPLICE JOINT INSPECTION CRITERIA

Jib Size	Jib Connecting Pin Minimum	Jib Connecting Bore Maximum*	Maximum Difference Pin to Bore
# 6	1.116	1.128	.010
# 9	1.116	1.128	.010
# 15	1.116	1.128	.010

***Elongation of bore is a maximum of .002 difference at 90 degree readings**

⚠ CAUTION

FOR ANY INSPECTIONS THAT ARE NOT WITHIN THESE GUIDELINES, CONSULT AMERICAN CRANE SERVICE DEPARTMENT. DO NOT ATTEMPT ANY REPAIRS WITHOUT APPROVAL OF AMERICAN CRANE.

LACING REPAIR
(Sleeve Method)

TUBULAR BOOMS ONLY

1. Read Welding Instructions found in this tab before welding.
2. Saw off the entire damaged portion of the lacing. The absolute minimum length of undamaged lacing is 2-1/2" (6.35cm): the maximum length is 6" (15.24cm) (See Figure 1, B1 and B2). You must contact the Customer Service Department if welding is to be performed closer than 2" (5.08cm) to the chords.
3. Determine distance "C" between the stubs and measure the outside diameter of the stubs.
4. Select the required size repair tube from Table A. The repair tube length must be 1" (2.54cm) longer than dimension "C" giving a 1/2" (12.70mm) overlap on each stub. (See Figure 1).

Note: All welds to be unequal leg fillets. To eliminate notches for leg sizes, see Table "A".

5. Thoroughly clean the repair tube and stubs using degreasing solvents. Remove the paint from the welding area.
6. Mark the stubs so that when you slip the repair tube on, you can be sure it overlaps both stubs evenly.
7. When welding, use a fillet weld all around both ends. Use an E-7018 (ACC 826840) electrode. (See Figure 1).

   Electrodes are sold in 10 lb. (4.54kg) hermetically sealed cans.

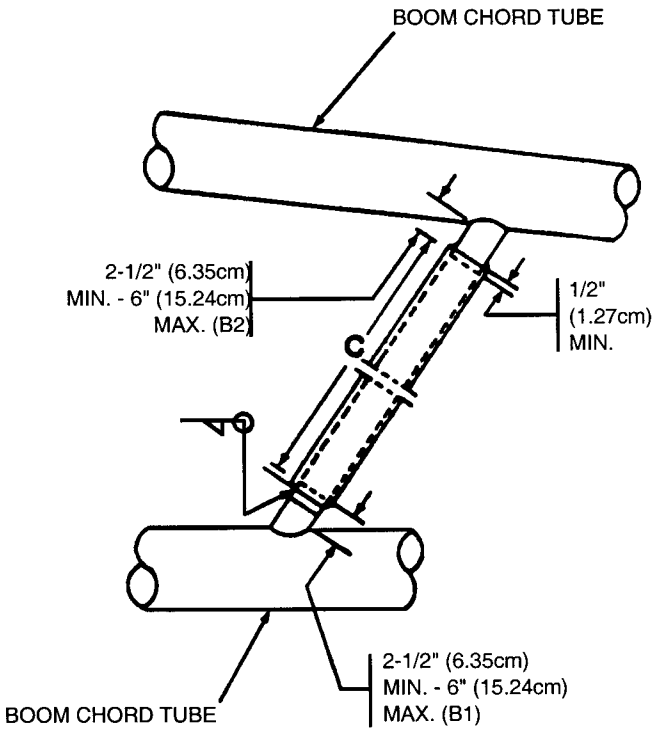


FIGURE 1

MAXIMUM NUMBER OF SLEEVE REPAIRS ALLOWED	LENGTH OF BOOM SECTION		
	10'	20' + 30'	40' + 50'
PER PANEL	3	4	5
PER SECTION	6	10	14

LOW CARBON STEEL 0.25% MAXIMUM TUBING MATERIAL (FOR SLEEVE REPAIR ONLY)

Table "A"

BOOM SIZE INCHES	SIZE OF ORIGINAL LACING	RECOMMENDED TUBE FOR REPAIRS	
		SIZE	PART NO.
47"	1-1/4" OD	1-1/2" OD x 0.095" Wall x 6'-6"	815986
59" 76" 77" 92"	1-5/8" OD	1-7/8" OD x 0.095" Wall x 6'-6"	815987
77"	1-7/8" OD	2-1/8" OD x 0.095" Wall x 6'-8"	826568
76" 77" 92"	2" OD	2-1/4" OD x 0.095" Wall x 6'-0"	815988
		2-1/4" OD x 0.095" Wall x 8'-0"	815988-2
92" 94"	2-1/4" OD	2-1/2" OD x 0.095" Wall x 8'-0"	840300
92" 94"	2-1/2" OD	2-3/4" OD x 0.095" Wall x 6'-0"	826712
		2-3/4" OD x 0.095" Wall x 8'-0"	826712-2
94"	2-3/4" OD	3-1/4" OD x 0.188" Wall x 8'-0"	840301
94"	3" OD	3-1/2" OD x 0.188" Wall x 8'-0"	840302
94"	3-1/2" OD	4-1/8" OD x 0.250" Wall x 8'-0"	840303
94"	4" OD	4-5/8" OD x 0.250" Wall x 8'-0"	840304

Table "A" (Metric)

BOOM SIZE METERS	SIZE OF ORIGINAL LACING	RECOMMENDED TUBE FOR REPAIRS	
		SIZE	PART NO.
1.19	3.18cm OD	3.8cm OD x 241cm Wall x 1.98m	815986
1.50. 1.93. 1.96. 2.34	4.13cm OD	4.8cm OD x 241cm Wall x 1.98m	815987
1.96	4.76cm OD	5.4cm OD x 241cm Wall x 2.03m	826568
1.93. 1.96. 2.34	5.08cm OD	5.7cm OD x 241cm Wall x 1.83m	815988
		5.7cm OD x 241cm Wall x 2.44m	815988-2
2.34. 2.39	5.72cm OD	6.4cm OD x 241cm Wall x 2.44m	840300
2.34. 2.39	6.35cm OD	7.0cm OD x 241cm Wall x 1.83m	826712
		7.0cm OD x 241cm Wall x 2.44m	826712-2
2.39	6.99cm OD	8.3cm OD x 478cm Wall x 2.44m	840301
2.39	7.62cm OD	9.0cm OD x 478cm Wall x 2.44m	840302
2.39	8.89cm OD	10.5cm OD x 635cm Wall x 2.44m	840303
2.39	10.16cm OD	11.8cm OD x 635cm Wall x 2.44m	840304

Note: Do not use the above listed sleeve material for complete lacing replacement. The material specifications for sleeve lacing material are different than the material specifications of original lacings used in all tubular booms.

WELDING PROCEDURES FOR LACING REPLACEMENT IN HIGH STRENGTH TUBULAR BOOMS

WELDING PROCEDURES

1.0 SCOPE

1.1 The following welding procedure shall be used when replacing lacing on high strength tubular booms of the following sizes: 47", 59", 77", 92", standard and heavy duty.

1.1.1 This procedure shall be used only when the lacing repair method stated on Pages 3-93 & 3-94 of the Operating and Maintenance Manual **cannot** be used.

1.1.2 This procedure obsoletes previously issued welding standards WEL-2000 through WEL-2011 (last issue dated October, 1977) and combines the welding procedure requirements into a common welding standard.

1.2 This procedure does not apply to the repair of tubular high lift jibs, since these types of repairs are **not** authorized by American Crane. If jib damage has occurred, contact the American Crane Service Department.

2.0 RESPONSIBILITY

2.1 The Structural components of American products are manufactured from a variety of heat treated carbon and alloy steels. Because of this, welding is extremely critical and must be performed in accordance with the proper welding procedure (which will be supplied by American), or **permanent damage will result**.

Satisfactory repairs can be achieved if the welding procedures are followed by a qualified welder. However, due to the unique requirements of performing these repairs, it is understood that American assumes no liability for any repairs performed by any personnel other than certified welders employed by American Crane. American Crane will provide, at your request, certified welders anywhere in the world for a nominal charge.

2.2 American Crane Corporation strongly recommends that welders performing lacing replacement welding be qualified in accordance with the A.W.S. Structural Welding Code - D1.1, A.W.S. Specifications for Welding Earthmoving and Construction Equipment - D14.3 (Method A), A.S.M.E. Pressure Vessel Code - Section IX, A.P.I. Standard for Welding Pipelines and Related Facilities - Standard 1104, or an equivalent industry accepted code or standard.

3.0 FOR INFORMATION AND MATERIAL

3.1 If any doubt arises on the feasibility of repairing a boom or additional information is required contact:

American Crane Corporation
Service Department
202 Raleigh Street
Wilmington, NC USA 28412

Telephone: (910) 395-8500
FAX: (910) 395-8538

3.2 Through the use of the "Tubular Boom Lacing Request Form" OE-153, secure replacement lacing from American Crane Corporation **ONLY**. Lacings are a special material and have critical dimensions.

4.0 INSPECTION OF BOOM SECTION PRIOR TO REPAIR

4.1 Visually examine the entire boom section to determine the extent of damage to lacing, chord tubes, boom splice (pin end) castings, and other parts.

4.2 The chord tube must not be damaged in any way. Bends, cracks, arc strikes, or gouges are not permissible. If chord tube damage is found, contact American Crane Service Department.

4.3 Inspect the boom section for corrosion damage to the lacing or chord tube, impact dents to the lacing or chord tube and cracks in the boom splice connections. If this type of damage is found, contact American Crane Service Department.

4.4 If four (4) or more damaged lacing in a row are found, contact American Crane Service Department.

4.5 If the framing lacing (the lacing that hold the boom square) or numerous lacing on one panel are damaged to the extent of possibly affecting the squareness of the boom section, the boom section must be placed in a squaring fixture or pinned to a mating boom section of known accuracy to insure squareness is maintained during lacing replacement.

4.6 If the damaged lacing have not been broken or bent at the chord tube or near the weld (within 2-1/2", 6.35cm) they should be repaired by following the lacing repair procedure detailed in the Operating and Maintenance Manual, Pages 714 and 715.

5.0 REMOVAL OF LACING

5.1 Damaged lacing are to be removed and replaced in a sequence such that chord straightness and boom section squareness are maintained.

5.2 Using a hacksaw or grinder, cut the lacing as close as possible to the chord tube. Air carbon arc cutting equipment may also be used, but, **DO NOT** cut the lacing closer than 1/2" (12.7mm) from chord tube. Grind lacing stub flush. Extreme caution must be taken during lacing removal not to gouge or remove any chord material.

5.3 Grind and blend excess lacing and weld material to the contour of the chord tube. **DO NOT** grind into the chord tube.

5.4 Clean all dirt, grease, paint, rust or other foreign matter from the weld area.

5.5 Perform Magnetic Particle or Liquid Penetrant Examination of the chord tube surface in the ground area to assure absence of cracks.

6.0 LOCATING & WELDING OF NEW LACING

6.1 When performing welding on boom sections, extreme care must be taken when attaching welding ground connection. Attach ground connection directly to the part being welded. **DO NOT** ground through bearings, bushings, etc.

6.2 Protect chords, lacing and wire rope from arc strikes and weld spatter by wrapping with insulating type blankets or use other shielding materials, i.e., steel plate, wood, etc.

6.3 Determine the position of the replacement lacing by measuring the existing good lacing junctions (see Figure 1) and locate the replacement lacing accordingly. Maximum allowable gap 1/16" (1.6mm) per end. Weld size must be increased equal to gap.

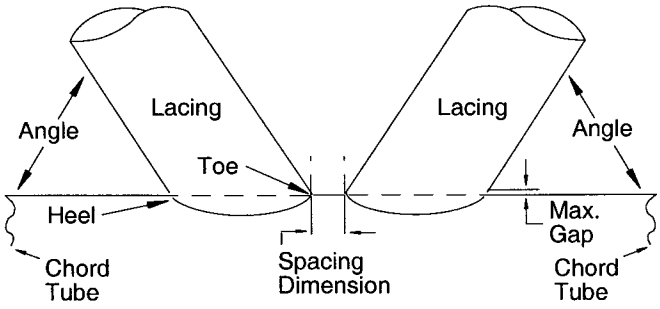


Figure 1

6.4 Locate and tack weld the replacement lacing. Place the tack weld at the toe and heel on each end. Tack weld using 3/32" (2.4mm) diameter or 1/8" (3.2mm) diameter E-9018M welding electrode.

6.5 Position the boom section so that the lacing are welded in a flat position, within the limits shown in the following figure (see Figure 2).

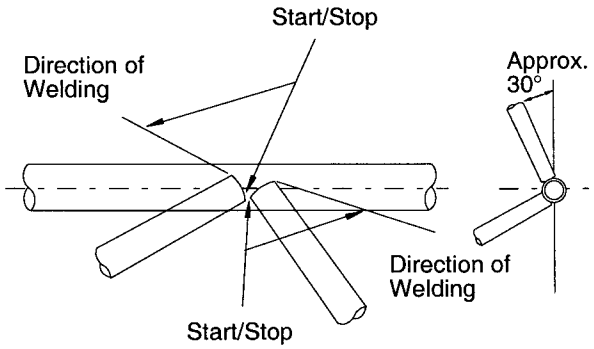


Figure 2

Note: Weld 1st side Toe to Heel and 2nd side Heel to Toe.

6.6 Select electrode type, size, amperage, voltage, weld travel speed (inches or mm per minute), preheat temperature, and interpass temperature valves from Table 1 below, based on the chord diameter or circumference.

Note: On certain boom sections the top chord tubes are different size (diameter) than the bottom chord tubes. It is of utmost importance that both the top and bottom chord tubes are measured and the proper procedure selected and used.

(1) See Section 8.0 for approved electrodes. Electrodes must meet the requirements of A.W.S. A5.5, latest revision.

6.7 Lacing shall be welded from toe to heel for one-half of the lacing and from heel to toe on the second one-half of the lacing (see Figure 2).

6.8 Chip and wire brush all slag and weld spatter between passes and at the completion of the weld. Grind out any defects and reweld.

8.0 AMERICAN CRANE APPROVED ELECTRODES

8.1 The following electrodes have been tested and are approved for use:

(A) Chemtron ATOM Arc E-9018
(B) Hobart LH 918M
(C) Airco Code Arc 9018M
(D) McKay 9018M
(E) B.O.C. Fortrex E-9018M
(F) AFROX E-9018M

Note: Electrodes MUST be obtained in hermetically sealed cans only.

9.0 ELECTRODES STORAGE & CONTROL

9.1 The welding electrodes (E-9018M) required to successfully perform the lacing replacements are a low hydrogen type. They **must** be obtained in moisture-free hermetically sealed cans, free from physical damage that would result in exposure of the electrodes to the atmosphere. It is essential that these electrodes remain moisture-free for acceptable welding application.

9.2 **Maximum** exposure time for E-9018M, once the container seal has been broken is **one (1) hour.**

9.3 Storage of these electrodes (E9018M) after the can has been opened shall be in an electrode storage oven at a temperature of at least 250°F (120°C).

9.4 Electrodes which have been exposed to the atmosphere longer than one (1) hour shall be either destroyed or baked in a oven at 750-800°F (399-427°C) for one (1) hour. The electrodes must then be cooled at a controlled rate of 250°F (120°C) over a two (2) hour span. Electrodes shall not be rebaked more than one (1) time.

TABLE 1

Chord O. D.	Inches	3	3.5	4	4.5	5.0	6.0
	mm	76.2	88.9	101.6	114.3	127.0	152.4
Chord Circumference	Inches	9.42	10.99	12.56	14.13	15.70	18.84
	mm	239.3	279.1	319.0	358.9	398.8	478.5
(1) Electrode Type			E-9018M		E-9018M	E-9018M	E-9018M
	Inches		1/8		1/8	5/32	5/32
Electrode Dia. (Max)	mm		3.2		3.2	4.0	4.0
Amperage (Max)			130		140	170	170
Voltage (Max)			22		22	22	22
Travel Speed Per Minute (Min.)	Inches		9		9	8	8
	mm		228.6		228.6	203.2	203.2
Preheat Temp. (Min)	°F		70-100		70-100	200	200
	°C		21-38		21-38	93	93
Interpass Temp. (Max)	°F		200		300	300	400
	°C		93		150	150	204

7.0 INSPECTION OF THE COMPLETED LACING REPLACEMENT

7.1 Visually inspect the finished lacing replacements completely.

7.2 The chord tube and lacing must be free of undercutting and arc strikes. If arc striking does occur, they shall be buffed out completely.

7.3 The welds must be of equal leg length on the chord tube and lacing, and equal in size to the welds on adjacent lacing. The weld must be smooth and uniform.

7.4 The start/stop areas must be relatively smooth. Craters shall be filled to at least 90% of the full weld cross section and large humps shall be blended.

7.5 Prime and finish paint all new lacing and weld areas immediately after the weld area has cooled to 100°F (38°C) or below.

WELDING PROCEDURES TO REPLACE A036 ANGLE OR TEE LACING TO A030 ANGLE CHORD

WELDING PROCEDURES

1.0 SCOPE

1.1 The following welding procedure shall be used to replace A036 Angle or Tee Lacing to A030 Angle Chord.

2.0 RESPONSIBILITY

2.1 The structural components of American Crane products are manufactured from a variety of heat treated carbon and alloy steel. Because of this, welding is extremely critical and must be performed in accordance with the proper welding procedure (which will be supplied by American Crane), or **permanent damage will result**.

Satisfactory repairs can be achieved if the welding procedures are followed by a qualified welder. However, due to the unique requirements of performing these repairs, it is understood that American assumes no liability for any repairs performed by any personnel other than certified welders employed by American Crane. American Crane will provide, at your request, certified welders anywhere in the world for a nominal charge.

2.2 American Crane Corporation strongly recommends that welders performing lacing replacement welding be qualified in accordance with the A.W.S. Structural Welding Code - D1.1, A.W.S. Specifications for Welding Earthmoving and Construction Equipment - D14.3 (Method A), A.S.M.E. Pressure Vessel Code - Section IX, A.P.I. Standard for Welding Pipelines and Related Facilities - Standard 1104, or an equivalent industry accepted code or standard.

3.0 FOR INFORMATION AND MATERIALS:

3.1 If any doubt arises on the feasibility of repairing a boom or additional information is required contact:

American Crane Corporation
Service Department
202 Raleigh Street
Wilmington, NC USA 28412

Telephone: (910) 395-8500
FAX: (910) 395-8538

3.2 Secure replacement lacing from American Crane Corporation **ONLY**. Lacings are a special material and have critical dimensions. Any substitutions **MUST** br approved by American Crane Service Department.

4.0 INSPECTION OF BOOM SECTION PRIOR TO REPAIR

4.1 Visually examine the entire boom section to determine the extent of damage.

4.2 The chord angles must not be damaged in any way. Bends, cracks, arc strikes, or gouges are not permissible. Examine chord angles for straightness. If angle chord damage is found, contact American Crane Service Department.

4.3 Inspect boom sections for corrosion damage to the lacing or to the angle chord, impact dents to the lacing or to the chord and cracks in the boom splice connections. If this type of damage is found, contact American Crane Service Department.

4.4 If four (4) or more damaged lacing in a row are found, contact American Crane Service Department.

4.5 If the framing lacing (the lacing that hold the boom square) or numerous lacing on one panel are damaged to the extent of possibly affecting the squareness of the boom section, the boom section must be placed in a squaring fixture or pinned to a mating boom section of known accuracy to insure squareness is maintained during lacing replacement.

5.0 REMOVAL OF LACING

5.1 Damaged lacing are to be removed and replaced in a sequence such that chord angle straightness and boom section squareness are maintained.

5.2 Prior to removing damaged lacing, measure and record Dimension A (Views I, II, III and IV). (See page 3-100 for illustration).

5.3 Use carbon/arc (air arc) or grinder, cut the lacing as close to the chord as possible being **careful** not to remove any chord material.

5.4 Grind and blend excess material to the contour of the chord. **Do not grind into the chord.**

5.5 Clean all dirt, grease, paint, rust or other foreign matter from the weld area.

5.6 Perform Magnetic Particle or Liquid Penetrant Examination of the chord in the ground area to assure absence of cracks.

6.0 LOCATING & WELDING OF NEW LACING

6.1 When performing welding on boom sections, extreme care must be taken when attaching welding ground connections. Attach ground connection directly to the part being welded. **DO NOT** ground through bearings, bushings, etc.

6.2 Protect **chords**, **lacing** and **wire rope** by wrapping with insulating type blankets or use other shielding materials, i.e., steel plate, wood, etc.

6.3 Secure the new lacing with a clamp to hold in position and eliminate any gaps. Position the new lacing as close as possible to the same position as the old lacing (refer to Dimension "A" which was taken per 5.2).

6.4 Locate and tack weld the replacement lacing into place. Use a 3/32" (2.4mm) diameter or 1/8" (3.2mm) diameter E7018 electrode.

6.5 Position the boom section so that the lacing may be welded in as flat a position as possible.

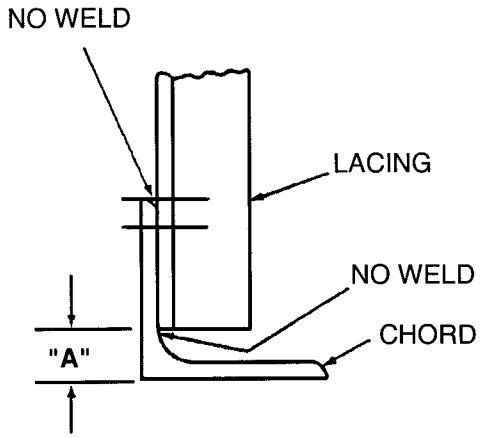
6.6 Do not weld across the top, bottom or around the corners of the lacing (refer to Views I, II, III and IV).

6.7 Weld using a 1/8" (3.2mm) E7018 electrode at 130 amperes, 22 volts. Weaving the electrode shall not exceed two (2) times the electrode diameter.

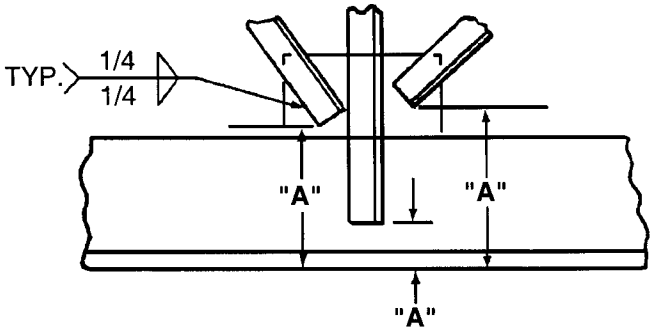
6.8 Prior to welding, the repair area within 3 inches (76.2mm) of the weld joint shall be preheated to 70-100° F (21-38° C).

6.9 A 300° F (149° C) maximum interpass temperature shall be maintained.

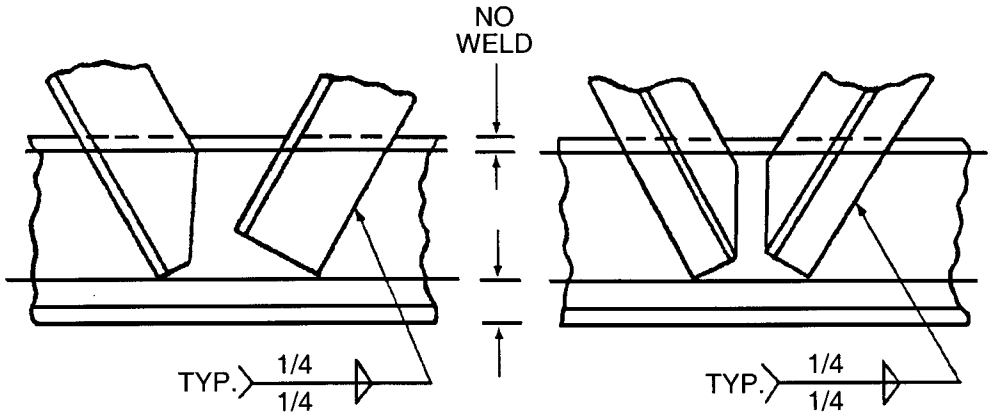
6.10 Chip, clean, and wire brush all slag and weld spatter between passes and after the final pass.



View I



View II



View III

View IV

7.0 INSPECTION OF COMPLETED LACING REPLACEMENT

7.1 Visually inspect the finished lacing replacements for weld quality and straightness of chord angles.

7.2 The welds must be of equal leg length on the angle chord and lacing. The weld must be smooth and uniform.

7.3 The start/stop areas must be smooth. Craters shall be filled to at least 90% of the full weld cross section and large humps shall be blended.

7.4 The chord and lacing shall be free from undercut. There shall be a smooth transition between the chord and the weld.

7.5 The weld and weld area must be free of arc strikes. If arc striking does occur, they shall be buffed out completely.

8.0 PAINTING

8.1 Prime and finish paint all repaired areas immediately following completion of the repairs, after the weld area has cooled to 100°F (38°C) or below.

9.0 AMERICAN CRANE APPROVED ELECTRODES

9.1 The following electrodes have been tested and are approved for use:

(A) Chemtron ATOM Arc E7018
(B) Hobart LH 718
(C) Murex Speedex HTS-M-MR
(D) Airco Code-Arc 7018MR
(E) Lincoln LH78 and LH70
(F) Esab 7018
(G) Westinghouse WIZ-18

Note: Electrodes **MUST** be obtained in **hermetically sealed cans only**.

10.0 ELECTRODE STORAGE & CONTROL

10.1 The welding electrodes (E7018) required to successfully perform the lacing replacements are a low hydrogen type. They **must** be obtained in moisture-free hermetically sealed cans, free from physical damage that would result in exposure of the electrodes to the atmosphere. It is essential that these electrodes remain moisture-free for acceptable welding application.

10.2 **Maximum** exposure time for E7018 electrodes, once the container seal has been broken, is **two (2) hours.**

10.3 Storage of these electrodes (E7018) after the can has been opened shall be in an electrode storage oven at a temperature of at least 250°F (120°C).

10.4 Electrodes which have been exposed to the atmosphere longer than **two (2) hours** shall be destroyed. Once the electrodes have been exposed to the atmosphere, even though the time limit of **two (2) hours** has not been exceeded, they shall **not** be returned to the electrode storage oven.

WELDING PROCEDURES TO REPLACE A061 CRIMPED TUBULAR LACING TO A030 ANGLE CHORD

WELDING PROCEDURES

1.0 SCOPE

1.1 The following welding procedure shall be used to replace A061 Crimped Tubular Lacing to A030 Angle Chord.

2.0 RESPONSIBILITY

2.1 The structural components of American Crane products are manufactured from a variety of heat treated carbon and alloy steel. Because of this, welding is extremely critical and must be performed in accordance with the proper welding procedure (which will be supplied by American Crane), or **permanent damage will result**.

Satisfactory repairs can be achieved if the welding procedures are followed by a qualified welder. However, due to the unique requirements of performing these repairs, it is understood that American assumes no liability for any repairs performed by any personnel other than certified welders employed by American Crane. American Crane will provide, at your request, certified welders anywhere in the world for a nominal charge.

2.2 American Crane Corporation strongly recommends that welders performing lacing replacement welding be qualified in accordance with the A.W.S. Structural Welding Code - D1.1, A.W.S. Specifications for Welding Earthmoving and Construction Equipment - D14.3 (Method A), A.S.M.E. Pressure Vessel Code - Section IX, A.P.I. Standard for Welding Pipelines and Related Facilities - Standard 1104, or an equivalent industry accepted code or standard.

3.0 FOR INFORMATION AND MATERIALS:

3.1 If any doubt arises on the feasibility of repairing a boom or additional information is required contact:

American Crane Corporation
Service Department
202 Raleigh Street
Wilmington, NC USA 28412

Telephone: (910) 395-8500
FAX: (910) 395-8538

3.2 Secure replacement lacing from American Crane Corporation **ONLY**. Lacings are a special material and have critical dimensions. Any substitutions **MUST** br approved by American Crane Service Department.

4.0 INSPECTION OF BOOM SECTION PRIOR TO REPAIR

4.1 Visually examine the entire boom section to determine the extent of damage.

4.2 The chord angles must not be damaged in any way. Bends, cracks, arc strikes, or gouges are not permissible. Examine chord angles for straightness. If angle chord damage is found, contact American Crane Service Department.

4.3 Inspect boom sections for corrosion damage to the lacing or to the angle chord, impact dents to the lacing or to the chord and cracks in the boom splice connections. If this type of damage is found, contact American Crane Service Department.

4.4 If four (4) or more damaged lacing in a row are found, contact American Crane Service Department.

4.5 If the framing lacing (the lacing that hold the boom square) or numerous lacing on one panel are damaged to the extent of possibly affecting the squareness of the boom section, the boom section must be placed in a squaring fixture or pinned to a mating boom section of known accuracy to insure squareness is maintained during lacing replacement.

5.0 REMOVAL OF LACING

5.1 Damaged lacing are to be removed and replaced in a sequence such that chord angle straightness and boom section squareness are maintained.

5.2 Using a hacksaw or oxy-fuel torch, cut the lacing as close to the chord as possible being **careful** not to remove any chord material.

5.3 Grind and blend excess material to the contour of the chord. **Do not grind into the chord**.

5.4 Clean all dirt, grease, paint, rust or other foreign matter from the weld area.

5.5 Perform Magnetic Particle or Liquid Penetrant Examination of the chord in the ground area to assure absence of cracks.

6.0 LOCATING & WELDING OF NEW LACING

6.1 When performing welding on boom sections, extreme care must be taken when attaching welding ground connections. Attach ground connection directly to the part being welded. **DO NOT** ground through bearings, bushings, etc.

6.2 Protect **chords**, **lacing** and **wire rope** by wrapping with insulating type blankets or use other shielding materials, i.e., steel plate, wood, etc.

6.3 Position the new lacing as close as possible to the same position as the old lacing. If a gap greater than 1/16 inch (1.5mm) exists at each end, remove and build up the chord by welding to reduce the gap to 1/16 inch (1.5mm) or less.

6.4 Inspect the build up area for slag, cracks or lack of fusion and repair as required.

6.5 Locate and tack weld the replacement lacing into place. Use a 3/32" (2.4mm) diameter or 1/8" (3.2mm) diameter E7018 electrode.

6.5 Position the boom section so that the lacing may be welded in as flat a position as possible.

6.7 Weld using a 1/8" (3.2mm) E7018 electrode at 130 amperes, 22 volts. Weaving the electrode shall not exceed two (2) times the electrode diameter.

6.8 Prior to welding, the repair area within 3 inches (76.2mm) of the weld joint shall be preheated to 70-100° F (21-38° C).

6.9 A 300° F (149° C) maximum interpass temperature shall be maintained to minimize burn through and uncercutting possibilities on the tubular A061 lacing.

6.10 Chip, clean, and wire brush all slag and weld spatter between passes and after the final pass.

7.0 INSPECTION OF COMPLETED LACING REPLACEMENT

7.1 Visually inspect the finished lacing replacements for weld quality and straightness of chord angles.

7.2 The welds must be of equal leg length on the angle chord and lacing. The weld must be smooth and uniform.

7.3 The start/stop areas must be smooth. Craters shall be filled to at least 90% of the full weld cross section and large humps shall be blended.

7.4 The chord and lacing shall be free from undercut. There shall be a smooth transition between the chord and the weld.

7.5 The weld and weld area must be free of arc strikes. If arc striking does occur, they shall be buffed out completely.

8.0 PAINTING

8.1 Prime and finish paint all repaired areas immediately following completion of the repairs, after the weld area has cooled to 100°F (38°C) or below.

9.0 AMERICAN CRANE APPROVED ELECTRODES

9.1 The following electrodes have been tested and are approved for use:

(A) Chemtron ATOM Arc E7018
(B) Hobart LH 718
(C) Murex Speedex HTS-M-MR
(D) Airco Code-Arc 7018MR
(E) Lincoln LH78 and LH70
(F) Esab 7018
(G) Westinghouse WIZ-18

Note: Electrodes **MUST** be obtained in **hermetically sealed cans only**.

10.0 ELECTRODE STORAGE & CONTROL

10.1 The welding electrodes (E7018) required to successfully perform the lacing replacements are a low hydrogen type. They **must** be obtained in moisture-free hermetically sealed cans, free from physical damage that would result in exposure of the electrodes to the atmosphere. It is essential that these electrodes remain moisture-free for acceptable welding application.

10.2 **Maximum** exposure time for E7018 electrodes, once the container seal has been broken, is **two (2) hours.**

10.3 Storage of these electrodes (E7018) after the can has been opened shall be in an electrode storage oven at a temperature of at least 250°F (120°C).

10.4 Electrodes which have been exposed to the atmosphere longer than **two (2) hours** shall be destroyed. Once the electrodes have been exposed to the atmosphere, even though the time limit of **two (2) hours** has not been exceeded, they shall **not** be returned to the electrode storage oven.

ALL BOOM AND JIB LACING - GUIDELINES FOR FIELD EVALUATION

WARNING

DO NOT USE any Boom and Jib Sections that do not meet ALL of the following conditions. Any conditions which are not met must be corrected prior to use.

ALL BOOM AND JIB LACING - TUBULAR AND ANGULAR

1.0 SCOPE

This procedure provides guidelines for determining whether a tubular, tubular crimped, angle or tee, lacing needs to be repaired or replaced because of damage not conforming to the following specifications.

2.0 POLICY

2.1 The evaluation and/or subsequent repairs to any boom lacing shall be performed by qualified personnel. Original American lacing will be used for replacement. **American assumes no liability for repairs performed by personnel not employed by American Crane.**

2.2 Definitions

2.2.1 To provide a common understanding and consistent interpretation of the terms used within this procedure, the following definitions will apply:

2.2.1.1 "Corrosion"

A condition of removed material or wall thickness reduction due to chemical action on steel.

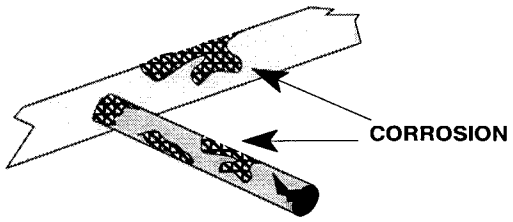


FIGURE 1

2.2.1.2 "Gouge"

A condition of removed material or wall thickness reduction that may have been caused by striking a sharp object or abrasive wear.

2.2.1.3 "Dent"

A condition where the lacing surface has been deformed from its normal shape without any noticeable removal of material. The dent may have no effect on the overall straightness of the lacing.

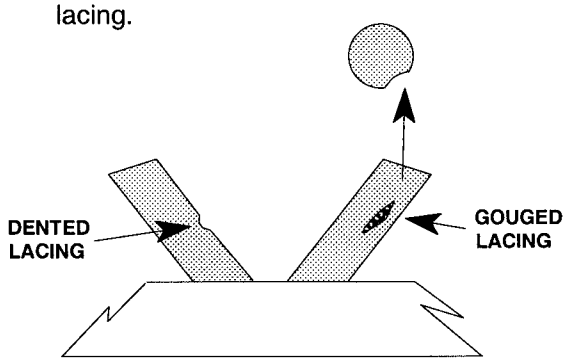


FIGURE 2

2.2.1.4 "Bend"/"Bow"

A condition where a permanent gradual change in the direction of center line of the lacing or variation in straightness.

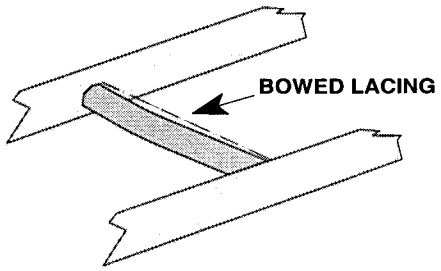


FIGURE 3

2.2.1.5 "Kink"

A condition where the lacing has been bent to a point where there is a crease formed across the diameter.

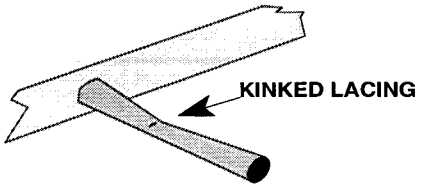


FIGURE 4

3.0 TUBULAR LACING ACCEPTANCE CRITERIA

3.1 The maximum reduction in wall thickness due to "corrosion" or a "gouge" cannot exceed 10% of the original wall thickness. The maximum length shall not exceed 100% of the lacing diameter and the maximum width shall not exceed 25% of the lacing diameter.

EXAMPLE: the "gouge" depth measures .011 in. (.3mm) and the original wall thickness is .095 in. (2.4mm), therefore the wall reduction is 12% which is unacceptable. The diameter of the lacing is 2.0 inches so the largest size can be 2.0 in. (50.8mm) long and .5 in. (12.7mm) wide.

3.1.1 One method of measuring is to use ultra sound and measure a good area of the lacing then measure the defective area to compare.

3.2.1 Another method is to use a micrometer to measure the diameter of the lacing in a good area. Then measure the defective area and compare. See Wall Thickness Table.

3.2 The maximum "dent" damage that is acceptable cannot exceed 2% of the original diameter. The maximum allowable length shall not exceed 100% of the diameter of the lacing. The maximum width shall not exceed 25% of the diameter of the lacing.

3.2.1 To measure the dent, use two scales or depth gauge.

3.3 The maximum "bend" or "bow" or variation from straight cannot exceed .002 in. (.05mm) per inch (25.4mm) of the length of the lacing up to 60 inches (15.24cm). Any lacing over 60 inches (15.24cm) long cannot exceed .120 in. (3.0mm).

