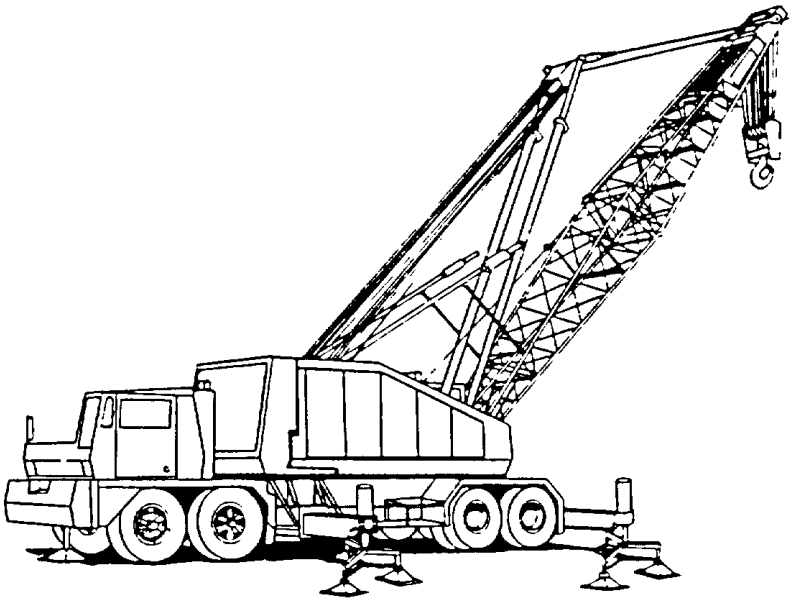
TECHNICAL MANUAL

FOR

CRANE, MOBILE, CONTAINER HANDLING, TRUCK-MOUNTED, 140-TON CAPACITY DED, FMC LINK BELT MODEL HC-238A, ARMY MODEL MHE 248, NSN 3950-01-110-9224



FMC CORPORATION
CABLE, CRANE AND EXCAVATION DIVISION

This copy is a reprint which includes current pages from Change 1.

HEADQUARTERS DEPARTMENT OF THE ARMY
15 JULY 1985

Change
No.1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C. *8 March 1987*

TECHNICAL MANUAL

CRANE, MOBILE, CONTAINER HANDLING, TRUCK-MOUNTED, 140-TON CAPACITY DED, FMC LINK BELT MODEL HC-238A, ARMY MODEL MHE 248, NSN 3950-01-110-9224

TM 10-3950-263-14&P-1, 15 July 1985, is changed as Follows:

1. Remove old pages and insert new pages as indicated below.
2. New or changed material is indicated by vertical bar in the margin of the page.
3. Added or revised illustrations are indicated by a vertical bar adjacent to the illustration identification number.

REMOVE PAGES	INSERT PAGES
5-1 and 5-2	5-1 and 5-2

4. File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

R.L. DILWORTH
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25F, Operator, Organizational, Direct Support and General Support Maintenance requirements for Crane, Container Handling, 140 Ton Capacity, Mobile, Truck Mounted, Model MHE 248.

TECHNICAL MANUAL
No. 10-3950-263-14&P-1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC., 15 July 1985

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS) FOR

CRANE, MOBILE, CONTAINER HANDLING, TRUCK MOUNTED, 140-TON CAPACITY, DED, FMC MODEL HC 283A, ARMY MODEL MHE 248, NSN 3950-01-110-9224

REPORTING OF ERRORS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, U.S. Army Tank-Automotive Command, ATTN: AMSTA-MB, Warren, MI 48397-5000. A reply will be furnished direct to you.

TM 10-3950-263-14 & P-1	Operator's Manual
TM 10-3950-263-14 & P-2	Service Manual (Maintenance Instructions)
TM 10-3950-263-14 & P-3	Parts Manual

NOTE

This manual is published to provide an authorized commercial manual for the use of the personnel to whom this Crane is issued.

Crane Manufacturer: FMC Corporation
Cable, Crane and Excavator Division

This technical manual is an authentication of the manufacturers commercial literature and does not conform with the format and content specified in AR 310-3, Military Publications. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

Operator's Manual

P. 1-12

WARNING
Always Stand In Clear View Of The Jack Or Beam Being Operated. Make Sure Nothing Is In The Way When Operating A Jack Or Beam To Avoid Injury Or Damage.

P. 1-16

WARNING
Handle With Care. The Starting Fluid Is Toxic, And Flammable.

P 1-21

WARNING
Always Disengage The Master Clutch When Leaving The Operator's Seat For Any Reason, Or When Working On The Machine. Failure To Disengage Master Clutch May Result In Accident.

P 1-32

WARNING
Trying To Lift The Machine With Damaged Components In The Lifting Sling Can Cause An Accident. A Very Heavy Load Is Being Lifted. If It Falls, The Machine Will Be Damaged. Personnel Nearby May Be Injured Or Killed.

P 1-33

WARNING
Before Lifting Crane, Inspect Lifting Sling Again. Make Sure Everything Is Assembled Right. Make Sure All Pins Have Keepers. Don't Let Anyone Near The Machine While It Is Being Lifted.

P 2-1

WARNING
Be Careful Not To Get Burned On Hot Oil When Draining Gear Cases.

Warnings

P 2-1, 2-6

WARNING
Be Careful Not To Get Battery Electrolyte On Your Skin, Or Clothing, Or Especially In Your Eyes. It Is Acid And Can Cause Injury. Don't Smoke Or Use Open Flame Near A Battery. Battery Gas Is Explosive.

P. 2-10

WARNING
Moving Machinery. Do Not Service, Maintain, Or Lubricate Unless Master Clutch Is Disengaged And Rotation Machinery Has Stopped Or Severe Personal Injury May Result.

P 2-15, 2-23, 2-25, 2-26

WARNING
Use Fuel Oil Or Cleaning Solvent In A Well Ventilated Area, Away From Flames.

P 2-17, 2-18, 2-25, 2-26

WARNING
Warn Personnel In The Immediate Area Before Using Compressed Air For Cleaning. Wear Safety Glasses. Compressed Air, Coming Into Contact With The Human Skin Or Causing Flying Metal Chips Can Cause Injury.

P 2-23

WARNING
Do Not Hold The Compressor Wheel, For Any Reason, While The Engine Is Running. This Could Result In Personal Injury.

P 2-27

WARNING
Hot Oil Can Cause Severe Burns. Be Careful When Draining The Oil.

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P 2-36

WARNING
Use Extreme Care When Removing A Radiator Pressure Control Cap From An Engine. The Sudden Release Of Pressure From A Heated Cooling System Can Result In Loss Of Coolant And Possible Personal Injury (Scalding) From The Hot Liquid.

P 4-2

WARNING
Anchor The Upper Machinery Against Rotation By Lowering The Attachment To The Ground Before Working On The Swing Lock.

P 5-6

WARNING
Don't Get Under Any Part Of The Boom, Especially When Boom Sections Are Being Raised, Lowered, Or Positioned.

P 5-9

WARNING
Do Not Get Under Any Part Of Boom, Especially While Boom Sections Are Being Raised, Lowered, Or Positioned

P 5-12

WARNING
Incorrect Disassembly Of A Pin Connected Boom May Result In Machine Damage, Personal Injury, Or Even Death. Before Disassembling Boom, Read And Be Sure You Understand Fig. 5-19, And The Disassembly Procedure On The Following Pages. As An Alternate Disassembly Procedure, Block Tightly Under The Pin Connection Before Removing Pins. Never Stand Under A Boom When Removing Pins.

P 5-18

WARNING
The Hammer And Block Method Requires Being Near Moving Machinery. Perform This Operation Slowly And Cautiously. The Operator And Workers Must Be Fully Informed Of The Procedures To Avoid Pinching Tools Or Body Parts In The Machine. Do Not Use Your Hands To Guide The Wire Rope At The Drum, Or Sheaves, Or Entanglement May Result.

P 5-23

WARNING
Warn Personnel In The Immediate Area Before Using Compressed Air For Cleaning. Wear Safety Glasses. Compressed Air, Coming Into Contact With The Human Skin Or Causing Flying Metal Chips Can Cause Injury.

P 6-2

WARNING
Engine Exhaust Gas (Carbon Monoxide) Is Deadly! Carbon Monoxide Is An Odorless, Colorless Gas Formed By Incomplete Combustion Of Hydrocarbon Fuels. Carbon Monoxide Is A Dangerous Gas That Can Cause Unconsciousness And Is Potentially Lethal. Some Of The Symptoms Or Signs Of Carbon Monoxide Inhalation Are:

Dizziness	**Vomiting**
Intense Headache	**Muscular Twitching**
Weakness and Sleepiness	**Throbbing In Temples**

The Best Protection Against Carbon Monoxide Inhalation Is A Regular Inspection Of The Complete Exhaust System. If You Notice A Change In The Sound Or Appearance Of Exhaust System, Shut The Unit Down Immediately And Have It Inspected And Repaired At Once By A Competent Mechanic.

P 6-4

WARNING
Do Not Smoke While Servicing Batteries. Explosive Gases Are Emitted From Batteries In Operation. Ignition Of These Gases Can Cause Severe Personal Injury.

b

P 6-7

WARNING
Before Commencing Any Maintenance Work On The Engine, Generator, Control Panel, Automatic Transfer Switch Or Associated Wiring, Disconnect Batteries. Failure To Do So Could Result In Damage To The Unit Or Serious Personal Injury In The Event Of Inadvertent Starting.

P 6-9

WARNING
Do Not Remove Dipstick With Engine Running. Oil Will Blow Out Causing Possible Injury.

P 6-10

WARNING
Do Not Use Ether Starting Aids. Ether Is Extremely Explosive And May Cause Personal Injury. Engine Damage Is Also Possible.

P 7-1

WARNING
Use Fuel Oil Or Cleaning Solvent In A Well Ventilated Area, Away From Flames.

P 7-2

WARNING
Reduce S-o-M System Pressure To Zero As Explained In Steps A And B Before Unscrewing The Relief Valve Cap, Or Before Removing The Pipe Plug From The Unloading Valve. Pieces Of The Valve May Explode Under Pressure Otherwise And Could Cause Injury.

P 10-1

CAUTION
This System Is Designed To Function With Crane Power From 10 Volts DC To 14 Volts DC. Voltages Outside Of These Limits Will Cause Erroneous Readings Or Damage To The System. The System Must Be Connected With Black Wire To Positive And White Wire To Negative Crane Power Supply.

P 10-3

WARNING
The Overload Warning System Is Not Fail Safe, It Can Malfunction. Do Not Depend Upon This System To Do The Operator's Job. The Operator MUST Use The Information On The Metal Capacity Plate Located In The Upper Cab, And Operate The Crane Within The-Guidelines Spelled Out In Paragraph 1-81 "Crane Operation" In The Operator's Manual.

P 10-5

CAUTION
Always Turn The Power Switch On The Display Assembly "OFF" Before Connecting Or Disconnecting A Cable Assembly Or Component. Otherwise A Power Surge Or Damage To The System Can Occur.

P 2-6, 2-15, 2-16, 2-17, A-61, A-66

WARNING
Do not service, maintain, or lubricate open gears, chain case, planetary speed reducer, swing bevel gear case, reduction shaft pinion case, gear cases, gears, drive chains or chain case unless engine is shut down and swing lock is engaged.

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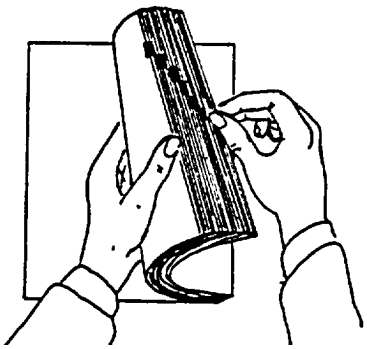
HC238A

Operator's Manual Quick Reference System

How To Use This Manual

The manual is divided into twelve major sections as shown above. Each section can be located with the tabs on the right hand edge of the page as shown in this picture. The first page of each section is an index of the subjects covered in that section. An alphabetical index of the whole book is in Section 11.

Tab Index



Operator's Manual List Of Illustrations R783

Operator's Manual List Of Illustrations R783

Warranty

Standard Warranty Cable Cranes

FMC CORPORATION, CABLE CRANE & EXCAVATOR DIVISION is hereinafter called the COMPANY.

The products manufactured by the COMPANY, exclusive of used or re-built machinery or equipment, are subject to the following warranty:

(A) Warranty.

"ALL of COMPANY's products are of high quality and are manufactured in conformity with the best commercial practices in the various lines. The COMPANY warrants all products manufactured by it to be free from defects in material and manufacture at the time of shipment for six (6) months from date of shipment or 1000 hours of operation, whichever shall occur first. The COMPANY will furnish without charge, f.o.b. its factory, replacements for such parts as the COMPANY finds to have been defective at the time of shipment, or at the COMPANY's option, will make or authorize repairs to such parts, provided that, upon request, such parts are returned, transportation prepaid, to the factory from which they were shipped.

"This warranty shall not apply to any product which has been subjected to misuse; misapplication; neglect (including but not limited to improper maintenance); accident; improper installation, modification (including but not limited to use of unauthorized parts or attachments), adjustments, or repair. Engines, motors, and any accessories furnished with the COMPANY's products, but which are not manufactured by the COMPANY, are not warranted by the COMPANY but are sold only with the express warranty, if any, of the manufacturers thereof. THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED (INCLUDING THOSE OF MERCHANTABILITY AND FITNESS OF ANY PRODUCT FOR A PARTICULAR PURPOSE), AND OF ANY OTHER OBLIGATION OR LIABILITY ON THE PART OF THE COMPANY.

(B) Limitation of Liability.

"It is expressly understood that the COMPANY's liability for its products, whether due to breach of warranty, negligence, strict liability, or otherwise, is limited to the furnishing of such replacement parts, and the COMPANY will not be liable for any other injury, loss, damage, or expense, whether direct or consequential, including but not limited to loss of use, income, profit, or production, or increased cost of operation, or spoilage of or damage to material, arising in connection with the sale, installation, use of, inability to use, or the repair or replacement of, the COMPANY's products.

The COMPANY reserves the right to make alterations or modifications in their equipment at any time, which, in their opinion, may improve the performance and efficiency of the machine. They shall not be obliged to make such alterations or modifications to machines already in service.

Any operation beyond rated capacity expressly prohibited in the operating instructions or safety manual furnished with the machine, or any adjustment, or assembly procedures not recommended or authorized in the operating or service instructions shall void such warranty.

Special Provisions

The standard machine warranty is modified by special provisions in solicitation DAAE07-80-B-5230.

J07 EQUIPMENT WARRANTY

J.7.1 Definitions

Acceptance. The word "acceptance" as used herein means the execution of the Acceptance Block and signing of a DD Form 250 by the authorized Government representative.