EXAMPLE: A lacing 48 in. (12.19cm) long may be acceptable with a "bow" of .096 in. (24.4mm) maximum from the centerline.

3.3.1 To measure the "bow" or "bend" use two blocks of equal size positioned at each end of the lacing. Draw a wire or line taut over the blocks and measure the variation

⚠ CAUTION

ALL BROKEN, CRACKED AND KINKED LACING MUST BE REPLACED

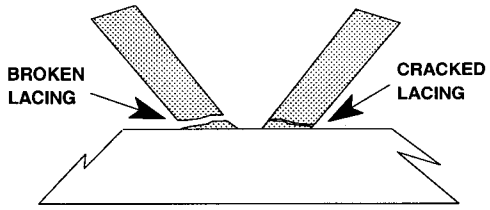


FIGURE 5

LACING WALL THICKNESS

OUTSIDE DIAMETER	WALL THICKNESS
.875" (22.2mm)	.072" (1.8mm)
1.00" (25.4mm)	.095" (2.4mm)
1.25" (31.8mm)	.095" (2.4mm)
1.50" (38.1mm)	.095" (2.4mm)
1.625" (41.3mm)	.095" (2.4mm)
1.625" (41.3mm)	.134" (3.4mm)
1.875" (47.6mm)	.095" (2.4mm)
2.00" (50.8mm)	.109" (2.8mm)
2.188" (55.6mm)	.120" (3.0mm)
2.25" (57.15mm)	.120" (3.0mm)
2.312" (58.7mm)	.120" (3.0mm)
2.500" (63.5mm)	.120" (3.0mm)
2.812" (71.4mm)	.120" (3.0mm)
3.00" (76.2mm)	.120" (3.0mm)
3.00" (76.2mm)	.156" (4.0mm)

These are current standard lacing sizes. Any lacings that are not listed, consult American Crane Service Dept.

4.0 REPAIR PROCEDURE FOR "BENT/BOWED" ANGULAR, TUBULAR OR TUBULAR CRIMPED LACING

4.1 Carefully "cold straighten" the lacing. **Do not use heat** to straighten the lacing. This may be accomplished by pulling or pushing the lacing straight, applying the forces at the center of the bow. The lacing surface must be protected by using belting, partial sleeves, hardwood, etc.

4.1.1 After the lacing has been straightened, carefully check to insure that no damage has occurred such as kinking or denting. Then magnetic particle (yoke method) examine or equivalent is required to insure that damage did not occur to the welds that attached "bent/bowed" lacing to the chord. Also chord straightness needs to be checked.

⚠ CAUTION

BEFORE PLACING BOOM OR JIB SECTIONS BACK INTO SERVICE, IT SHALL BE RE-PRIMERED AND FINISH PAINTED TO PROTECT AGAINST FUTURE CORROSION.

5.0 ANGULAR OR T LACING ACCEPTANCE CRITERIA

5.1 The maximum reduction of material thickness due to "corrosion" or a "gouge" cannot exceed 10% of the original material thickness. The maximum length shall not exceed 100% the width of the lacing leg and the maximim width cannot exceed 25% of the width of the lacing leg.

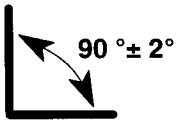
EXAMPLE: The angle lacing size is .25 x 2 x 2 in. (6.35 x 50.8 x 50.8mm), therefore, the maximum depth of gouge or corrosion cannot exceed .025 in. (.6mm). The maximum length cannot exceed 2.0 in. (50.8mm), the maximum width cannot exceed .5 in (12.7mm)

5.1.1One method of measuring is to use a micrometer to measure a damaged and undamaged area, then compare. See 6.0 for Corrosion or Gouge Repair.

5.2 Lacing with a "dent" type condition the maximum depth cannot exceed 15% of the thickness of the lacing. The maximum length is 100% the width of the lacing and the maximum width is 25% the width of the lacing.

EXAMPLE: The lacing is 2.0 in. (50.8mm) wide and .25 in. (6.35mm) thick, the maximum dent size is .037 in. (.9mm) deep, 2.0 in. (50.8mm) long and .50 in. (12.77) wide. Measure with a protractor.

The "square" of the angle must also be maintained.



See 6.0 for "dent" repair.

5.3 The maximum "bend" or "bow" or variation from straight cannot exceed .002 in. (.05mm) per inch (25.4mm) of the length of the lacing up to 60 inches (15.24cm). Any lacing over 60 inches (15.24cm) long cannot exceed .120 in. (3.0mm).

EXAMPLE: A lacing 48 in. (12.19cm) long may be acceptable with a "bow" of .096 (24.4mm) maximum from the centerline.

5.3.1 To measure the "bow" or "bend" use two blocks of equal size positioned at each end of the lacing. Draw a wire or line taut over the blocks and measure the variation

Any repair to bring the bowed angular lacing within specification can be performed as in section 4.0.

6.0 REPAIR PROCEDURE FOR ANGULAR OR T LACING WITH GOUGES, CORROSION, AND DENTS.

Note: All welding is to be performed by a qualified welder that is certified by an industry standard.

6.1 To repair the corrosion or gouge, clean the surface to be welded to remove paint scale, rust, moisture or other foreign material that will prevent proper welding.

a. Use 3/32 diameter E7018 electrode
b. Preheat required to 70° F (21°C) minumum
c. Maximum interpass temperature is 300°F (150° C)
d. Use Stringer Method only

After welding, grind to blend in smooth. Do not grind into base metal. Carefully inspect the area for cracks in the weld or material. If satisfactory, then prime and paint the repaired area.

6.2 If the lacing has a dent it can be repaired by heating the damaged area to 1000° F (378° C) and using a hammer to straighten the dent. Inspect the area for cracks in the material or welds. If satisfactory, prime and paint the repaired area. After repaired, the chord straightness must be inspected.

⚠ CAUTION

IF THE LACING CANNOT BE REPAIRED, IT MUST BE REPLACED USING PROCEDURES IN SECTION 7.0

7.0 REFERENCES

7.1 American Welding Standard WEL-2000 American Operating and Maintenance Manual - Welding Procedure for Lacing Replacement in High Strength Tubular Booms.

7.2 American Welding Standard WEL-2013 American Operating and Maintenance Manual - Welding Procedure for Lacing Replacement: A036 Angle or Tee Lacing to A030 Angle Chord.

7.3 American Welding Standard WEL-2012 American Operating and Maintenance Manual - Welding Procedure for Lacing Replacement: A061 Crimped Tubular Lacing to A030 angle Chord.

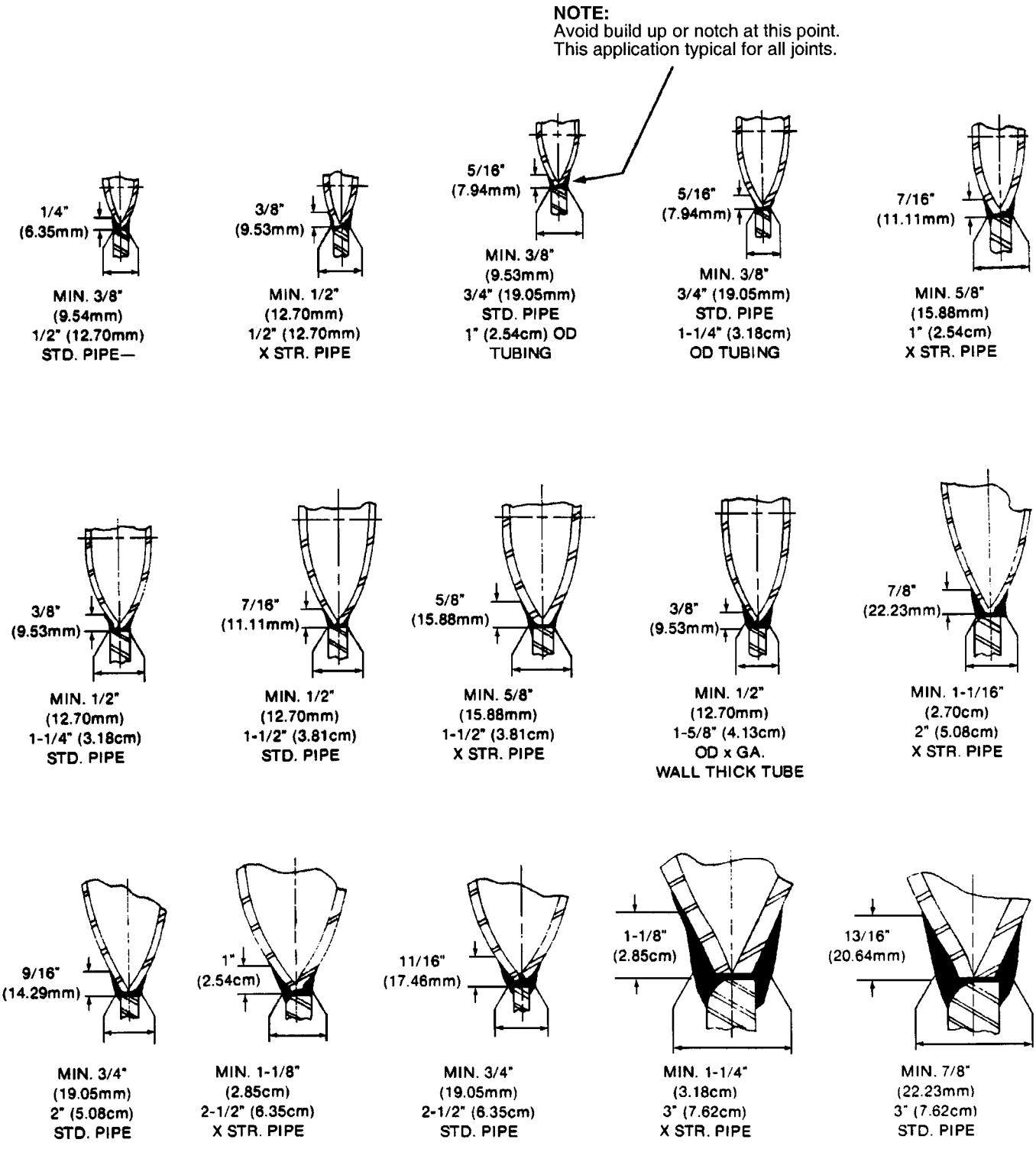
7.4 American Tubular Boom - Guidelines for Field Evaluation American Operating and Maintenance Manual.

7.5 American Angular Boom - Guidelines for Field Evaluation.

AMERICAN CRANE CORPORATION does not authorize any type of repair in the field or shop on tubular high lift jibs due to the technical weld process. If it becomes necessary to replace lacings, the replacement must be performed by a welder supplied by AMERICAN CRANE CORPORATION.

FOR ANY INSPECTION RESULTS OR QUESTIONS THAT ARE NOT WITHIN THESE GUIDELINES, CONSULT AMERICAN CRANE SERVICE DEPARTMENT

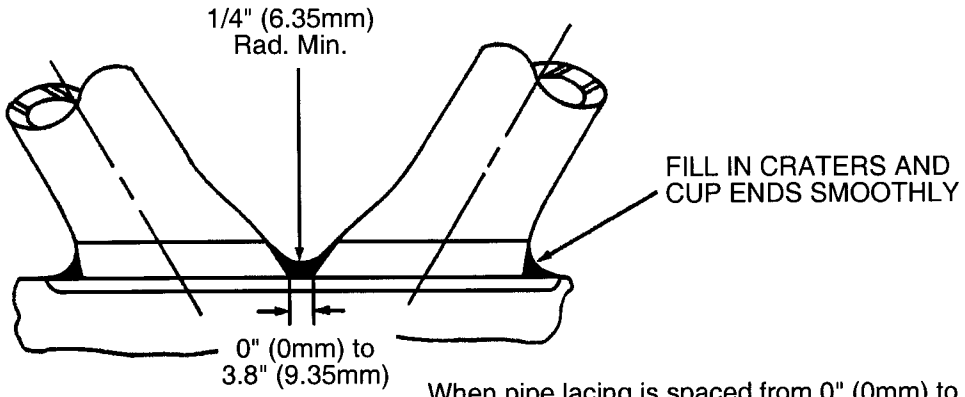
LACING REPAIRS - ANGLE CHORD BOOMS



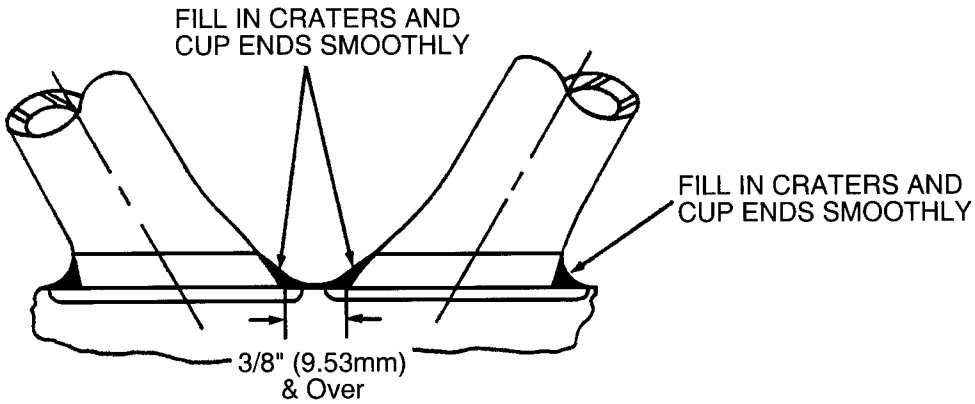
LACING REPAIRS

NOTE

These two welding applications shown are typical for pipe lacing, regardless of pipe size. Use E-7018 electrode for welding pipe lacing to chord angles.



When pipe lacing is spaced from 0" (0mm) to 3/8" (9.53mm) connect welds smoothly as shown, using a minimum of 1/4" (6.35mm) RAD.



When pipe lacing is spaced 3/8" (9.53mm) and greater, fill in craters and cup ends smoothly as shown.

Section 4

STRUCTURE

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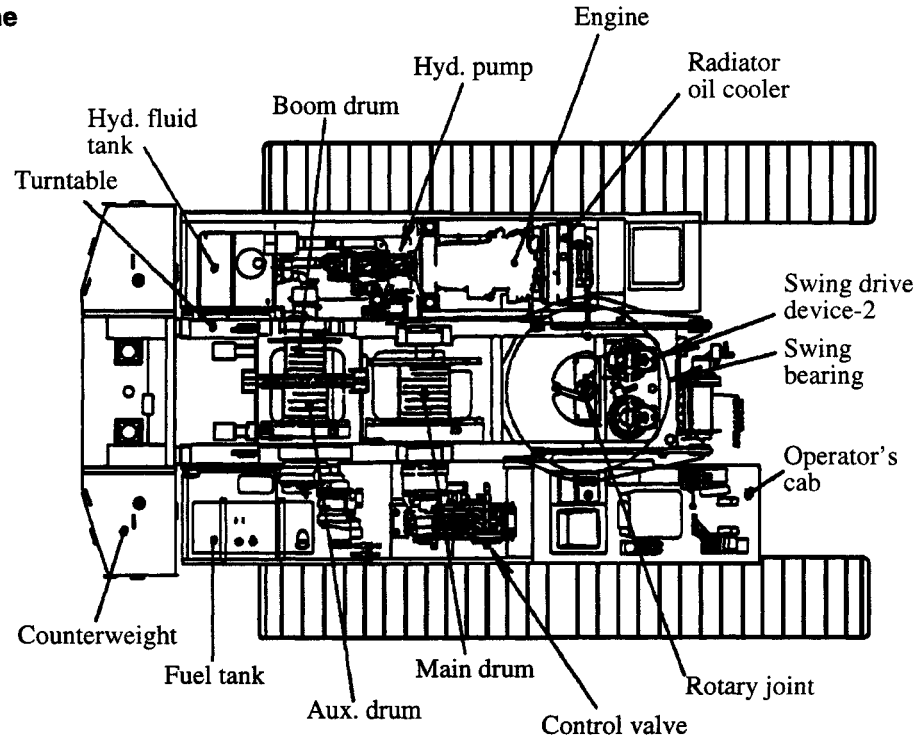
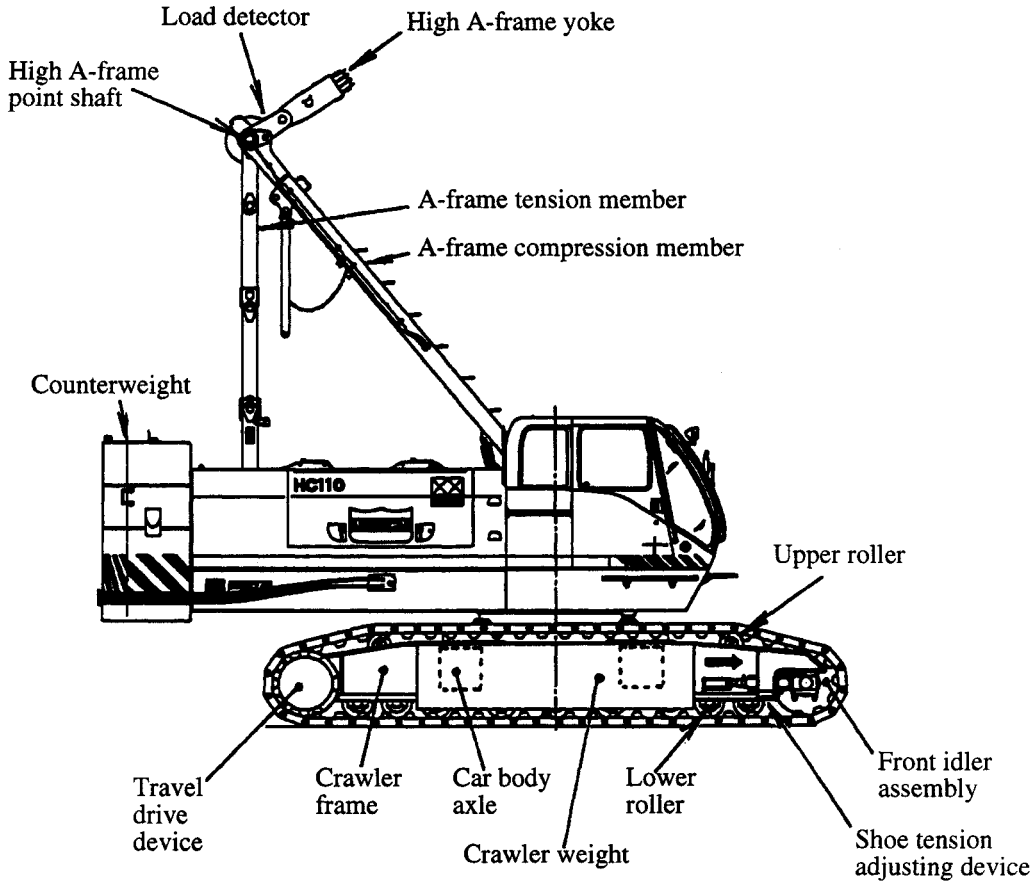
1. STRUCTURE AND NAME

1-1 Base machine





2. EXPLANATION OF PRINCIPAL STRUCTURE

2-1 Hook hoisting system

The main and auxiliary drums are installed tandem independently, and driven by separate hydraulic motors through reduction gears respectively to hoist and lower the hook. Rope speed can be controlled by stroke of operation lever and Hi/Lo speed selector switch.

The brake can be selected from two modes, either foot pedal or automatic brake system, by means of a select switch.

In the case of automatic brake mode, brake will be on at neutral position and foot brake operation is not necessary in this mode. When foot brake mode is selected, automatic brake will be released and brake will be operated by foot pedal. Hydraulic power assist system is applied for foot pedal breaking system and adjusted to proper foot pressure so delicate half brake operation can be done with great ease. During automatic brake mode, clutch should always be in the "ON" position while foot pedal brake mode winch lever should be in the neutral position and clutch should be in the "OFF" position. "ON" and "OFF" clutch can be selected by means of the winch lever automatically. Both main and auxiliary hoist drum are provided with ratchet drum locks, together with a counterbalance valve system.

Hydraulic motors:	Variable displacement axial piston type for both main and auxiliary drum drive
Reduction gear:	Two-stage planetary gear
Hoisting drums:	2 x grooved cylindrical drums on individual tandem shaft
Clutches:	Internal expanding band type, spring-loaded hydraulic released
Brakes:	External contracting band type foot pedal braking with hydraulic assist and spring-loaded automatic braking
Drum locks:	Spring-loaded and hydraulic cylinder released
Rope speeds:	High and low, both further controllable in stepless mode by manipulation of control lever Ultra-low speed mode can be controlled individually, engine speed and discharge volume of hydraulic pump which is controlled by swash plate angle of variable displacement axial piston pump.
Load lowering:	Both power load lowering drive and free-fall drive and free-fall modes possible

2-2 Boom hoisting system

An independent hydraulic motor provides the necessary power through the reduction gear, to permit independent operation from the other movements. Rope speed can be controlled in stepless mode through regulating stroke of the lever. Lowering is by power boom lowering drive. Operation safety is ensured by spring-loaded automatic brake and ratchet drum lock, together with a counter-balance valve system.

Hydraulic motor:	Axial piston type
Reduction gear:	Two-stage planetary gear
Hoisting drum:	Grooved cylindrical single drum on shaft
Brake:	Automatic spring-loaded, hydraulically released wet type multi-disc
Drum lock:	Spring-loaded and hydraulic cylinder released
Rope speed:	Stepless control by manipulation of lever stroke
Lowering:	Power boom lowering drive

2-2 Swing system

One gear pump unit and two axial piston motor units provide for independent operation from the other movements, acting through the reduction gear.

Ball bearing support of the swing, superstructure ensures smooth acceleration and stopping of the swing motion without causing oscillation of the suspended load. Spring-loaded parking brake systems are provided for stopping the swing motion. A manual locking device is also installed.

Hydraulic motor:	Axial piston type
Reduction gear:	Two-stage planetary gear and one-stage spur gear
Slewing bearing:	Single row ball bearing with internal gear
Parking brake:	Wet type multi-disc, spring-loaded hydraulically released
Swing lock:	Pin-lock type, 2 positions

2-4 Travel system

Travel is made by two hydraulic motors and reduction units which are fitted within crawler shoe width. Pivot-turn and spin-turn is easily made.

Travel brake is hydraulic brake actuated automatically by releasing control levers into the neutral position.

Hydraulic motor:	Axial piston type with brake valve
Reduction gear:	Three-stage planetary gear ("shoe-in" type)
Travel brake:	Wet type multi-disc, spring-loaded hydraulically released automatically

2-5 Manipulating system

2-5-1 Control levers

Control levers are arranged in two lever stands, on the right and left side of the operator's seat.

Main/auxiliary and boom hoisting/lowering motions, as well as travel and swing movements, are controlled by a remote control valve which actuates main control valve through change of hydraulic pilot. All controls therefore ensure light touch, and sensitive control without operator fatigue.

Combined simultaneous operation is possible for the three movements of main (or auxiliary) hoisting/lowering, boom hoisting/lowering and swing.

Engine throttle controls operating speed with wider range from delicate inching speed to maximum high speed by foot throttle pedal and engine grip throttle.

2-5-2 Operator's cab

The operator's cab is positioned on the right-hand front side of the superstructure. It is completely separated from the machine room, and has 360° viewing range through large glass windows. The cab is designed in compliance with International Standards (ISO) with a width of 37" (940mm) for operator's comfort to minimize fatigue in continuous operation.

2-6 Boom attachment

Provided by TEREX CORPORATION

2-7 High A-frame

Three-links collapsible frames are installed.

2-8 Counterweights

Upper counterweight:	Type A: Two pieces removable 22.1 US tons (20.0 metric tons)
	Type B: Four pieces removable 26.5 US tons (24.0 metric tons)
Crawler frame: counterweight	Two pieces removable 11.5 US tons

2-9 Fuel supply pump

Fuel tank and supply pump are located at the left side and rear end of turntable.

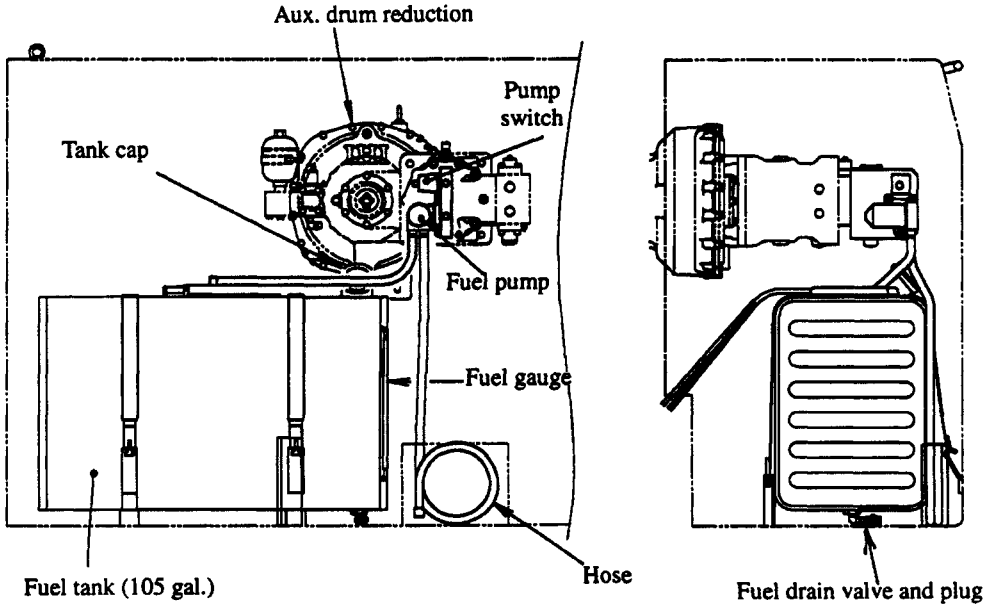
Fuel tank consists of 105 gallon capacity tank, 24V DC electric motor driven suction pump, and hose.

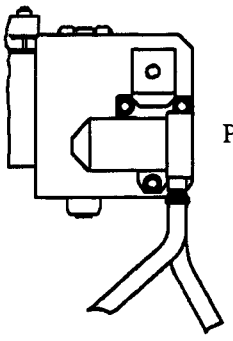
Hose should be cleaned before putting it in the drum or storage tank.

While driving the pump, carefully watch tank level . Otherwise, fuel will overflow.

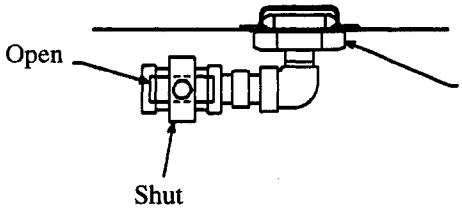
After supplying the fuel, clean up the hose and hang it beside the tank.

Tightly close both tank's caps.





Pump, Switch part



When you want to fully drain away the water collected on the tank bottom, loosen this nut.

3. WIRING DIAGRAM

3-1 Electrical system diagram

Notes:

1. Unless specified, wire size shall be 0.85mm^2.
2. For parenthesized symbol after each component name, refer to the explanatory note.
3. This diagram does not include a circuit which does not use the power supply of the base machine (DC24V battery).
4. Each component in a solid-line square is installed outside the control panel.
5. The component marked with ☆ is not installed to the machine without tower crane specification.
6. Use a red wire for the power supply and a black wire for ground.
7. The standard of other wires except the above is as follows:

Number	0~	100~	200~	300~	400~	500~	600~	700~
Color	White	Gray	Yellow	Blue	Green	Brown	Orange	Orange

8. In this circuit, the devices with oblique lines are not set.

Explanatory note:

(TW)... Used exclusively for tower crane and tower jib.

(LJ).... Used exclusively for luffing jib.

(OPT).. Shows the optional or selectable specification.

PB .... Push Button

PS .... Pressure Switch

KS .... Key Switch

(T.)..... Timer

(X)..... Relay

F..... Fuse

TS .... Toggle Switch

SN .... Sensor

(BZ).... Buzzer Alarm

(SL).... Solenoid

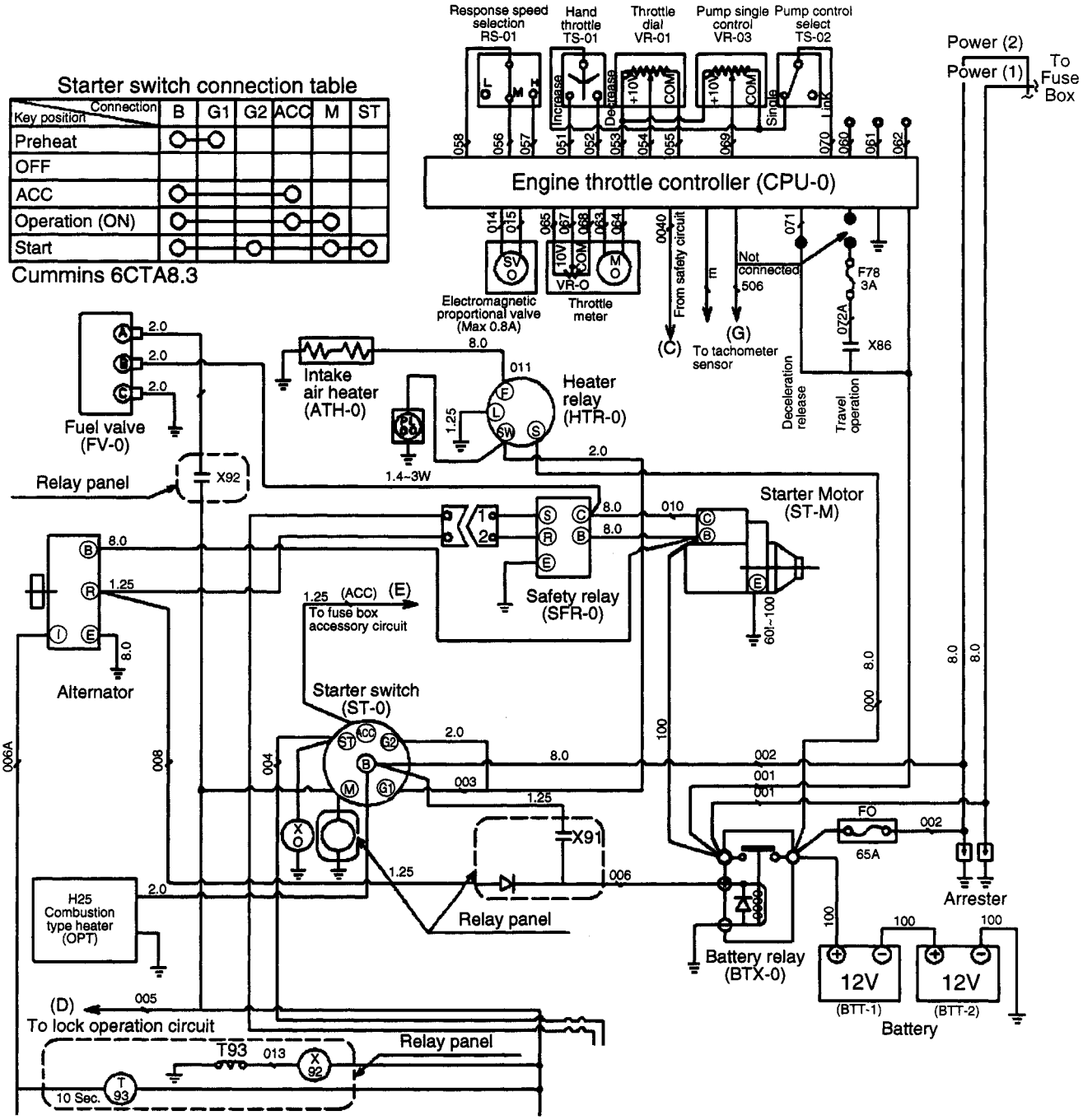
(L.).... Light

(M).... Motor

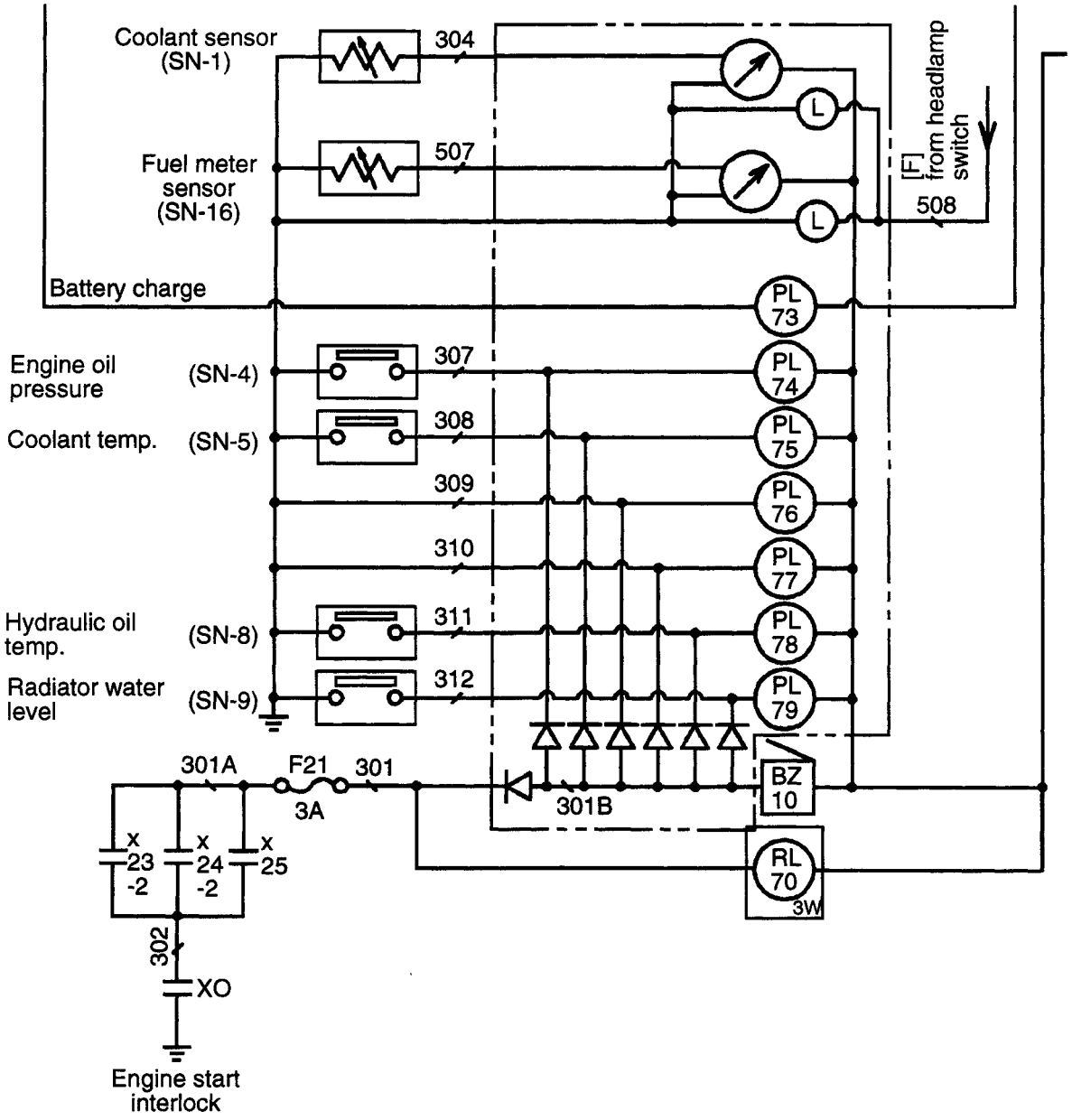
RL .... Red Light

M/L.... Moment Limiter

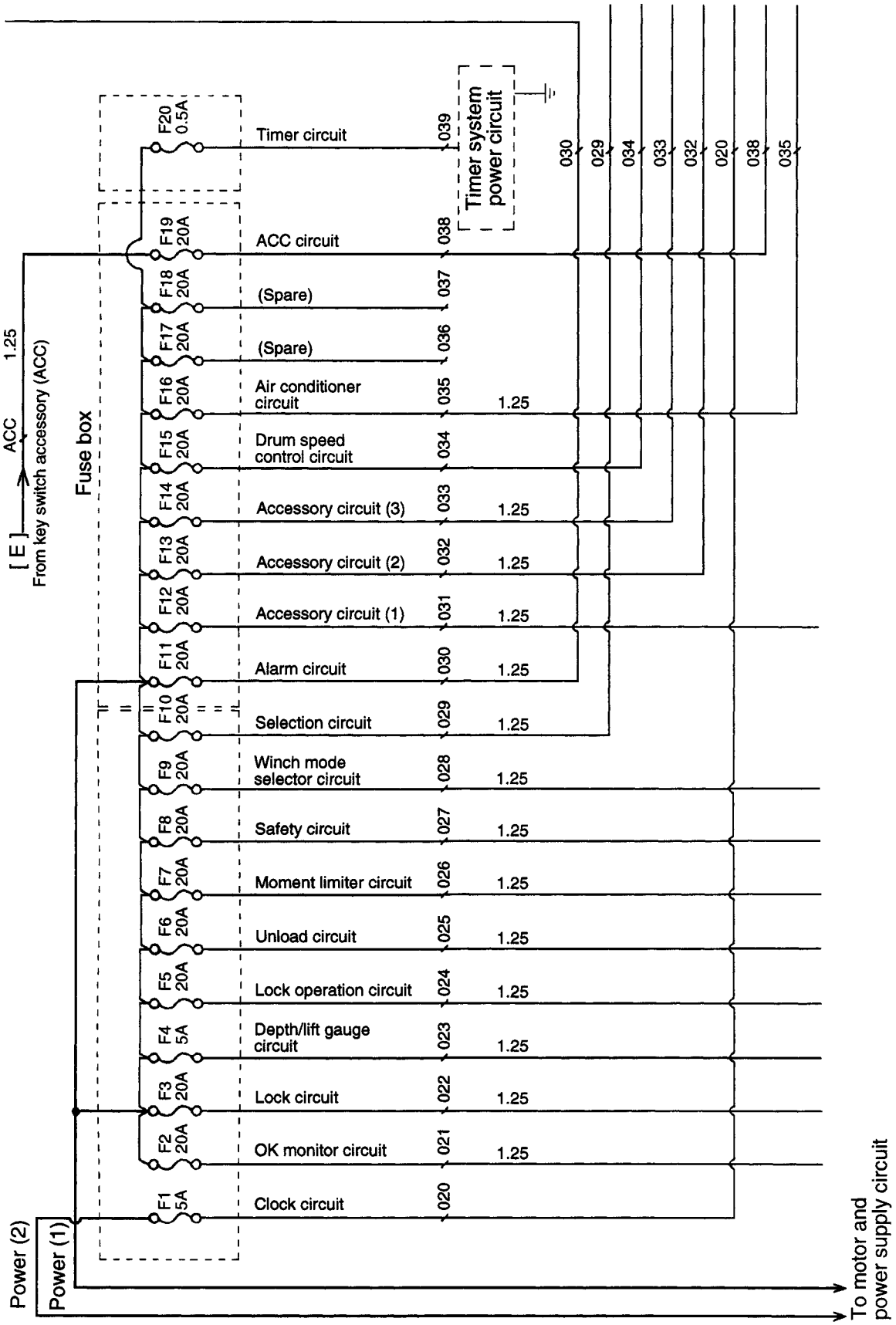
Motor and Power Supply Circuit



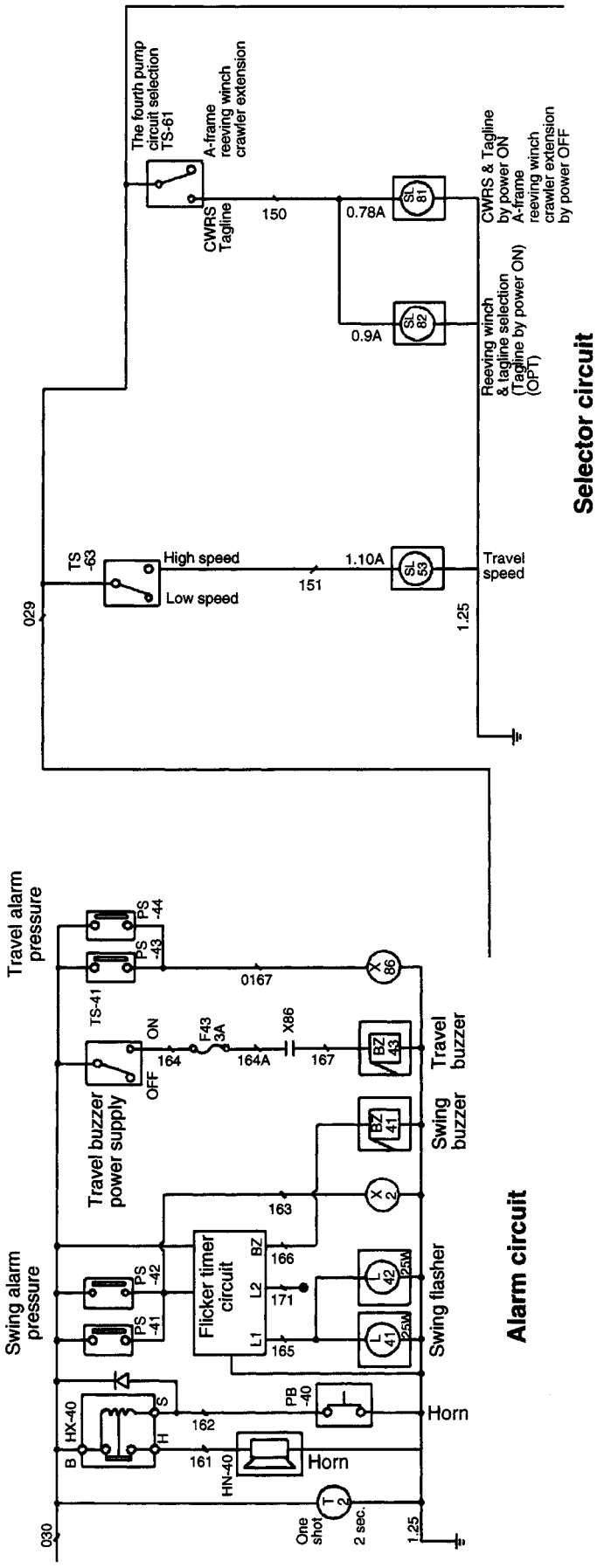
OK Monitor Circuit



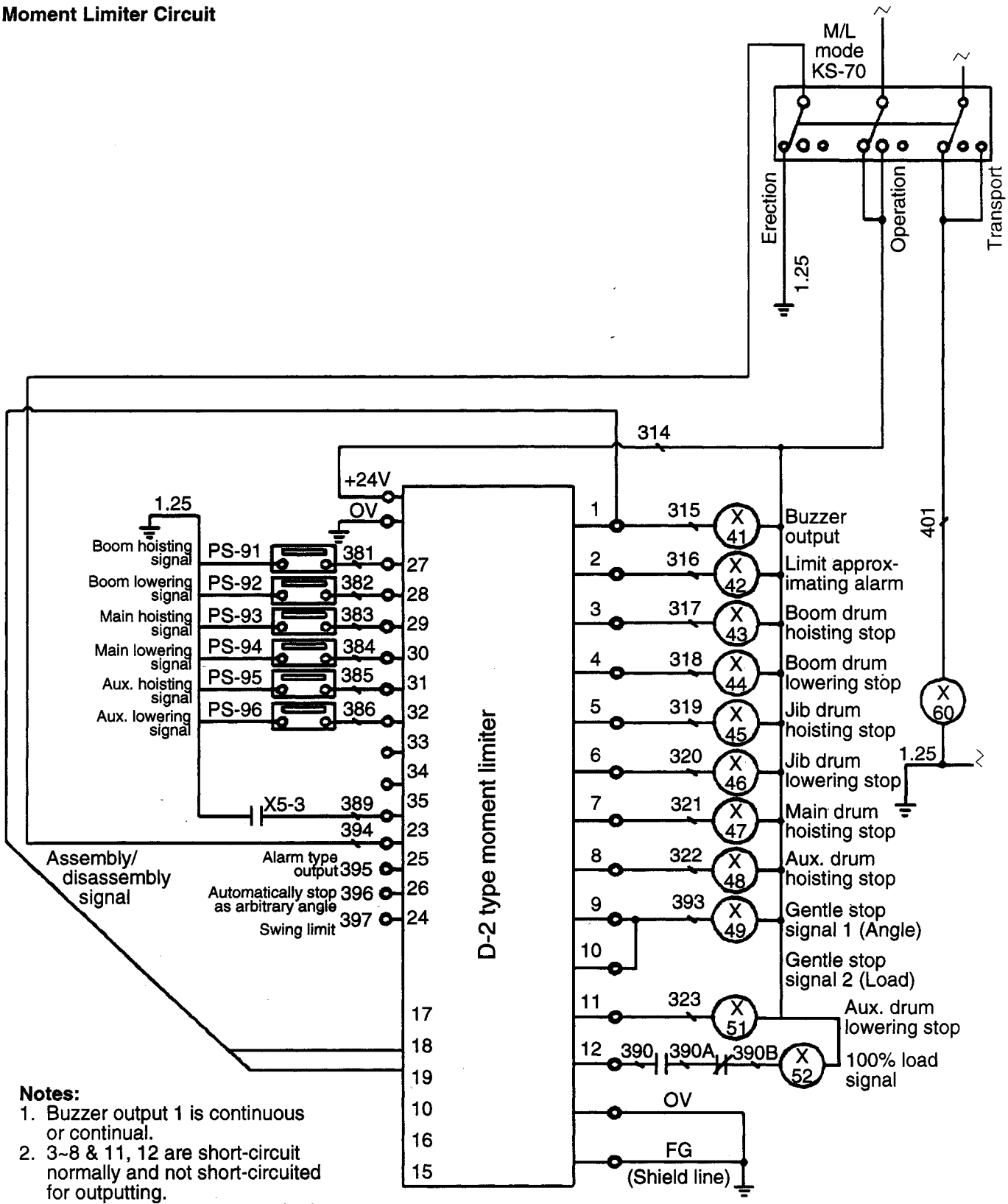
Fuse Box


Fuse box
F20 0.5A
Timer circuit
039
Timer system power circuit
F19 20A
ACC circuit
038
F18 20A
(Spare)
037
F17 20A
(Spare)
036
F16 20A
Air conditioner circuit
035
1.25
F15 20A
Drum speed control circuit
034
F14 20A
Accessory circuit (3)
033
1.25
F13 20A
Accessory circuit (2)
032
1.25
F12 20A
Accessory circuit (1)
031
1.25
F11 20A
Alarm circuit
030
1.25
F10 20A
Selection circuit
029
1.25
F9 20A
Winch mode selector circuit
028
1.25
F8 20A
Safety circuit
027
1.25
F7 20A
Moment limiter circuit
026
1.25
F6 20A
Unload circuit
025
1.25
F5 20A
Lock operation circuit
024
1.25
F4 5A
Depth/lift gauge circuit
023
1.25
F3 20A
Lock circuit
022
1.25
F2 20A
OK monitor circuit
021
1.25
F1 5A
Clock circuit
020
030
029
034
033
032
020
038
035
[E]
ACC
1.25
From key switch accessory (ACC)
Power (2)
Power (1)
To motor and power supply circuit

Alarm and Selector Circuits



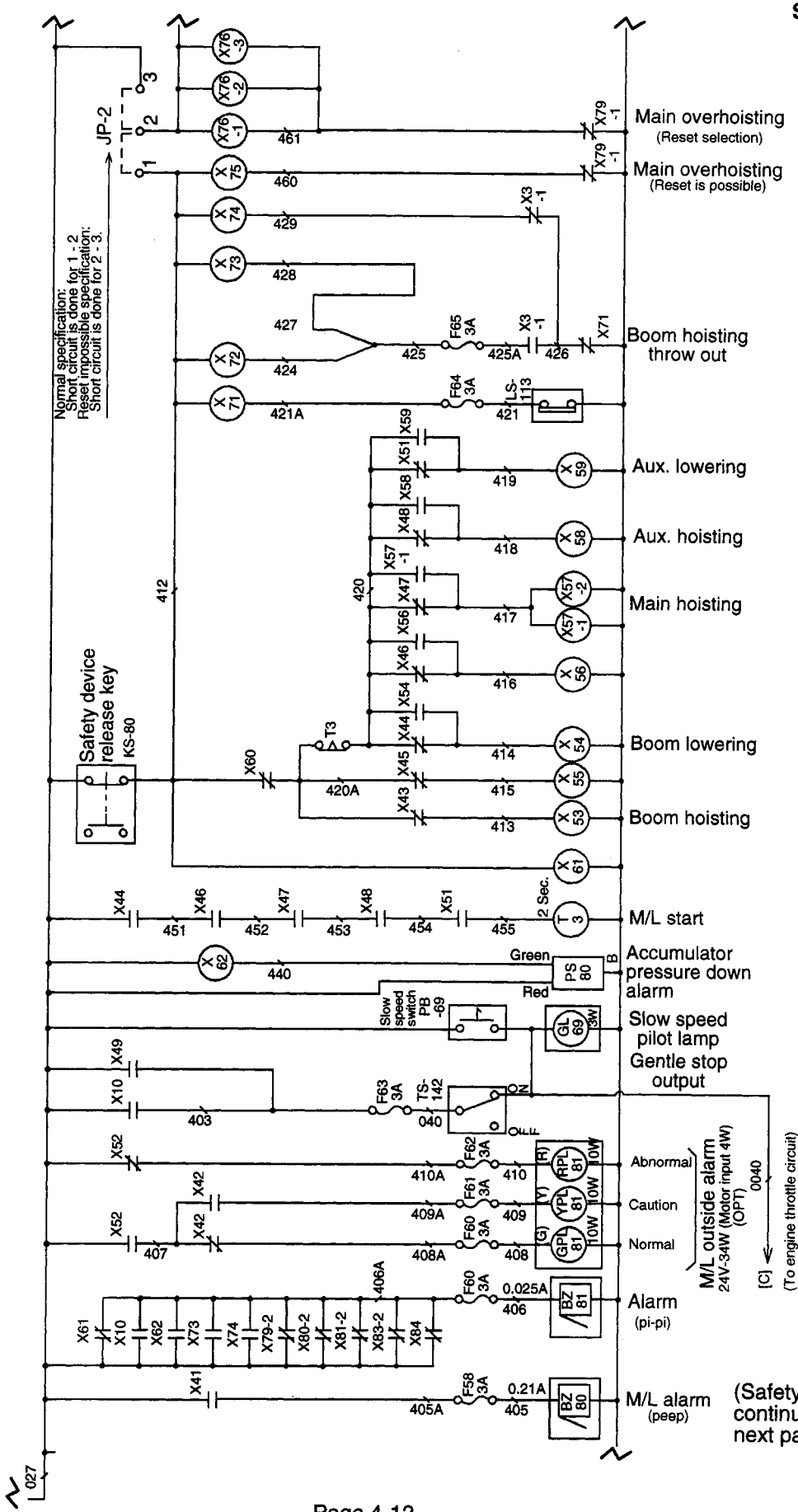
Moment Limiter Circuit



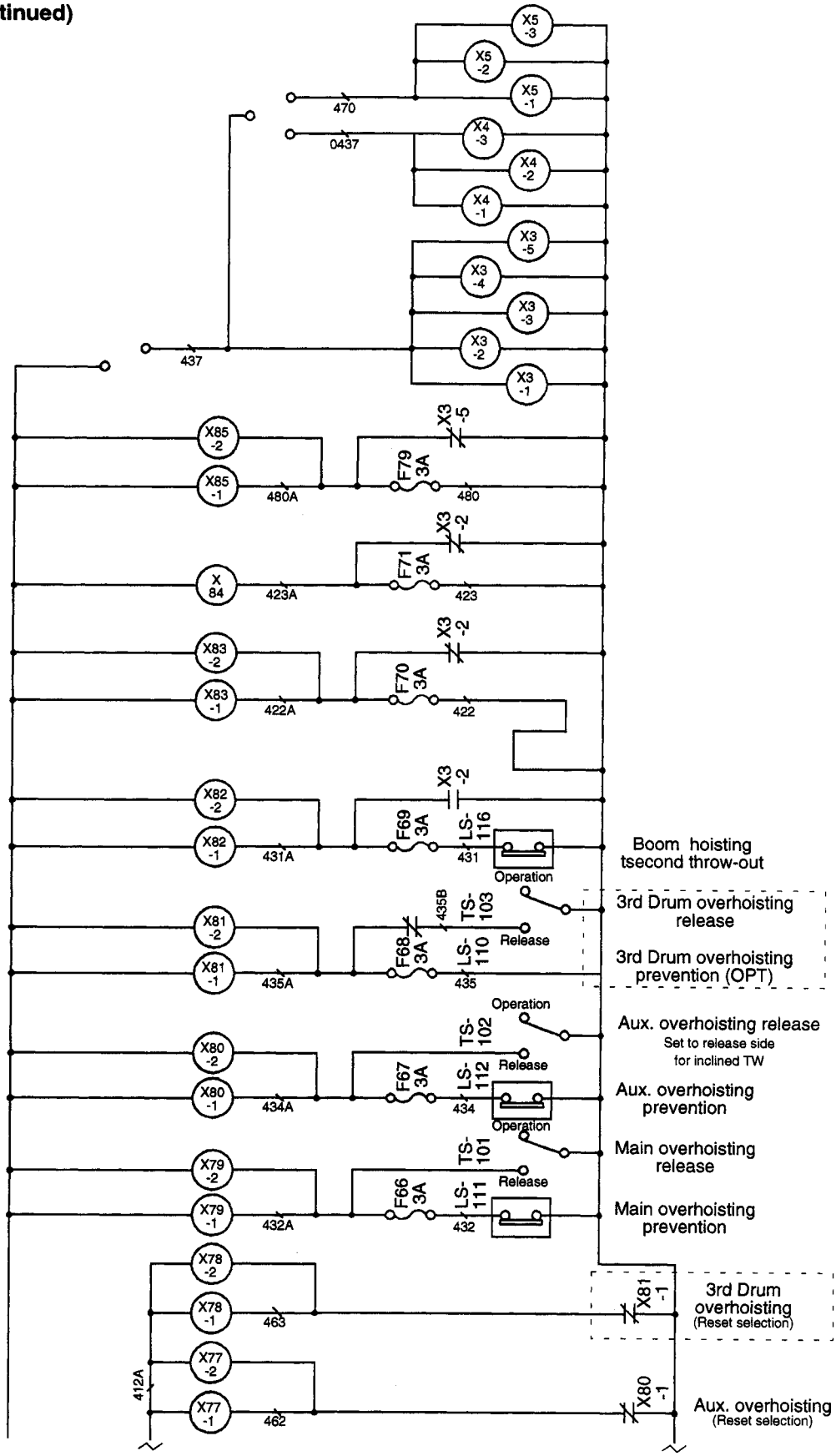
Notes:

1. Buzzer output 1 is continuous or continual.
2. 3~8 & 11, 12 are short-circuit normally and not short-circuited for outputting.
3. 2, 9 and 10 are short-curcuited for outputting.

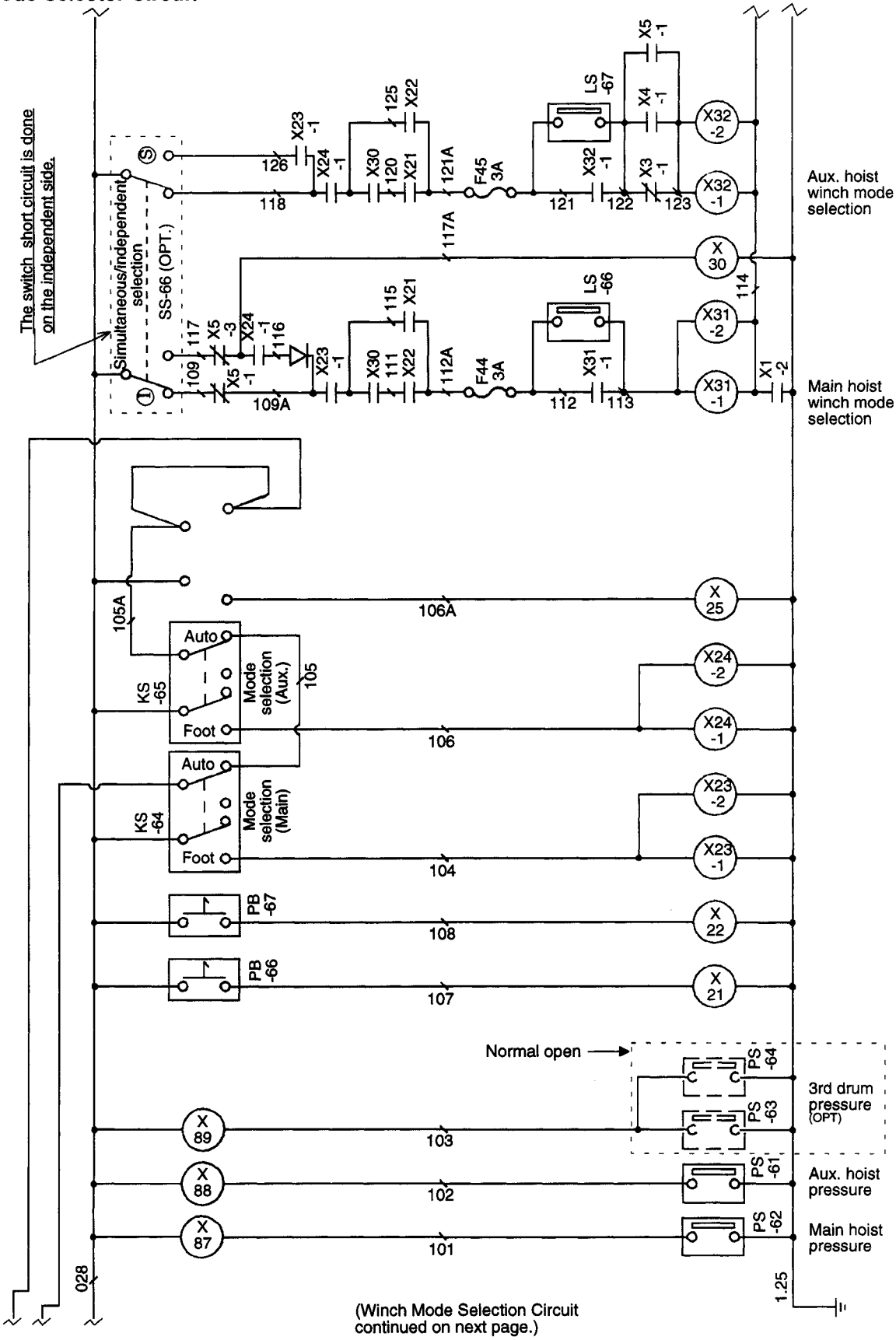
Safety Circuit



Safety Circuit (continued)

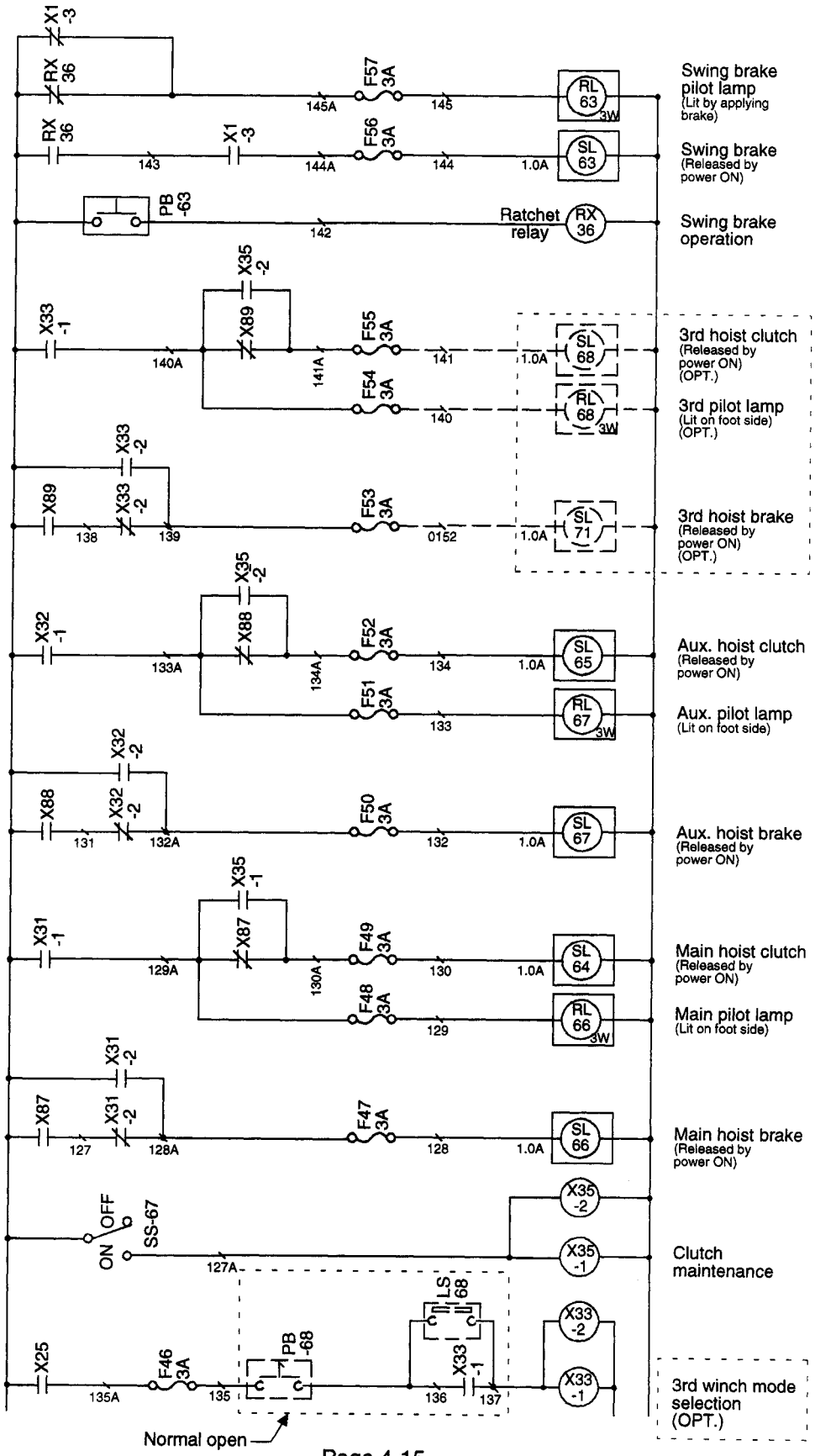


Winch Mode Selector Circuit

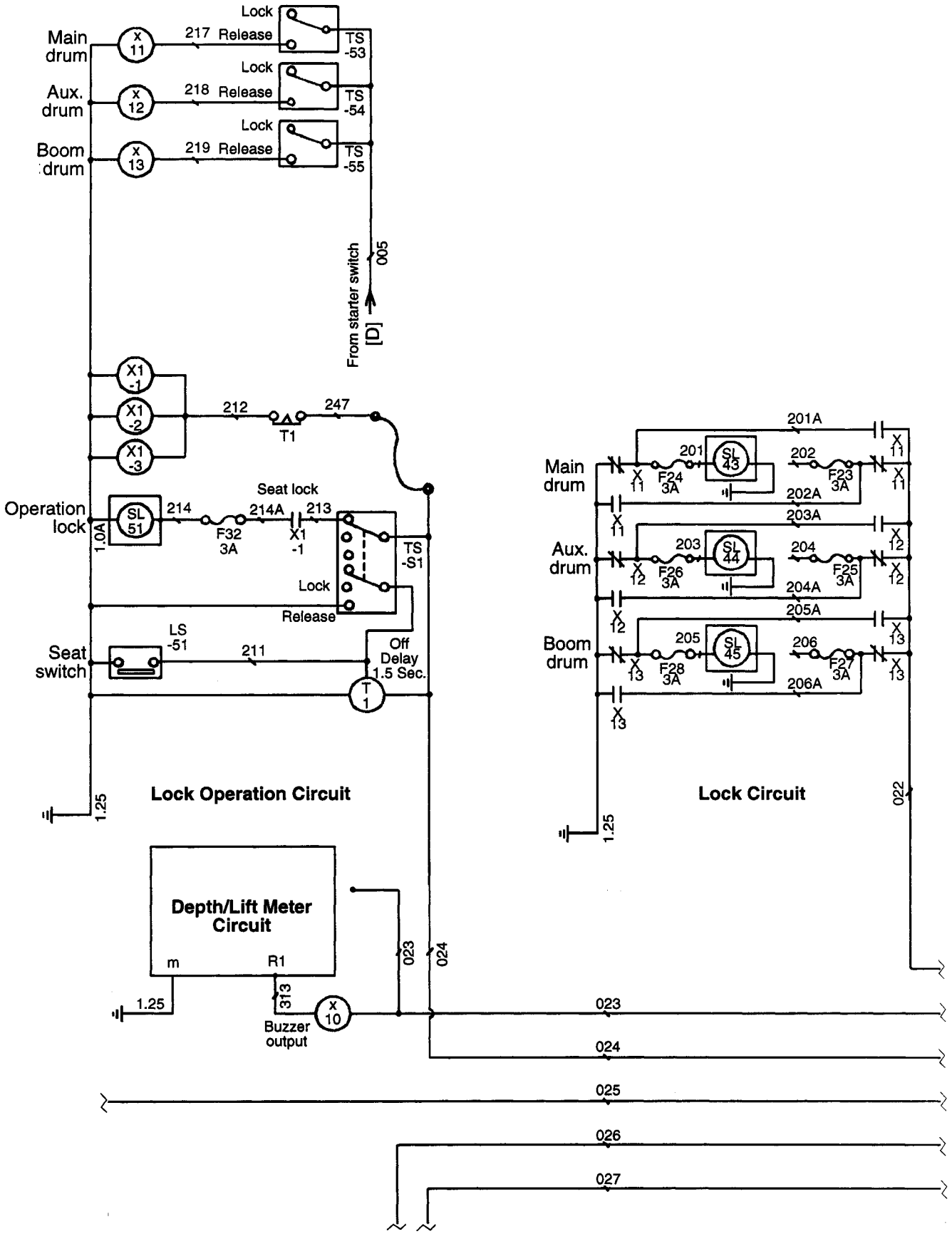


(Winch Mode Selection Circuit continued on next page.)

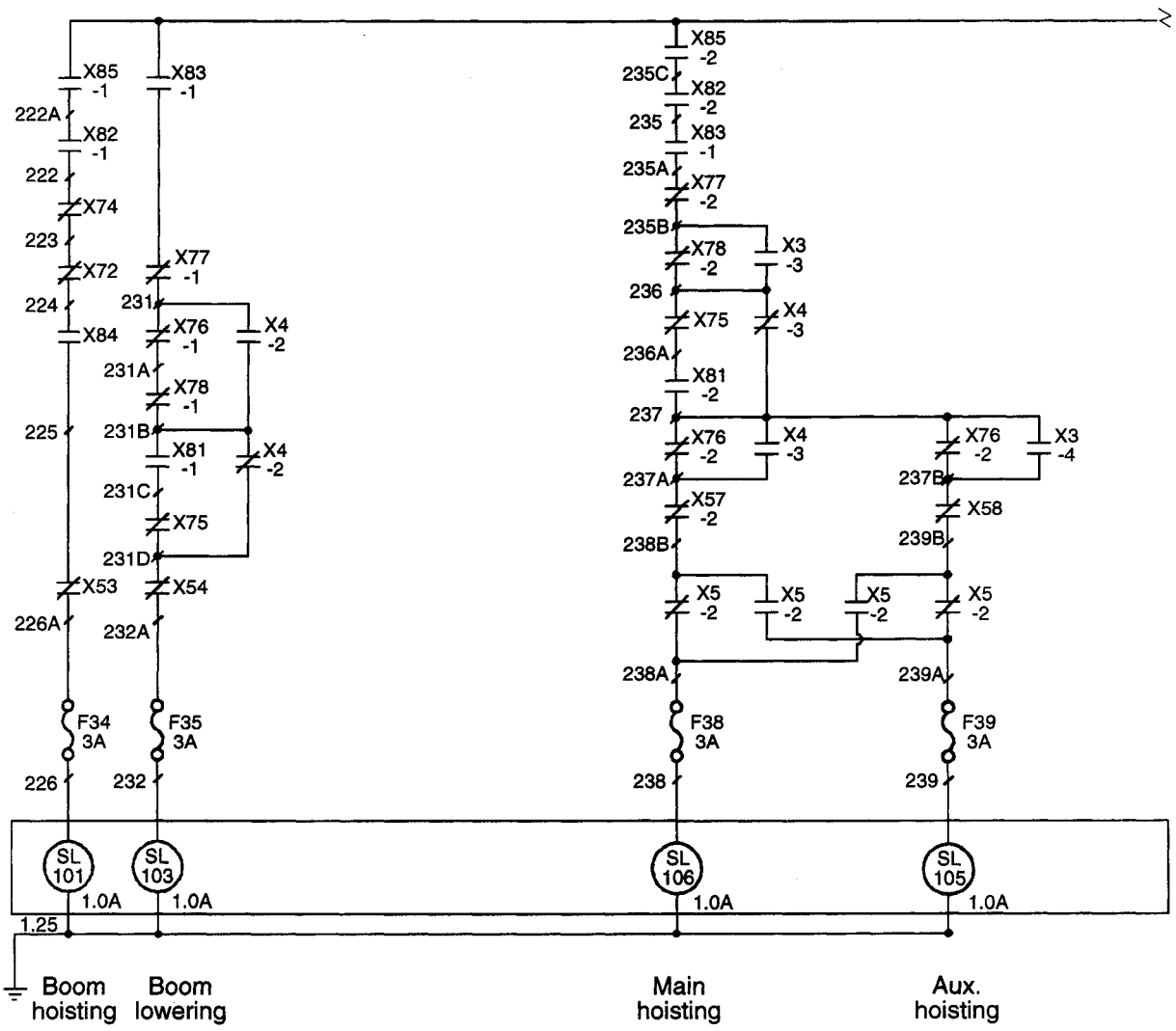
Winch Mode Selector Circuit (continued)



Lock Operation, Lock & Depth/Lift Meter Output Circuit

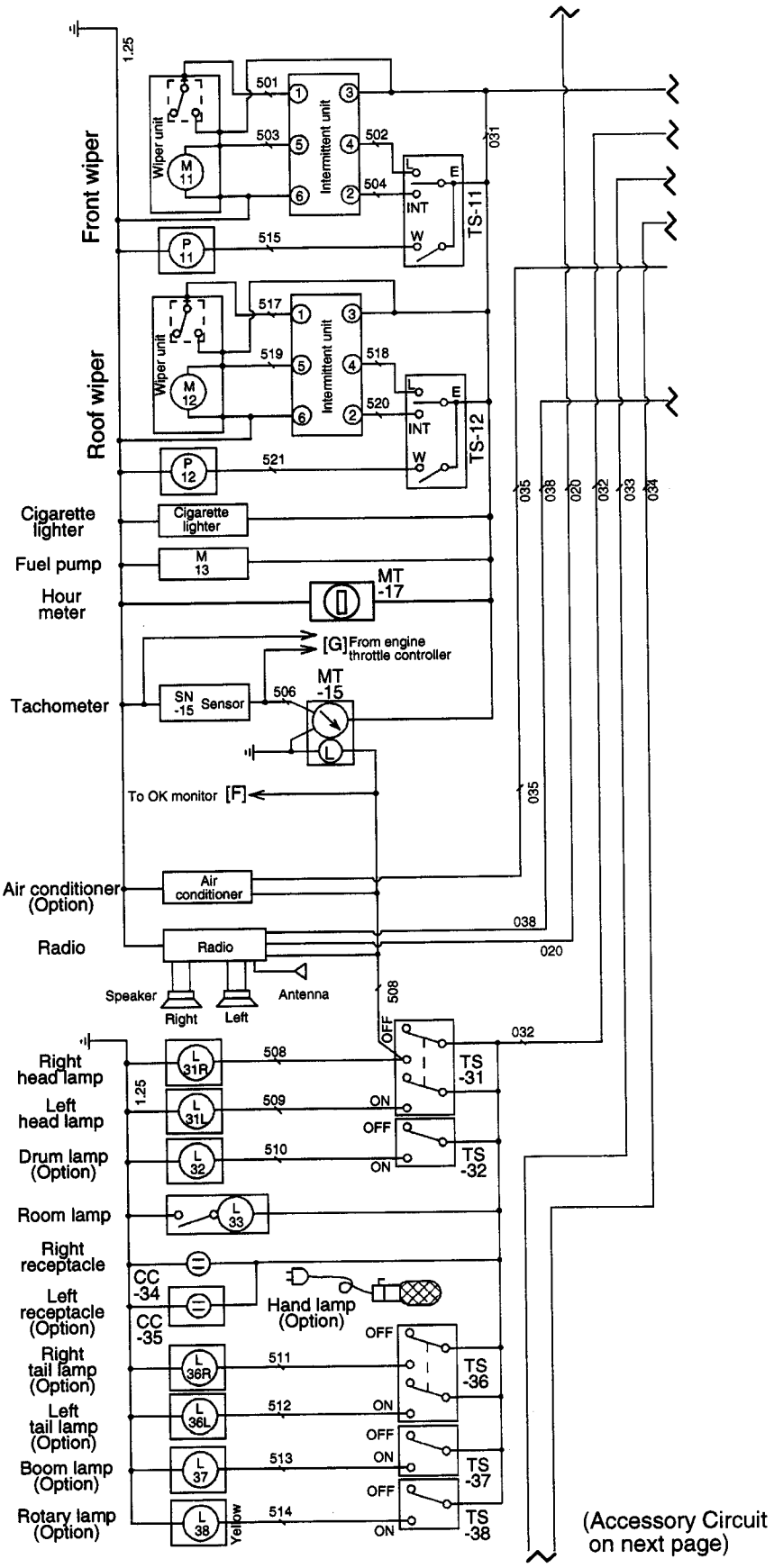


Unload Circuit

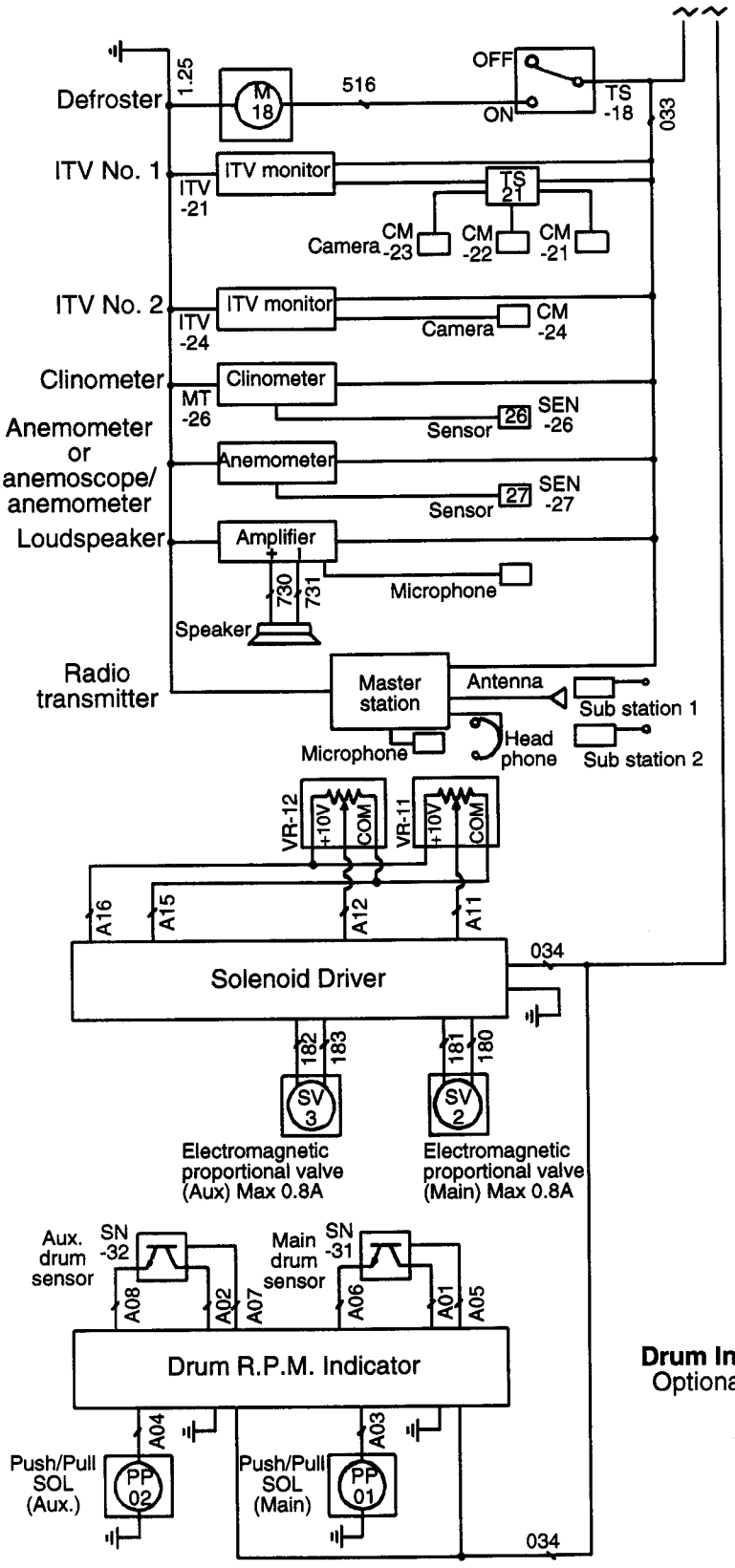


(Load by power ON and unload by power OFF)