Supplies. The word "supplies" as used herein means the end item and all parts and accessories thereof, furnished by the contractor, and any related services required under this contract. The word does not include technical data.

J.7.2 Warranty. Notwithstanding inspection and acceptance by the Government of the supplies furnished under the contract or any provision of this contract concerning the conclusiveness thereof, the contractor hereby warrants that the supplies are free from defects in design, material, and workmanship and will conform with the specifications and all other requirements of this contract for a period of 15 months from date of acceptance, as shown on the Material Inspection and Receiving Report (DD Form 250), or 1500 hours of operation, whichever occurs first. Equipment designated as Production Samples shall be treated as equipment delivered

Warranty

at the time as the production units. If a Safety Recall defect occurs during equipment warranty period, the contractor agrees to extend the term of the warranty by the period of time equal to the time period required to make necessary safety defect corrections. Additionally, to the extent of the contractor or his supplier(s) provide to commercial customers a greater warranty for the supplies furnished therein, the contractor hereby likewise provides such greater warranty to the Government. To the extent the terms of such greater warranty are inconsistent with or conflict with this warranty, the provisions of this warranty shall govern.

J.7.3 Remedies.

J.7.3.1 New Replacement Supplies. With respect to defective supplies, wherever located, the warranty shall include the furnishing, without cost to the Government, F.O.B. contractor's plant, branch or dealer facility, or F.O.B. original CONUS destination, or F.O.B. US Port of Embarkation, at the Government's option, new supplies to replace any that prove to be defective within the warranty period.

J.7.3.2 Corrective Action Options. In addition, the Government shall have the option (a) to return the equipment or parts thereof to the contractor's plant, branch or dealer facility for correction, or (b) to correct the supplies itself. When the Government elects to return the equipment or parts to the contractor's plant, branch or dealer facility, the cost of labor involved in the correction of the defective supplies shall be borne by the contractor. When the equipment or parts thereof are returned to the contractor for correction, the contractor shall bear all transportation costs to the contractor's plant and return. With respect to defective supplies, when the Government elects to correct them itself, the cost of labor involved in the correction of defects shall be borne by the Government. If the Government requires the assistance of Contractor personnel in disassembly/reassembly of items removed in connection with repair or replacement of defective parts, the Contractor will be reimbursed for labor at a rate to be negotiated between the Contracting Officer and the Contractor at the time of repairs.

J.7.3.3 Notification. If the Government elects to have warranty repair or replacement performed by the contractor, the Government shall deliver the parts or equipment to contractor's local facility or dealership for warranty corrective repair or replacement. If the Government elects to effect warranty repairs or replacement itself, the contractor shall be notified in writing of repairs required under the warranty within 30 days after discovery of the defect. Within 10 days after receipt of such notices, the contractor shall submit to the Contracting Officer a written recommendation as to the corrective action required to remedy the defect. In any event, the Contracting Officer may, upon the expiration of the 10 day period set forth above, proceed with correction or replacement as set forth in the paragraph, Remedies, above, and the contractor shall, notwithstanding any disagreement regarding the existence of a breach of warranty, comply with the Contracting Officer directions related to such correction or replacement. After the notice, but not later than 30 days after receipt of the contractor's recommendation for corrective action.

The Contracting Officer will, in writing, notify the contractor of the parts used by the Government in repair or replacement and all other costs or expenses required for Government correction of warranty defect as set forth in the paragraph, Remedies, above. The contractor shall respond within 30 days after receipt of this notice, of his intention to furnish identified replacement parts and/or cost reimbursements to the Government. In the event it is later determined that the contractor did not breach the warranty in paragraph, Warranties, above, the contract price will be equitably adjusted pursuant to the terms of the "Changes" clause of the contract. Failure to agree to such an equitable adjustment or upon any determination to be made under this clause shall be a dispute concerning a question of fact within the meaning of the "Disputes" clause of this contract.

The Contractor shall furnish with his proposal a listing of distributors, dealers, and franchise outlets where warranty claims may be exercised.

J,7.4 Decalcomania. A synopsis or simplified summary of the warranty coverage and its implementation will be printed on a decalcomania approximately 3" x 4" and shall be mounted in view of the operator as near as possible to the center of the instrument panel of each vehicle. On those vehicles requiring concealed markings and registration numbers said decalcomania shall be placed in a readable position on the engine side of the firewall.

J.7.5 Rights. The rights and remedies of the Government provided in this clause are in addition to and do not limit any rights afforded to the Government by any other clause in the contract.

Exceptions To Warranty

The following supplies are not covered under the 1500 hour or 15 month warranty: (1) Tires (2) Batteries (3) Light Bulbs (4) Windshield wipers (5) Electrical Wires (6) Lubricants (7) Filters.

Warranty

Preparation Of Warranty Claims

(1) Use warranty claim no. 531 for all claims over $25. These forms are available at no charge from the factory.
(2) Claims less than $25.00 will not be processed.
(3) Campaigns - A $25.00 minimum will be paid on all claims identified as a campaign and listing the campaign only on the individual warranty claim.
(4) Delivery and applicable follow-up reports must be on file before warranty consideration will be given.
(5) Warranty Claim must be typed and mailed to the manufacturing division where the particular machine was manufactured no later than 45 days after work is completed. Do not type on the reverse side of the warranty claim form. If additional space is required on the warranty claim form, attach an additional sheet.
(6) The upper right hand corner of the claim must be completely and correctly filled out. Information about description of the job must also be furnished.
(7) Under Section 1 and 2 of the warranty claim, explanation must be given covering problem as diagnosed and corrective action taken. The statement "installed or replaced" will not be accepted as a satisfactory explanation of the diagnosis of problem and corrective action taken. Neither will the statement making reference to a previous report be accepted in lieu of information correctly filled out explaining the problem and correct action taken.
(8) Section 3 entitled "Name of Part(s) That Failed or Caused Failure" must be completely filled out to enable the factory to determine disposition of defective parts. The serial number of the replacement part is also required to ensure future warranty of the part replaced.
(9) Section 4 of the claim entitled "Other" is reserved to list things not provided for elsewhere on the form. Examples: A freight bill, outside purchase of parts, outside labor for machine shop, etc. A copy of the paid invoice must accompany each claim.
(10) Section 5 is to list item number of part, description of part, quantity of part, invoice number and cost covering parts claimed.
(11) If part or parts were supplied from your "stock", type the word "stock" in the invoice section provided in Area 5.
(12) If parts were ordered where a 5 or 10% added cost was assessed for emergency shipment, a copy of the invoice must be attached.
(13) If a large group of parts were ordered from the factory for warranty repair, a legible copy of the FMC invoice attached in lieu of filling out Section 5 if preferred.
(14) If an incorrect FMC part number is listed or a part claimed that cannot be identified, it will be eliminated from the claim and will not appear on the credit memo.
(15) Section 6 and 8 are reserved for factory use only. Do not enter any information in these areas.
(16) Section 7 under labor, type hours only.

Returning Defective Or Failed Parts To The Manufacturing Division

(1) Do not send defective parts to the factory. Hold all defective parts until information is received as to their disposition. If and when the parts are needed by the manufacturing division, the manufacturing division will forward instructions wither verbally or in writing and/or both. In all cases an A.T.R. number (Authorization to Return and Authorization to Receive) will be assigned with shipping instructions.

A.T.R. 87 - - - is used by the Bowling Green plant.
FMC Corporation
Crane & Excavator Division
U.S. 31. W. South
Bowling Green, Kentucky 42101

The Receiving Departments have orders not to accept any shipment of warranty parts without an A.T.R. number clearly displayed on all parts, shipping cartons, tags, bills of lading and other papers required by transportation companies.

If the part to be returned is a large item that cannot be crated (Example: boom sections, large hydraulic cylinders, frames, counterweights, etc.) it will be necessary to have the A.T.R. number legibly marked or painted with some waterproof marking device. If it is a part that is apt to be rolled over, it is required that the number be marked on two or more sides of the component.
(2) Parts must be returned in clean condition. Hydraulic parts must be sealed to prevent contamination. Any parts received without covering port plugs, etc., will not be inspected or forwarded to the vendor as vendors refuse any warranty consideration of hydraulic components not properly protected.
(3) Shipping of parts for more than one claim in one shipment is discouraged. However, if for some reason or other, this must be done than each individual part must be identified by item number, claim number and A.T.R. number.

Warranty

Submitting Of Warranty Claims

(a) Prepare claim as outlined under "PREPARATION OF WARRANTY CLAIMS".
(b) Distribute copies as follows:

Copy #1 White	(	Forward copies to the Manufacturing Division
Copy #2 Yellow	(	responsible for the model involved. For your
Copy #3 White	(	assistance we are listing below the mailing
Copy #4 Pink	(	address of each of the models manufactured.
Copy #5 Green	(	
Copy #6 Blue	(	Government copy. Copy should be retained for your records.

(c) You will be advised on the disposition of any alleged defective parts.
(d) Approximate time for processing claims that are within the time frame of normal warranty will fall in the following categories:
  (1) If material is not required for inspection, the claim will be accepted or rejected within 45 days of receipt of the #3 copy. The Government will assume the responsibility for destroying and scrapping related parts under the direction of the Warranty Supervisor.
  (2) If material is required for inspection, the claim will be accepted and credit issued within 45 days of receipt of the part or parts at the factory or a designated location. If inspection reveals the part or parts were not defective, the factory will re-invoice the Government to cancel the credit previously issued.
  (3) Government will be notified by phone followed by confirming letter with shipping instructions for alleged defective parts. If parts not received within 3 days a follow-up letter will be sent to distributor. If parts not received within 30 days after follow-up letter mailed, warranty claim will be cancelled.
  (4) A disputed warranty settlement must be presented in writing to Construction Equipment Distribution Operation, 2800 Lakeside Drive, Bannockburn, Illinois 60015, Attention: Service Department, no later than 45 days after the warranty claim status report is dated.

  If the Government does not reply to FMC within the 45 day time frame, the warranty claim will not be opened to any further discussion at a later date.

Listed below are the mailing addresses and models for the Manufacturing Division. Direct claims to the attention of the Warranty Departments.

FMC Corporation
Crane and Excavator Division
Box 9500
Bowling Green, Kentucky 42101

Campaign Procedures (Safety Recall)

A. Labor compensation for announced factory modification and retrofits implemented by CCED.
  (1) FMC will compensate the Government 100% of its charge out rate which must be on record with the company at the time the claim is received, for performance of work related to the campaign.
    (a) If FMC has established the work time required to effect the campaign, only the time so established will be recognized in establishing the amount of the claim.
    (b) If FMC has not established the hours required to effect the campaign, the company will accept actual documented time expended by the distributor, provided the time is reasonable and can be substantiated.
B. Travel Time - Per Diem
  (1) FMC will compensate the Government at 100% of their charge out rate, on record with the company, for actual travel time expended in the performance of campaign work up to a maximum of eight hours.
  (2) The standard 10% add-on clause, as found in the warranty labor program, will not apply to computing the credit amount on the warranty claim.
  (3) In addition to travel time, a reasonable per diem will be allowed for living expenses. Per diem receipts must accompany claim.

Warranty

C. Overtime

(1) Overtime charges will not be accepted, unless agreed to by the company prior to the performance of the work.

D. Limits of FMC Responsibility

(1) FMC reserves the right to make alterations or modifications in their equipment at any time which in their opinion may improve the performance and efficiency of the machine. FMC shall not be obligated to make such alterations or modifications to machines already in service
(2) FMC will not be under obligation to credit the Government with the price of the new part or to reimburse the Government for the labor cost for repairing or replacing defective part unless, within thirty (30) days of the date of the campaign work performed, the Government submits a typewritten claim listing parts used and the FMC allotted time provided in the campaign letter, or if FMC has not established the time, satisfactory proof of the time reasonably expended in repairing or replacing the defective part.
(3) FMC will issue a minimum of $25.00 per claim.
(4) Claims which cover campaign work performed on more than one machine will not be accepted.
(5) The work must be completed within the time frame stated in the campaign agreement and campaign instructions. If campaign work is not completed within the stated time frame, FMC assumes no responsibility for any damage that might be incurred due to delay of campaign completion.

E. Requirements for Qualification

(1) The Government will utilize only qualified personnel in the performance of campaign work. These personnel must have attended an authorized factory school on the particular product line within the past 18 months.
(2) The Government must maintain properly equipped service vehicles and shop facilities as dictated by general industry standards.
(3) The Government must have any specialized material, equipment, and tools, required by general industry standards.
(4) The Government must maintain a current and updated service library; including service manuals, bulletins, policy handbook, parts books, and/or microfilm.

VOLUME ONE

OPERATION AND MAINTENANCE

**(Service Manual Is contained In Volume Two;
Repair Pars is contained In Volume Three)**

TABLE OF CONTENTS

OPERATOR'S MANUAL

SECTION 0 - OPERATING SAFETY

General

Read this every day - someone's life may depend on it, maybe your own.

When a crane or excavator is maintained and used properly, it can be a safe, highly useful piece of equipment, but as with many commonly used things such as a lawn mower, a motor boat, or even a kitchen knife, if not used properly it can be dangerous.

Think safety. You, the operator, are in charge of an important piece of equipment. It is very important that you know what it can do. It is also important that you know what it should not do. No set of instructions can anticipate all of the situations you will run into. The rules given here cover general usage, and some of the more specific cases. If conditions arise not covered by these rules, consult the manufacturer. A phone call may save someone's life.

Index

This section is intended to cover operating practices on both hydraulic and non-hydraulic machines. Correct operating practices for both types are similar, but different problems will arise on each type of machine. For this reason, there is a paragraph in this section on hydraulic/machine safety. The other sections, for the most part, apply to both types of machines.

Reference Material

Additional material on safe operation is available from several sources. FMC strongly recommends that crane/excavator users obtain this information:

1 SAE - Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pa. 15096, publishes a list called "Safety Considerations For The Operator", SAE J153, in their "Recommended Practices Manual".

2 **PCSA (Power Crane and Shovel Association Construction Industry Manufacturers Association), 111 E. Wisconsin Avenue, Milwaukee, Wisc. 53202, standard No. 1, "Mobile Power Crane and Excavator Standards", contains a section on safety. Safety booklets on crane and excavator operating safety are also available from PCSA.**

3 The Department of Labor, occupational Safety and Health Administration, publishes safety and health regulations and standards under authority of the Occupational Safety and Health Act (OSHA). Its address is "Occupational Safety and Health Administration, U.S. Dept. of Labor, Washington, D.C., 20210.

4 American National Standards Institute, (ANSI) C/O The American Society Of Mechanical Engineers, United Engineering

Center, 345 East 47th Street, New York, N.Y. 10017 includes standards for safe operation, inspection, and maintenance in their ANSI B30.5 - 1968 and B30.15 - 1973.

General Safety Rules

1 **Read the operator's manual and heed it.** The manual contains Important Information.

2 **Whenever an operator leaves the control station for any reason, the following must be done:**
- **a** Lower the bucket, grapple, load, etc. to the ground.
- **b** Engage the swing lock. Disengage the master clutch. Shut off the engine. Engage the park brake (tire mounted) or travel brakes (crawler mounted).
- **c** Never depend upon a brake to suspend a load unless the operator is at the controls, alert and ready to handle the load. Brake slippage, vandalism, mechanical malfunctions, could cause the load to drop if left in the air unattended.

Note: The brake pedal locks are intended to allow the operator to rest his legs when suspending a load for a short period of time, but the operator must remain in his seat with his feet on the pedals. Failure to follow these instructions could lead to an accident.

3 **An operator must not eat, read, or otherwise divert his attention while operating a machine.** Remember - operating is a full time job.

4 **Don't allow crane loads, bucket, grapple, etc. to pass over people, or endanger their safety.** Remove all loose objects from load. All non-operating personnel should leave the immediate area when machine is operating.

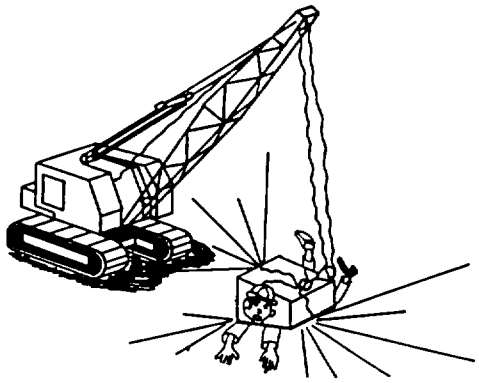


Fig. 1

Never leave a load in the air. It may fall.

Fig. 2

Don't let anyone hitch a ride.

5 **Don't let anyone ride the hook block, bucket, grapple, etc.** These machines are intended to lift objects - not people. They are not elevators.

6 **Be sure your work area is clear.** Make sure you have proper clearance for machine boom or load, Don't swing, travel, hoist, or lower load, raise or lower boom, extend or retract outrigger beams, raise or lower jacks, without first making sure no one is in the way. If your vision is obscured, locate a signal man so you can see him, and he can see all areas you can't. Follow his signals. Be sure you and the signal man understand each others signals. (See hand signal chart on back cover). Use the horn to signal or warn. Make sure everyone on the job understands signals before starting work.

Fig. 3

Watch your clearances

7 **Inspect the machine daily. Don't operate a damaged or poorly maintained machine.** Pay particular attention to the clutches, brakes, attachment, and wire ropes. If a component is worn or damaged, replace it before operating. Remember - parts are cheaper than people.

Be sure clutch and brake surfaces are clean and dry. A small amount of clutch or brake slippage may dry out wet linings. Avoid excessive heating; it shortens lining life. If oil or grease gets on linings, clean them immediately with a nonflammable, low toxicity solvent. If linings are saturated, replace them.

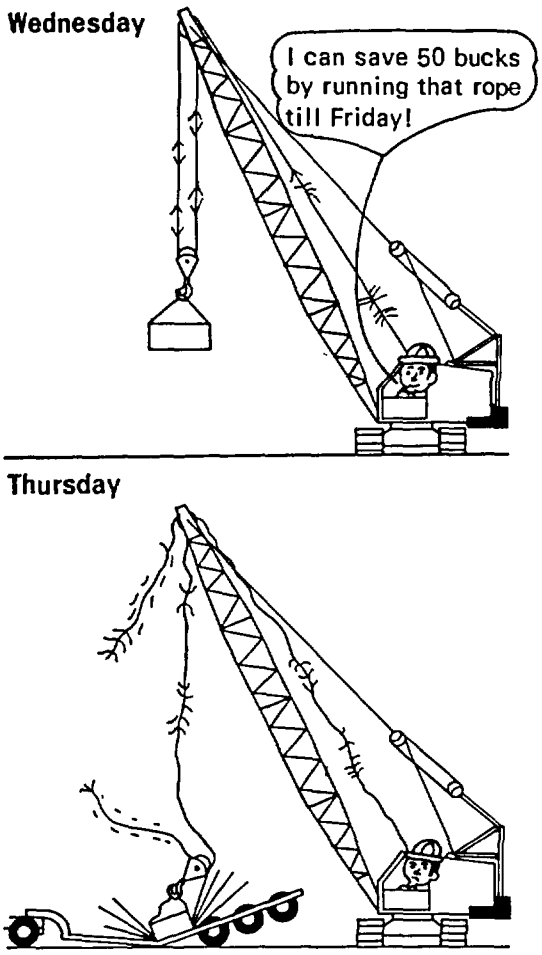


Fig. 4

Don't work with worn or damaged rope.

OSHA (Occupational Safety And Health Act) regulations state, "a thorough inspection of all ropes shall be made once

a month and a full written, dated and signed report of rope condition kept on file where readily available". Replace any worn or damaged rope. Pay particular attention to boom hoist ropes and pendants. Check end connections (pins, sockets, wedges, etc.) for wear or damage.

8 **Don't let the load or bucket hit the boom. Don't let the boom rest on or hit against a building or any other object.** A dented

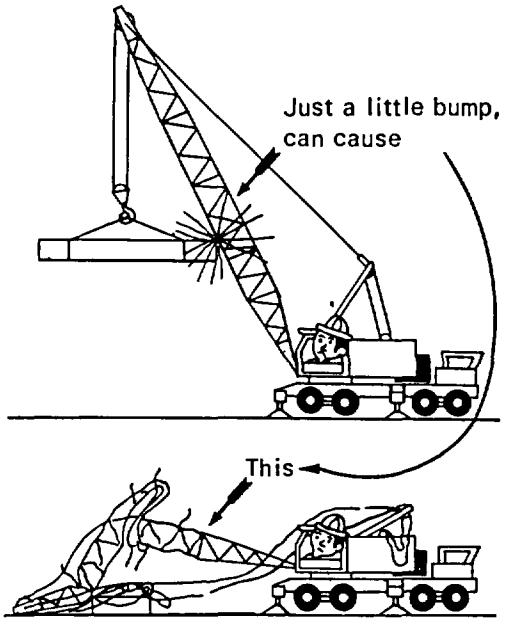


Fig. 5

Don't let the load hit the boom.

or damaged boom may result, which will weaken the boom. If the damage is severe, the boom may collapse. If a lattice or diagonal bracing member is broken or cracked, replace it. If bent, straighten it. Important - Detailed information on boom repair is available from your distributor. Some of the steel used in booms is a special type which can be ruined by wrong repair procedures. If a chord is damaged or bent, even a small amount, Don't Use It. Don't try to repair it. Chords are so vital to the strength of the boom that it is not practical to attempt repairs.

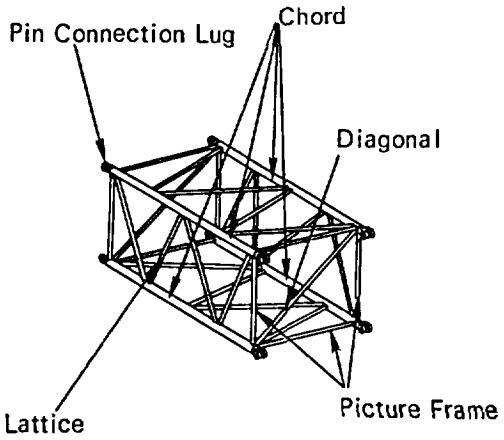


Fig. 6

Boom extension nomenclature.

If the boom, mast, gantry, etc. are struck or damaged, by anything, stop. The loading on a boom increases as the boom is lowered; therefore a damaged boom or boom suspension system may collapse during lowering. Use a helper crane to assist in lowering a damaged boom.

9 **Be sure the boom hoist pawl is always engaged except when lowering the boom.** Don't rely on the boom hoist brake alone to hold the boom. Wear, improper adjustment, water or oil on linings, and other factors may reduce the ability of the

brake to hold the boom.

10 **Always replace protective guards and panels before operating machine.**

11 **Always wear hard hats, safety glasses, steel toe shoes, and any other safety equipment required by local or job conditions on regulations.**

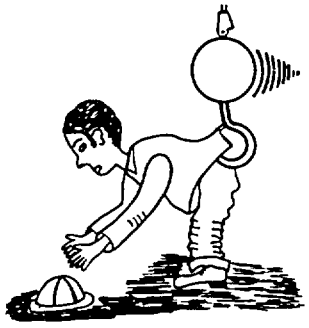


Fig. 7

Dress properly on the job.

12 **Never get on or off a machine In motion**. Use both hands when climbing onto a machine. If a ladder is provided, use it. Be careful when walking on track shoes. They may be slippery and cause a fall.

13 **Keep your machine clean, In good repair, and in proper adjustment.** Oil or grease on the decks may cause falls. Improper adjustments can lead to machine damage, load dropping, or other malfunction.

14 **Keep a dry chemical or carbon dioxide fire extinguisher of 5BC rating or larger In the cab or In the Immediate vicinity of the machine at all times.** Instruct all operating and maintenance personnel in proper use of the extinguisher. Check periodically to make sure It is fully charged and is in working order.

15 **Never tamper with safety devices.** Keep them in good repair and properly adjusted. They were put on the machine for your protection.

16 **Don't smoke when fueling, or fuel up near an open flame.** Keep the nozzle in contact with the filler neck to prevent static electric sparks. Shut off the engine when fueling.

17 **Before performing repairs or adjustments, lower attachment to the ground, or onto blocking.** Be sure of safe footing before standing or walking on boom or jib. Use a ladder, planking or lift platform to prevent falls. On truck mounted machines, lower machine off the outriggers. If this is not possible, block securely under the outrigger beams. Lock the starter, or remove battery cables so machine can't be started. Remove ignition key. Post warning signs in cab so no one will try to start the engine.

18 **Always reduce pressure in hydraulic system to zero before working on any part of the system.** Work control levers back and forth with engine shut down to reduce the pressure to zero.

19 **Keep fingers, feet, and clothing away from sheaves, drums, and ropes unless the machine is shut down and everyone knows what you are doing.** Never place a hand on lines when climbing to the top of the machine. A sudden movement may pull them into the drum or sheaves.

20 **When checking battery level, use a flash light - not an open flame.** Battery gas is explosive. If the battery explodes you may get acid in your eyes, which may cause blindness. Don't check battery

charge by shorting across posts. The resulting spark could cause the battery to explode. Check with a tester or hydrometer. Don't smoke near batteries, especially when they are being charged.

Fig. 8

Never use an open flame to check a battery.

When using jumper cables to start an engine be sure to connect negative post to negative post, and positive post to positive post. Always connect the two positive posts together first, and the two negative posts last to prevent a spark when the cables are connected. This spark could cause the battery to explode.

21 **When working Inside a building, check clearance to avoid a collision.** Check load limits on floors or ramps so you won't crash through. Always check work areas for dangerous features. Don't operate close to an overhang or deep ditch. Avoid caving edges, falling rocks, slides, etc. Never park machine where a bank can fall on It, or it can fall In an excavation. Don't park where rain can wash out footings.

22 **Pinch points, which result from relative motion between mechanical parts can cause Injury. Keep clear of rotating upper or moving parts.**

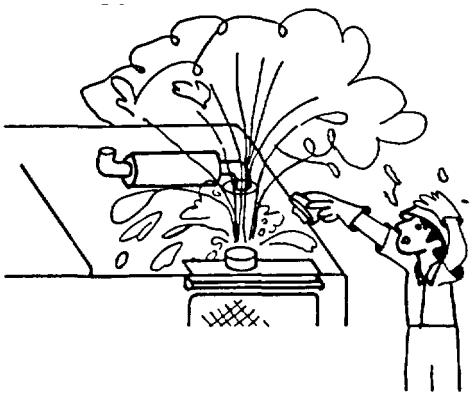


Fig. 9

Be careful when removing radiator caps.

23 **Use extreme caution when removing radiator caps, drain plugs, grease fittings, hydraulic pressure caps, etc.** They may fly off and hit you, or you may be burned by hot oil, water or steam.

24 **Always wear safety glasses when drilling, grinding, or hammering on metal.** If you do not wear safety glasses flying chips may Injure the eyes.

Working near power lines

1 **All electrical power lines are dangerous. Contact with them, whether insulated or not, can cause death or injury.** When operating near power lines, the best rule is to have the power company cut off the power and ground the lines. However, in some cases, you will be unable to have the power cut off. Follow these rules whether the power is cut off or not.

- **a** **Be alert** - you are working around conditions which can cause death.
- **b** Keep all parts of the machine - fall lines, hook block, and load - at least

15 ft. (4.75m) from the line, or other distance specified by TB 385-101. Slow down machine operation.

c Assume that every line is "hot".

d Appoint a reliable person equipped with a loud signal (whistle or horn) to warn the operator when any part of the machine or load moves near the power line. This person should have no other duties while the machine is working around the power line.

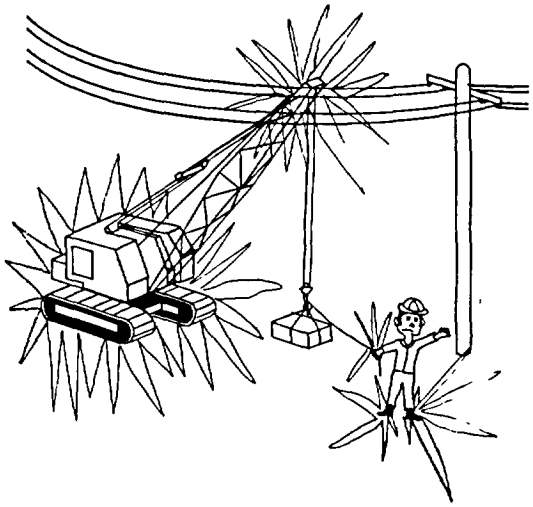


Fig. 10

Stay away from power lines.

e Warn all personnel of danger. Allow no unnecessary person in the area. Don't allow anyone to lean against or touch the machine. Don't allow sling men or load handlers to hold load, lines, or rigging gear unless absolutely necessary. Use dry hemp or dry plastic ropes as tether lines. Make certain everyone stays 15 ft. (4.75m) away from the load, or such distance as required by applicable code.

f The use of boom point guards, proximity devices, insulated hooks, or blocks, or swing limit stops do not assure safety. Even if codes or regulations require the use of such devices you must follow rules listed here. If you do not follow them, the result may be serious injury or death. The following illustrations portray some of the limitations of the devices.