Accessory Circuit 1 & 2



Accessory 3, Drum Speed Control & Drum Indicator Circuit

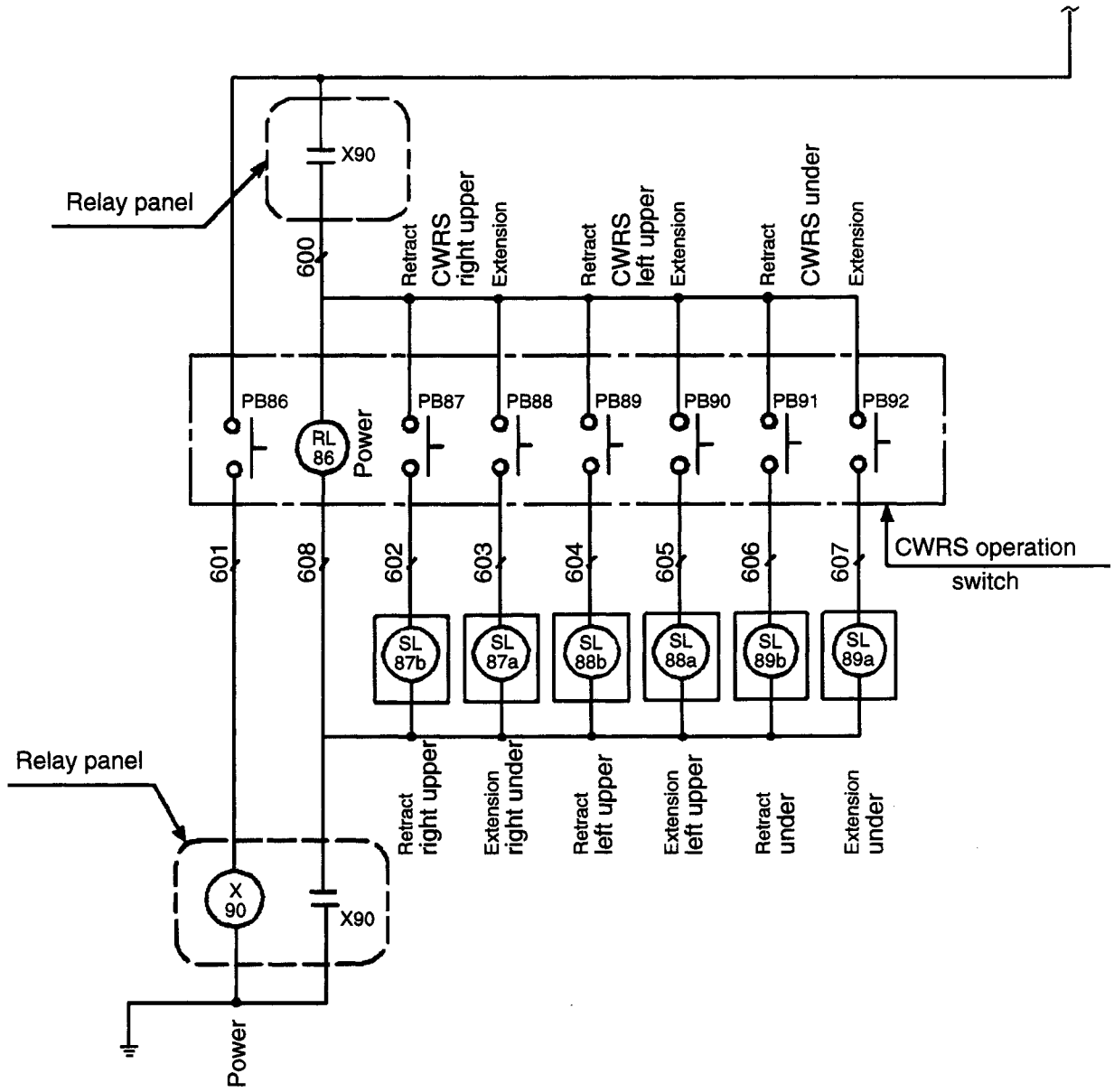


Accessory Circuit (3)
Optional Specification

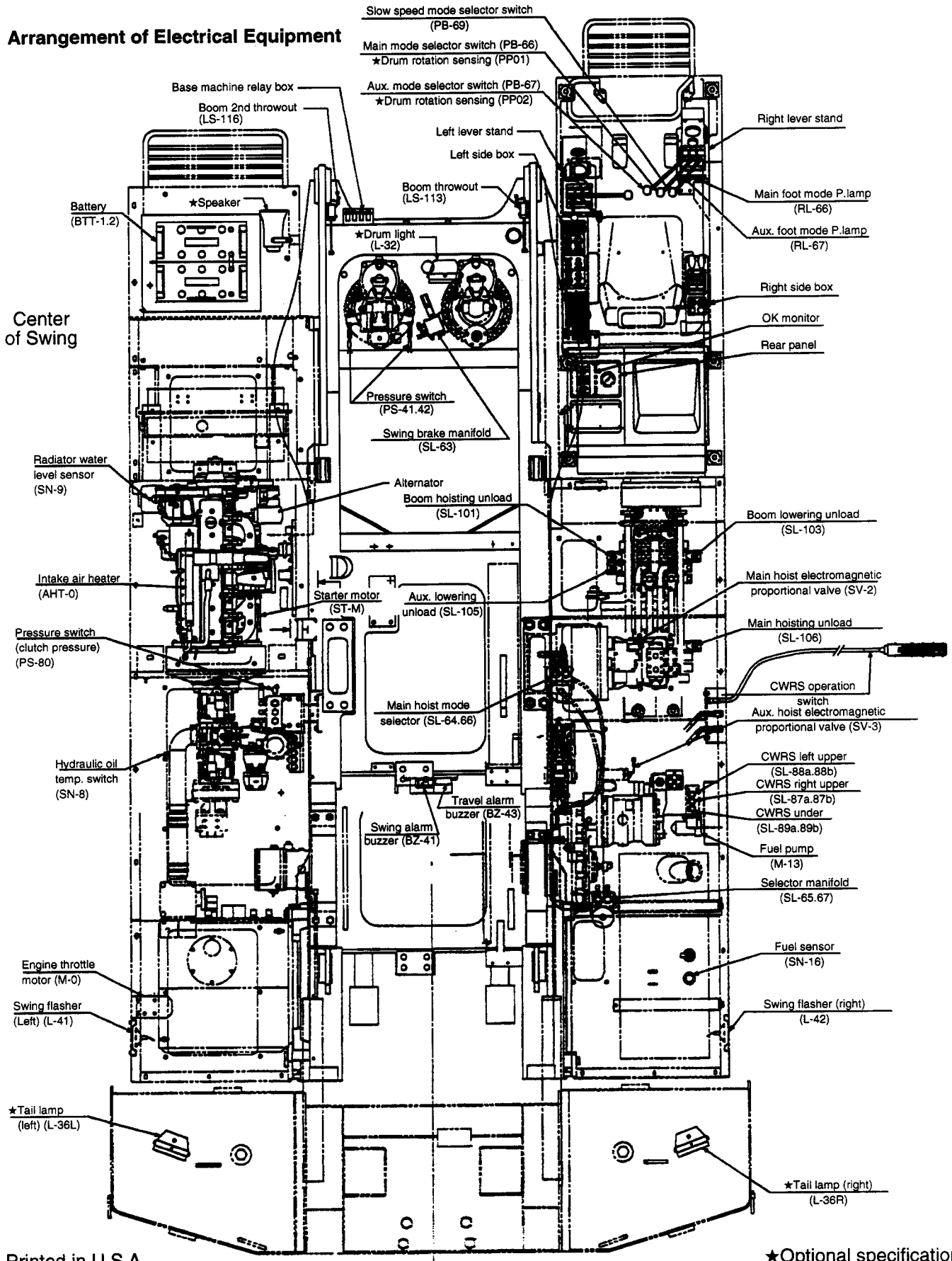
Drum Speed Control Circuit

Drum Indicator Circuit
Optional Specification

CWRS Circuit

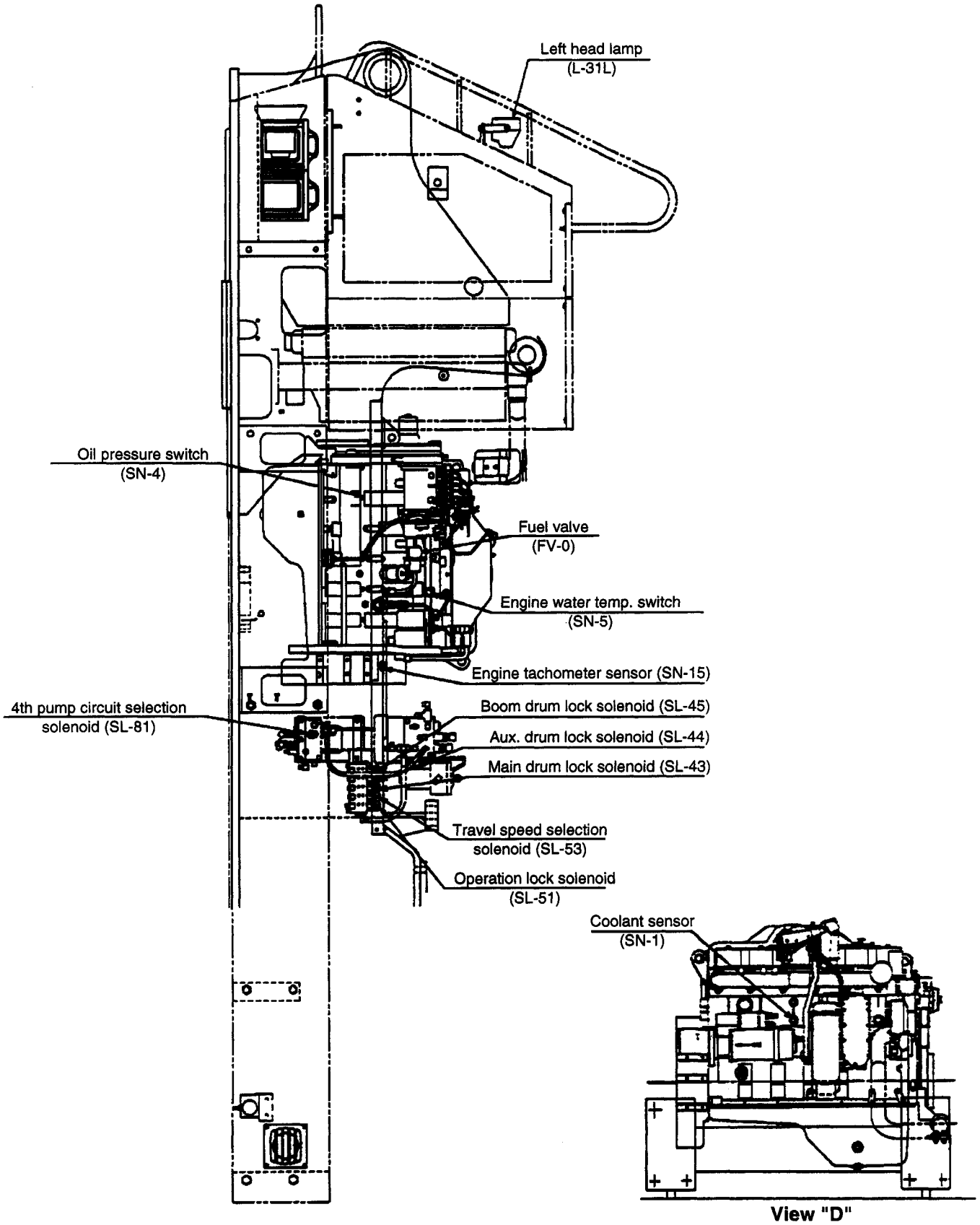


4. Arrangement of Electrical Equipment

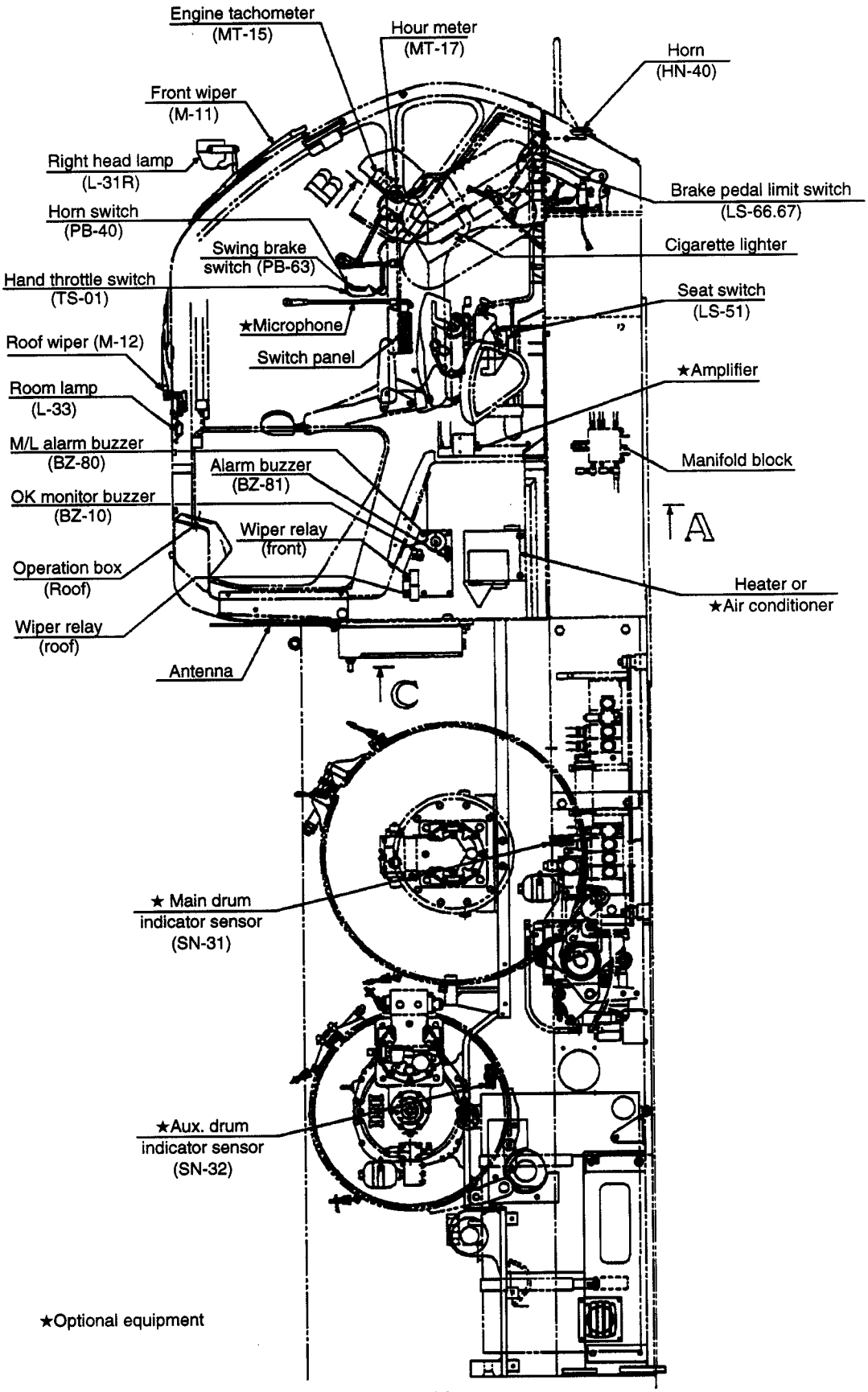


★Optional specification

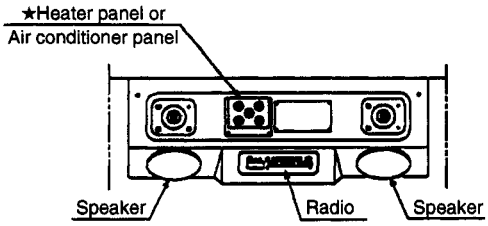
Arrangement Of Electrical Equipment (continued)



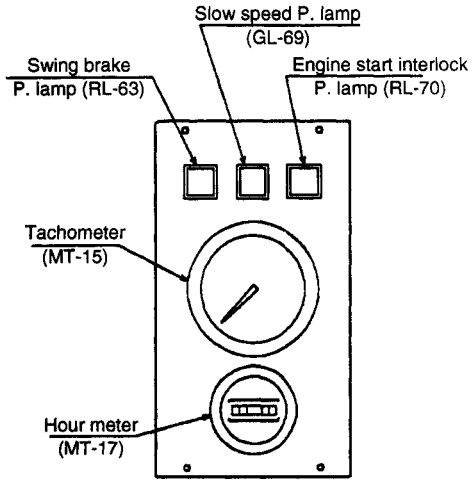
Arrangement Of Electrical Equipment (continued)



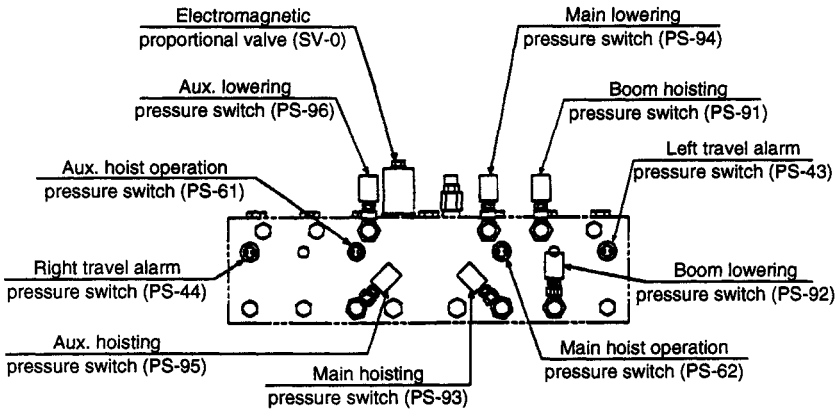
Arrangement Of Electrical Equipment (continued)



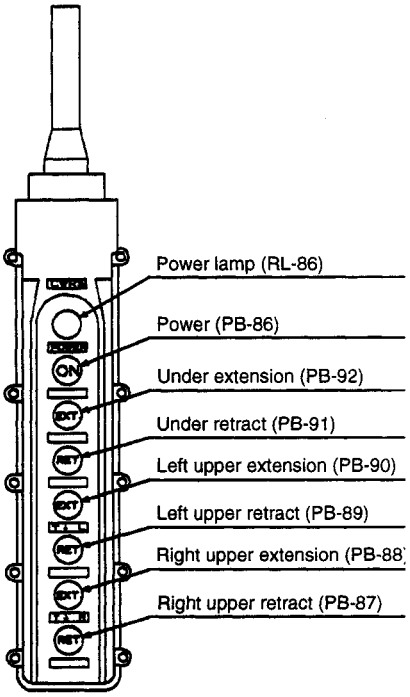
Operation box (roof)
(as viewed from front)



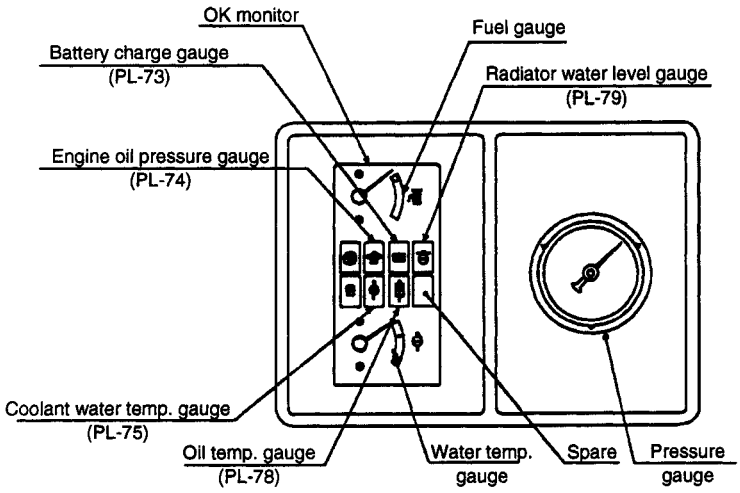
View "B"



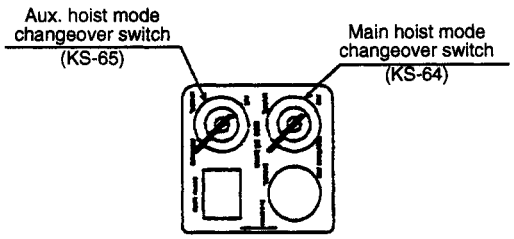
View "A"



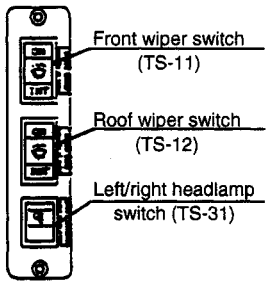
CWRS Operation Switch



Rear Panel

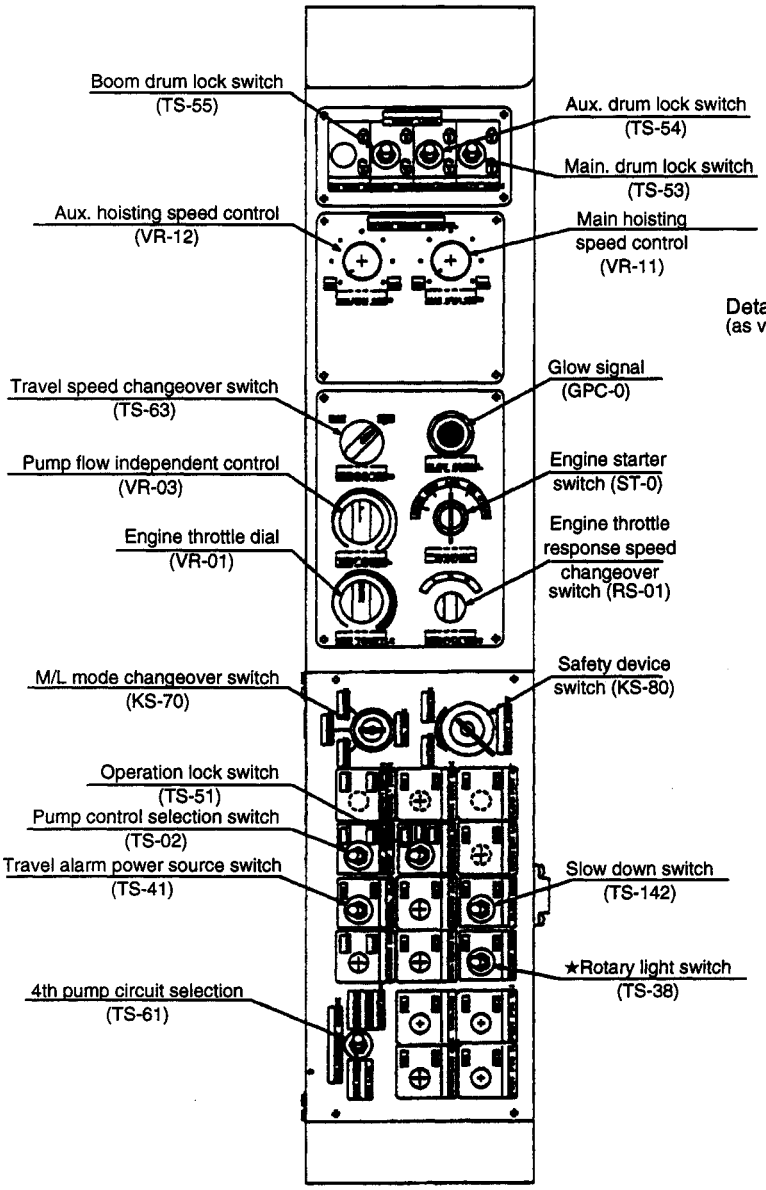


Right side box switch

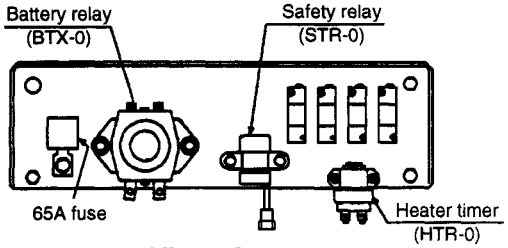


Switch panel

Arrangement Of Electrical Equipment (continued)

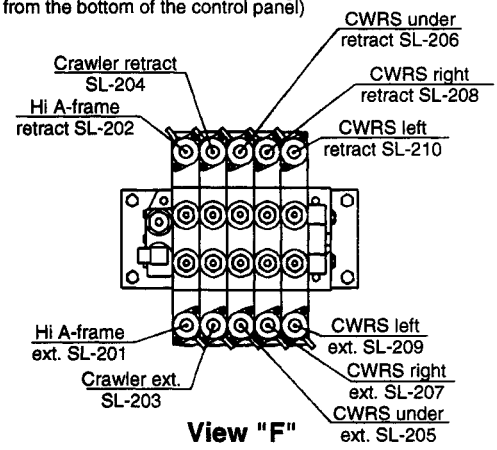


Left Side Box

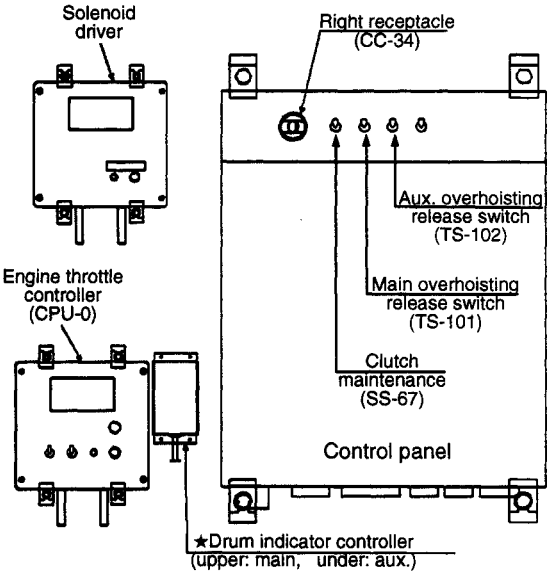


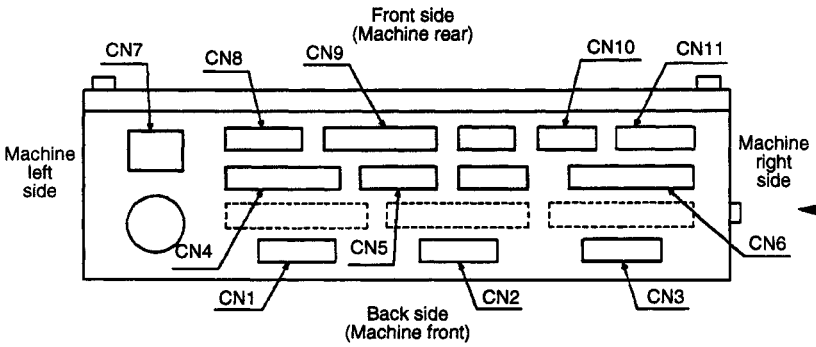
View "E"

Detail of control panel connectors arrangement
(as viewed from the bottom of the control panel)



View "F"

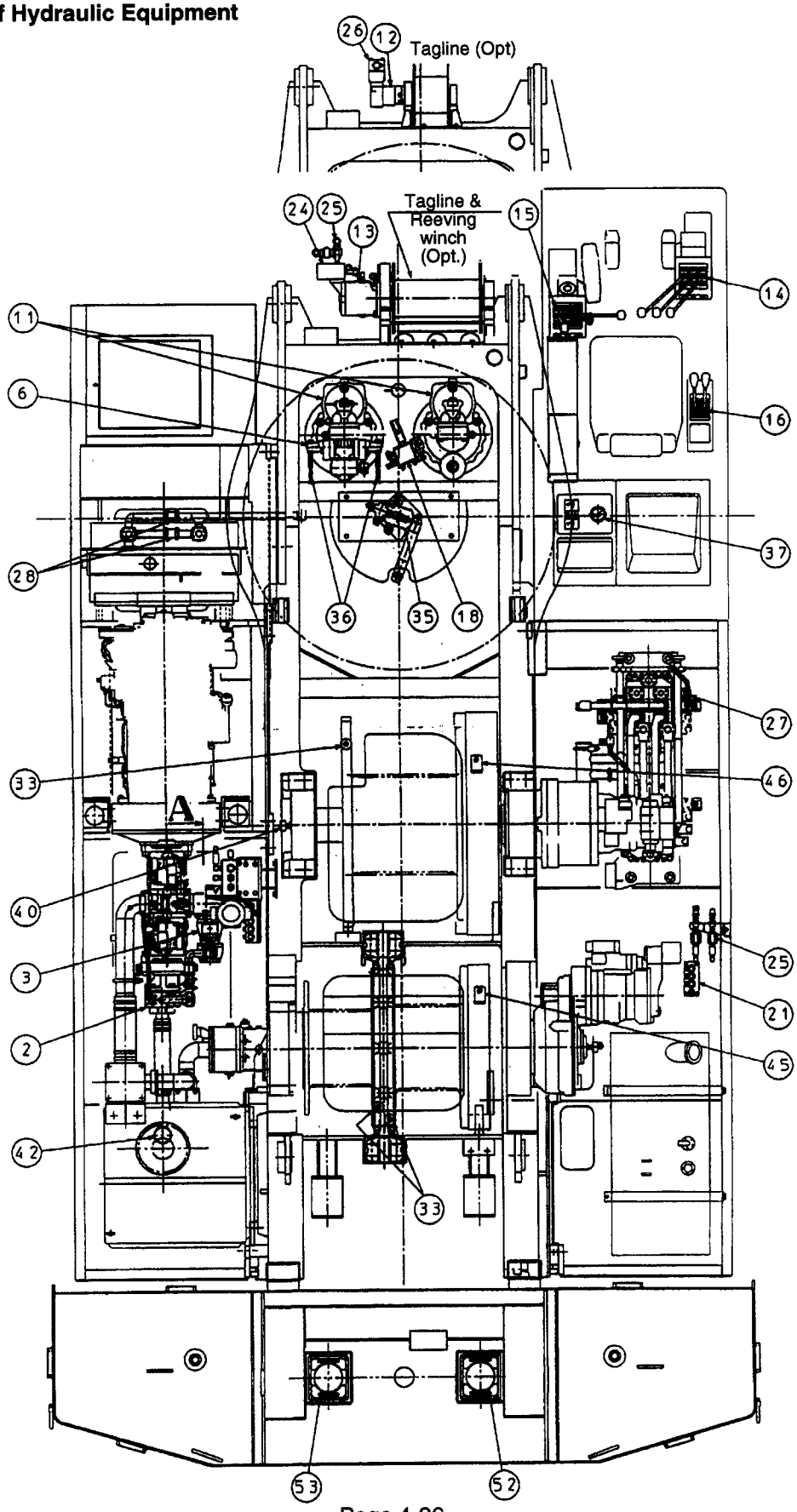




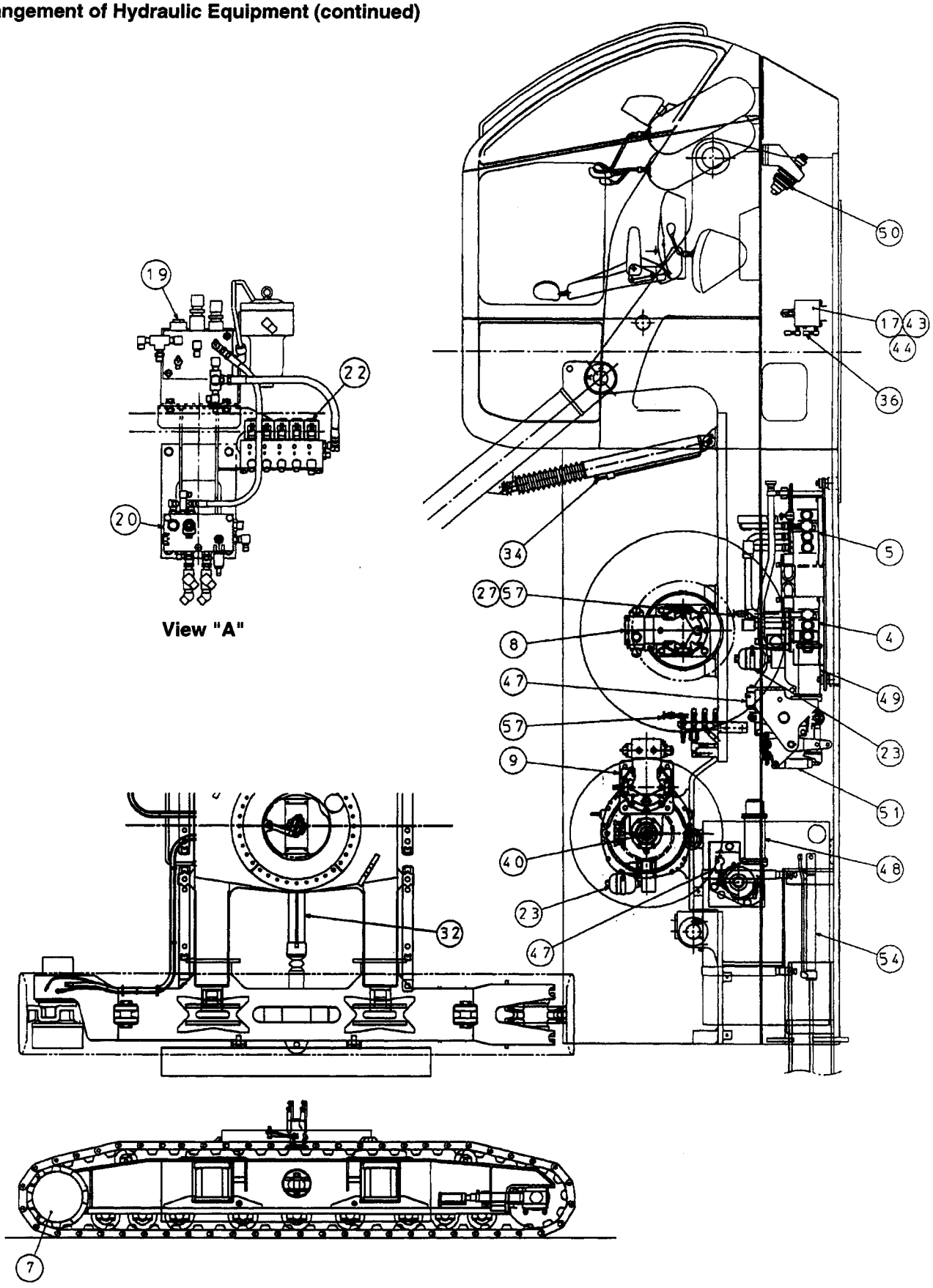
View "C"

Detail of control panel connectors arrangement
(as viewed from bottom of the control panel)