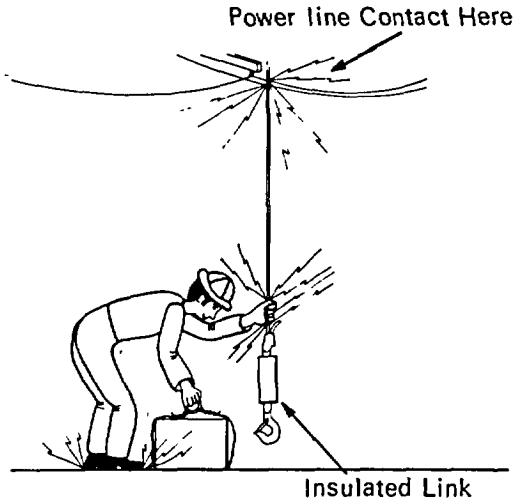


Fig. 11

Even though crane equipped with insulating link and boom peak guard. In this situation, the man is not protected.

g **Grounding the machine may increase the danger.** Popr grounding such as a pipe driven into the ground, gives little or no protection. In addition, a grounded machine may strike an arc so heavy that a live line may be burned down. This could cause the machine and the area around it to be electrified.

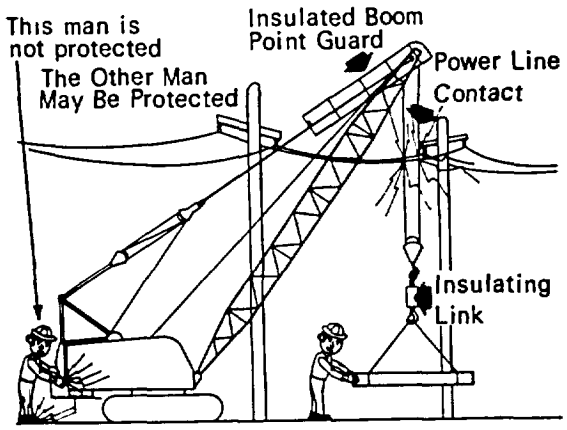


Fig. 12

Crane equipped with both an insulating link and an insulating boom point guard

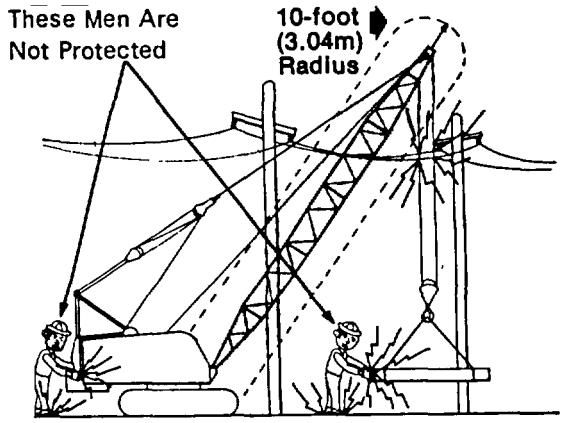


Fig. 13

Crane equipped with proximity device.

Shaded area shows "sensitivity zone" with full boom length sensor used, and adjusted for 10-foot (3.04m) clearance. Contact can be made outside this zone by the fall lines, hoist ropes, gantry, cab, etc. In such cases the warning will not sound until contact is made, and the machine is electrified and deadly.

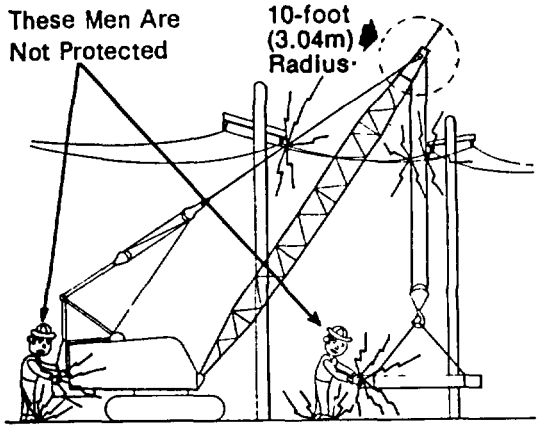


Fig. 14

Crane equipped with proximity device. Shaded area shows sensitivity zone with probe near boom peak and adjusted for a 10-foot (3.04m) clearance. Contact can be made outside this zone by the fall lines, hoist ropes, gantry, cab, boom, etc. In such cases, the warning will not sound until the machine Is electrified and deadly.

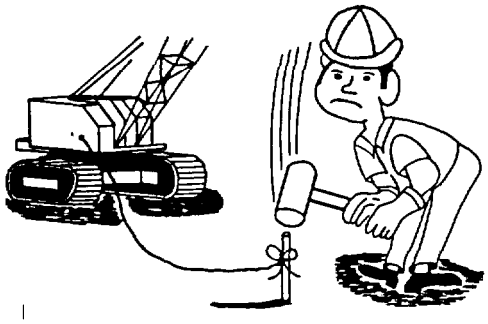


Fig. 15

Grounding the machine to a pipe driven into the ground gives little or no protection.

h When operating near radio or T V. transmitting stations, high voltage can be induced in metal parts of cranes, or in their loads. This can occur even

if the machine is some distance from the transmitter or antenna. Painful, dangerous shocks may occur. Consult trained electronic personnel before operating machine is begun to determine how to avoid hazards.

2 What do you do if a power line is touched by machine or load?

a. Keep cool - think - a mistake can kill someone.

b. Warn all personnel to keep clear.

c. If machine will still operate, try to move it away from contact. You, the operator, are reasonably safe in the cab unless the machine is on fire or an arc is cutting through the cab near you.

d. Move away from contact in reverse to that which caused the contact. Example: If you swing left into wire, swing to the right to break contact. Remember once an arc has been struck, it will stretch out much further than you think before it breaks. Keep moving away from the line until arc breaks.

e. When arc breaks, continue moving until you are at least 15 Ft. (4.57m) away (or as specified by local code.). Stop the machine. Thoroughly Inspect machine for damage. Repair any damage before further use.

f. If you cannot disengage from the line, and machine is not on fire or no arc is cutting through the cab, stay in your seat until power line can be shut off.

g. If you must leave the machine, Don't step off. Leap From The Machine as far as you can.

3 When using a magnet:

a. Lifting magnet generators produce voltages in excess of 200 volts and present an electrical shock hazard. Only trained personnel should work on the magnet, controller, or wiring. Never open the controller door with the generator running.

b. Do not let workmen touch magnet or load.

c. Do not let workmen get between magnet and a metal object.

d. If necessary to position a load, use a dry, wooden stick.

e. Open magnet disconnect switch at magnet control panel before connecting or disconnecting leads.

Crane Boom Safety

1. The operator, supervisor, or person in charge of the load must observe the following rules.

a. Loads must be well secured before lifting. Be sure that the rigging can't slip off or pull away from the load, or get out of position on the load. Be sure load is rigged so it won't fall over.

b. Chains and slings must be of adequate size, in good condition, and not twisted around each other.

c. The load must not catch on an obstruction when lifting or swinging. Be sure load, fall lines or any other part of machine does not snag or strike any obstruction.

d. Avoid sudden starts and stops. Lift carefully, swing gently, brake smoothly, lower and set loads carefully. Jerking the load, swinging and plugging the swing clutches roughly,

lowering the load rapidly, and slamming on the brakes, will put shock loadings and possible side loadings on the boom. Cowboys sometimes use rough treatment to break horses rough treatment can also break a machine. Unnecessary abuse labels the operator as a beginner. Be a professional.

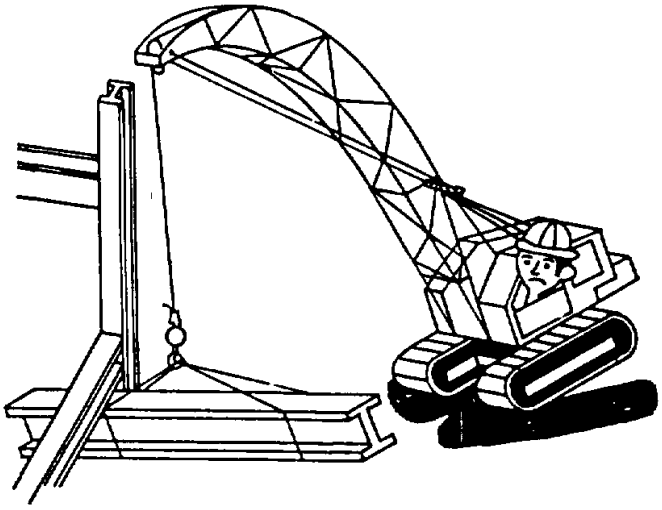


Fig. 16

Make sure load doesn't get caught

e. Never wrap the hoist line around the load. Never use discarded, worn, or damaged rope for slings. It may break and drop the load.

f. The machine must be level before making a lift. Use levels if the machine is so equipped. If not use a good carpenter's level placed on a smooth horizontal surface on the upper or lower frame. Remember a 3 degree side tilt can reduce capacities by 50% or more.

The hook block and fall lines can be used as a "plumb bob" to level a machine, Fig. 17. Pick up a compact load (2000 -3000 lbs.) (907-1360 kg) a few Inches above the ground. If machine is level, fall lines will hang directly between the boom feet, as you face the boom. Now swing over the side. The lines should still hang directly between the boom feet. Don't use this method on a windy day.

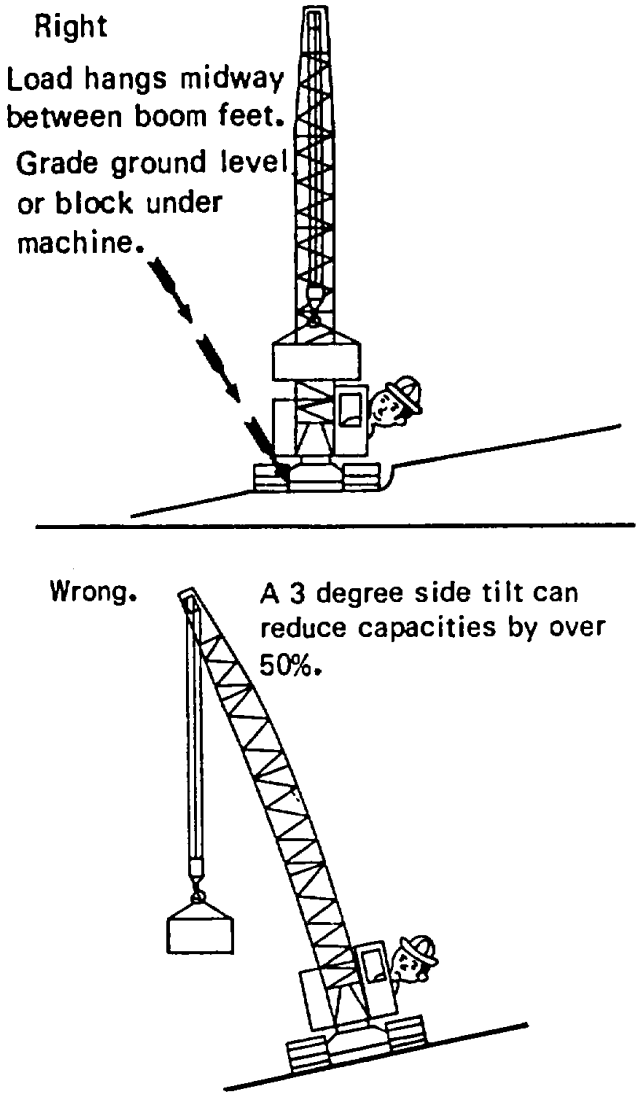


Fig. 17

Level the machine

2 The hoist line must be vertical when

starting to lift. If not, load will swing in, out, or sideways when lifted from the ground.

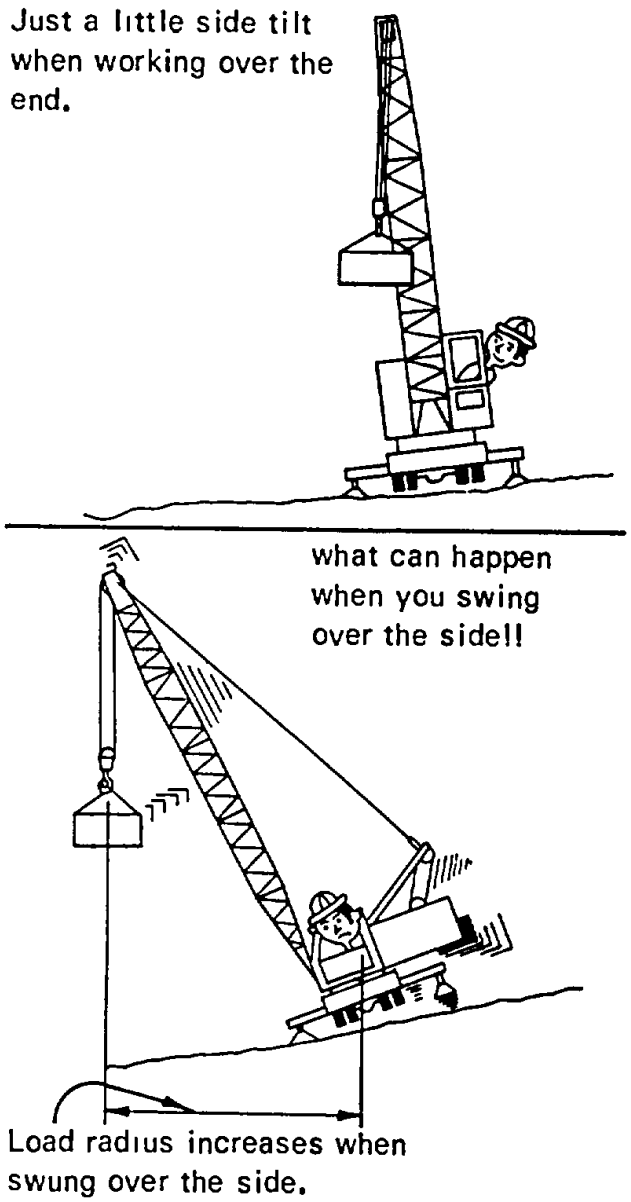


Fig. 18

Effect of side tilt

When picking a heavy load, machine will lean toward the boom. This is caused by elasticity of the machine and the boom. The lean is more noticeable when picking over the side on rubber. The lean will increase operating radius so the load will swing outward when it clears the ground. This outswing is dangerous to anything in the path of the load and because of the increase in load radius may overload the machine. To overcome this outswing, boom up as the load is lifted so fall lines remain vertical. When setting the load on the ground, lower boom after load touches down to avoid hook block swing when it is unhooked from load, or the boom contacting the boom backstops.

3 **When swinging a load from over end to over side, the lean described above will increase**. This is especially noticeable when operating on tires. Since tilt acts to increase load radius, it must be compensated for when swinging the load. Swing slowly. Change boom angle (Raise or lower boom), while swinging, to maintain a constant radius, and prevent inswing or outswing of load. If not, a dangerous condition may result.

4 **Know your load. Don't try to guess or estimate the load.** Use a scale weight, carefully calculated weight, a hook scale, or a load indicating system. Remember the weight you are lifting includes the weight of any lifting slings, or gear, the hook block, and any overhaul weights. If picking off the boom with the jib installed, the weight of the jib and rigging must also be considered part of the load. The total load weight must never exceed the rated capacity of the machine, as listed on the capacity chart, for the position, boom length, load radius and condition of operation being used.

Remember - capacity chart ratings are based on ideal conditions:

a Standing on firm, level surface
b Calm wind
c No side loads or outswing of load
d Good visibility
e Machine in A-1 condition and equipped as when leaving the factory

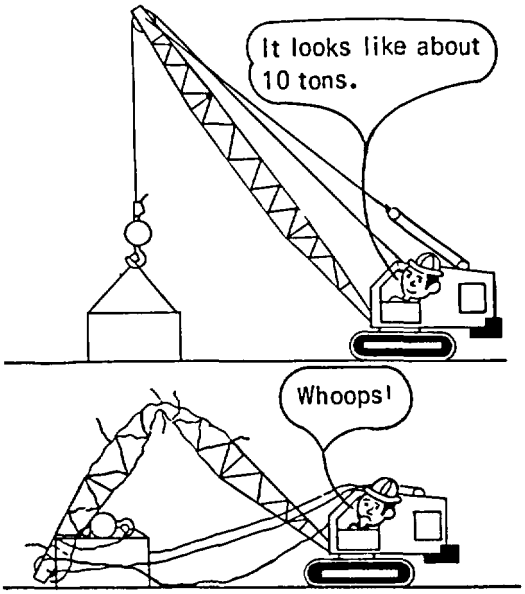


Fig. 19

Know your load

When such conditions cannot be attained, loads being handled must be reduced to compensate. The amount loads are reduced depends upon how good, or how poor, the actual operating conditions are. It is a matter of judgement and experience. Some factors which may require reduction of loads below listed ratings are:

a Soft or unpredictable supporting surfaces
b Wind
c Hazardous surroundings
d Inexperienced personnel
e Poor visibility
f Fragile loads
g Machine in poor condition

When in doubt, don't take a chance. Reduce ratings more than you think you need to.

Avoid working a machine in high winds. If you must work in a wind, reduce capacities considerably below those shown on the capacity chart. Wind blowing against the load and the boom produces a side load on the boom and reduces its capacity.

When lifting large loads such as building panels in a wind, the movement of the load may pose a danger to workmen or building structures. Outswing of a load will increase load radius, and may overload the machine. This could lead to boom failure or machine tipping.

5 **Don't operate at radii and boom lengths where the capacity chart lists no capacity. Don't use longer booms or jibs than listed on the chart.** Any of the above can tip the machine over, or cause boom and/or jib failure.

6 **Keep the load lines as short as possible to prevent excessive swinging.** Always use the shortest boom length which will do the job. Remember, the shorter the boom, the stronger it is.

7 **Watch out for centrifugal force when swinging a load.** Swing gently. Cen-

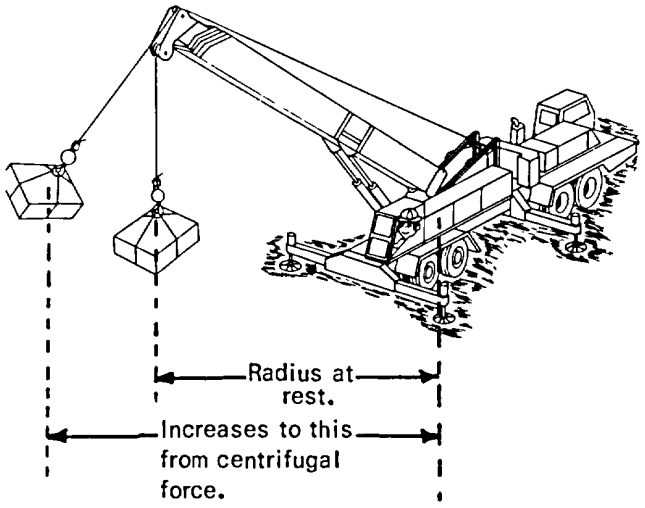


Fig. 20

Watch out for centrifugal force

trifugal force tends to increase load radius. This increase in radius could overload the machine and cause machine damage and tipping. When stopping the swing, overswing of the load can side load the boom. The use of a tagline is recommended to control this force.

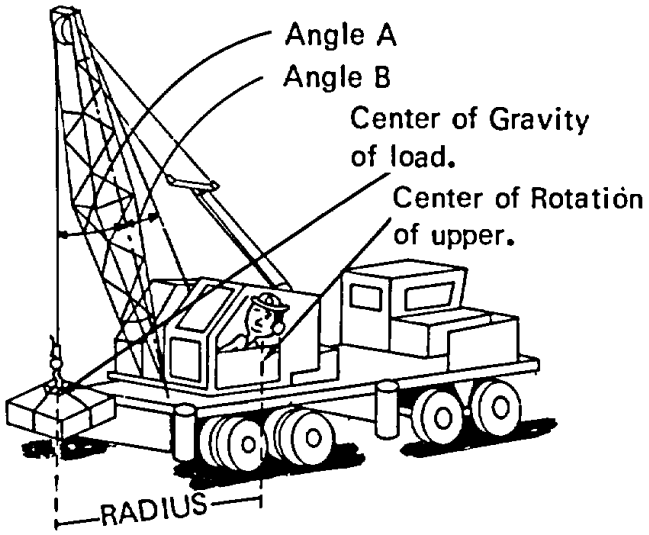


Fig. 21

Load Radius

8 **Know the load radius.** Don't guess it. Determine radius by using the boom angle indicator, the boom length, and the capacity chart, or measure It with a steel tape. Remember radius Is the horizontal distance from the centerline of rotation of the upper to the center of gravity of the load when the load is hanging free.

9 **Know the boom length.** Don't guess. Use of an incorrect boom length can cause an accident.

10 **Use at least the number of parts of hoist line specified in the wire rope capacity plate to handle the load.** In case your machine Is not so equipped, one is included on page 31. Local codes may require more parts of line than shown. Check code requirements and use them where applicable.

Use special care when handling loads on single part line with boom at a short radius. This Is especially Important when hoist line is off rear drum. The boom may be whipped back over machine. In single line operation, make sure Angle A is always greater than Angle B. (See Fig. 21).

11 **Test the hoist brake by raising the load a few inches and holding.** It should hold easily. It takes more brake to hold a load in the air when the drum Is full of rope, than a few inches above the ground with only one wrap on the drum.

12 **Don't pull sideways on the boom, not even a little bit.** Lift straight up on every load. Moving trucks, rail cars, barges, or

anything else by pulling sideways with the hoist line Is liable to buckle the boom. It may also damage the swing mechanism. Pulling sideways on a boom set at a high angle can turn the machine over sideways.

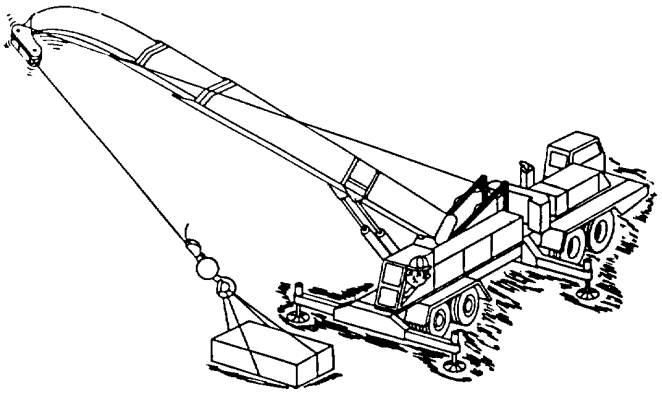


Fig. 22
Never use a boom to pull loads sideways

13 **Never move a crane away from the load while handling near capacity loads.** Due to load inertia (weight) the load will tend to stay in position when the machine starts to move, and then will swing in toward the machine. The inertia effect will tend to increase load radius and decrease stability. This could lead to boom failure or machine tipping.

14 **When operating on outriggers, the beams must be fully extended.** Jacks must be extended so tires are clear of ground, and machine is level. Be sure that blocking or pontoons are set on firm surface, adequate to support the blocking or pontoon loading without settling, slipping, or collapse. Blocking or matting under pontoons must form a smooth level surface under the entire pontoon. However, do not also block under outrigger beams inside of pontoons as this reduces stability. Remember there are tremendous loadings on pontoons and blocking, the weight of the entire machine plus any load.

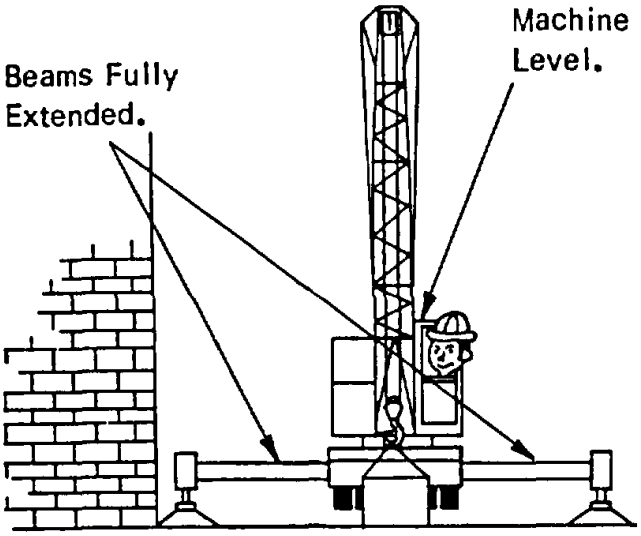


Fig. 23
Use of outriggers

When blocking or matting under pontoons, be sure that each pontoon is supported fully no unsupported pontoon area is permissible. Be sure pontoons are on a smooth surface. Rough surface, rocks, etc. under pontoon will cause unequal loadings, may puncture it, and cause collapse.

Capacities are based on outriggers fully extended. Working with outriggers partially retracted will reduce capacities and machine stability considerably and may cause an accident. If it is absolutely necessary to operate a machine with outrigger beams partially retracted, reduce capacities to those shown on the chart for "on rubber". Remember the machine must be level.

Avoid working with only rear outriggers

extended. If you swing over the side, the machine may tip over, or the boom may be damaged from side loadings because the machine is not level.

When working a machine with mechanical (non-hydraulic) outriggers, make sure the beams are pinned in place, otherwise they can "creep in" while operating, causing an unstable condition and possibly tipping the machine over.

15 **When using a boom length where retractable gantry or live mast is required, be sure they are fully extended and pinned in place.**

16 **When operating a lifting crane on crawlers, where the tracks sink into the soil any noticeable amount, use matting.** Timbers used for matting should be at least as long as the total width of the lower and should be heavy enough to withstand loadings without damage. Timbers should be close together to form a solid platform.

When lifting over crawler ends, block under track ends so full support is provided where track leaves the ground.

17 **Don't alter any part of the machine.** Additions to or changes in any part of the equipment can create loadings which the machine was not designed for. Such changes may seriously affect the useable capacities and make the entire capacity chart invalid. Such changes can dangerously overload or weaken critical parts and may cause disastrous failure.

18 **Don't operate over the front of a truck**

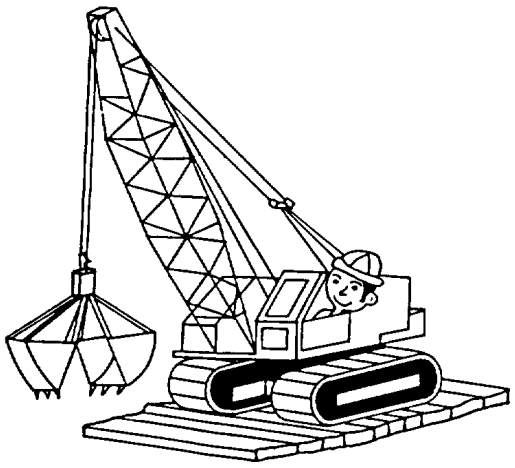


Fig. 24
Use matting on soft ground

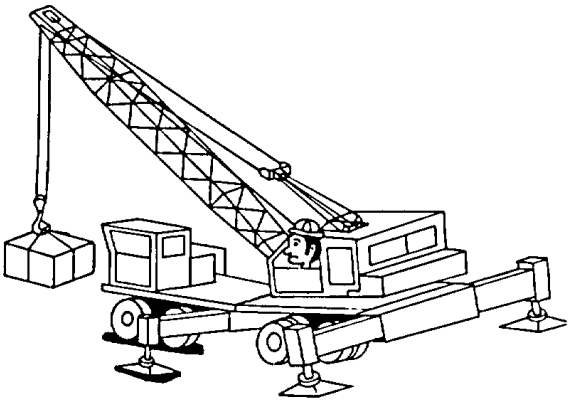


Fig. 25
Working over the front can cause accidents

crane either on tires or on outriggers unless the machine being used is rated over the front. Lifting loads over the front can cause damage to the carrier. Also the operator's vision may be obscured by the front of the carrier. If it is absolutely necessary to work over the front, consult the factory for special instructions and load ratings.

19 Don't exceed the rated capacities of the machine under any circumstances. While a crane has more stability when lifting over a corner (as compared to straight over the side) the machine capacity is not increased. Any time you exceed the rated capacities listed on the capacity chart in the operator's cab, you are overloading the machine. Overloads can damage the machine and such damage may cause failure and accidents.

20 Don't pick loads on main hoist and jib at the same time, even if total load weight is within machine capacity. Loads on the jib stress the boom and drastically reduce its ability to handle loads.

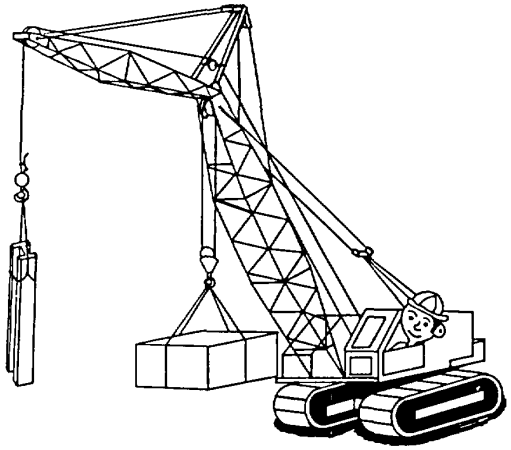


Fig. 26
Don’t pick loads on main hoist and jib at the same time

21 Don't work with jib angles greater than 30 degrees with respect to the boom. The greater the angle, the less capacity the jib has. Working with jib angles over 30 degrees (with respect to the boom) may cause jib or suspension failure, and may cause dangerous twisting forces in the boom.