5. Arrangement of Hydraulic Equipment

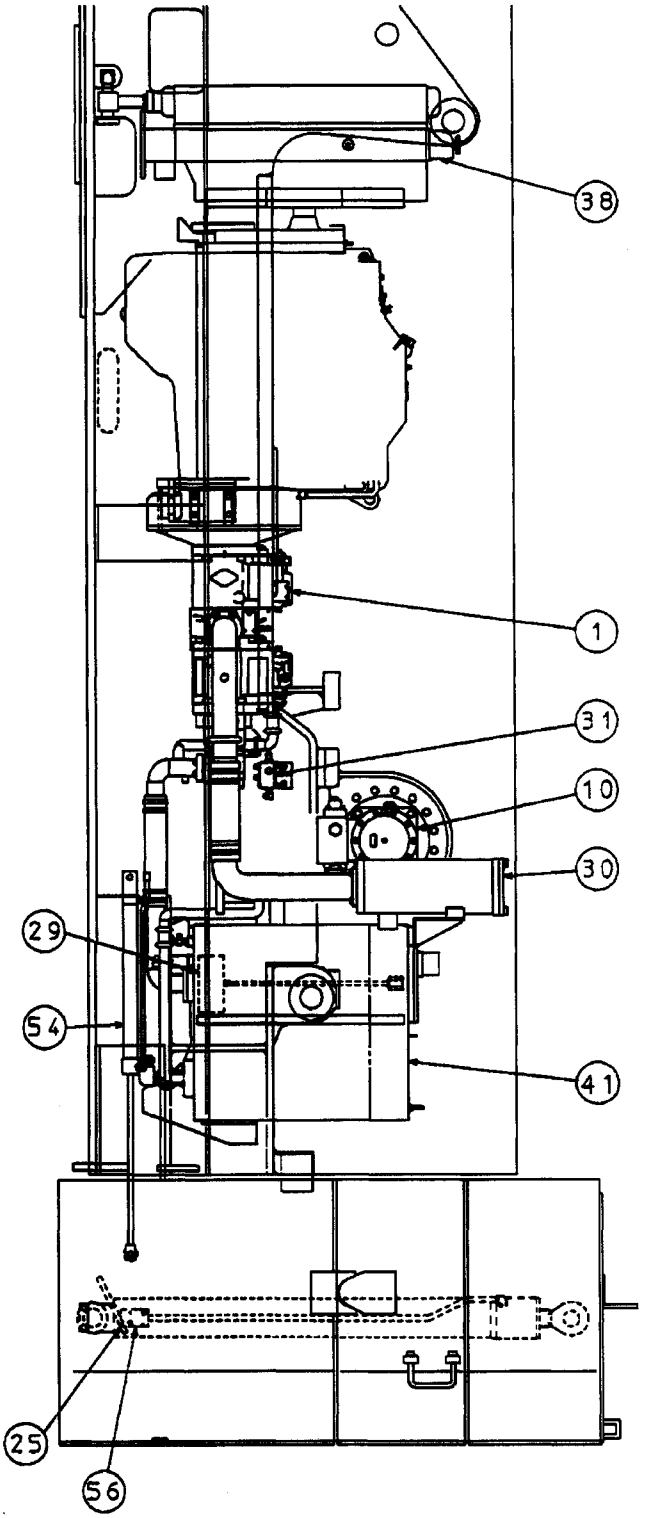


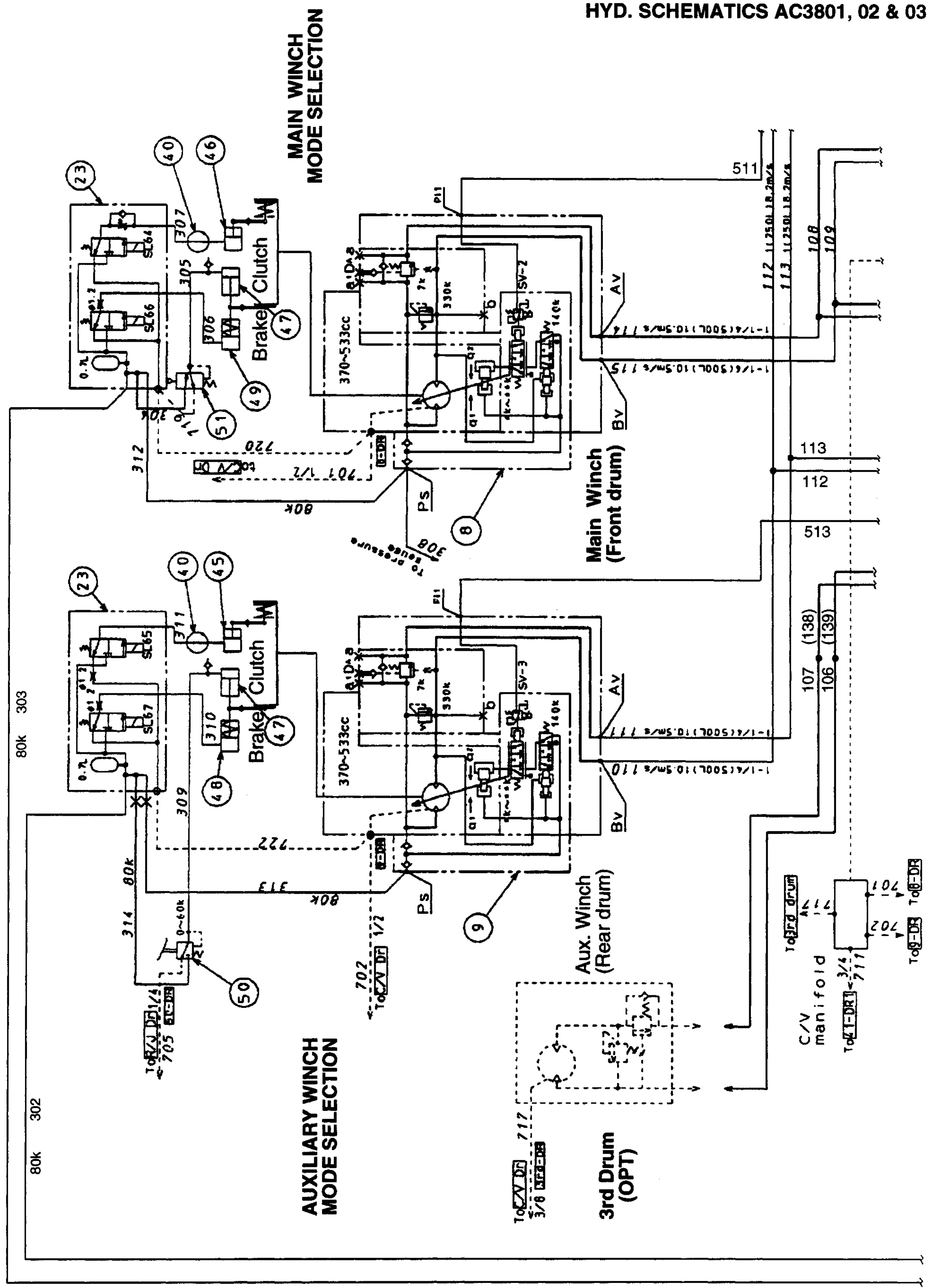
Arrangement of Hydraulic Equipment (continued)

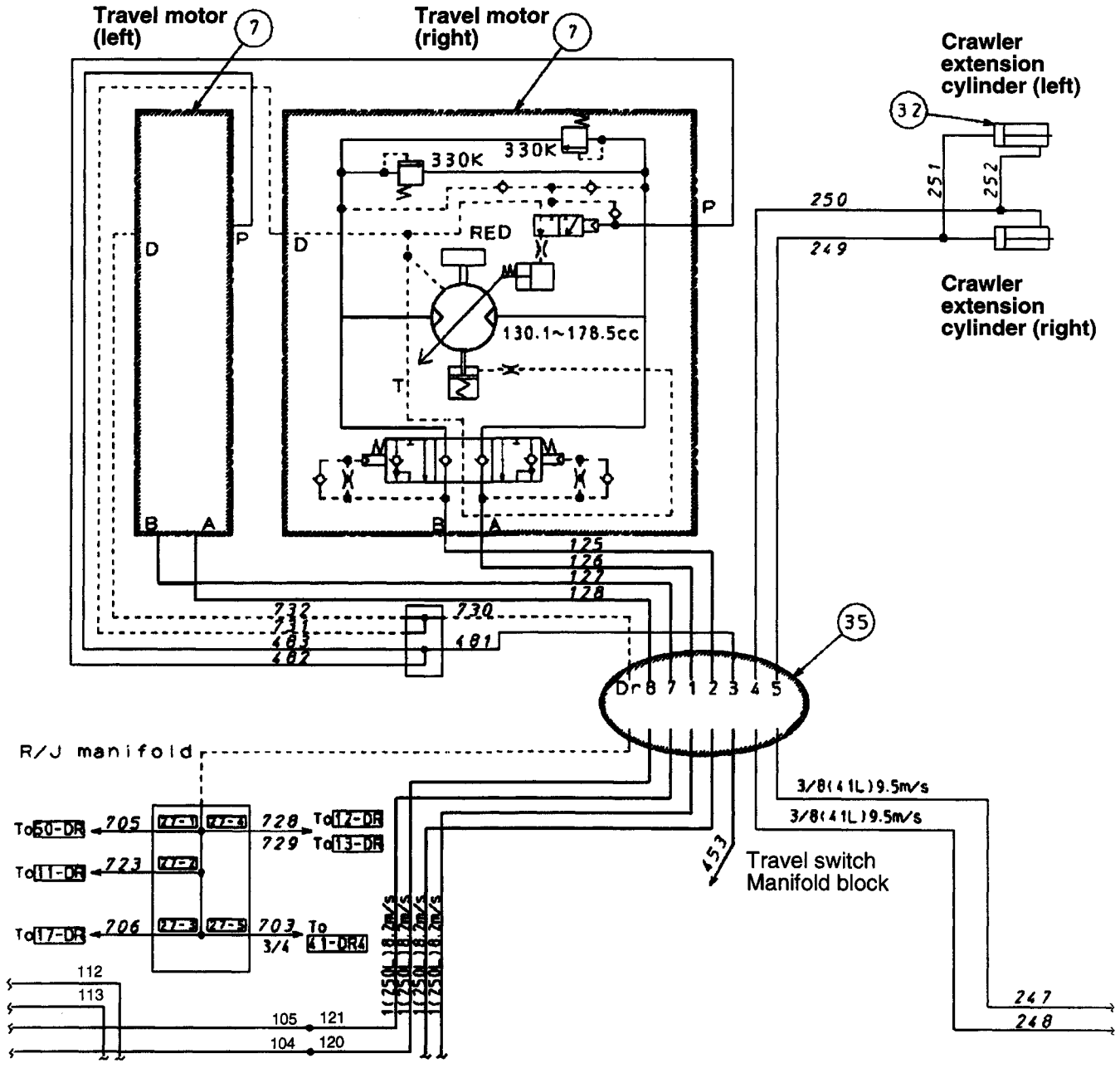


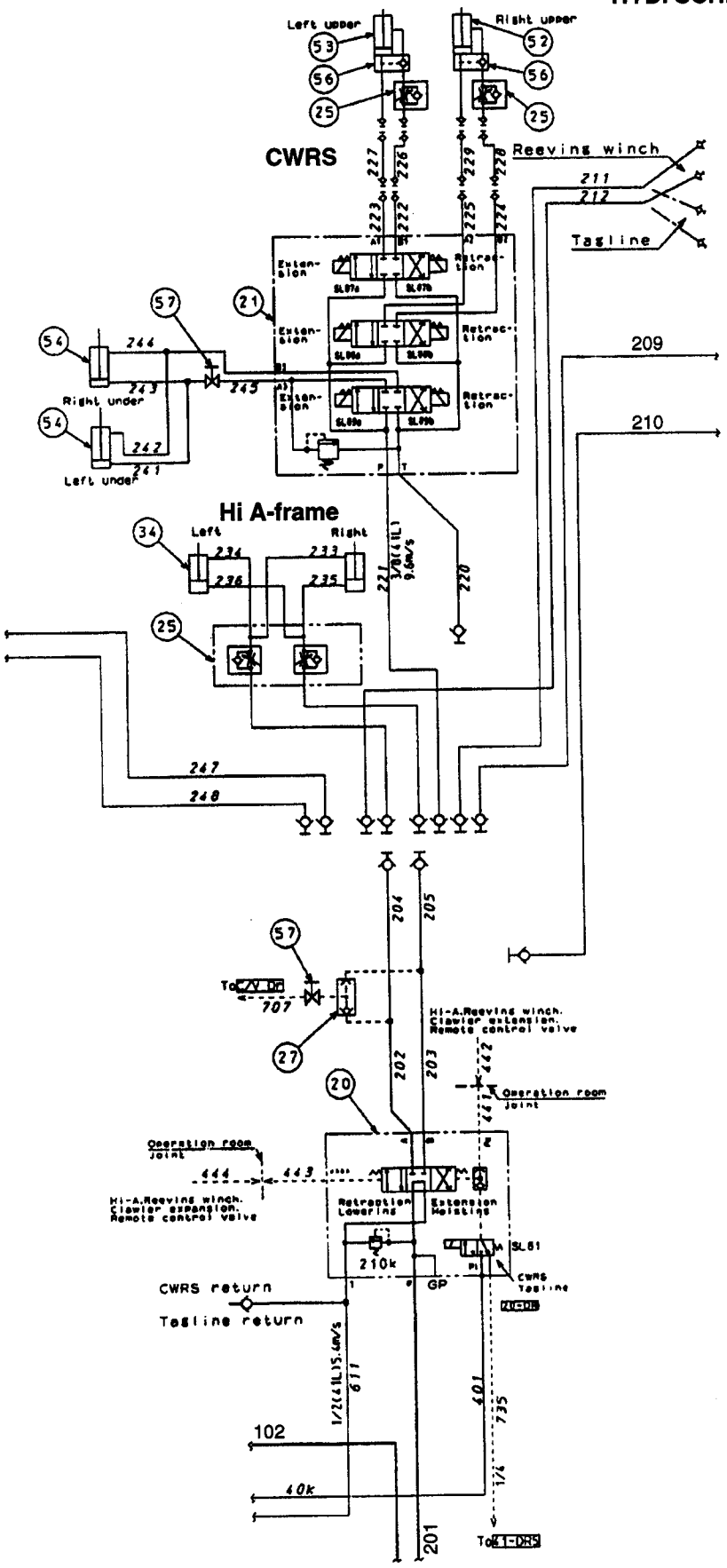
Arrangement of Hydraulic Equipment (continued)

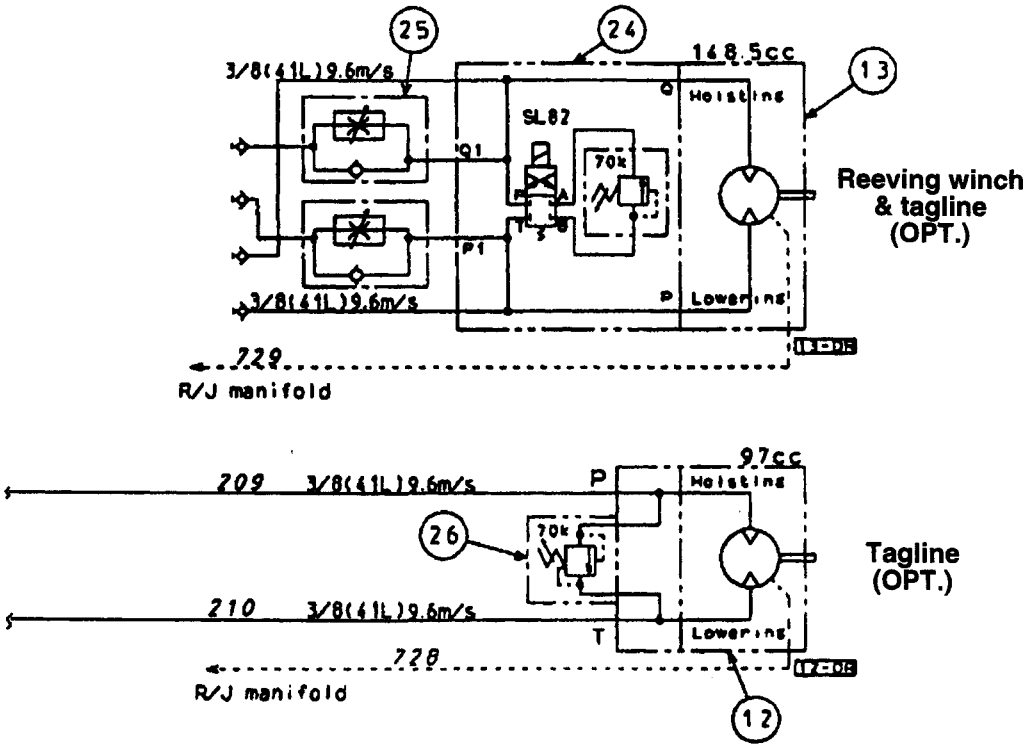
No.	Component	Code No.
1	Piston pump	0780025UA
2	Gear pump	0780011UA
3	Gear pump	0780012UA
4	4 Control valve	0783650UA
5	4 Control valve	0783651UA
6	Swing valve	0756026UA
7	Travel unit	0669767UA
8	Motor (main)	0781150UA
9	Motor (aux.)	0780151UA
10	Motor (boom)	0781152UA
11	Motor (swing)	1757633UA
12	Motor (tag)	0757670UA
13	Motor (reeving)	0757661UA
14	Remote control valve	0756329UA
15	Remote control valve	0756330UA
16	Remote control valve	0756954UA
17	Manifold, solenoid valve	0786902UA
18	Manifold, solenoid valve	0754597UA
19	Manifold, pressure valve	0754596UA
20	Manifold, directional valve	0754858UA
21	Manifold, directional valve	0786936UA
22	Manifold, solenoid valve	0754868UA
23	Manifold, solenoid valve	0754595UA
24	Manifold, solenoid valve	0754860UA
25	Restrictor valve	0753212UA
26	Relieving valve	0751316UA
27	Shuttle valve	0754541UA
28	Check valve	0753241UA
29	Suction filter	0755228UA
30	Return filter	0787404UA
31	Hydraulic valve	0786912UA
32	Extension cylinder	0782251UA
33	Oil cylinder	0759044UA
34	Hi-A cylinder	0782250UA
35	Rotary joint	0755856UA
36	Pressure switch	085818010
37	Pressure gauge	0755601UA
38	Radiator & Cooler	0668513UA
39	---	---
40	Rotary joint	0712202UA
41	Hydraulic oil tank	D28404600
42	Air breather	0755002UA
43	Male adapter	071232410
44	Male adapter	071232402
45	Clutch cylinder	0759034UA
46	Clutch cylinder	0752713UA
47	Assist cylinder	0759011UA
48	Brake cylinder	533511005
49	Brake cylinder	533601500
50	Brake valve	0756383UA
51	Clutch valve	551090100
52	CWRS Cylinder, (R)	0782242UA
53	CWRS Cylinder, (L)	0782252UA
54	CWRS Cylinder,	0782243UA
55	---	---
56	Valve, check	0753059UA
57	Valve, gauge	0754538UA
58	Valve, relief	

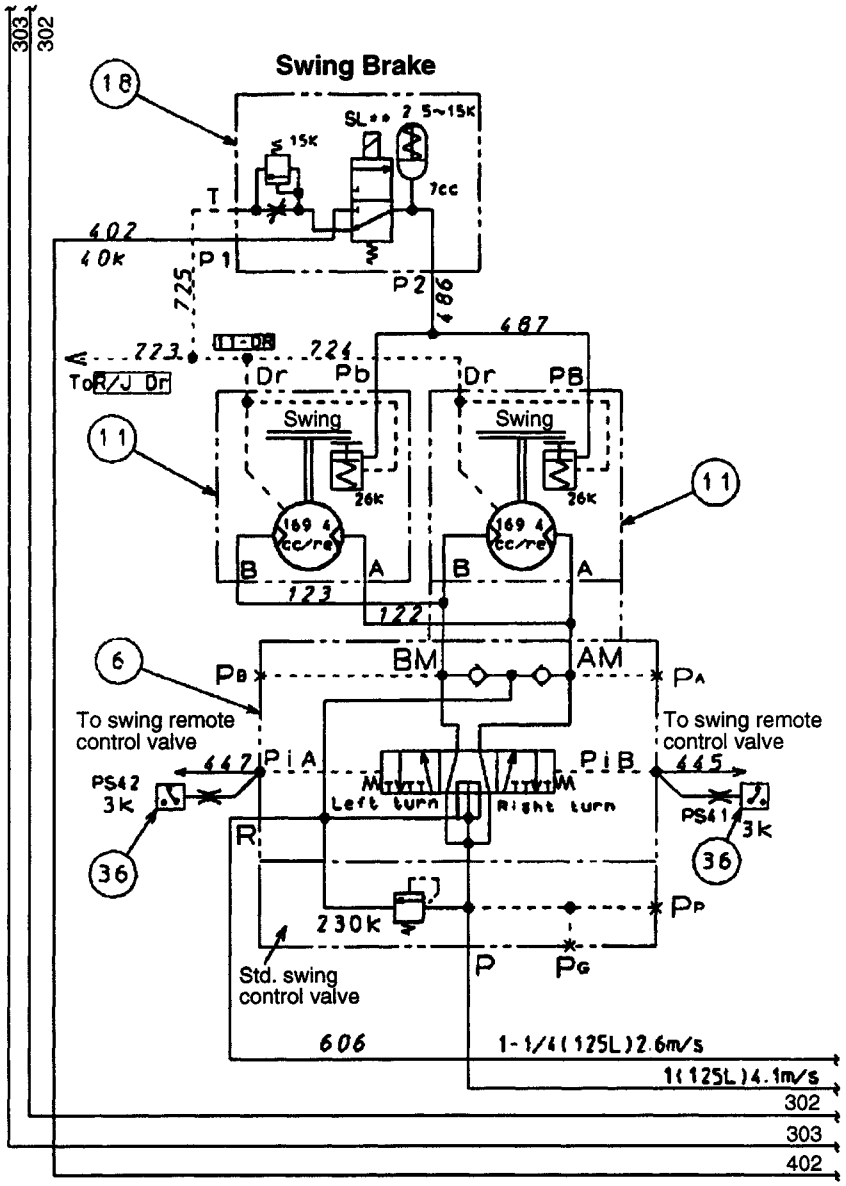


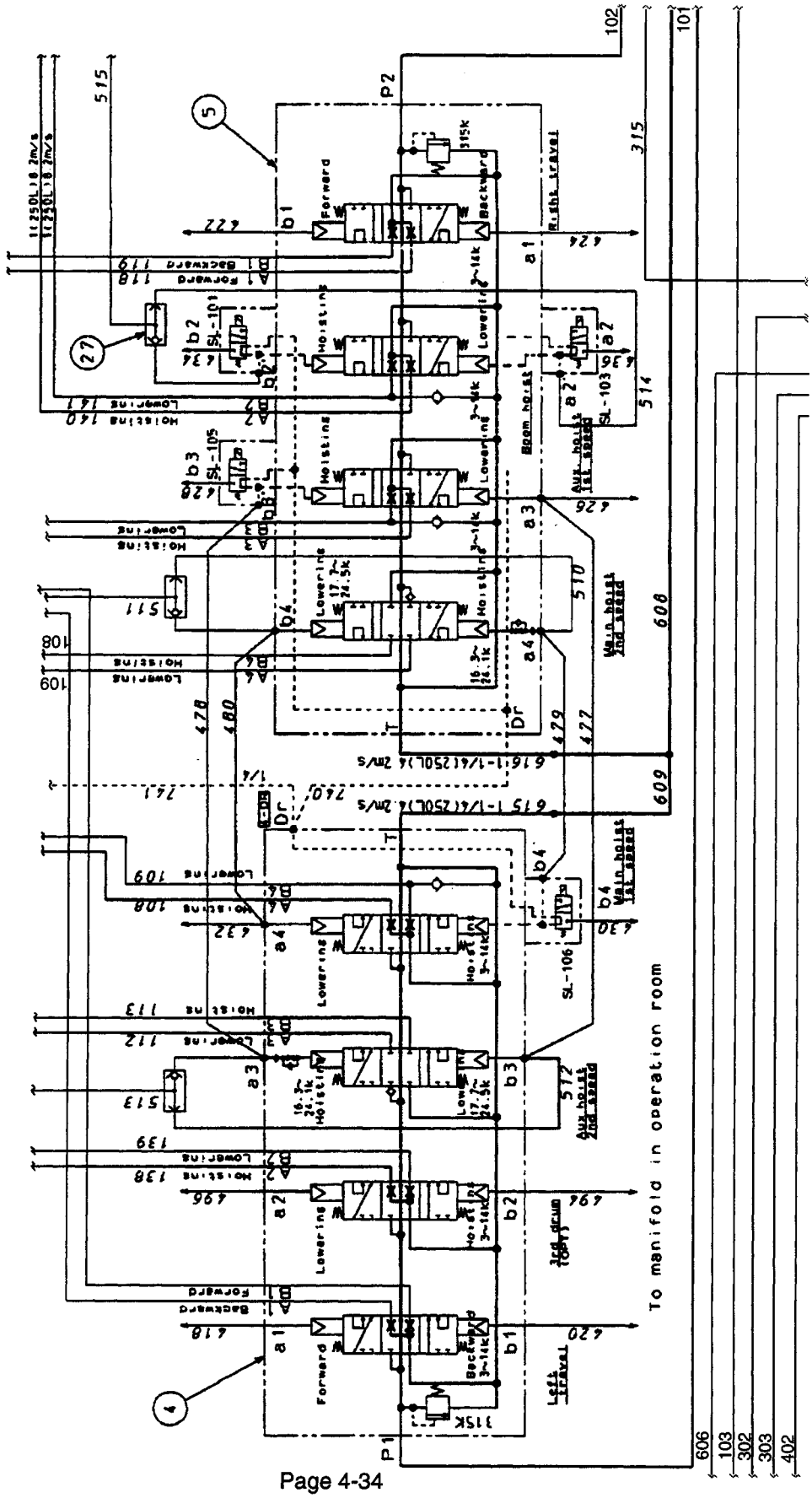

MAIN WINCH MODE SELECTION
AUXILIARY WINCH MODE SELECTION
Main Winch (Front drum)
Aux. Winch (Rear drum)
3rd Drum (OPT)
C/V manifold
Clutch
Brake
Av
Bv
Ps
370~533cc
511
513
113
112
108
109
107
106
(138)
(139)
80k 303
80k 302
To pressure gauge

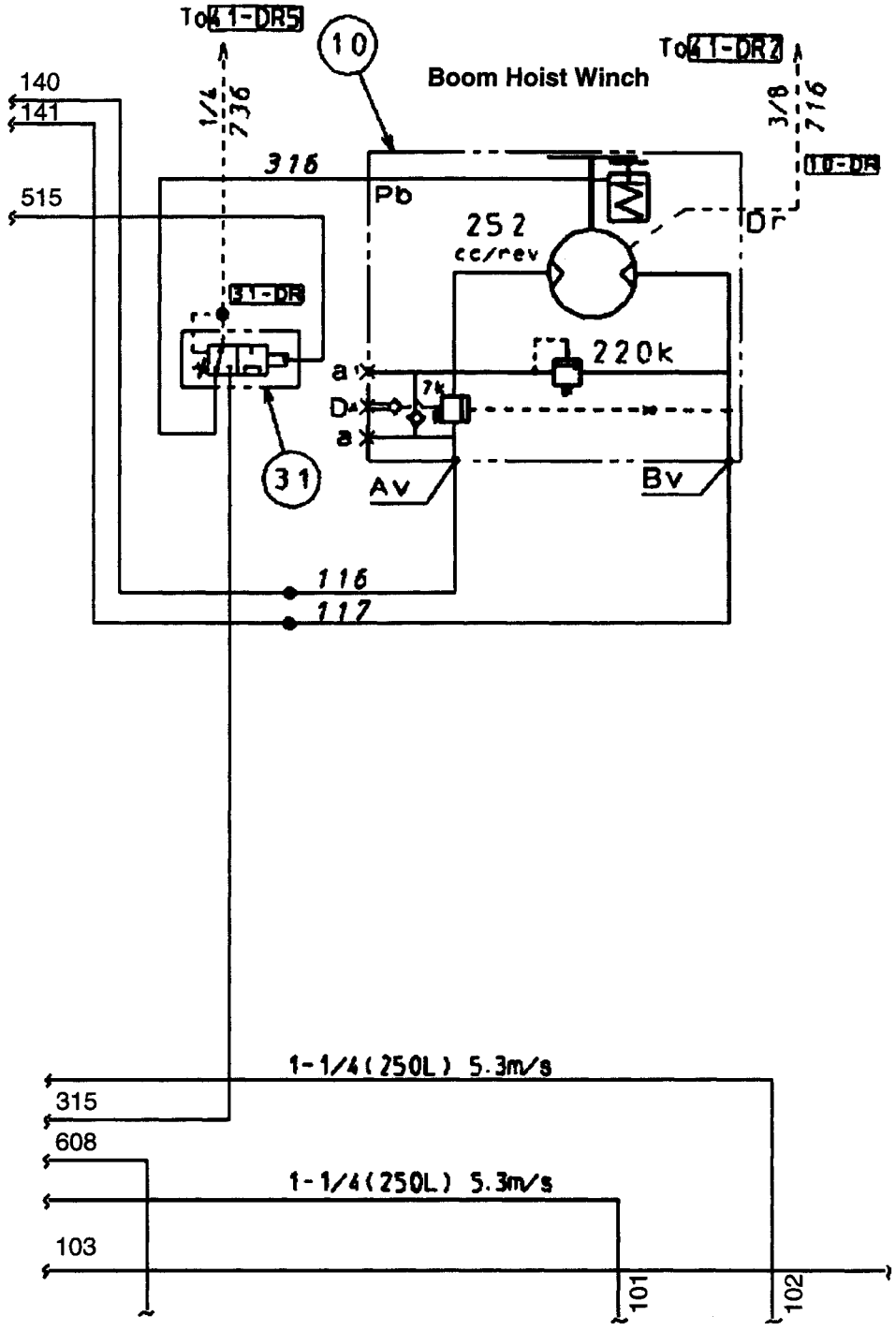

Travel motor (left)
7
Travel motor (right)
7
Crawler extension cylinder (left)
32
Crawler extension cylinder (right)
330K
330K
RED
130.1~178.5cc
D
P
T
B
A
250
249
251
252
125
126
127
128
732
731
730
483
482
481
35
Dr 8 7 1 2 3 4 5
R/J manifold
To 50-DR
705
To 11-DR
723
To 17-DR
706
728
729
To 12-DR
To 13-DR
703
To 3/4
41-DR4
112
113
105
121
104
120
3/8(41L)9.5m/s
3/8(41L)9.5m/s
153
Travel switch Manifold block
247
248

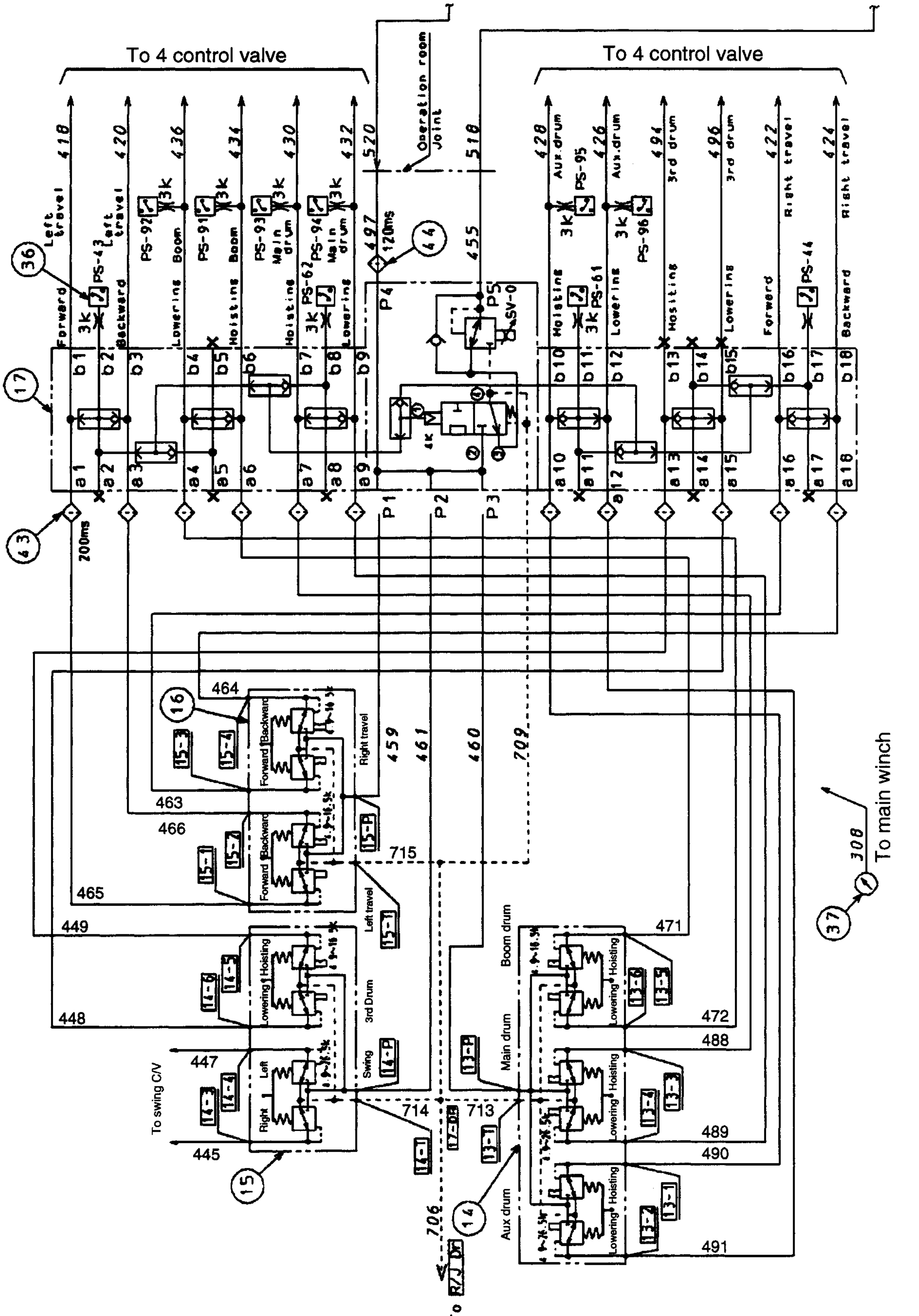

Left upper
Right upper
CWRS
Reeving winch
Tagline
Extension
Retraction
Right under
Left under
Hi A-frame
Left
Right
209
210
To CV DG
Hi-A.Reeving winch. Crawler extension. Remote control valve
Operation room joint
Retraction Lowering
Extension Hoisting
SL61
210k
GP
CWRS return
Tagline return
102
40k
201
To 61-DRS

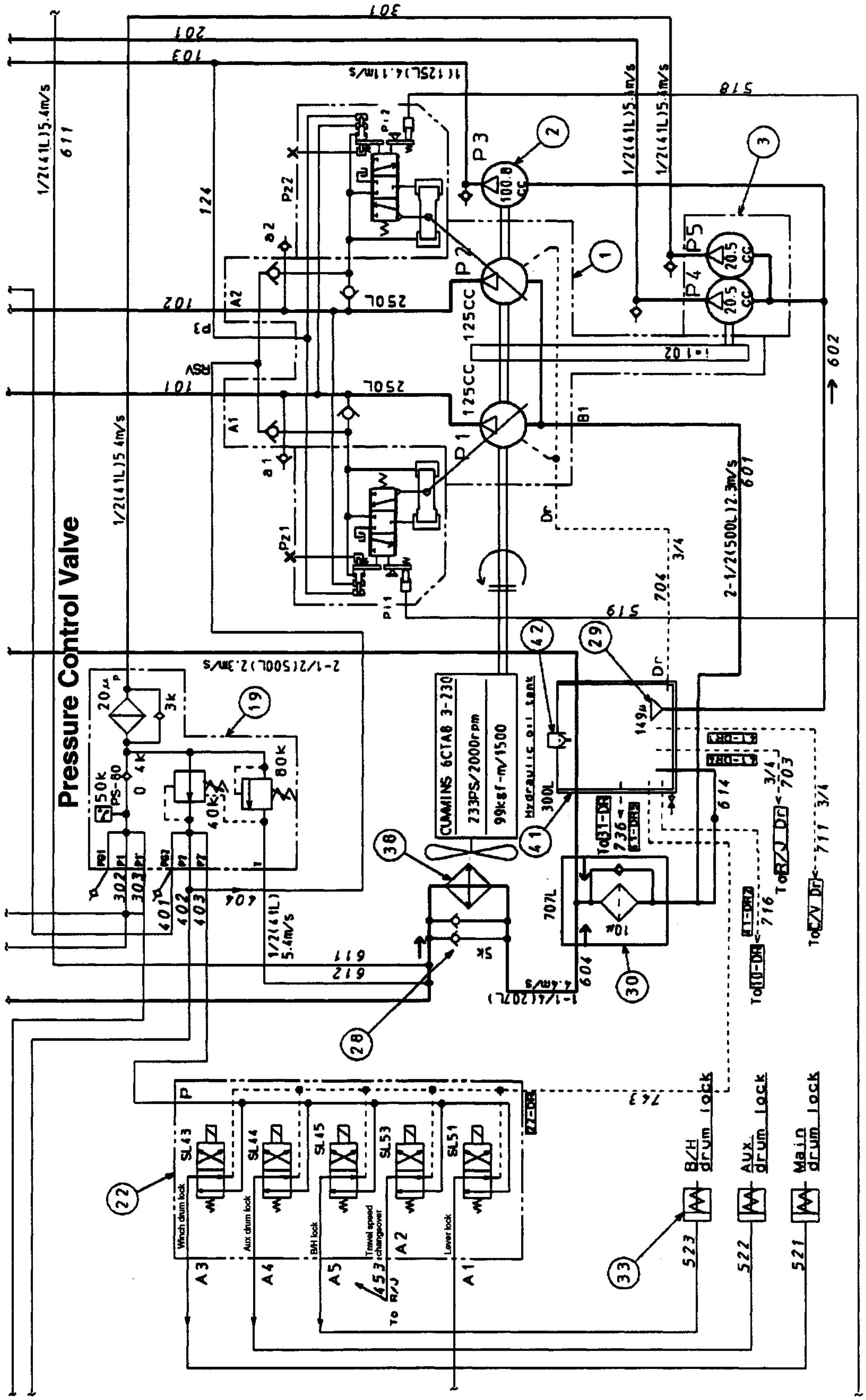

25
24
148.5cc
3/8(41L)9.6m/s
Hoisting
SL82
70k
Q1
P1
13
Reeving winch
& tagline
(OPT.)
3/8(41L)9.6m/s
P
Lowering
729
R/J manifold
97cc
209
3/8(41L)9.6m/s
P
Hoisting
26
70k
210
3/8(41L)9.6m/s
T
Lowering
728
R/J manifold
Tagline
(OPT.)
12