22 Never use longer jibs than specified for your machine. Never use a jib on a longer boom than specified for your machine. Tipping may result.

23 Know how much counterweight is on the machine. Some capacity charts list different capacities with differing amounts of counterweight. Make sure you know how your machine is equipped and use the correct column on the chart.

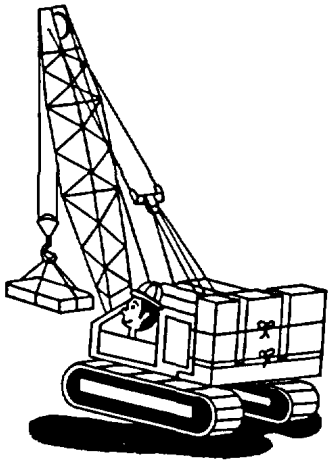


Fig. 27
Don’t add extra counterweight

Don't increase the counterweight above that specified. Don't add anything to the machine that will act as additional counterweight. Remember that anything which has weight, if carried behind machine's tipping point, acts as counterweight. Adding counterweight affects backward stability of the machine, particularly

when working over the side. It also encourages overloading of the machine which can cause a disastrous accident.

24 Traveling with a suspended load should be avoided if possible. It is especially hazardous when terrain is rough or irregular, on a side slope, or in hilly areas. When traveling with a load, observe the following rules:

a. Tether the load to reduce load swing. Don't tether to boom structure.

b. Travel by the smoothest, most level route. If a smooth level route is not available, don't travel with a suspended load unless the route to be taken is graded to provide a smooth level path. If its not possible to grade the route, move the load by stepping. Pick the load and set it down along side the travel route. Travel unloaded machine beyond load, pick load, swing, and set down farther along route. Continue procedure until load is at its destination.

c. Carry load as close to the ground as possible.

d. Avoid side swing of load. If tethering won't hold load directly below boom, swing until boom points directly down hill. While this may reduce stability of the machine, it will reduce boom side loadings also. Carrying the load near the ground will reduce the danger of overturning.

e. Don't attempt to carry loads which approach the machine's rating.

f. Don't travel with a load on soft ground. If machine sinks into ground, stability can be affected to the point of tipping the machine over.

g. Keep all personnel clear of machine and load. Be prepared to set load down quickly at any time.

h. When traveling up or down slopes keep the upper facing downhill to reduce the tendency for the boom to fall over the cab. If necessary to face uphill, keep the boom down.

i. Fully extend outrigger beams. Extend or retract jacks until pontoons just clear the ground.

j. Inflate carrier tires as shown on tire inflation chart for making lifts on rubber.

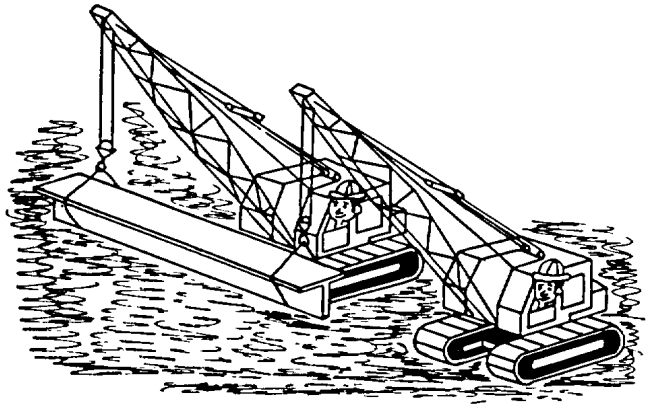


Fig. 28
Avoid using multiple cranes on a lift.

25 Lifts where two or more cranes work together can be hazardous and should be avoided. Such lifts should be made only under the direction of a qualified engineer. If a multiple crane lift is unavoidable, observe the following rules:

a. Cranes must be level and located on firm surfaces.

b. Cranes should be the same size and capacity, use the same boom length, and be reeved similarly.

c. Truck cranes must be completely sup

ported on fully extended outriggers.

d. Cranes must be positioned so that each boom point is directly over its load attaching point. Fall lines must be-vertical during all phases of the lift.
e. Rigging must be placed so each crane lifts a share of the load well within the crane's capacity.
f. During handling be sure that more load is not transferred to any crane than it can handle.
g. Don't attempt to travel when making multiple crane lifts.
h. Coordinate plans with the other operator before beginning to lift.
i. Use only one signal man.
j. Use of an operable load and angle indicating system is desirable.

26 Don't lift more than one separately rigged load at a time, even if both loads combined don't exceed the crane's capacity. Your full attention cannot be given to both loads, creating a dangerous situation.

27 Use caution when booming up to minimum radius. Be prepared to stop boom travel. If the boom limit device malfunctions, the boom and backstops may be damaged, or someone may be hurt. Do not boom into boom limit device in normal operation.

28 When operating near minimum radius, be ready to boom down as you set the load down to compensate for the tendency of the boom to move back against the backstops when the load is released. This action occurs because of the elasticity in the boom and boom hoist system. Severe bending in the boom can occur if it is allowed to bear against the backstops too heavily.

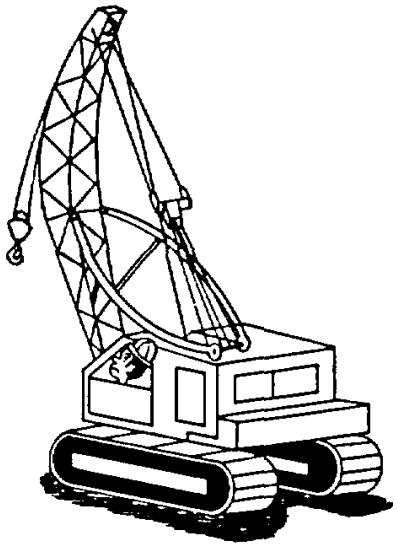


Fig. 29
Use caution when booming to minimum radius

29 Watch out for "two blocking" (pulling hook block into boom sheaves). This can cause rope breakage or can pull the boom back over the cab, resulting In an accident.

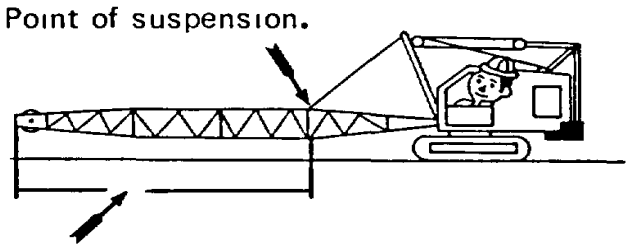


Fig. 30
Cantilevering boom

30 Know the maximum amount of boom that can be cantilevered, (projected beyond point of suspension) during boom assembly and disassembly. Exceeding this amount can cause boom or boom suspension failure.

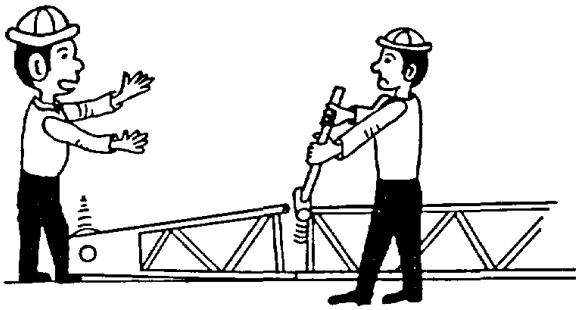


Fig. 31
Block under upper section before unpinning

31 Block under the boom upper section before unpinning from extensions. Since the upper section is tapered, it will fall to the ground when unpinned possibly resulting in an accident.

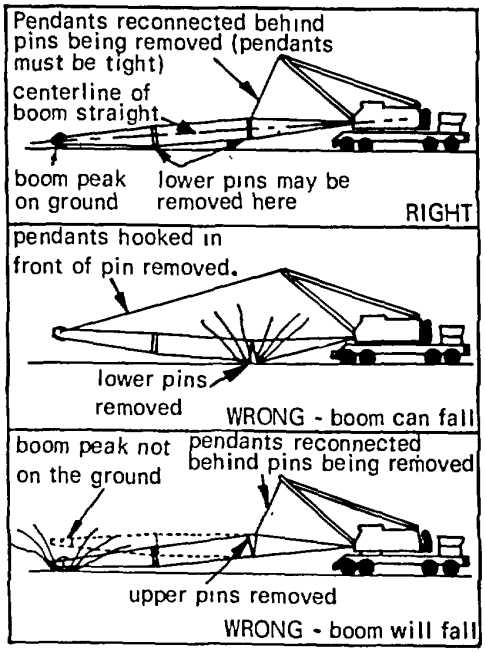


Fig. 32
Pin connected booms.

32 When disassembling bolted boom, block securely under each end of each section when unbolting them. Otherwise boom may fall and kill or injure someone. Never get under a boom, especially when assembling or disassembling it.

33 Disassembly of any pin connected boom can be hazardous. Removing the boom pins without reconnecting pendants behind the pins being removed can cause the boom to fall to the ground. If you are under the boom when it falls, you may be killed. Never remove boom pins unless boom peak is resting on the ground, and pendants are reconnected as shown in Fig. 32.

If there is any doubt in your mind about the boom disassembly procedure, block tightly under the boom before removing the pins.

34 When operating a machine equipped with any form of load indicating mechanism, overload warning system, or any automatic safety device, remember that such devices cannot replace the skill and judgment of a good operator. For instance such devices cannot tell when a machine is located on a supporting surface that will give way, or that too few parts of line are being used to hoist a load, or correct for the effects of wind, or warn that the device may be improperly adjusted, or correct for side pulls on the boom, or for many conditions which may occur and which may create hazards. It requires all the skill, experience, judgment, and safety consciousness that a good operator can develop to attain safe operation. Many safety devices can assist the

operator in performing his duties, but he should not depend on them to keep him out of trouble.

35 Don't lash a machine down unless you are using an operable load indicating system, or are sure of the weight of every load. Lashing a machine down encourages overloading, and, If machine can't tip you can be seriously overloaded with no Indication of it. Machine damage or injury may result.

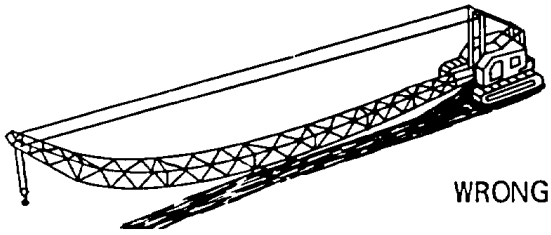


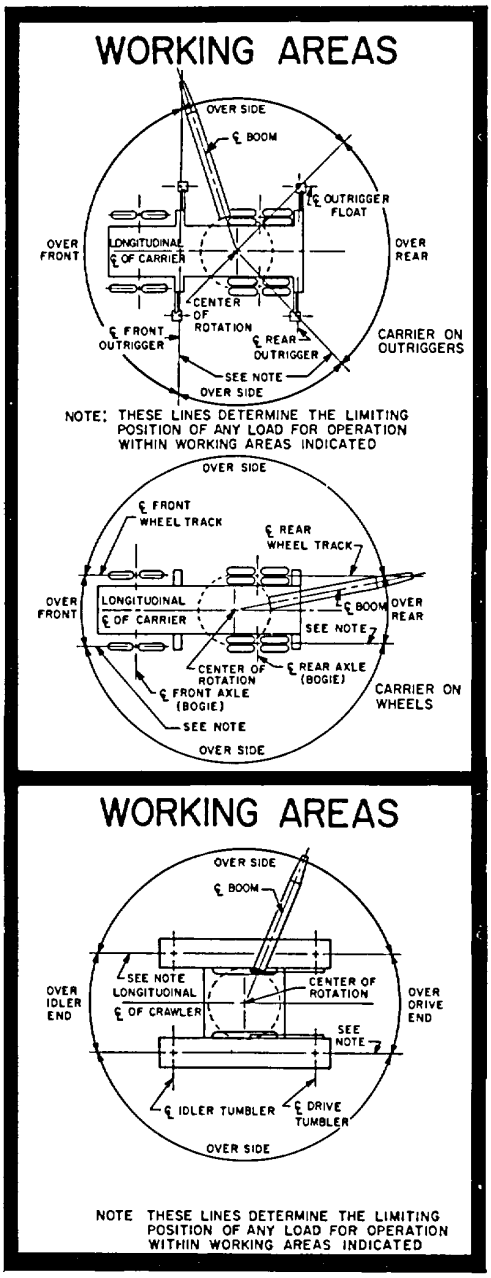
Fig. 33

Use mid-point suspension where required

36 If the boom length is such that mid-point or intermediate suspension is required, make sure It is installed and properly adjusted. Long booms may buckle In the middle from their own weight without this suspension.

37 Working areas for machines are defined as "over front", "overside", "over rear", or "360 degrees." Permissable loads per the machine capacity chart will vary from lifting quadrant to lifting quadrant. The operator must make sure capacity ratings are not exceeded no matter what quadrant 'he is operating In, or when swinging from one quadrant to another.

Fig. 34 Is a copy of plates found in upper cab.



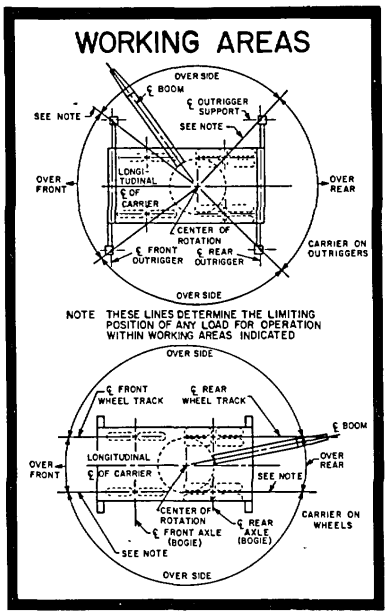


Fig. 34
Working area charts

38 After slack rope operation, make sure rope is properly seated in sheaves and on drums before continuing to operate. Use a stick or mallet to seat the rope, not your hands.

39 Never lower the boom or load beyond the point where two full wraps of rope are left on the drum. This condition could occur when lowering a load below ground level. If all the rope runs off the drum, the load will jerk which could break the rope and drop the load.

40 On some machines equipped with live mast, it is permissable to connect live mast to boom lower section with links for transportation purposes, and in some cases for boom make up. Be extremely cautious about raising boom above horizontal with the links connected. If you boom up too far, the live mast legs and boom throat will engage and damage the mast and boom.

41 When operating a crane equipped with torque convertor or fluid coupling, remember to speed up engine before engaging boom hoist or load hoist clutch. If the engine Isn't running fast enough, the boom or load may go down instead of up. Keep your foot on the brake until engine speed is fast enough to raise the load. The boom hoist pawl should be engaged at all times except when lowering the boom.

42 Make sure there is a latch on the hook, and that it works properly. Without a, latch, it Is possible for slings or chains to come off the hook and allow the load to fall.

43 When lifting submerged loads, the suction caused by the load resting on the bottom acts to increase the weight of the load in some cases to many times the actual load weight. This same effect can occur on land, for example, when a load is imbedded in mud. To break a load loose from suction, Don't pull sideways or a boom may collapse. If possible, rig the load so it is lifted from one end. Don't yank or jerk on the load. A steady pull, maintained for some time will often free

the load without overloading the equipment.

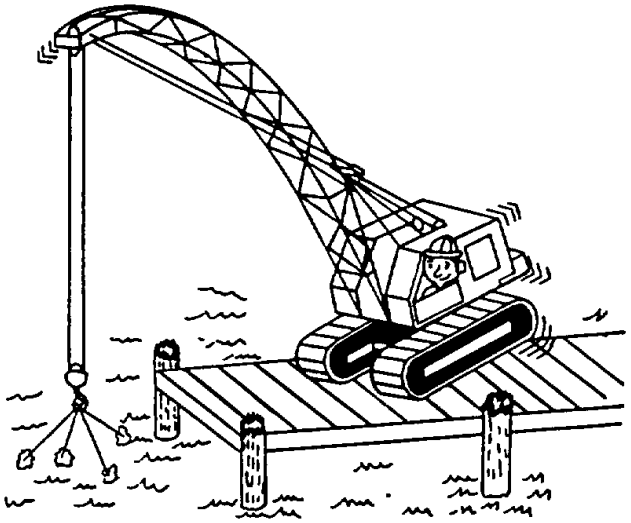


Fig. 35
Use caution when lifting submerged loads

When a submerged load reaches the surface, don't attempt to lift it out of the water all at once. It may be saturated with water and weigh many times what you expect. Allow it to drain as you raise the load slowly. Be patient, since draining may take a long time. A load when removed from the water, even when fully drained, will have a greater effective weight than it will when submerged because of buoyancy.

44 Don't extract piling, casings, or other such loads by yanking or jerking on them. The practice of pulling on the load until the machine has tipped, then releasing the hoist line, allowing the machine to drop back and catching the hoist line on a clutch or brake may break the boom. If the piling, or casing won't pull out with a smooth, steady pull, use an extractor, pulling frame, or some similar rigging intended for this purpose. Pulling on a load that is not free to be lifted can develop loadings in the machine far in excess of the normal weight of the load. Imposing such loads on a machine can damage the machine and may cause disastrous failure. When using a pile extractor, use a shock or vibration insulator unit.

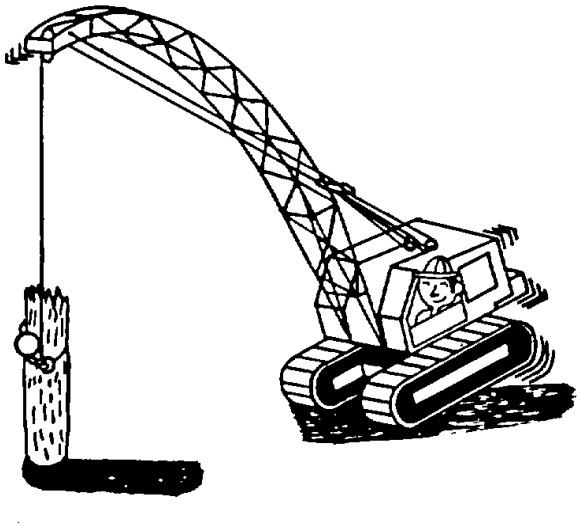


Fig. 36
Use caution when extracting piling, casing, etc.

45 Operation with auxiliary equipment such as pile driver leads, pile hammers, or caisson boring attachments imposes additional loading on the machine. This causes a major reduction in lifting capacities of the machine. Changes in augers and kelly bar lengths with drilling attachments and in pile hammer attachments further complicate the manner in which lifting capacities are reduced. The weight of each piece of auxiliary equipment is to be considered a part of the live load acting at the radius of the center of gravity of the piece.

Demolition Work

1 Demolition work can be particularly

hazardous. Shock loadings and side loadings from demolition ball and clamshell bucket work can be severe. The repetitive nature of such work Imposes heavy demands on all parts of the machine. Restrict demolition ball weights to not exceed over 50% of machine capacity (on tire capacities for truck cranes) at maximum radius at which you handle the ball, with the boom length you are using. In no case however, should the ball weight exceed 50% of the available line pull.

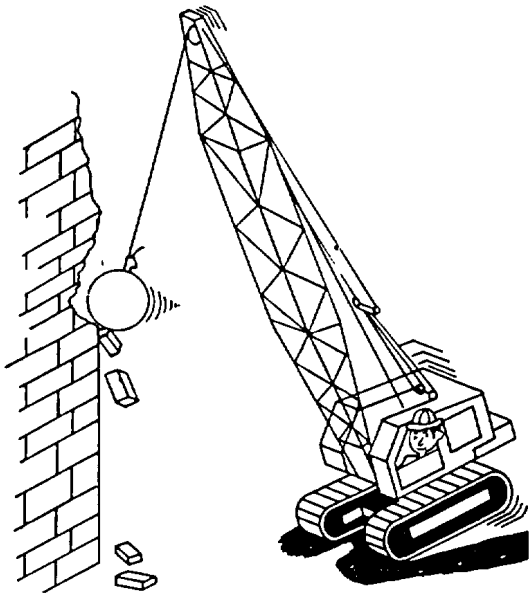


Fig. 37
Use caution when using demolition ball

When using a clamshell bucket, be sure you stay within the boom length and load limitations shown in the lifting capacity chart in the machine. Failure to do so may create fatigue which can lead to eventual failure.

When using demolition ball, avoid sudden clutch and brake applications. Work steadily and smoothly. Don't try to knock the whole structure down with one blow. Use good aim. If the ball misses its target, out swing could cause machine tipping or overload. When swinging back, ball may hit the boom and damage it.

When using a clamshell bucket on demolition work, and taking a bite on a piece of unknown weight, be ready to release the closing line as more weight than you can handle may break loose. Be prepared to drop the load.

2 **When dismantling a structure where a portion is being cut loose while suspended by a crane, be sure the weight of the portion being cut loose is known, and the crane pull on the load is equal to the weight.** The point of attachment must be directly above the center of gravity of the load. The fall lines must be vertical. This is an extremely hazardous operation. The services of a professional engineer should be used to plan and supervise such lifts.

Excavator Safety

1 **Keep holding line taut when hoisting a clamshell.** Don't permit it to overhaul the closing line, otherwise bucket will open to "dribble" the load. Release closing line gently to avoid shock to holding line and boom when opening bucket.

2 **When loading a truck load from the rear, never swing over the cab.** Make sure the truck driver leaves the cab during loading.

3 When loading a truck, with a hoe, raise boom when extending dipper, to avoid hitting the truck.

4 Keep crawlers back from the edge of the hole to keep the machine from falling in.

5 Know the exact location of buried lines (gas, water, sewer, telephone, electric, etc.). Avoid them with a safety margin. Mark locations clearly to avoid guess work.

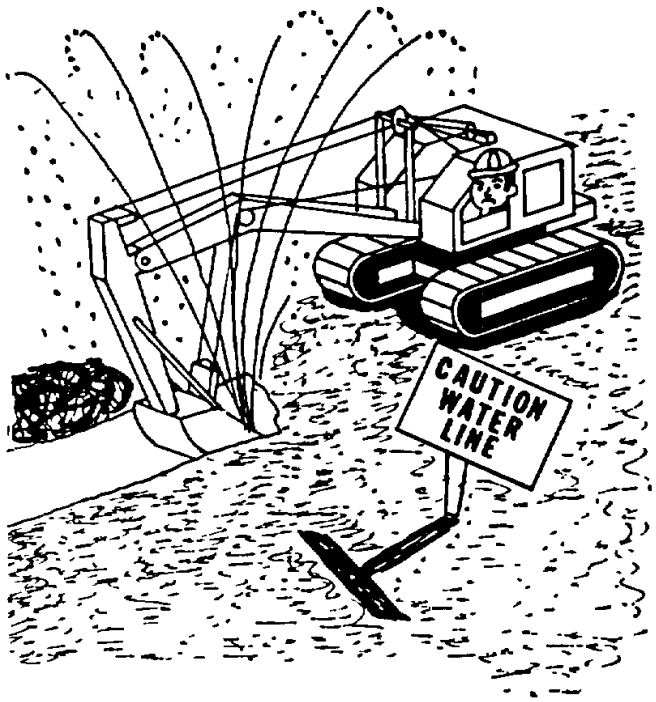


Fig. 38

Be careful where you dig

6 Don't operate a dragline or clamshell with more than the recommended boom length installed on the machine. Many factors are considered when setting maximum boom lengths on a machine. Exceeding the maximums may effect machine stability or strength, and cause a failure or accident.

7 Avoid slack lines when digging. Slack lines cause improper spooling on drums, damage the rope and shorten rope life. The rope may break prematurely causing an accident.

Carrier Operation

1 Road the machine safely. Watch for narrow bridges and low clearances. When maneuvering in tight places, post a signal man on the ground to guide you. Check load limits, height, width, and length restrictions in the area you are traveling. Make sure your machine complies with all regulations.

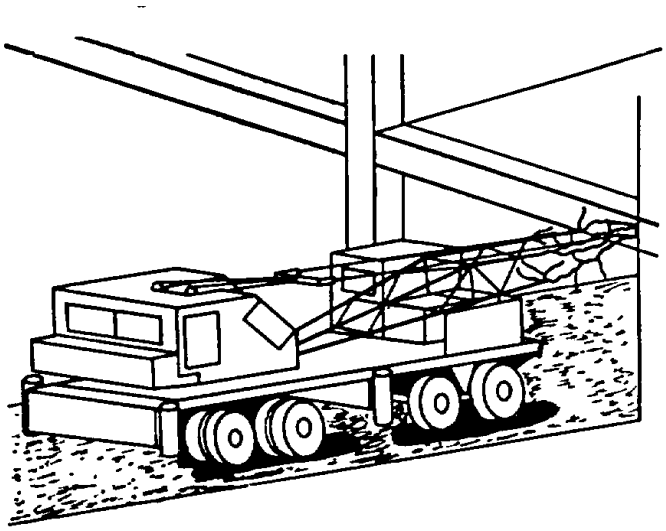


Fig. 39

Travel safely

2 When roading a carrier mounted machine, note the following:

a. Operate with lights on. Use proper warning signs, flags, and other such devices. Use an escort service if required.

b. Lock swing lock in upper unless you are traveling with boom installed and it is necessary to swing the upper for

clearance, or if boom is on dolly.

c. Lash down or otherwise restrain the hook block.

d. Check operator's manual for maximum allowable travel speed, maximum amount of boom that can be transported, and any other travel limitations. Don't exceed these maximums. Machine damage or accident will result.

e. When traveling with outriggers retracted, secure them in retracted position. If they should accidentally extend while the machine is traveling, a serious accident may result.

f. When roading a machine, store pontoons in storage areas provided, and fasten them securely. If a pontoon should fall off machine, it could cause a serious accident.

3 **Check tires daily for correct pressure.** Never stand in front of a tire when inflating. The lock ring may fly off and injure you. Use a clip on inflator, and stand behind the tire tread. Use a guard in front of tire.

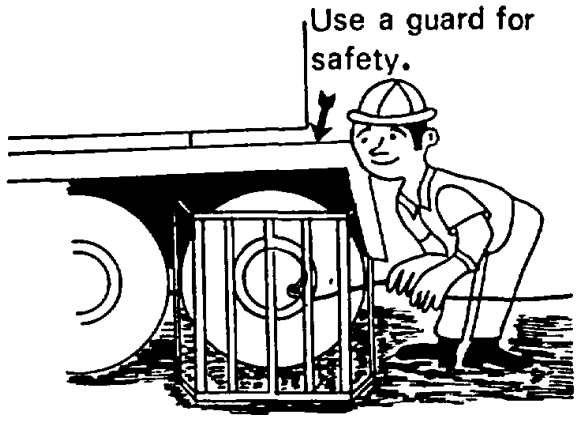


Fig. 40
Be careful when inflating tires

4 **When working on rubber, tires must be inflated to pressures shown on tire inflation chart to make the lifts shown on the capacity chart.**

5 **Shift carrier transmission to neutral before operating upper.** Machine rocking may damage transmission or drive line. Apply the operating or digging brakes if working on rubber. If necessary, leave the engine running to maintain air pressure.

When parking a wheeled crane, shift to neutral and apply park brake. Block wheels if on a hill.

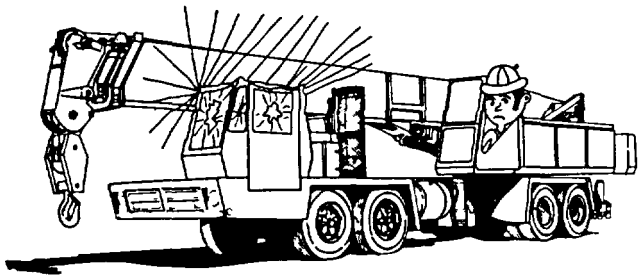


Fig. 41
Be careful of carrier cab

6 **When swinging upper, be careful of carrier cab.** Swinging into the cab will damage it, and probably the boom too. Always engage the swing lock when roading the machine.

7 **If your carrier is equipped with safety belts or shoulder harness, use them.** They are there for your protection.

8 **Brake firmly in one application.** Avoid fanning the brakes. This may exhaust air pressure so fast the compressor can't

keep up.

9 If a machine must be towed, move slowly. Take up slack in chain or rope. Don't jerk, It may break. Keep chain or rope taut while towing.

10 Before attempting to move the carrier, make sure there is enough air pressure to operate the brakes. Always check brake operation before driving the machine.

11 Always look before you back up, or better yet, post a signal man to guide you. If your machine is equipped with a back up alarm, make sure it is working properly. If not, use the horn as a signal. Use a code such as one beep stop, two beeps forward, three beeps backward. Make sure everyone on the job site knows the code. If machine is equipped with a back up alarm, make sure it works properly.