303
302
Swing Brake
18
SL
2.5~15K
15K
7cc
T
402
40k
P1
P2
725
486
487
723
724
11-DR
To R/J Dr
Dr
Pb
Dr
PB
Swing
Swing
11
11
26K
26K
169.4 cc/rev
169.4 cc/rev
B
A
B
A
123
122
6
BM
AM
PB
PA
To swing remote control valve
To swing remote control valve
447
PiA
PiB
445
PS42
3k
PS41
3k
Left turn
Right turn
R
36
36
230k
PP
P
PG
Std. swing control valve
606
1-1/4(125L)2.6m/s
1(125L)4.1m/s
302
303
402

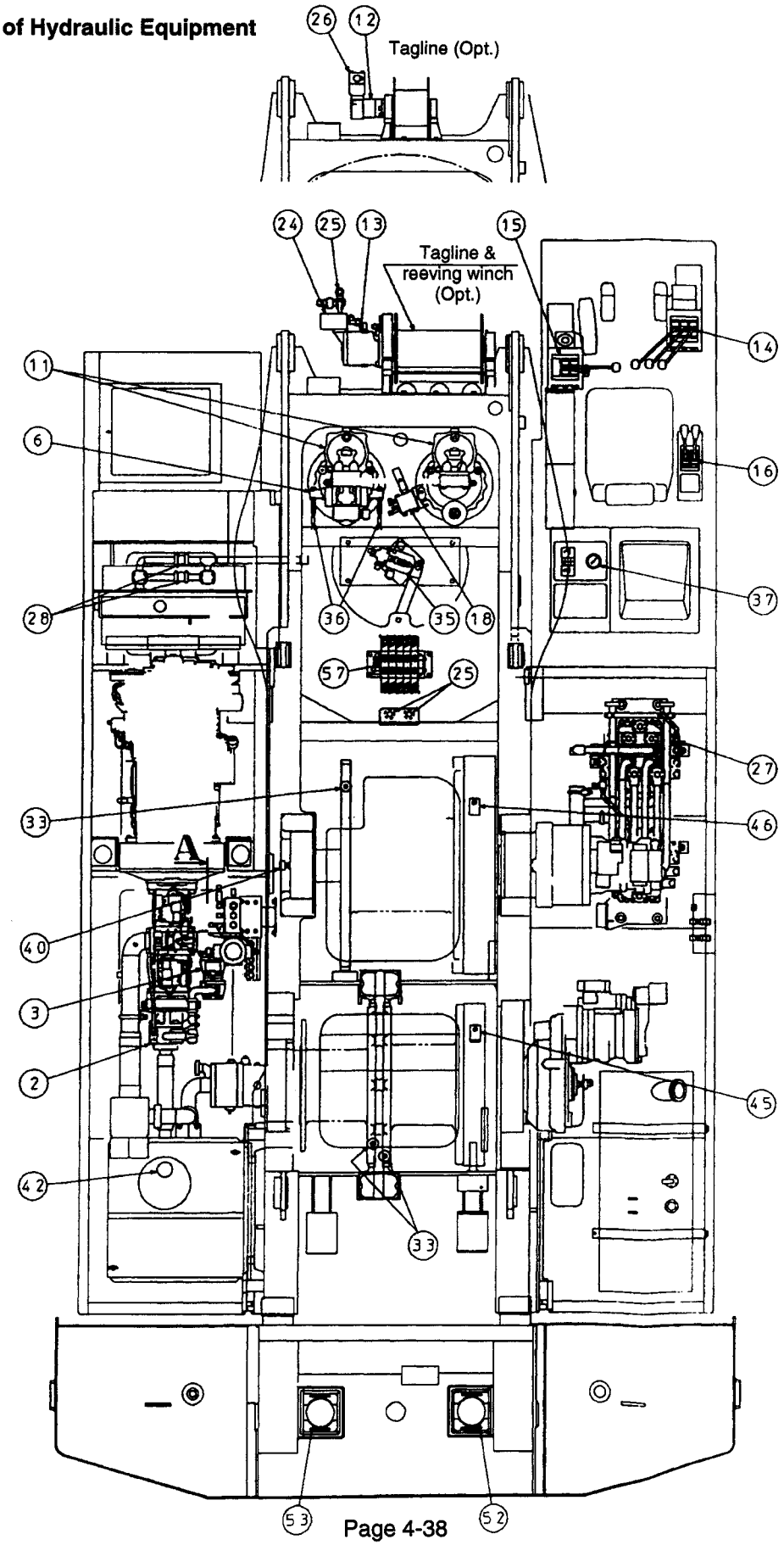

To manifold in operation room
Forward
Backward
Hoisting
Lowering
Boom hoist
Main hoist 1st speed
Main hoist 2nd speed
Aux hoist 1st speed
Aux hoist 2nd speed
Right travel
Left travel
SL-101
SL-103
SL-105
SL-106
P1
P2
T
Dr


To 41-DR5
10
Boom Hoist Winch
To 41-DR2
140
141
1/4
736
316
Pb
3/8
716
10-DR
515
252
cc/rev
31-DR
220k
a
D
a
31
Av
Bv
116
117
1-1/4 (250L) 5.3m/s
315
608
1-1/4 (250L) 5.3m/s
103
101
102

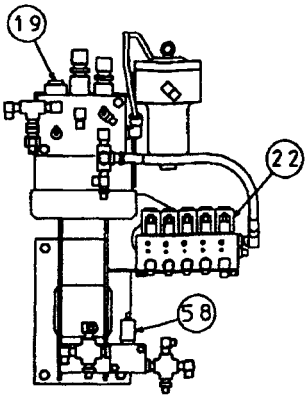

To 4 control valve
To 4 control valve
Operation room joint
To main winch
308
To swing C/V
To R/J Dr
706
709
715
714
713
459
461
460
464
463
466
465
449
448
447
445
471
472
488
489
490
491
Right travel
Left travel
3rd Drum
Swing
Boom drum
Main drum
Aux drum
P1
P2
P3
P4
P5
SV-0
120ms
200ms


Pressure Control Valve
CUMMINS 6CTA8 3-230
233PS/2000rpm
Hydraulic oil tank
B/H drum lock
Aux. drum lock
Main drum lock

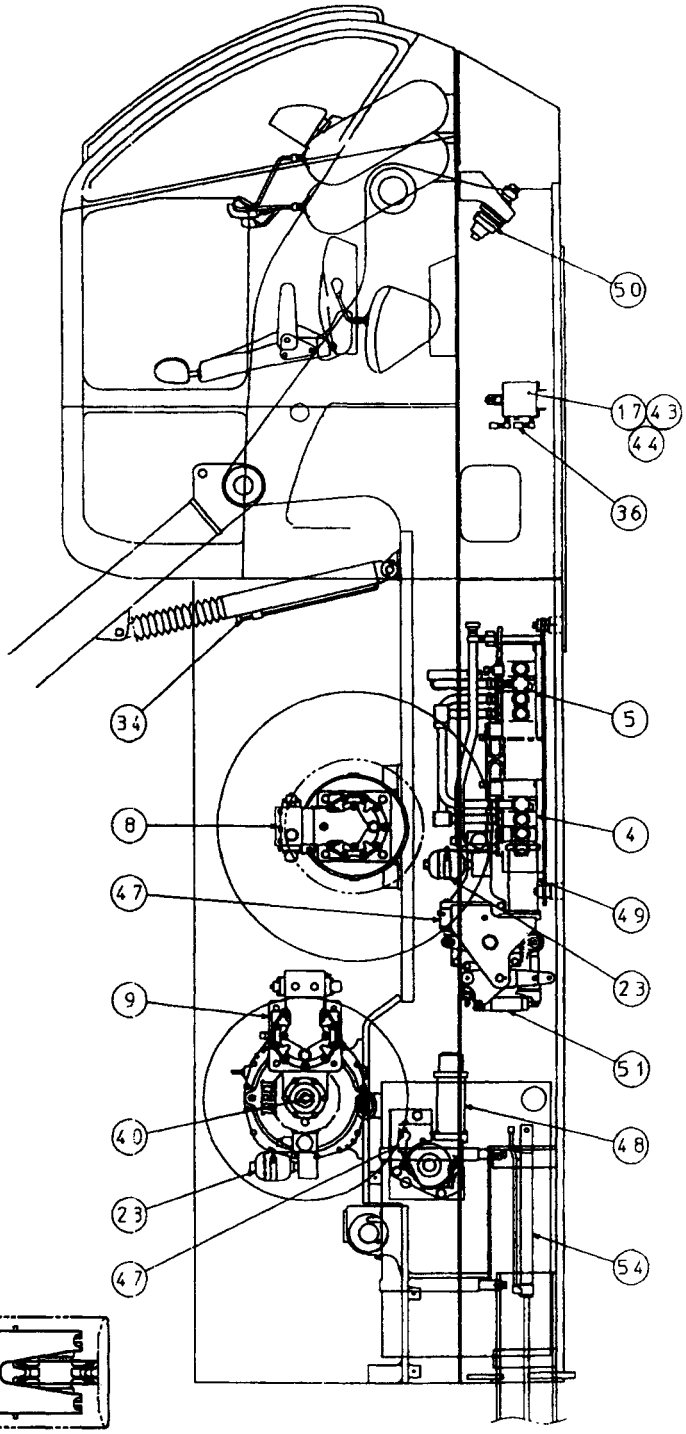
5. Arrangement of Hydraulic Equipment

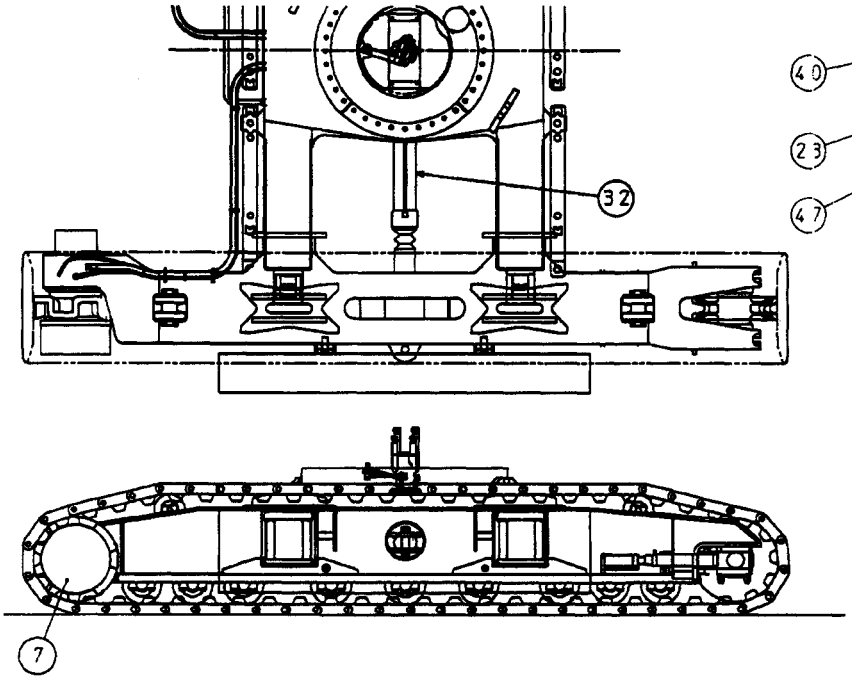


Arrangement of Hydraulic Equipment (continued)



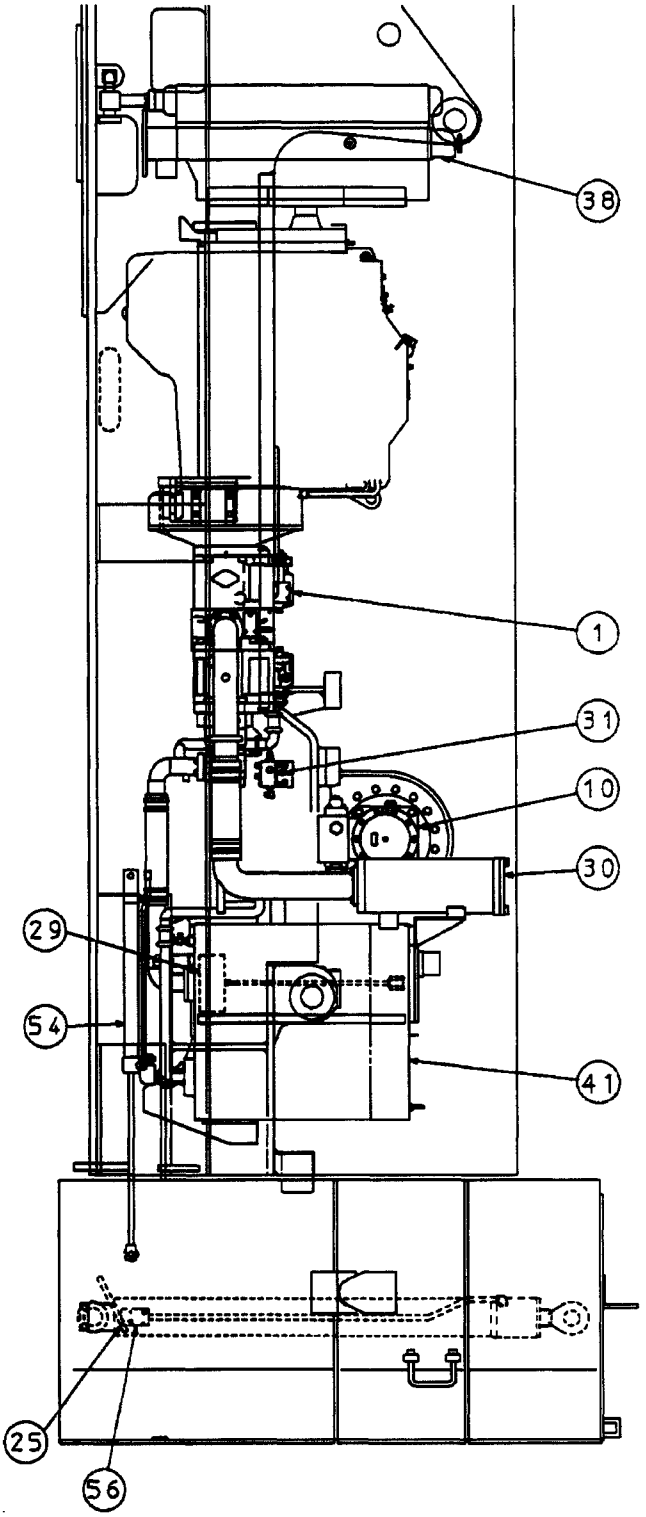
View "A"

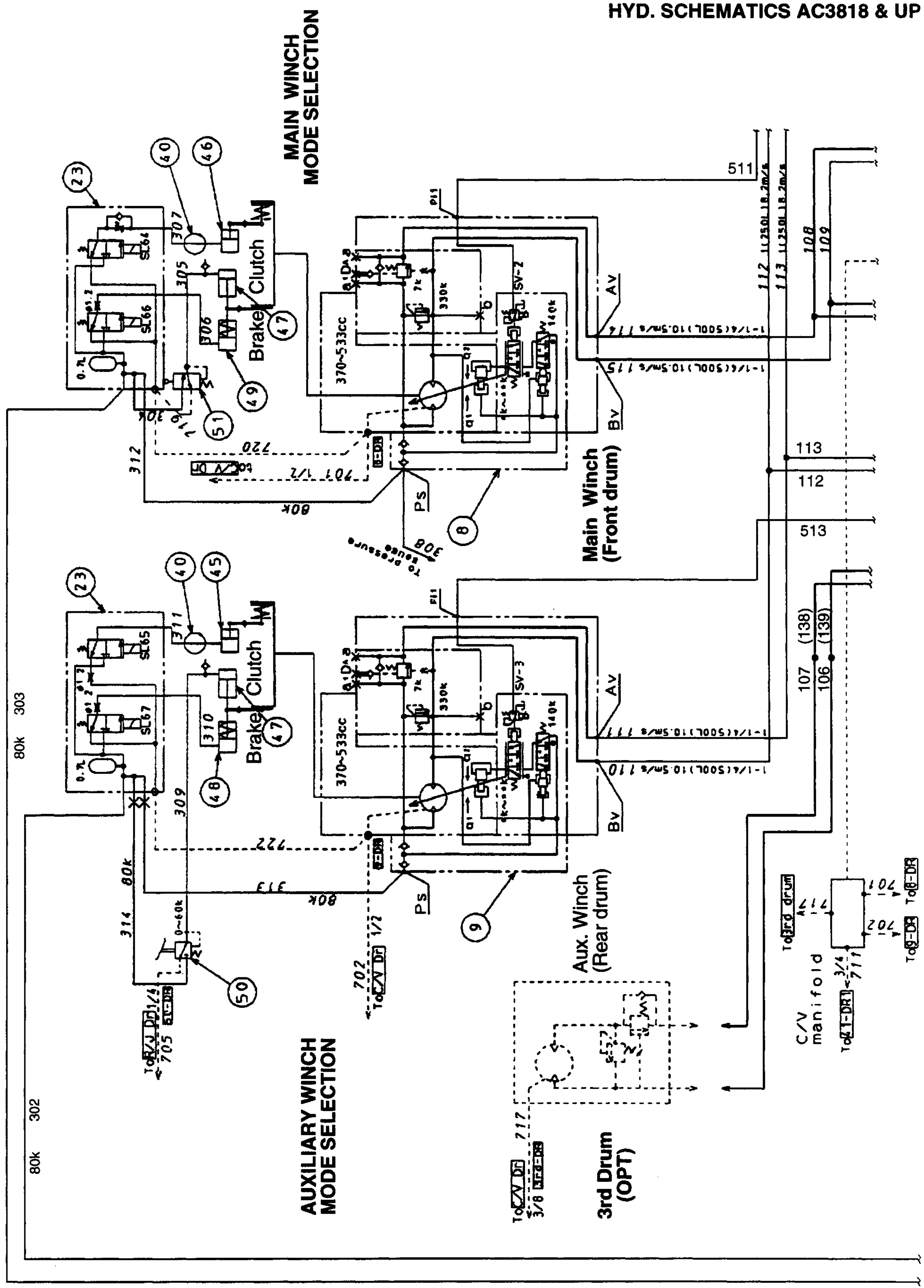


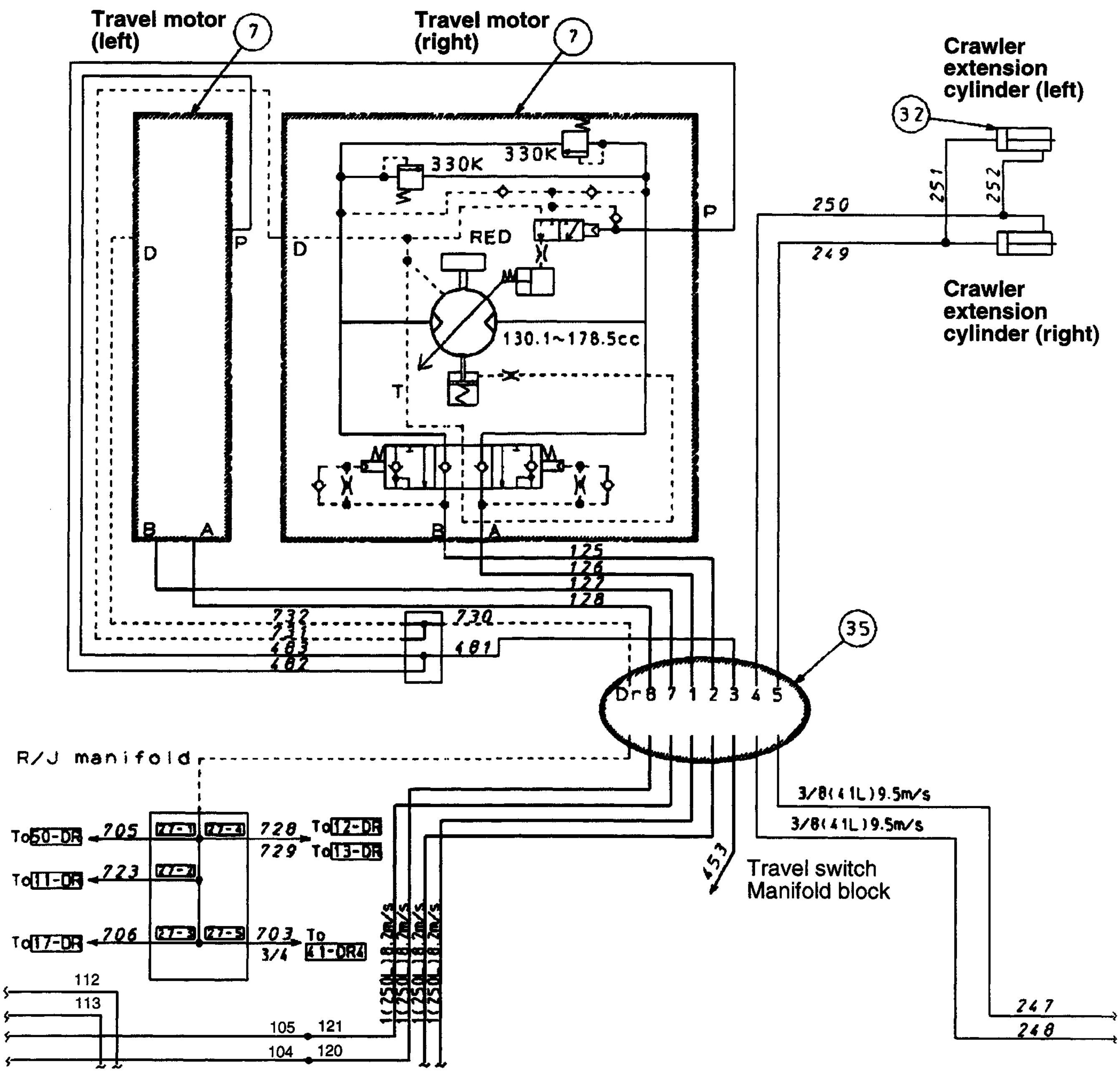


Arrangement of Hydraulic Equipment (continued)

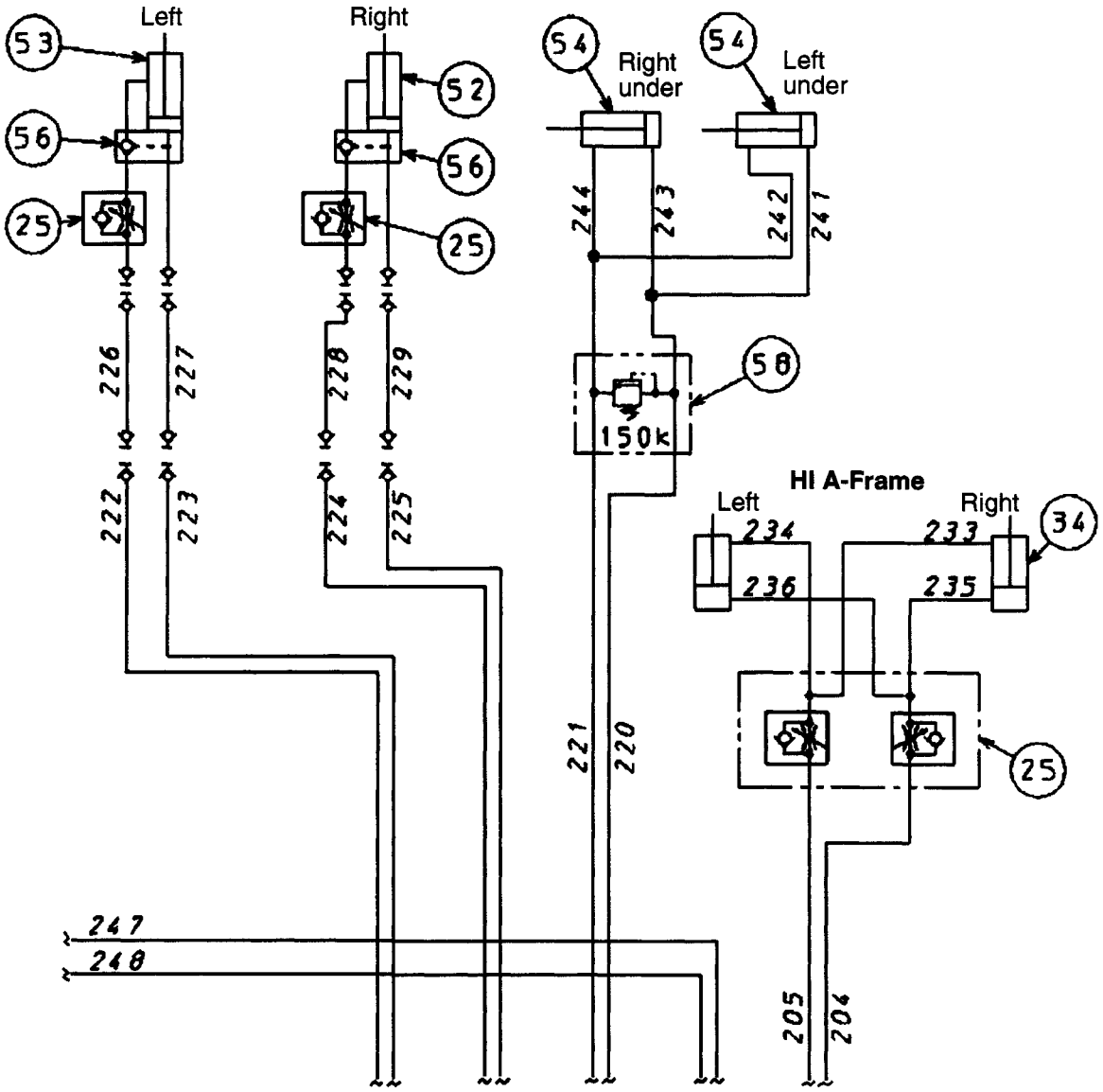
No.	Component	Code No.
1	Piston pump	0780025UA
2	Gear pump	0780011UA
3	Gear pump	0780012UA
4	4 Control valve	07836500UA
5	4 Control valve	0783651UA
6	Swing valve	0756026UA
7	Travel unit	0669767UA
8	Motor (main)	0781150UA
9	Motor (aux.)	0780151UA
10	Motor (boom)	0781152UA
11	Motor (swing)	0757633UA
12	Motor (tag)	0757670UA
13	Motor (reeving)	0757661UA
14	Remote control valve	0756329UA
15	Remote control valve	0783672UA
16	Remote control valve	0756954UA
17	Manifold, solenoid valve	0786902UA
18	Manifold, solenoid valve	0754597UA
19	Manifold, pressure valve	0754596UA
20	---	---
21	---	---
22	Manifold, solenoid valve	0754868UA
23	Manifold, solenoid valve	0754595UA
24	Manifold, solenoid valve	0754860UA
25	Restrictor valve	0753212UA
26	Relieving valve	0751316UA
27	Shuttle valve	0754541UA
28	Check valve	0753241UA
29	Suction filter	0755228UA
30	Return filter	0787404UA
31	Hydraulic valve	0786912UA
32	Extension cylinder	0782251UA
33	Oil cylinder	0759044UA
34	Hi-A cylinder	0782250UA
35	Rotary joint	0755856UA
36	Pressure switch	085818010
37	Pressure gauge	0755601UA
38	Radiator & Cooler	0668513UA
39	---	---
40	Rotary joint	0712202UA
41	Hydraulic oil tank	D28404600
42	Air breather	0755002UA
43	Male adapter	071232410
44	Male adapter	071232402
45	Clutch cylinder	0759034UA
46	Clutch cylinder	0752713UA
47	Assist cylinder	0759011UA
48	Brake cylinder	533511005
49	Brake cylinder	533601500
50	Brake valve	0756383UA
51	Clutch valve	551090100
52	CWRS Cylinder, (R)	0782272UA
53	CWRS Cylinder, (L)	0782273UA
54	CWRS Cylinder,	0782243UA
55	---	---
56	Valve, check	0753059UA
57	Valve, gauge	0783671UA
58	Valve, relief	0741214UA

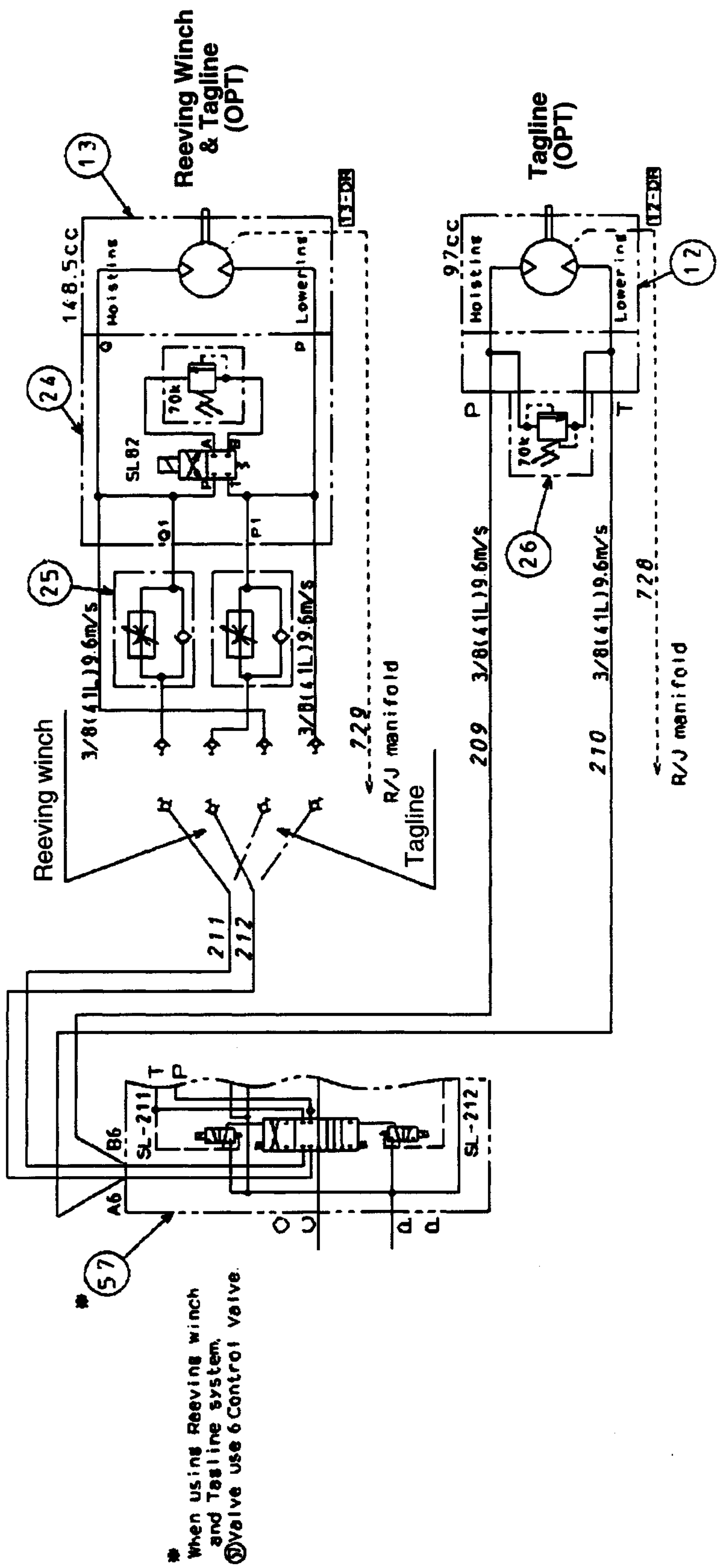


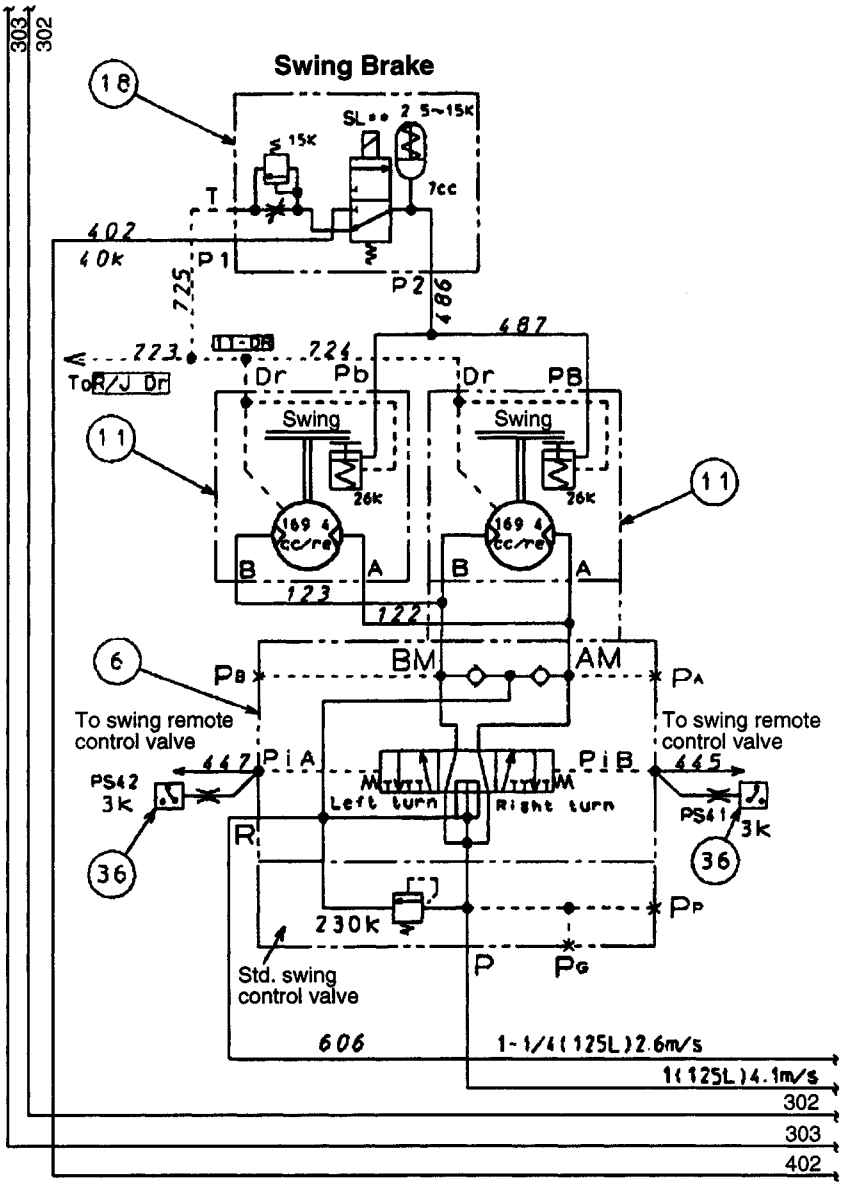

MAIN WINCH MODE SELECTION
AUXILIARY WINCH MODE SELECTION
Main Winch (Front drum)
Aux. Winch (Rear drum)
3rd Drum (OPT)
C/V manifold
Clutch
Brake
370~533cc
Av
Bv
Ps
511
513
113
112
107
106
(138)
(139)
80k
303
302

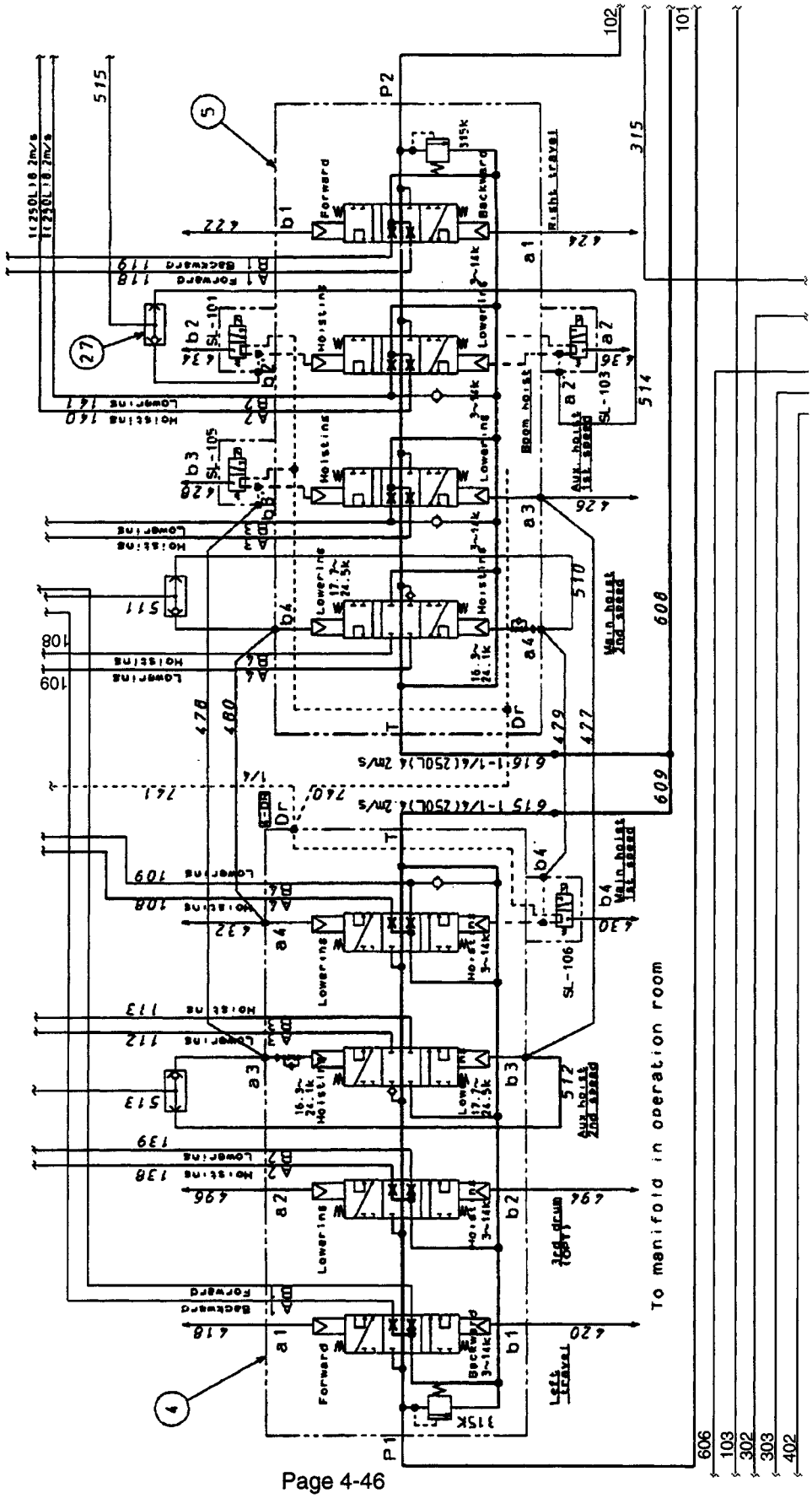

Travel motor (left)
7
Travel motor (right)
7
Crawler extension cylinder (left)
32
Crawler extension cylinder (right)
330K
330K
RED
130.1~178.5cc
D
P
B
A
T
250
251
252
249
125
126
127
128
732
731
483
482
730
481
35
Dr 8 7 1 2 3 4 5
R/J manifold
To 50-DR 705
To 11-DR 723
To 17-DR 706
728 To 12-DR
729 To 13-DR
703 To 41-DR4
3/4
112
113
105
104
121
120
3/8(41L)9.5m/s
3/8(41L)9.5m/s
453
Travel switch Manifold block
247
248

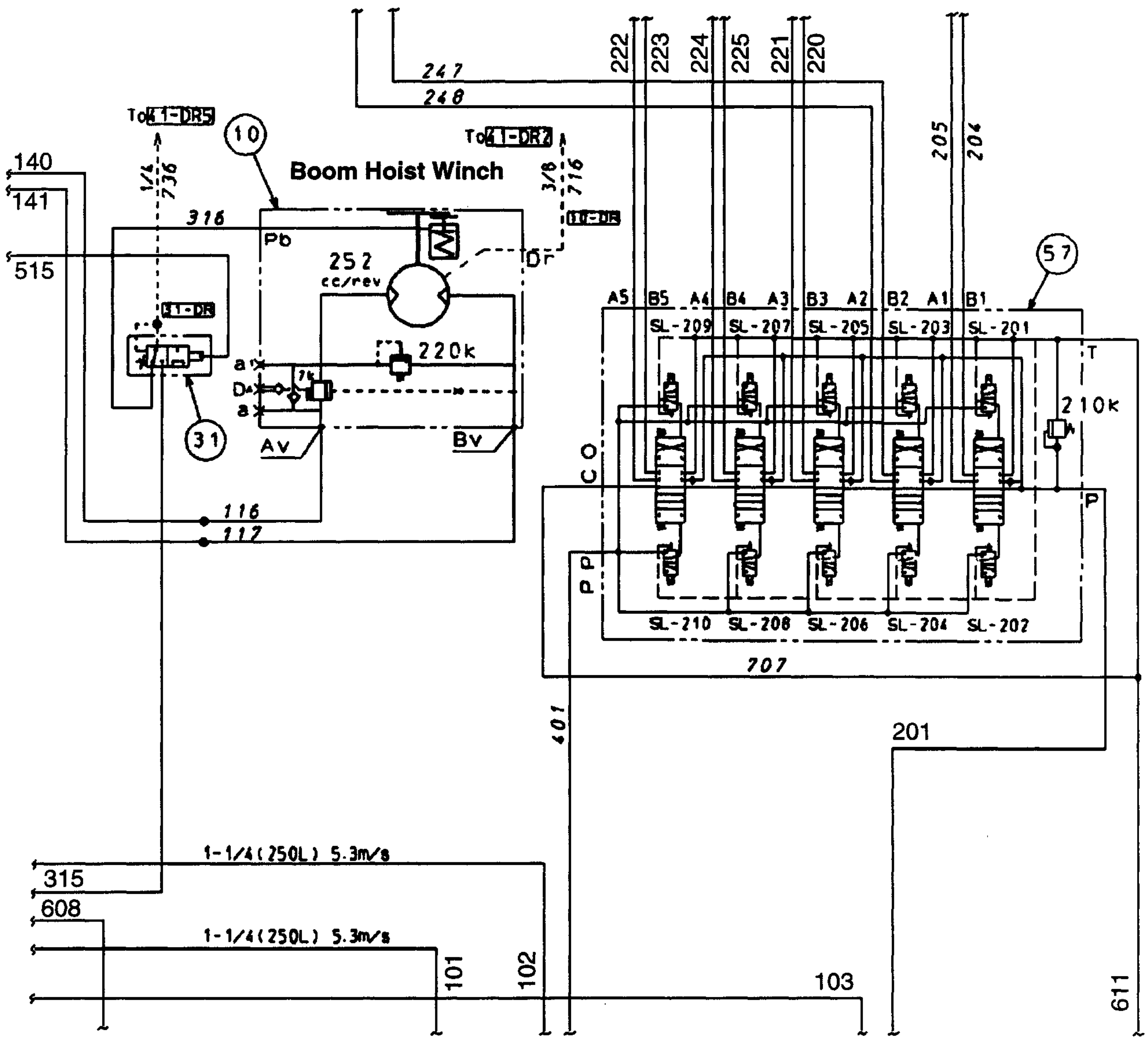
CWRS

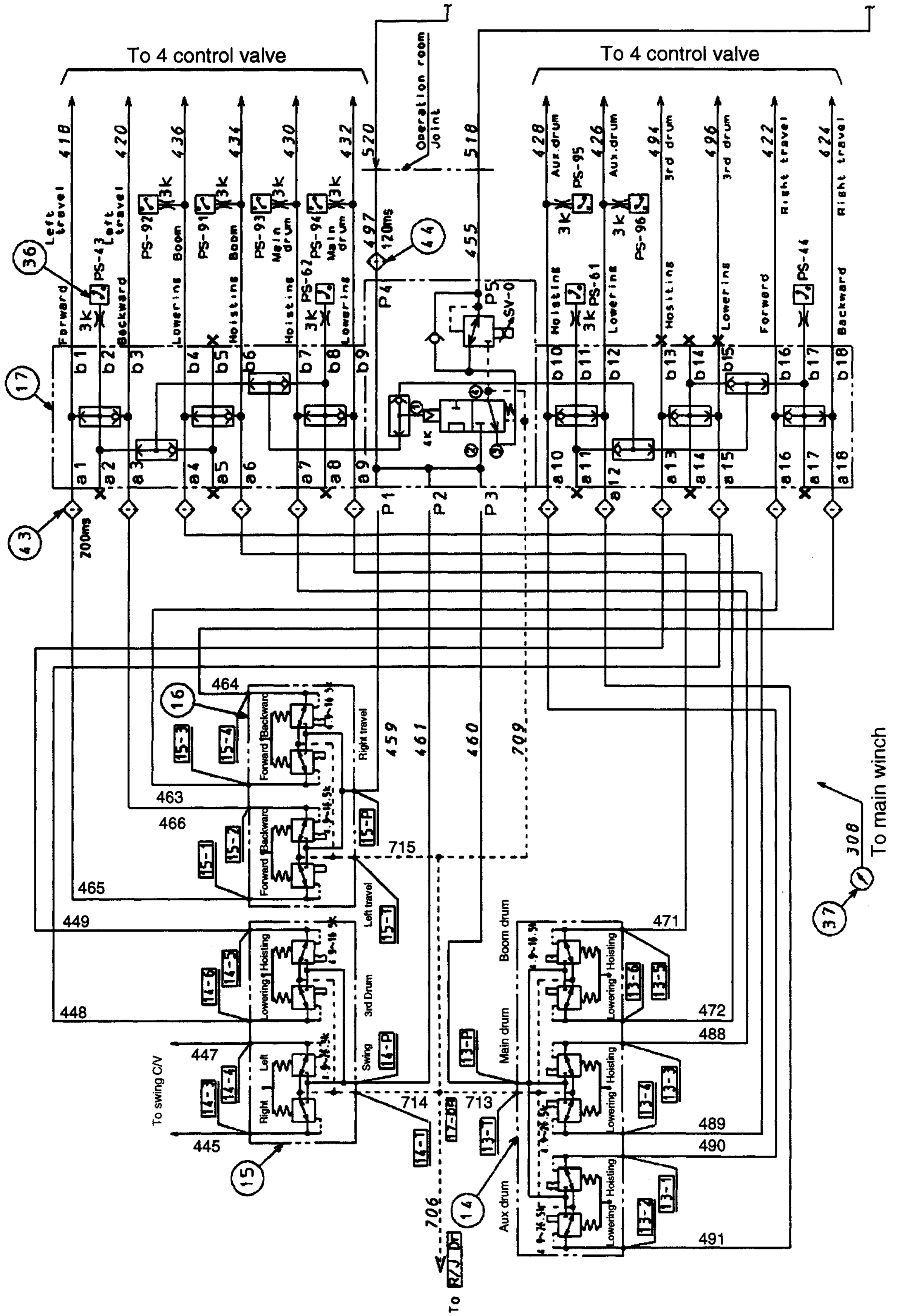

Left
Right
53
52
54
Right under
54
Left under
56
56
25
25
244
243
242
241
226
227
228
229
58
150k
222
223
224
225
HI A-Frame
Left
Right
234
233
34
236
235
221
220
25
247
248
205
204

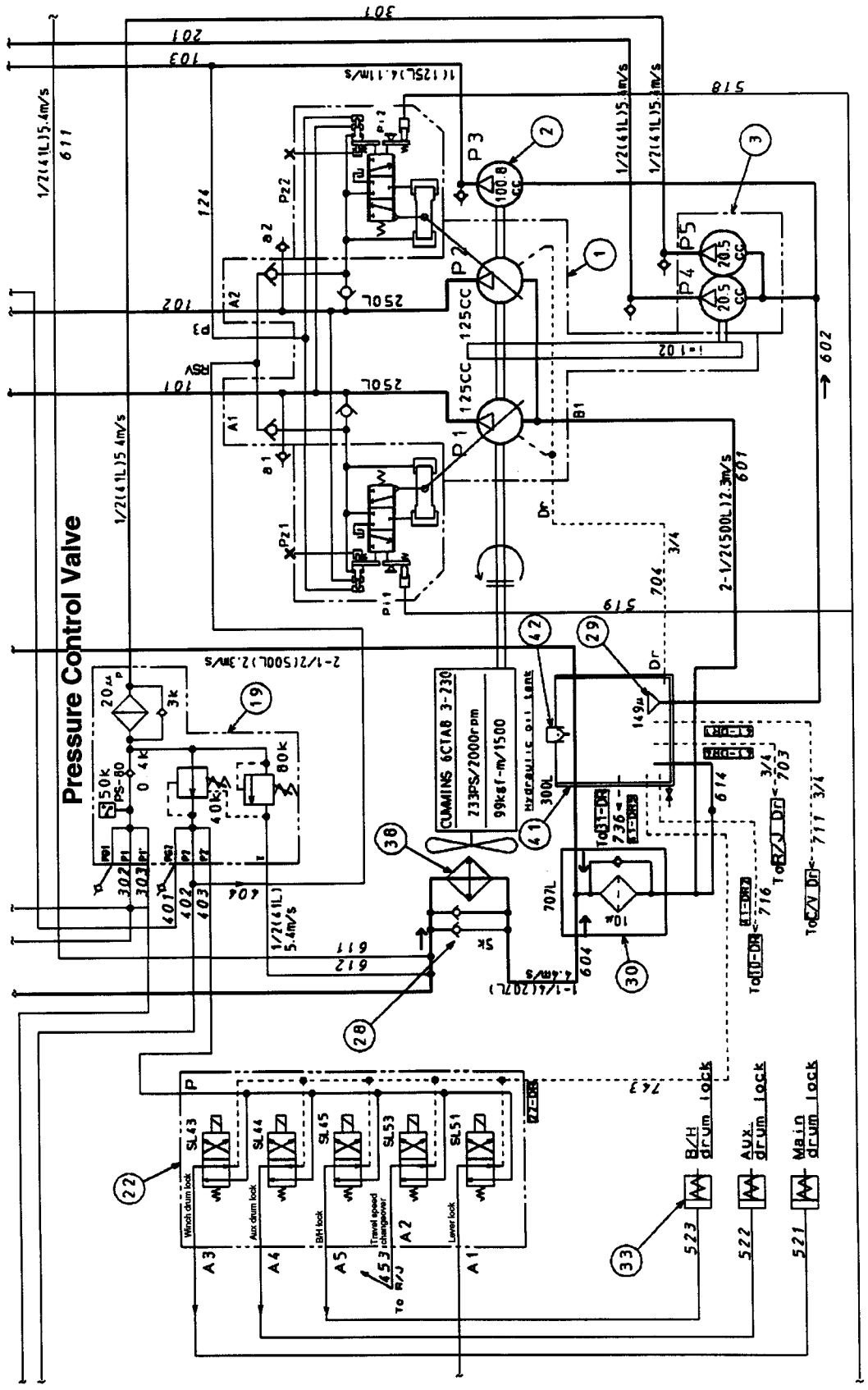

Reeving Winch
& Tagline
(OPT)
Tagline
(OPT)
148.5cc
97cc
Hoisting
Lowering
SL82
70k
Q1
P1
3/8(4 1L)9.6m/s
209
210
211
212
728
729
R/J manifold
Reeving winch
Tagline
SL-211
SL-212
A6
B6
13
12
24
25
26
57
* When using Reeving winch and Tagline system, 57 Valve use 6 Control Valve.


303
302
Swing Brake
18
SL
2.5~15K
15K
7cc
T
402
40K
P1
P2
725
486
487
723
724
11-DB
To R/J Dr
Dr
Pb
Dr
PB
Swing
Swing
11
11
26K
26K
169.4 cc/rev
169.4 cc/rev
B
A
B
A
123
122
6
BM
AM
PB
PA
To swing remote control valve
To swing remote control valve
447
PiA
PiB
445
PS42
3K
Left turn
Right turn
PS41
3K
36
36
R
230K
PP
P
PG
Std. swing control valve
606
1-1/4(125L)2.6m/s
1(125L)4.1m/s
302
303
402


To manifold in operation room
P1
P2
Forward
Backward
Hoisting
Lowering
Left travel
Right travel
Main hoist 1st speed
Main hoist 2nd speed
Aux. hoist 1st speed
Aux. hoist 2nd speed
Boom hoist
SL-101
SL-103
SL-105
SL-106
315K
606
103
302
303
402


Boom Hoist Winch
To 41-DR5
To 41-DR7
10-DR
31-DR
140
141
515
316
1/4
736
3/8
716
247
248
Pb
252
cc/rev
Dr
220k
7k
a
Dr
a
Av
Bv
116
117
10
31
57
222
223
224
225
221
220
205
204
A5
B5
A4
B4
A3
B3
A2
B2
A1
B1
SL-209
SL-207
SL-205
SL-203
SL-201
SL-210
SL-208
SL-206
SL-204
SL-202
T
210k
P
CO
PP
707
401
201
1-1/4(250L) 5.3m/s
315
608
1-1/4(250L) 5.3m/s
101
102
103
611


To 4 control valve
To 4 control valve
464
463
466
465
449
448
447
445
715
714
713
471
472
488
489
490
491
To swing C/V
To main winch

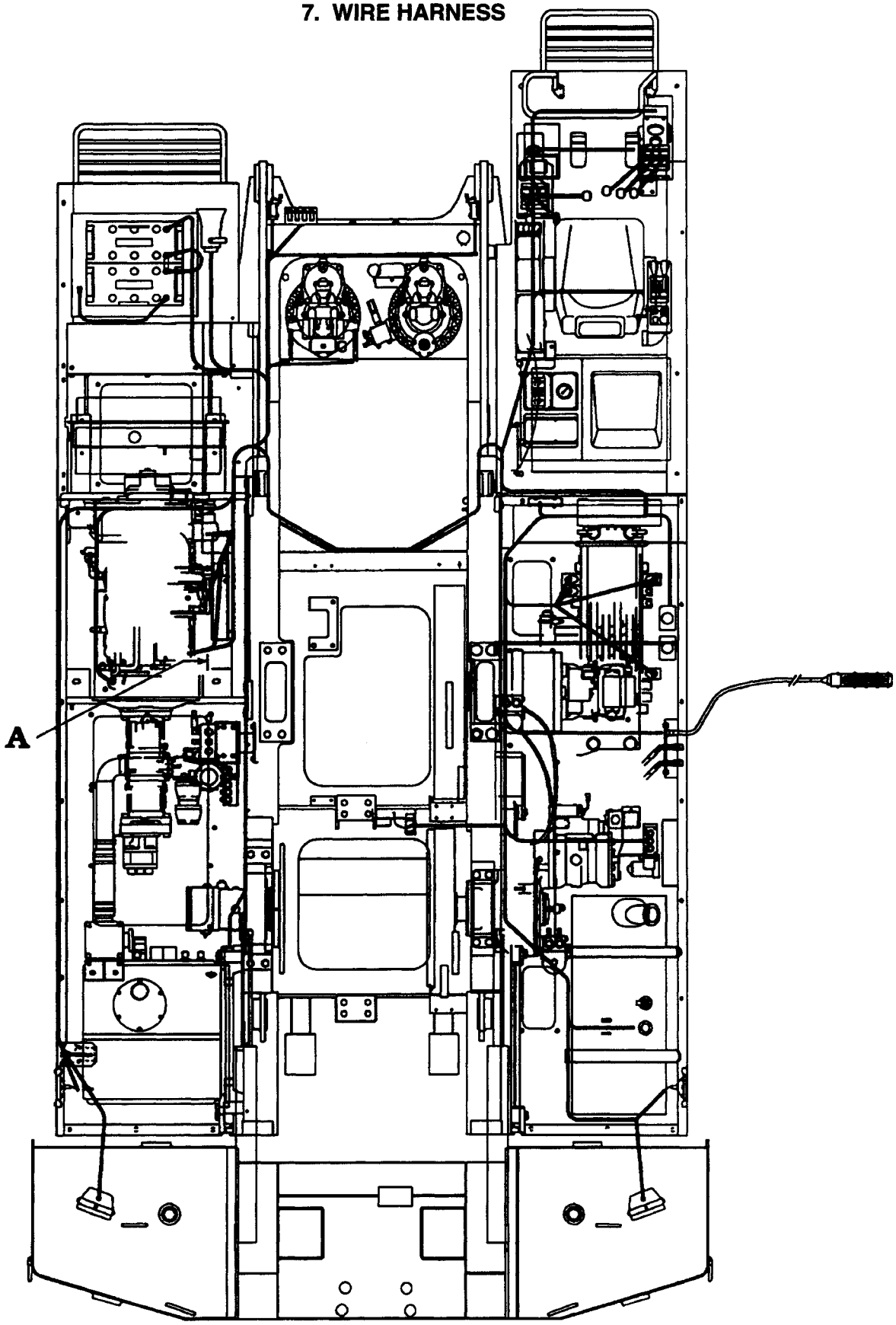

Pressure Control Valve
P1
P2
P3
P4
P5
125CC
100.8 CC
20.5 CC
CUMMINS 6CTAA 3-230
233PS/2000rpm
99kgf-m/1500
SL43
SL44
SL45
SL53
SL51
Winch drum lock
Aux drum lock
B/H lock
Travel speed changeover
Lever lock
B/H drum lock
Aux. drum lock
Main drum lock

6. OPERATONAL AIDS SITUATION TABLE

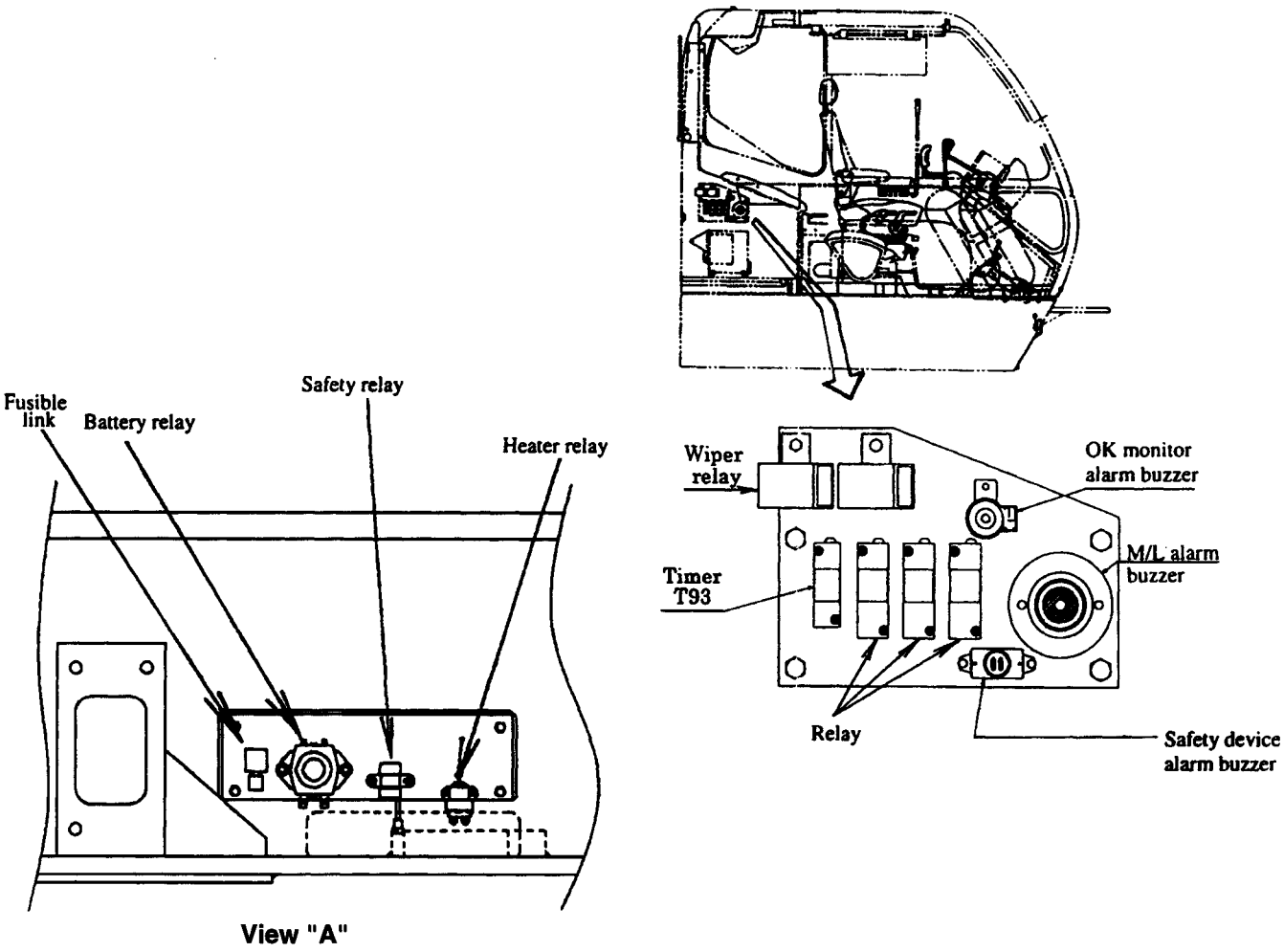
NOTE: ■ Shows that the operational aid can be released by the bypass switch.
✕ Shows that the operational cannot be released by the bypass switch.

Work Mode		Crane (with jib) and boom crane								
Output / Operational aid		Buzzer or voice output	Slow down operation	Boom drum hoisting stop	Boom drum lowering stop	3rd drum hoisting stop	3rd drum lowering stop	Main winch drum hoisting stop	Aux. winch drum hoisting stop	Aux. winch drum lowering stop
General operational aids	Boom throw-out (boom angle: 81°)	Beep, beep		■						
	Main hook overhoisting prevention device	Beep, beep Main hook is over hoisted			■			■	■	
	Jib hook overhoisting prevention device	Beep, beep Aux. hook is over hoisted			■			■	■	
	3rd overhoisting prevention device									
Moment limiter	Load ratio: 100% or more	Beep overload			■			■	■	
	Load ratio: 90% ~ less than 100%	Beep, beep will stop soon automatically	✕							
	Boom: beyond the upper limit angle	Boom is over hoisted	✕	■				■	■	
	Boom: below the lower limit angle	Boom is over lowered	✕		■					
	Boom: beyond the upper limit set angle - set optionally	Boom is over hoisted	✕							
	Boom: below the lower limit set angle - set optionally	Boom is over lowered	✕							

7. WIRE HARNESS

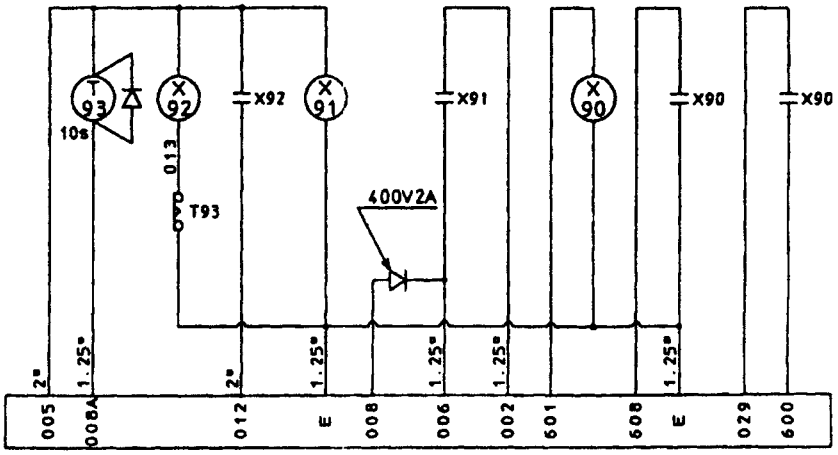


WIRE HARNESS (Continued)



View "A"

[Circuit diagram in panel]



Section 5

OPERATOR AIDS

Printed in U.S.A.
5/01

1. KINDS OF OPERATOR AIDS

1-1 Overload prevention device (moment limiter)

When actual load reaches the permissible load limit, this operator aid functions to automatically stop load lifting and boom lowering and sounds buzzer in order to prevent a mobile crane from turning over. Even when the moment limiter is activated, operations toward the safer side, namely load lowering and boom hoisting, are allowed. If the moment limiter operates, the machine should be returned to the safe area immediately. Automatic stop will be cancelled in about 2 seconds. When the boom is hoisted excessively (beyond the rated upper limit angle) or the maximum working radius (rated lower limit angle) at the present boom length is reached, the moment limiter also issues the boom stop command and sounds the buzzer. In this case, lower or hoist the boom to the normal position and then release the stop status.

1-2 Hook overwind prevention device

This device prevents over-winding of the hook and thereby protects the machine from backward turnover of boom and other dangers. Upon activation of this device, hook hoisting stops and the buzzer sounds continuously. On this occasion, lower the hook or load while paying adequate attention to safety. Once the hook is separated from the over-wind detection weight, the stop status is released. Even when the stop is activated, the hook can be lowered.

Kinds of hook overhoisting prevention devices:

Main hook overhoisting prevention

3.5 ft. jib hook overhoisting prevention

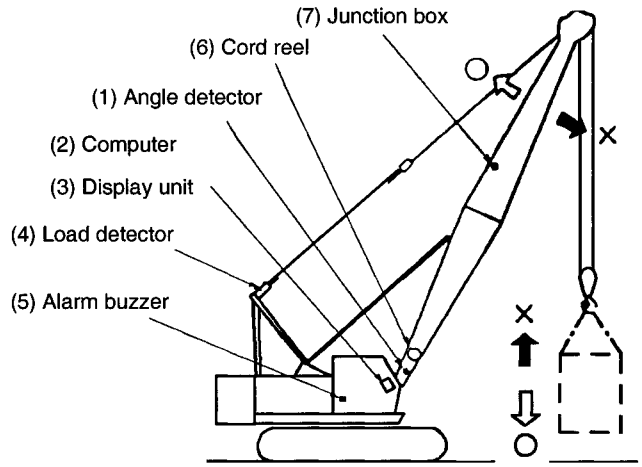
29.5 to 59.0 ft. hook overhoisting prevention

1-3 Boom overwind prevention device (boom throw-out)

When the boom is hoisted up to 81°, the limit switch at the boom foot is activated to stop the boom hoisting operation and sound the buzzer continuously. Lower the boom to release this prevention device. Keep the crawlers extended during operation. You may retract the crawlers only at transportation, such as trailer transportation. You can move the crawler on a side by 22.44 inches.

2. MOMENT LIMITER

2-1 Outline of moment limiter (overload prevention unit)



O : Safe side

X : Dangerous side

This operator aid stops dangerous side operation (boom lowering and load hoisting) and sounds the alarm buzzer when an actual load beyond the rated load is applied to the hook. Note, however, operations can be performed on the safe side (boom hoisting and load lowering) even if this operator aid is activated.

Function of each unit:

1. Angle detector

   This detector sends a voltage, which varies with boom angle, to the computer unit.

2. Computer unit

   This unit comprises an electronic circuit. It calculates the permissible load in the present working position according to a voltage signal from the angle detector and the permissible load in the load detector. Moreover, it calculates the actual load through the reception of a voltage signal applicable to the weight of the lifted load. The load in the load detector is compared with the weight of the lifted load. When the value by comparison reaches 90%, the buzzer sounds intermittently. When the value by comparison reaches 100%, the buzzer sounds continuously and the machine stops automatically.

3. Display unit

   This unit displays working radius, main boom angle, actual load and permissible load. In addition, this unit is capable of setting working conditions.

4. Load detector

   This is a strain gauge type detector mounted on the A-frame yoke. This detector sends a voltage signal, which responds to the change of load, to the computer unit.

5. Alarm buzzer

   90% and 100% signal levels in the computer unit are informed by the intermittent and continuous sounds of a piezoelectric buzzer, respectively, as a warning to the operator.

6. Cord reel

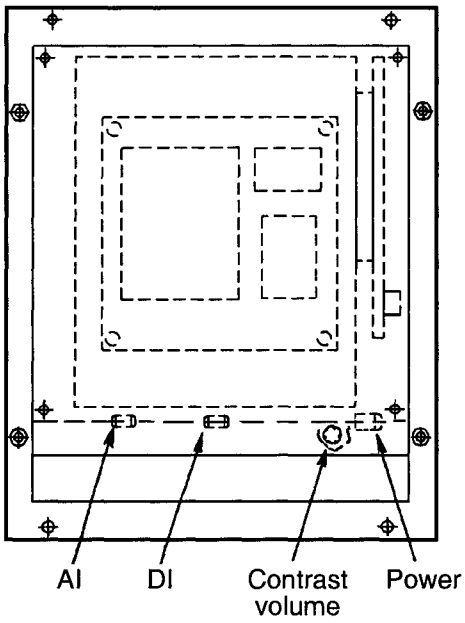
   This is a wiring cord winding drum used to wind excess cord on it depending on boom length.

7. Junction box

   The junction box of outer boom houses cables for the jib hook and main hook overwind detector. The wiring of the boom hoisting throw-out is independent of the junction box.

2-2 Outline of computer unit

(Installed on the left side when you face the main hoisting drum clutch)



Connected layout
AI: Load cell and boom angle detector
DI: Main harness

POWER: Power supply
24V DC

Power supply: 24 V DC Operable within a range of 18.5 to 35 V
Automatically reset below 18.5 V and within 35 to 36 V
Fuse blowout beyond 36 V

Principal configuration:
CPU (central processing unit), 16 bits

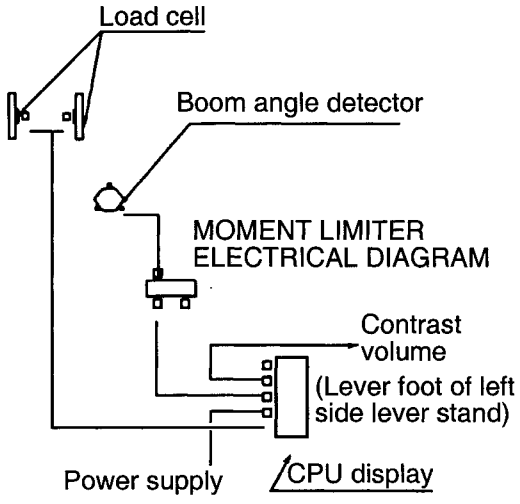
Memory:	ROM.	For main software - Read Only Memory
	RAM.	For computation - Random Access Memory
	EEP ROM. . . .	For writing set value, etc.
	Operation box:	LED for monitor, various operation switches

Signal output circuit:

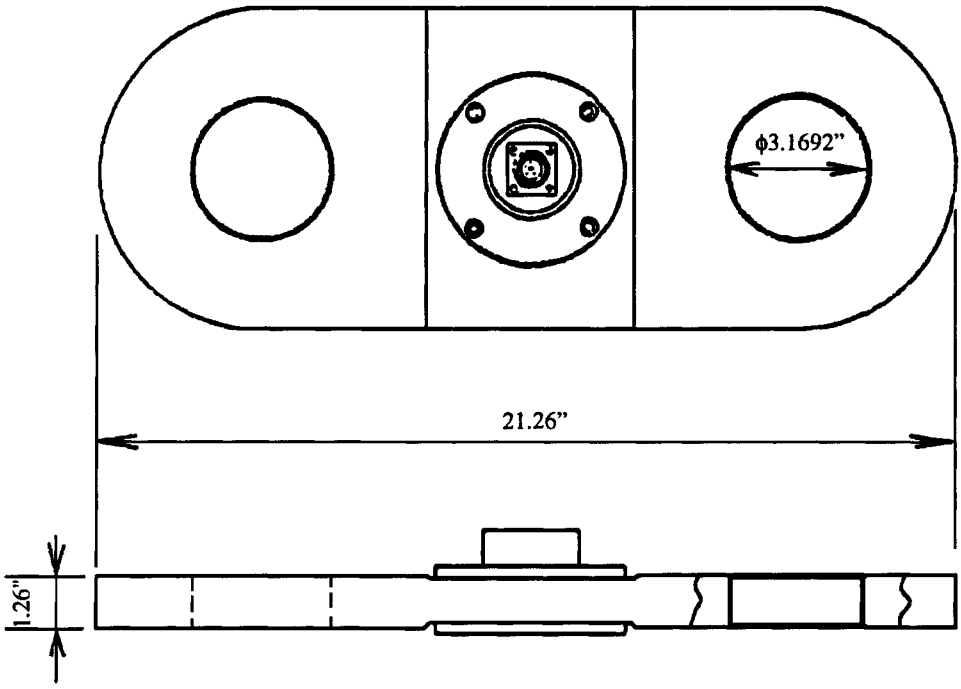
Relay output	Signal OFF (power turned on at normal operation)
	Signal ON (power turned off at automatic stop)
	Signal ON (power turned off at computation error)
Buzzer output:	Intermittent sound within 90 to 100%
	Continuous sound above 100%

NOTICE

1. **Before plugging in or unplugging the IC card, be sure to turn the overload prevention device switch to transportation position or engine starting switch OFF position. If the power supply remains turned on, there is a risk of the IC card being damaged.**
2. **The setting/operation selector switch should normally be set on the operation side.**

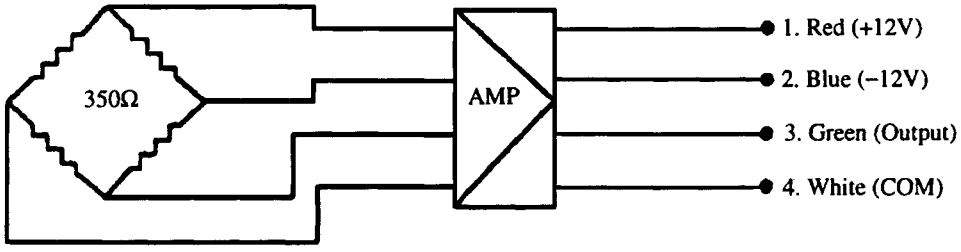


2-3 Outline of sensor (Load detector)

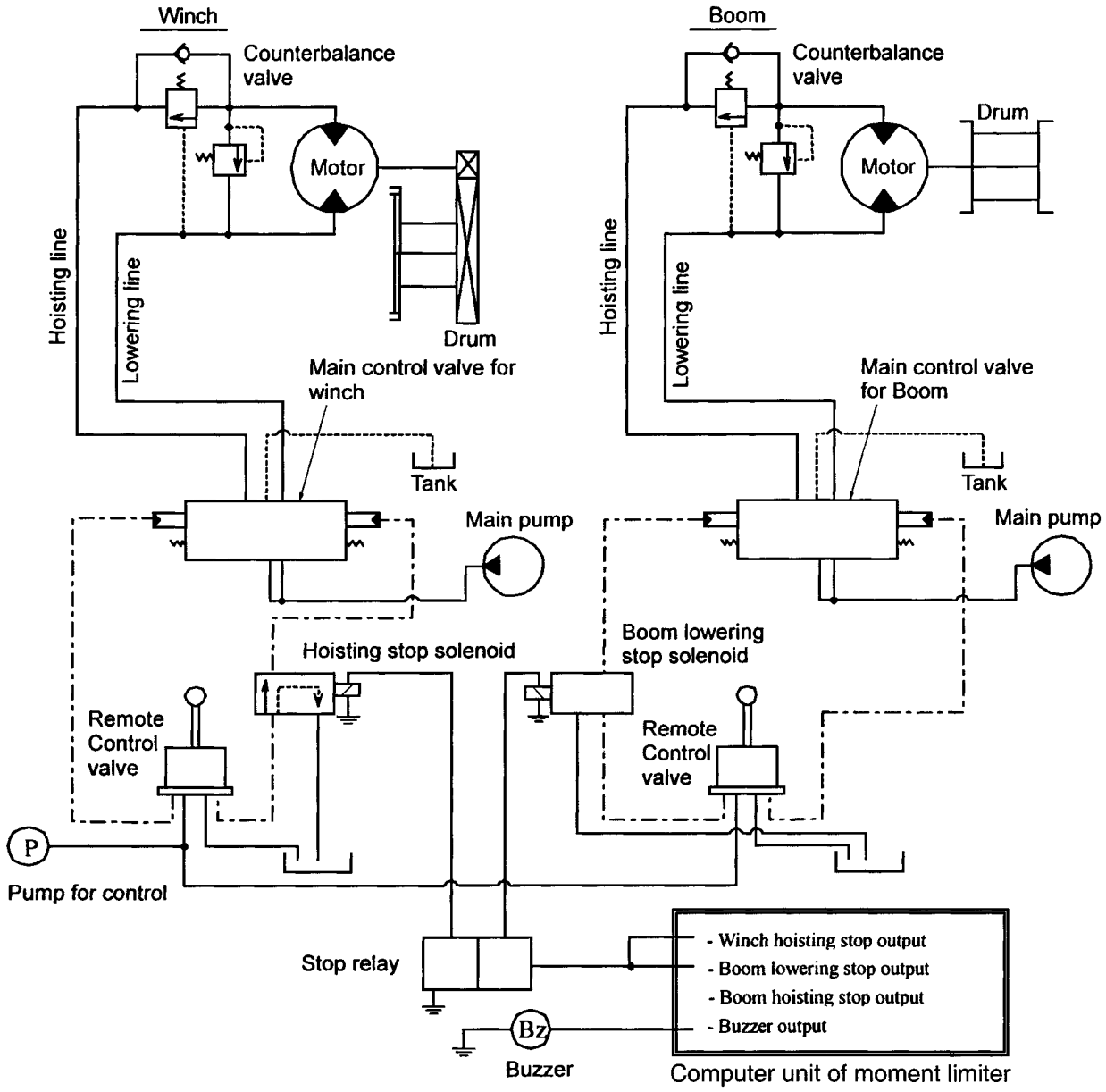


45t tension type load cell
with built-in amplifier power
power supply ±12V DC

LT-30TAJ307



2-4 Stop mechanism



When the stop relay is activated in response to 100%-level stop output of the moment limiter, power supply to the winch hoisting stop solenoid and boom lowering stop solenoid is turned off. As a result, the solenoid valve is switched over. Pressurized fluid from the remote control valve normally passes through the solenoid valve and acts on the end of spool of the main control valve. When the stop solenoid is switched over, the pressurized fluid from the remote control valve returns from the solenoid valve to the tank. Consequently, the main control valve returns to the neutral position.

When the main control valve has returned to the neutral position, the pressurized fluid from the main pump is no longer supplied to the winch motor and boom motor. Therefore, winch hoisting and boom lowering are stopped by the counter balance valve and disc brake. With or without a load, boom lowering stop output and buzzer output are issued when the maximum working radius is reached. When the boom is hoisted at 81°, boom hoisting stop output and buzzer output are issued.

Automatic stop device

On activation of the automatic stop device, the relay is activated due to activation of the microswitch (for boom throw-out or hook overwind prevention) or stop command of the moment limiter. When the relay is activated, power supply to each solenoid valve in the load hoisting circuit and the boom hoisting/lowering circuit is turned off. When power supply to the solenoid valve is turned off, the valve is switched over.

Operating fluid via the remote control valve of operator's seat passes through the solenoid valve and flows into each main control valve. The fluid presses the end of spool of the main control valve until the valve is switched over.

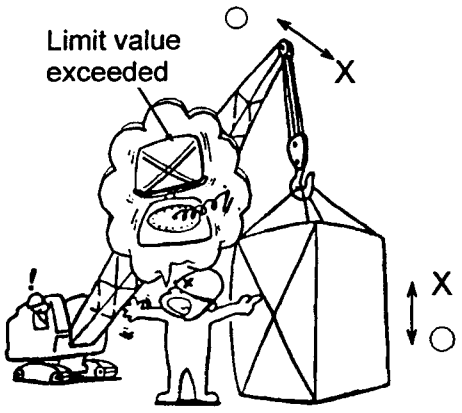
The pressurized fluid of the main pump passes through the control valve and flows into each motor. When the solenoid valve is switched over as mentioned above, the controlling fluid, which was led from the remote control valve to main control valve, returns to the tank. Therefore, the main control valve returns to the neutral position. When the main control valve has returned to the neutral position, the pressurized fluid of the main pump is no longer led to each hoisting motor. Consequently, the hoisting motor stops to disable load hoisting, boom hoisting or boom lowering.

Activation of overload prevention device and method of its release

When the actual value exceeds 90% of the limit value, the buzzer beeps intermittently. When the actual value exceeds 100%, the buzzer beeps continuously.

The machine automatically stops according to the stop signal from the moment limiter, and both load hoisting and boom lowering are disabled.

In case the machine is automatically stopped according to the stop command of the moment limiter, the working distance should be shortened by hoisting the boom or the load ratio should be reduced by lowering the load to the ground. Once the machine has returned to the safe area, the buzzer stops beeping. Return the crane to the safe area, an automatic stop is released in about 2 seconds and all the operation can be done.



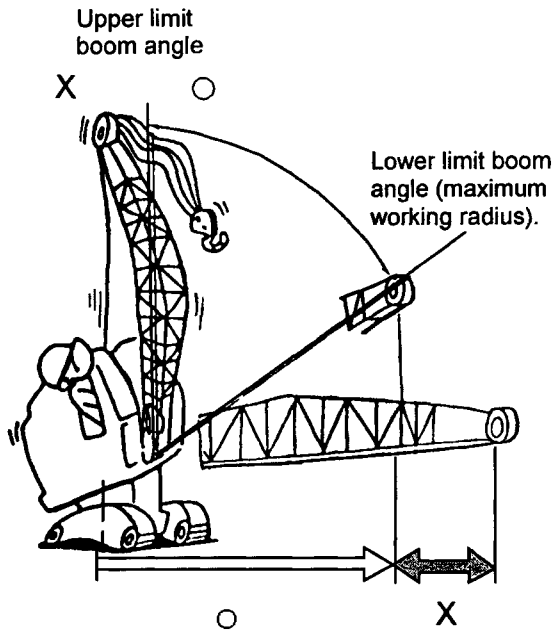
⚠ CAUTION

1. **Even if the machine is automatically stopped, boom lowering and load hoisting can be continued by turning the bypass switch to the released side. However, such an operation can cause a mobile crane to turn over. Never try such an operation.**
2. **If crane operation is carried out with the bypass switch kept released for any reason, there is a risk of machine tip-over, backward boom turn-over (boom hoist), etc. because the operator aid does not function. To prevent this, never try such an operation.**
3. **During crane operation, never turn off the power supply of overload prevention device.**

Boom stop at rated upper limit or rated lower limit (at maximum working radius)

Regardless of whether or not a load is lifted, the boom automatically stops when it is hoisted at the upper limit angle or it is lowered so as to reach the maximum working radius at the present boom length. At the same time, the alarm buzzer sounds. The same action is taken in case of the tower jib.

The lower limit boom angle varies with the boom length. Refer to the rated overall lifting load table.



Release:

To release the automatic stop status, lower or hoist the boom.

When the buzzer stops, the stop status is released.

⚠ CAUTION

1. **When attempting to hoist the crane boom from the ground, hoisting operation is disabled because the boom stop command is issued as mentioned above. In this case, first turn overload prevention device switch to erection position or turn the bypass switch to released side, and then proceed to hoisting operation.**
2. **When the boom reaches the determined angle, be sure to turn to operation position of overload prevention device switch (moment limiter switch).**

⚠ CAUTION

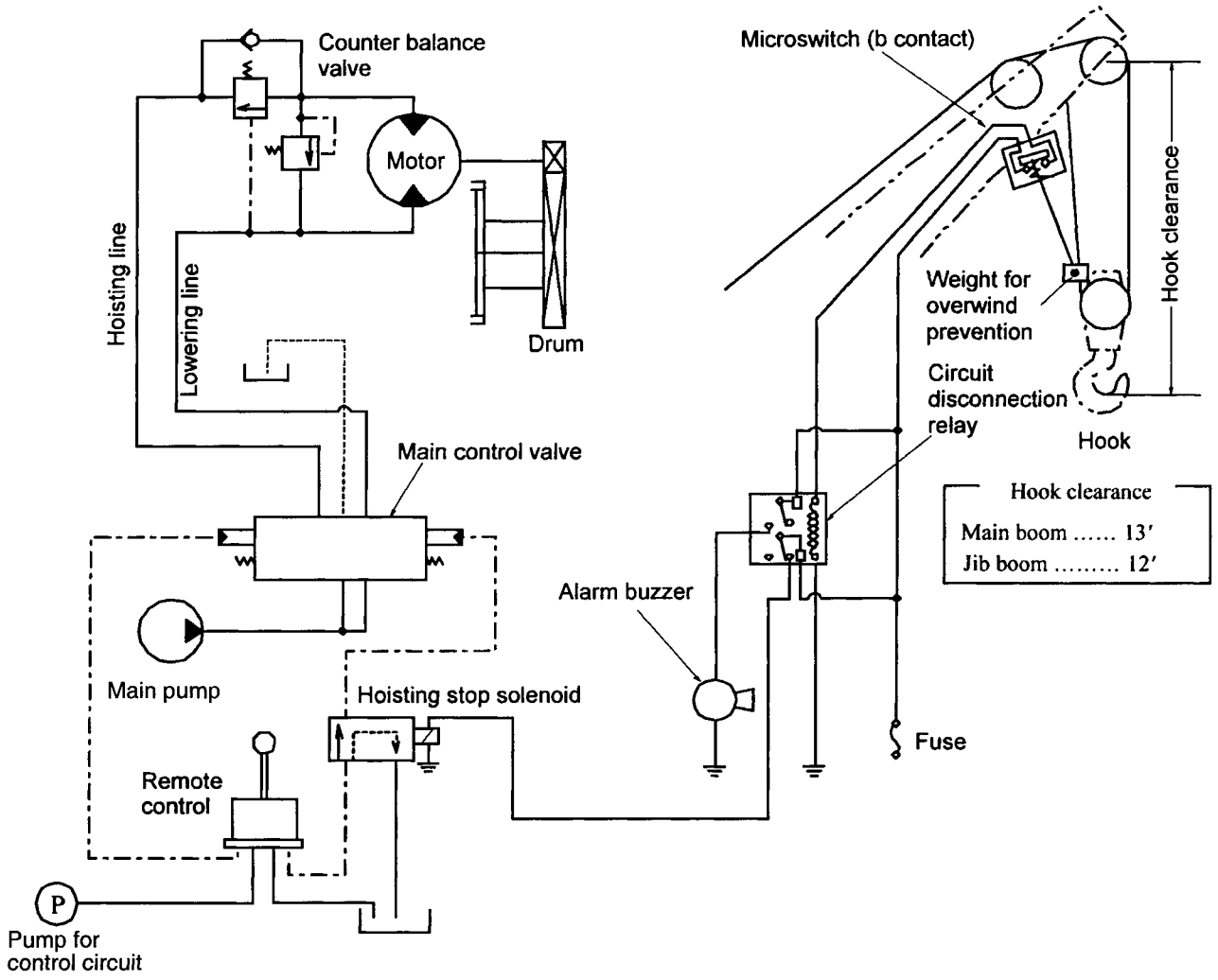
1. **Before the start of daily operation, the function of the overload prevention device must be checked. As a convenient method of functional check, the following procedure is usable:**

   Start lowering the boom without lifting a load. Confirm that when the lower limit boom angle is reached, the buzzer sounds continuously, the boom automatically stops, and the load ratio display becomes 100%. If confirmation is made, the function of the overload prevention device is normal.
2. **Never connect or disconnect cables without turning off the power switch, otherwise the computer unit may be damaged. Also, refrain from plugging in or unplugging the IC card without cutting off the power supply. Otherwise, the IC card may be damaged.**

   After turning engine key to the OFF position or changing the overload prevention device switch to a transportation position, it carries out.

3. HOOK OVERWIND PREVENTION DEVICE

3-1 Outline of activation



When the hook pushes up the weight of overwind prevention device in hoisting, the contact of the microswitch opens so that excitation of the circuit disconnection relay is interrupted. The hoisting stop solenoid valve is switched over and the operating fluid from the remote control valve returns to the tank circuit through the overwind stop solenoid valve. Consequently, the force which has pushed the spool of the main control valve is lost. The spool of the main control valve returns to the neutral position and the hydraulic fluid in the main circuit is also returned to the tank circuit. This means that the route of fluid supply to the motor is cut off. Thus, the revolution of the motor is stopped with the counterbalance valve, thereby preventing the hook from being hoisted further. At the same time, the alarm buzzer is sounded.

To release this function, lower the hook until the alarm buzzer stops beeping. Make sure that the microswitch always functions normally.

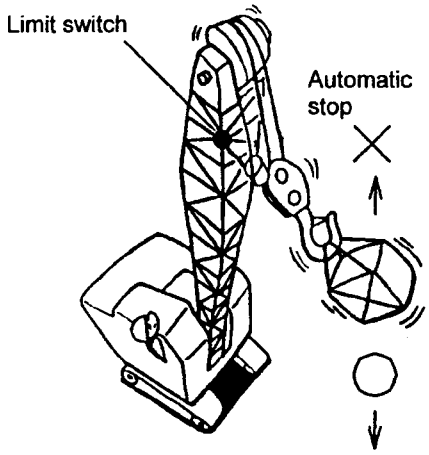
3-2 Activation check of limit switch and overwind prevention device

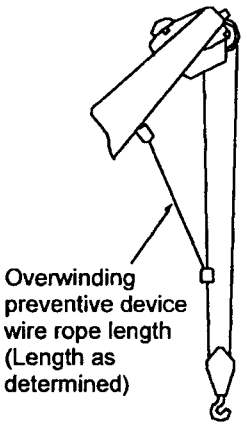
When the hook pushes up the weight for the overwind prevention device, the "b" contact of limit switch opens to activate the stop relay. On activation of the stop relay, hoisting of the hook stops and the alarm buzzer sounds.

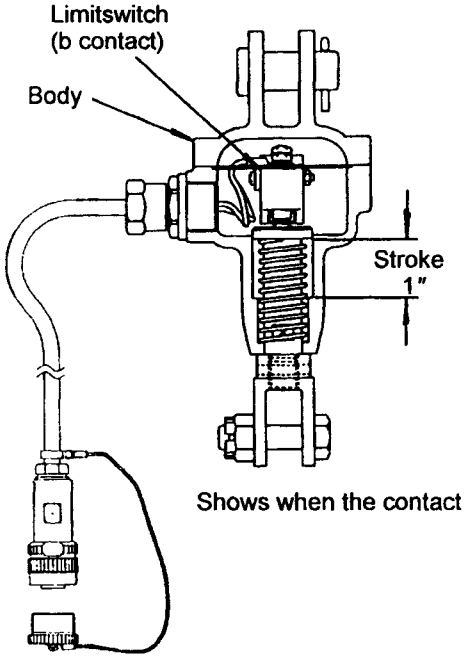
To release the stop status, lower the hook until it is separated from the weight for overwind prevention device. Once the hook has been separated from the weight, the buzzer sound stops to indicate that the hoisting stop status is released.

⚠ CAUTION

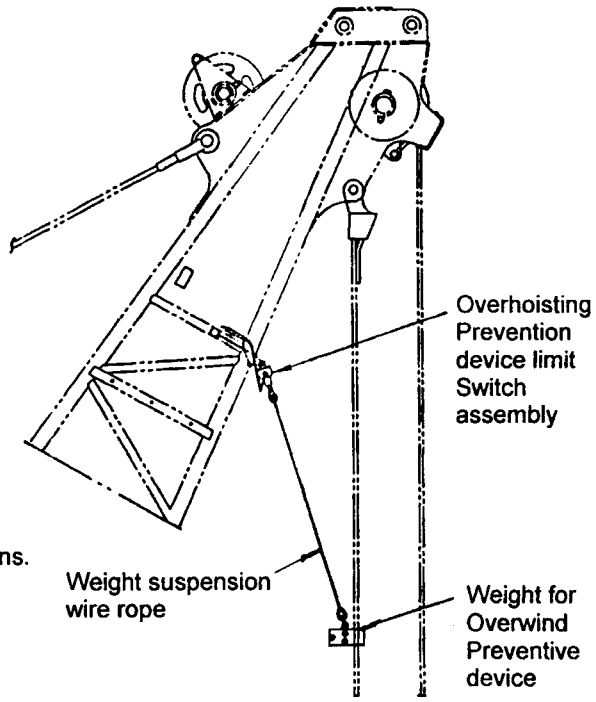
1. **The weight for overwind prevention device should be suspended by the wire rope of the determined length, without fail. If the rope length is not proper, the overhoisting prevention device may not work.**
2. **Before crane work, confirm each activation of the limit switch and entire automatic stop mechanism. For confirmation, the hook should be hoisted at a very slow speed so that hook hoisting can be stopped immediately.**







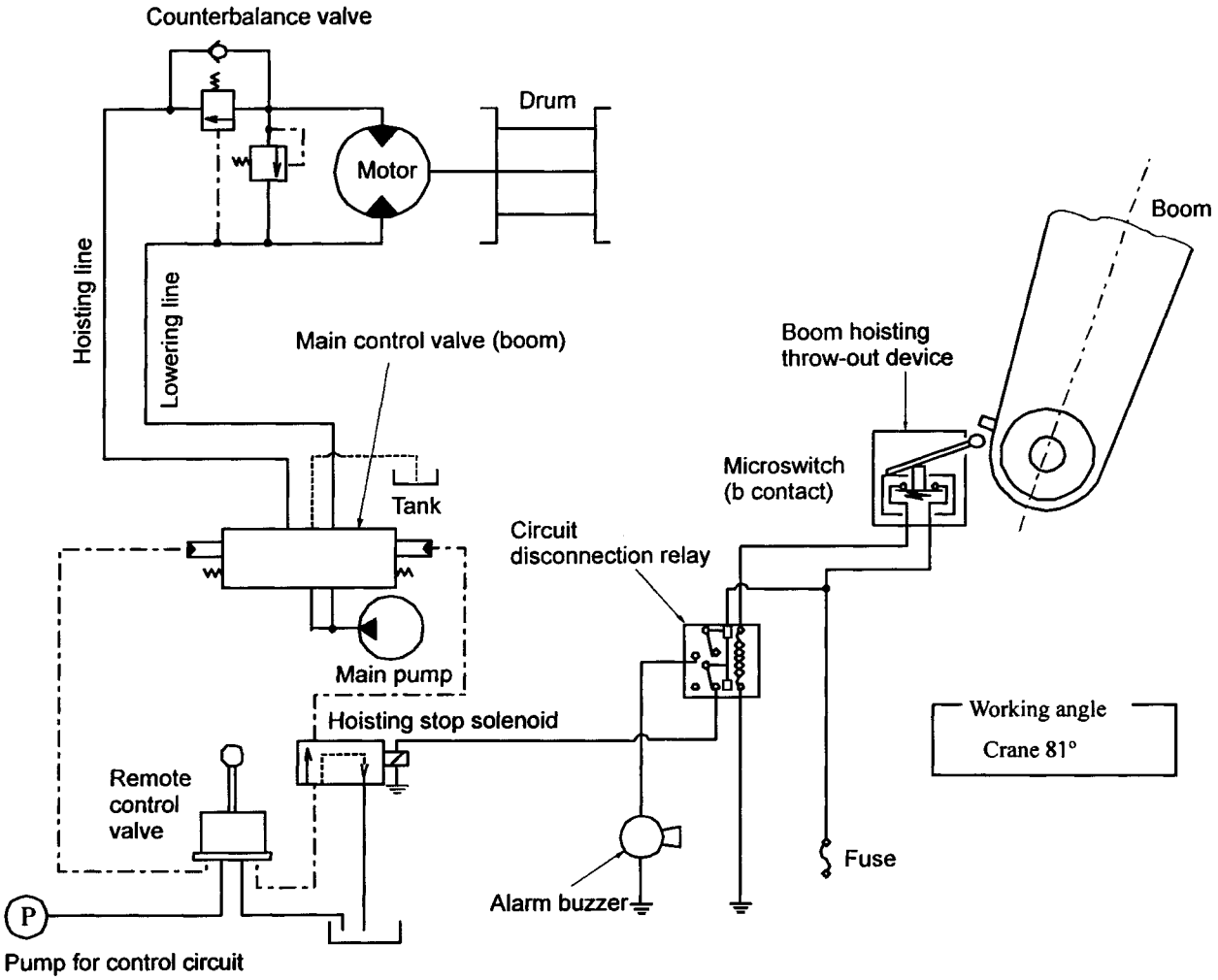
Limit switch area



Hook overwind preventive device

4. BOOM OVERWIND PREVENTION DEVICE (BOOM THROW-OUT)

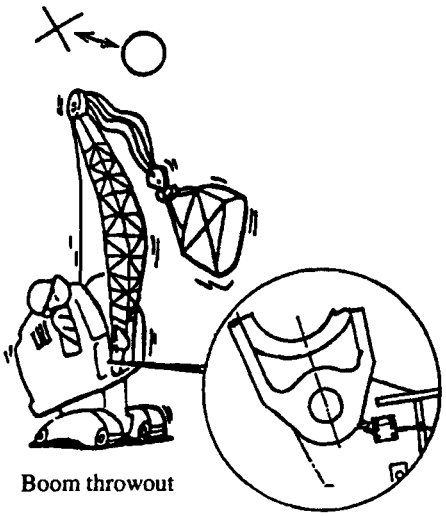
4-1 Outline of activation



When the contact of the limit switch opens due to activation of the boom hoisting throw-out in boom hoisting, the circuit disconnection relay operates. As a result, power supply to the hoisting stop solenoid valve is cut off and the solenoid valve is switched over. Since operating fluid from the remote control valve returns to the tank through the hoisting stop solenoid valve, the force which pressed the spool end of the main control valve is now unavailable. Therefore, the spool of the main control valve returns to the neutral position. This means that the fluid of the main pump also returns to the tank circuit. So, pressurized fluid is no longer supplied to the motor. Consequently, the motor is stopped with the counterbalance valve and multiple disc brake, thereby preventing the boom from being hoisted excessively. As soon as boom hoisting stops, the buzzer sounds an alarm. To release the stop status, lower the boom until the buzzer stops. The throw-out device must always be kept in the normally operable status.

4-2 Boom overhoist prevention device (boom throw-out)

When the boom is hoisted beyond the specified angle, the limit switch of boom throw-out is activated, so that the boom hoisting winch stops and the alarm buzzer sounds. To release the automatic stop status, lower the boom until the limit switch roller and boom foot are separated from each other. When the buzzer stops beeping, the stop status is released.



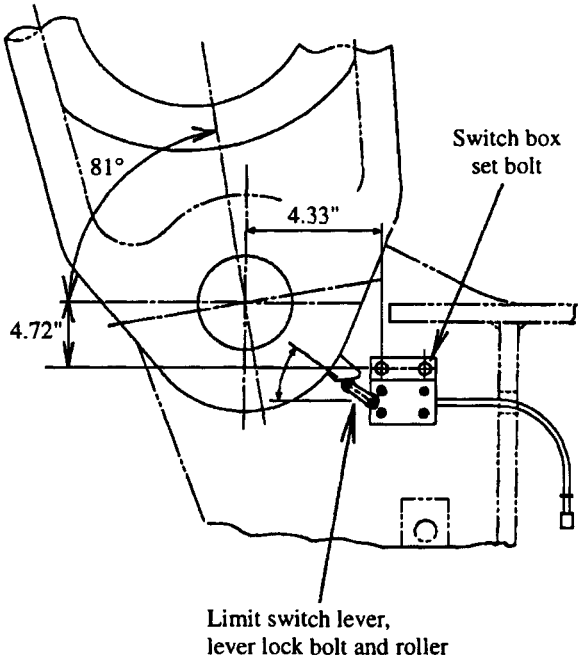
Boom throwout

NOTICE

1. **It is recommended to avoid lifting a heavy load with the boom angle close to the maximum. When lifting a heavy load, it can be predicted that the boom moves backward after releasing the load and therefore the automatic stop device is activated.**
2. **In preoperational check, confirm that the boom throw-out functions normally.**

4-3 Boom throw-out adjustment

Adjust the boom throw-out so that it is activated at a boom angle of 81° in the standard crane.



1. Move the machine onto level ground.
2. Slow down engine rotation and hoist the boom at about boom angle of 81°.
3. Loosen the lever fixing bolt of the limit switch. The overhoist preventive device operates where the roller at the lever end hits the block and the limit switch clicks.
4. Move the boom up and down several times and make sure that the throw-out operates at 81°. Finely adjust the lever mounting position if necessary.
5. Tighten the lever lock bolt securely to prevent the lever from moving.

4-4 Second throw-out

The second throw-out is to be mounted at the boom foot on the left side.

Adjust the operating angle to 83°. When the second throw-out operates, the boom and load hoisting stop. Operate the limit switch by hand to check the operation of the second throw-out.

Section 6

SPECIFICATIONS

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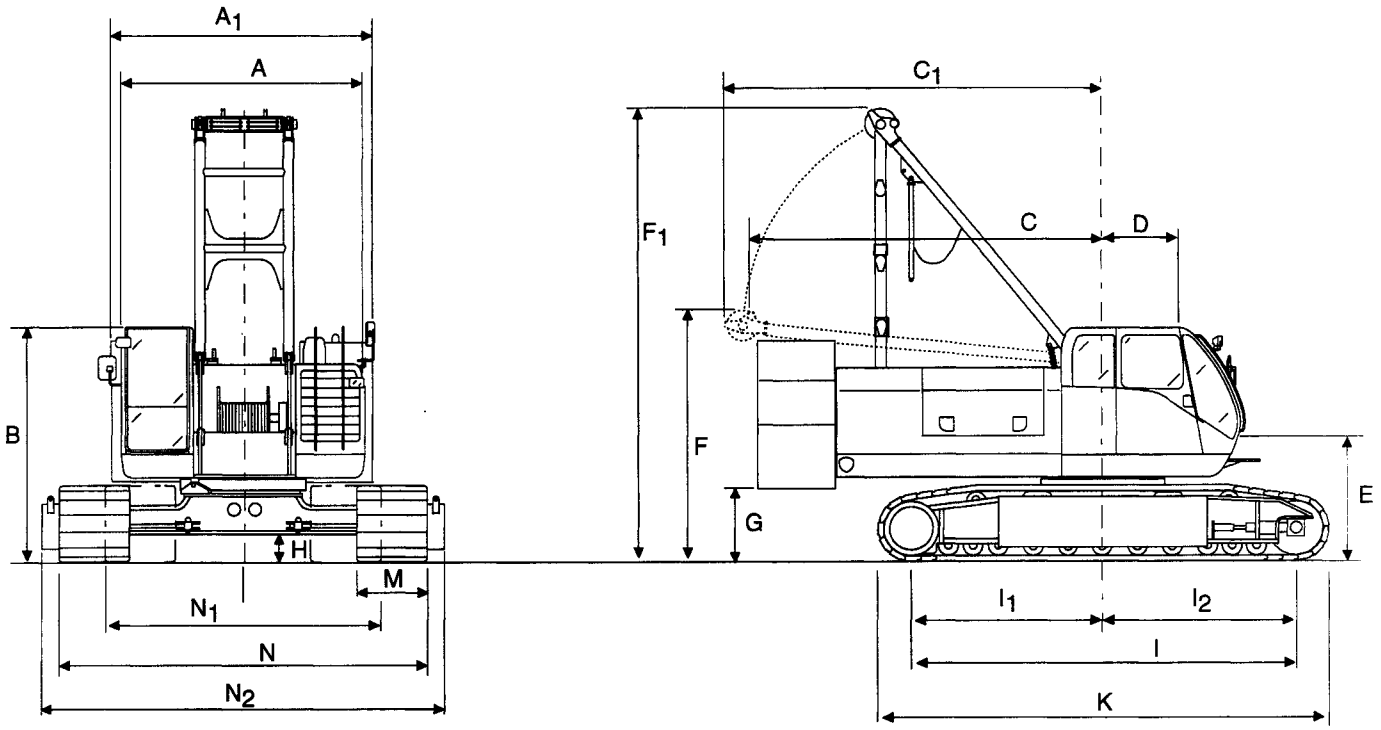
EXTERNAL DIMENSIONS OF MODEL HC 110 CRANE



		FT	MM
A	Width of machinery cab	11'-5/8"	3369
A_1	Width of counterweight	11'-9 3/4"	3423
B	Height over operator's cab	11'-0"	3353
C	Tail swing	16'-4 7/8"	5001
C_1	Center rotation to end of A-frame lowered	17'-5 7/8"	5331
D	Center rotation to boom foot	3'-7 1/4"	1100
E	Ground to center of boom foot	6'-4 1/2"	1943
F	Height over A-frame lowered	11'-5 5/8"	3496
F_1	Height over A-frame raised	21'-9 1/8"	6633
G	Ground to bottom of counterweight	3'-9"	1143
H	Minimum ground clearance	1'-5"	432

		FT	MM
I	Center to center of crawler tumblers	17'-11"	5461
I_1	Center of drive tumbler to center of rotation	8'-11 1/2"	2731
I_2	Center of idler tumbler to center of rotation	8'-11 1/2"	2731
K	Overall length of crawlers	20'-10 3/4"	6370
M	Width of tread shoe (standard)	36"	915
N	Overall width of crawlers, Shoes extended (Type A)	16'-2 5/8"	4943
	Overall width of crawlers, Shoes extended (Type B)	17'-1/2""	5195
N_1	Shoes retracted	11'-11 7/8"	3655
N2	Width over sideframe counterweights extended		
	Type A	17'-9 5/8"	5655
	Type B	18'-7 3/8"	5675

2. BASE MACHINE PERFORMANCE

1. Speed

Name	Speed		Remarks
	High Speed	Low Speed	
Swing	3.0 min^{-1} (3.0 RPM)		
Travel	✣ 0.87 MPH	✣ 0.6 MPH	
Main hoist	✣ 328/164 FPM	✣ 164/82 FPM	1st layer on drum
Auxiliary hoist	✣ 328/164 FPM	✣ 164/82 FPM	1st layer on drum
Boom	✣ 180 FPM		1st layer on drum

The values marked with " ✣" vary with load value.

2. Gradeability

30% (17°)	In base machine configuration

3. Drum winding capacity

Name	Drum groove rope dia. (mm)	Strength	Rope Length
Main hoist	Lebus type 1" (25.4)	89,800 Lbs.	
Auxiliary hoist	Lebus type 0.875" (22.2)	79,600 Lbs.	
Boom	Lebus type 0.75" (19.1)	51,200 Lbs.	

The rope winding capacity does not represent the usable rope length.

MACHINE BASE PERFORMANCE (Continued)

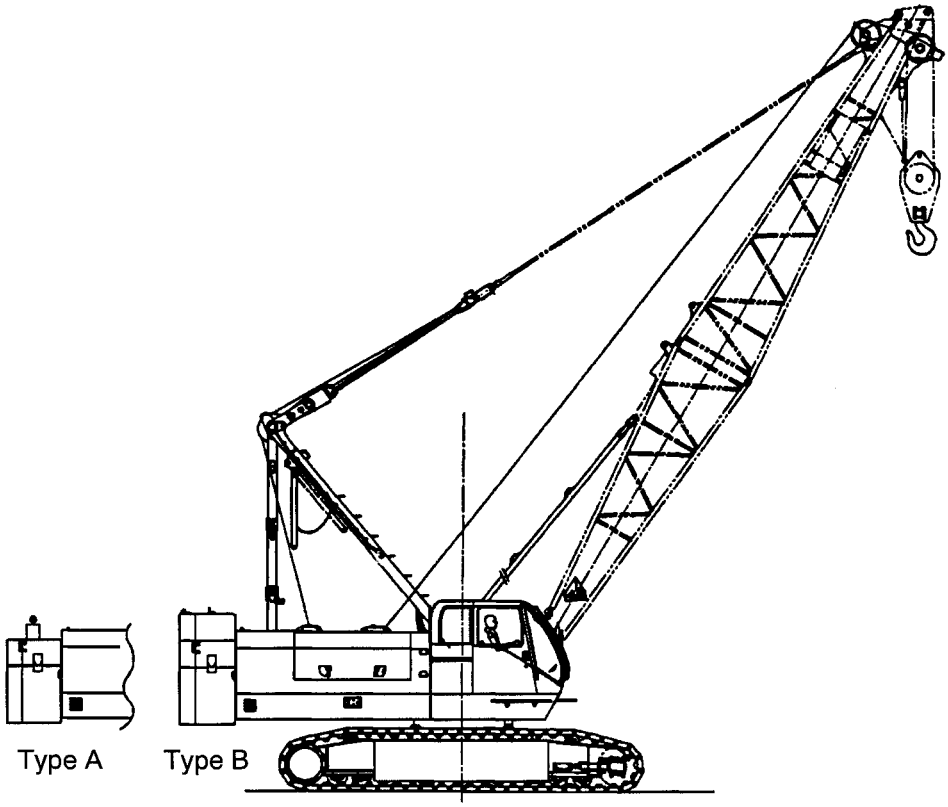
5. Engine

Maker	Cummins Engine Company, Inc.
Model	6CTA8.3-C230
Type	4-stroke water cooled vertical type, direct fuel injection
No. of cylinders - diameter x stroke	6 - 4.49" x 5.31"
Engine displacement	504 cu. in. (8268cc)
Compression ratio	16.5 : 1
Rated output	171.5 kW/2000 min $^{-1}$ (230 HP/2000 rpm)
Maximum torque	801 ft.-lbs./1500 min $^{-1}$
Fuel consumption ratio	Approx. 0.45 lbs/1500 min $^{-1}$
Minimum rpm with no load	950 ± 25 min $^{-1}$
Supercharger	Exhaust turbo charger & after cooler
Starter	24V - 8.6 kW motor
Air cleaner	Dry filter paper type
Generator	24V - 70A
Battery	24V - 150AH x 2 units
Engine oil capacity	H - 5.0 gal., L - 4.0 gal. (total amount 5.8 gal.)
Fuel tank capacity	105 gal. (400*l*)
Coolant capacity	8.0 gal. (engine alone: 3.2 gal., radiator alone 3.5 gal.)

6. Hydraulic oil capacity

Tank oil volume for reaching level mark	79 gal. (300*l*)
Total oil volume for reaching level mark	119 gal. (in entire hydraulic system)

3. STANDARD CRANE PERFORMANCE



Lifting capacity	Main hoisting	Max. lifting load x working radius	110 US tons at 12 ft. radius
Boom length	Boom	Basic (inner + outer)	50 ft.
		Maximum length	220 ft.
	Jib	Minimum to Maximum	
	Maximum combination of boom and jib		200 ft. + 60 ft.
Working range	Boom	Working radius	
	Jib	Working radius	
	Boom	Max. lifting height above ground (with 220 ft. boom)	
	Jib	Max. lifting height above ground (with 200 ft. + 60 ft.)	
	Boom	Boom angle	30° to 81°
Number of rope parts	Main hoisting	100t hook	2 to 10 parts of line
	Jib hoisting		1 part of line
	Boom hoisting		12 parts of line
Counterweight	Upper machine		44,100 lbs.
	Crawler parts		23,080 lbs.
Working weight	With main boom 50 ft. long		Type A 175,000 lbs.
			Type B 185,000 lbs.