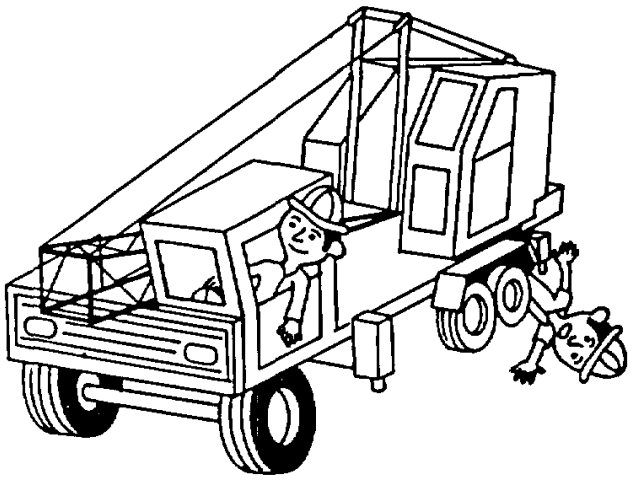


Fig. 42
Back the machine safely

12 When moving a machine around the job site with boom in the air, observe the following precautions:

a. Swing upper so boom is directly over rear of carrier. Engage the swing lock.

b. Shift carrier transmission into the lowest possible gear. Never move faster than creep speed.

c. The terrain must be smooth, and solid. If not, grade the area before moving the machine.

d. Tie down the hook block to prevent its swinging when moving.

e. Fully extended outrigger beams. Extend or retract jacks until pontoons just clear the ground.

f. Inflate carrier tires to pressure shown on tire inflation chart for making lifts on rubber before attempting to move the machine. This pressure is higher than normal, and will provide better machine stability. Reduce pressures to those shown for highway travel before driving carrier any great distance.

g. Lower the boom to the lowest possible angle for better machine stability and to avoid overhead obstructions before moving.

h. Engage clutch smoothly. Keep a steady foot on the accelerator. Don't jerk the machine.

i. Position a signal man to guide you.

j. Avoid traveling on a grade, particularly a side slope. If you must travel up a slope, go straight up, or better yet back up the grade for maximum machine stability and minimum side loadings.

13 Never coast down hill with clutch disengaged or transmission in neutral. Either practice makes control of the vehicle more difficult, and less safe.

14 Never leave carrier unattended with the engine running.

Crawler Operation

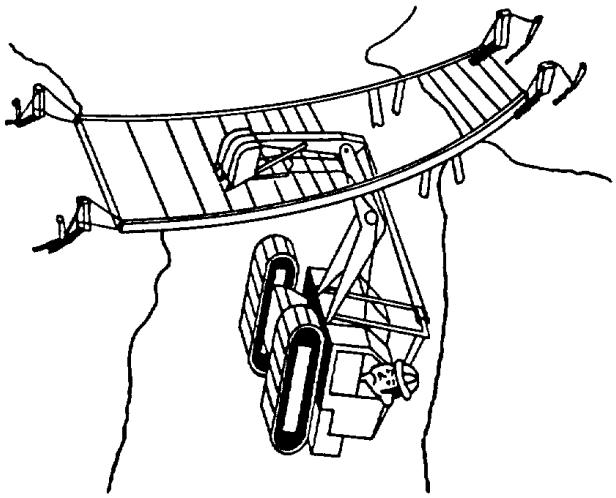


Fig. 43
Check load limits before traveling

1 Travel safely. Watch for narrow bridges or openings, low clearances, etc. When maneuvering in tight places, post a signal man on the ground to guide you. Check load limits, and know your machine weight. When transporting machine on a trailer, make sure it is securely tied down. Engage the swing lock. Use proper warning signs, flags, and so forth. Check local regulations before transporting, and follow them to the letter.

2 When towing machines, move slowly. Take up slack in chain or rope. Don't jerk, it may break. Keep taut while towing. Disengage traction brakes or crawlers before towing.

3 In cold weather, park where machine won't freeze down. Power train failure can result when trying to move a machine that is frozen down.

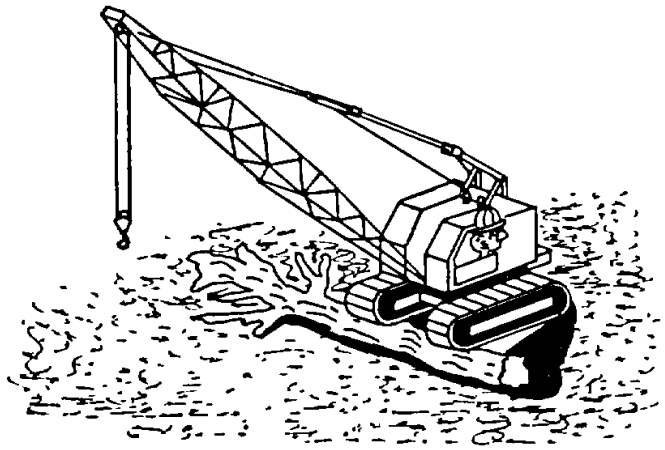


Fig. 44
If possible, go around obstacles

4 Avoid traveling over obstacles (rough terrain, rocks, logs, curbs, ditches, etc.), if at all possible. The size and type of obstacle that can be safely crossed will depend on many factors, including good judgment. When obstructions must be crossed, do so with extreme caution, at an angle if possible, and at slow speed. Ease up to the break over point, balance on the obstruction, ease down to minimize jolt of contract on the other side.

5 Cross a gully or deep ditch at an angle and very slowly. Carry boom at a low angle for increased stability.

6 Avoid sidehill travel whenever possible. Travel up or down the slope. Shift machine to lowest travel speed when starting up or down the slope. Keep the upper facing downhill over the cab. If necessary to face uphill, keep the attachment close to the ground. If the machine starts slipping sideways on a grade, immediately turn the machine downgrade.

7 One workman on the job should be designa-

ted a signal man, and the operators' should obey signals from him only. A signal to stop should be obeyed no matter who gives It. See hand signal chart on rear cover of this booklet.

Hydraulic Machine Operation

1 **Hydraulic machines are easy to operate.** So easy in fact, that almost anyone can do It. This very "ease of operation" leads to careless operation, or operation by unqualified personnel. Either of the above can result in an accident.

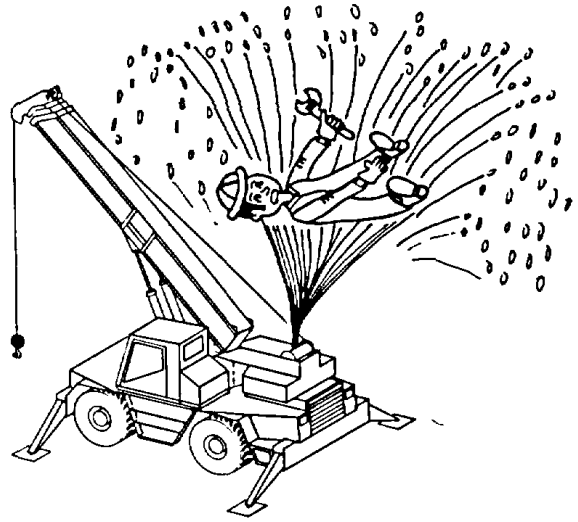


Fig. 45
Be careful when working on hydraulic systems

2 **Never work on a hydraulic machine without doing the following:**

a. On cranes, fully retract the boom. Lower boom to the limit of the boom hoist cylinders or into cradle. Lower the machine down off the outriggers.

b. On excavators, lower attachment until bucket is on the ground.

c. Disengage the master clutch. Shut off the engine. Work all control levers back and forth to relieve pressure and relax the attachment.

d. If the above instructions cannot be followed, block securely under the attachment so it cannot move.

e. Hydraulic oil becomes hot during operation. In some cases it becomes hot enough to cause severe burns. Be careful not to let hot hydraulic oil contact the skin.

f. On machines equipped with a pressurized or pre-charged sump tank, relieve the pressure before working on the hydraulic system. This pressure can push oil out of a connection, drain plug, etc. as it is loosened. This could cause an injury,

3 **When setting pressures, never exceed manufacturers ratings.** Always follow instructions to the letter. Over pressure can cause hydraulic component damage or failure. Over pressure in hydraulic circuits can also lead to damage or failure of mechanical parts on a machine. Any of the above can lead to an accident.

4 **Never put any part of your body into a hole on a hydraulic boom.** A sudden movement of the boom could cut it off.

5 **Never make a lift which is not in plain sight without a signal man.** This is particularly true on hydraulic yard cranes where the operator does not swing with the boom. This can lead to an accident or machine damage.

6 **When you pick a load with any crane, the load radius will increase.** Due to the design of hydraulic crane booms (cantilever boom, supported by cylinders, overlapping sections) this increase is much more pronounced. The Increase or outswing of the load can overload the boom, and lead to boom failure or tipping. Also, movement of the load can cause it to hit something. Make sure the load being lifted will remain within capacity as it is lifted and the boom deflects. See rule 2 page 19 also.

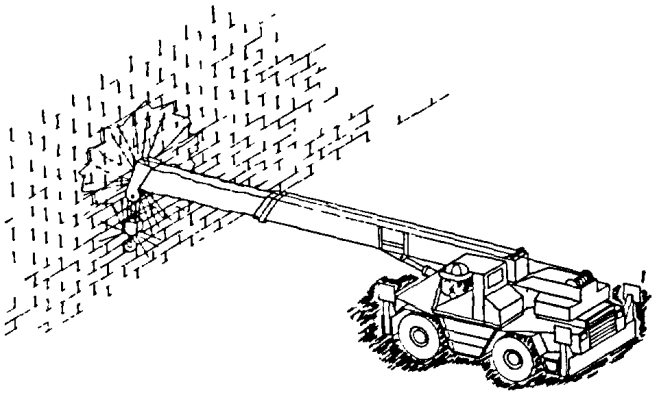


Fig. 46
Never use a hydraulic crane boom to push or pull.

7 **Never use a hydraulic crane boom to push or pull.** It is not designed for this purpose. Such action car) damage the boom and lead to an accident later on.

8 **Never operate a hydraulic crane at radii or boom lengths where capacity chart shows no capacity.** In some cases the machine can tip over with no load on the hook. This is particularly true over the side when on rubber, where these machines are the least stable. Also, if the boom Is fully extended at a low angle, the machine may tip until the boom touches the ground. In any case, Injury or machine damage may result.

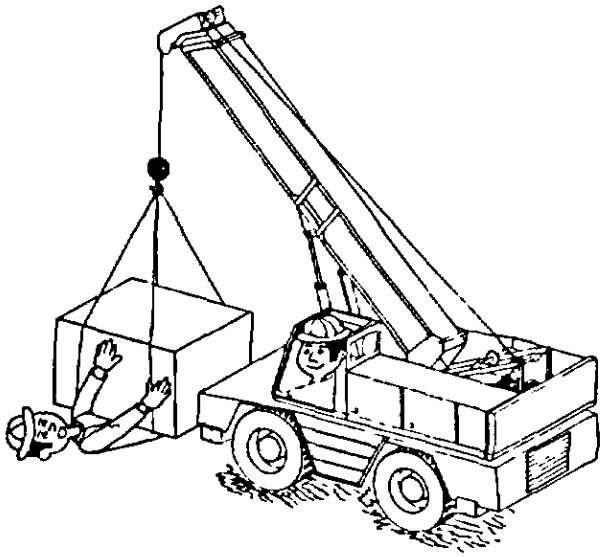


Fig. 47
When boom retracts load will lower

9 **When lowering or retracting the boom, the load will lower.** To compensate for this, the operator must take up on the hoist rope. Otherwise, movement of the load may cause an accident.

When extending the boom, the load will raise. The operator must let off on the hoist rope to keep the load in place. Extending the boom without letting off on the rope can lead to "two blocking". This is when the head sheaves contact the hook sheaves or ball. Two blocking can lead to machine damage, rope breakage, and load dropping.

10 When extending or lowering a boom with a load, load radius Increases. As radius Increases, capacity decreases. If capacity Is exceeded, the boom may bend, as the safety factor in the boom hoist cylinders exceeds the strength of the boom, or the machine may tip over. Sometimes, at low angles, a hydraulic crane boom can be extended with a load, but cannot be retracted. This Is because more power Is available In the boom cylinders to extend than to retract. If an operator extends his boom under load, thinking he can retract If he gets Into a precarious condition, it may cause an accident.

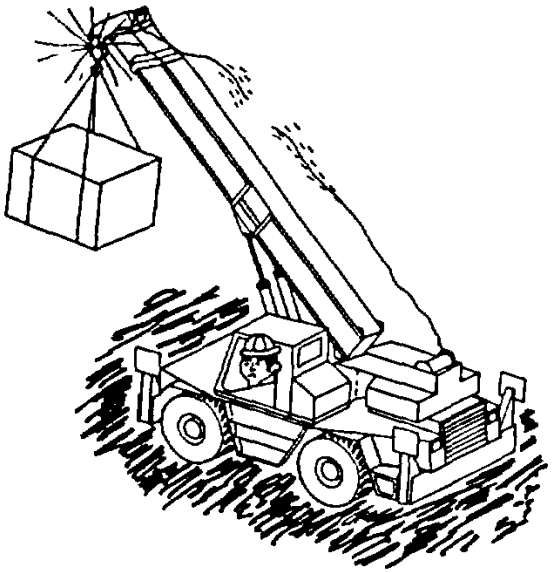


Fig. 48

Avoid two blocking

11 Most capacities on hydraulic machines are based on strength of materials. In these cases, overloads will cause something on the machine to break, before it will tip. Never use signs of tip as warning of overload.

12 When operating off the boom with the Jib Installed, deductions from the capacity chart must be made. The weight of the jib, backstops, stays, etc. must be subtracted from the capacity on the chart to obtain a "net" capacity. Failure to do so will result in an overload condition which can cause boom failure or machine tipping.

13 The boom must be extended In the correct manner before making a lift. On machines with single lever control, the smallest boom section extends first, then the next largest, etc. If one section starts to extend before the next smaller section Is fully extended, the boom has "sequenced" Incorrectly. When this happens, capacities must be considerably reduced if the machine is to be operated.

On machines with two-lever control, telescope the boom sections out equally. Load charts for these machines are bases on equally extended boom sections.

14 Know the load radius. This is particularly important on hydraulic cranes. Any two of three variables (1) boom length, (2) boom angle, (3) load radius must be known to properly figure what load can be lifted. On hydraulic cranes, it Is difficult to figure the boom length. This fact makes it Imperative that load radius and boom angle be known. Measure the radius with a steel tape. Find the boom angle by reading the angle Indicator.

15 Be careful when swinging a long load. While this applies to all cranes, it is particularly important on hydraulic yard cranes where the operator sits In a cockpit In the carrier frame. If one end of the load catches on an obstruction, the other end may hit the machine.

OPERATOR'S MANUAL

SECTION 0 - OPERATING SAFETY (CON'T)

Maximum lifting capacities based on wire rope strength.

Parts Of Line	3/8" Dia (9 52mm)	1/2" Dia (12 7mm)			5/8" Dia (15 87mm)					3/4" Dia (19 05mm)			
	Type A	Type A	K	N	Type A	F	K	N	P	Type A	K	N	P
1	3,400 1542,2kg	6,100 2766 9kg	3,900 1760 kg	7,600 3447,3kg	9,500 4309 1kg	10,200 4626,6kg	6,100 2760 kg	11,700 5307 03kg	6,700 3030 kg	13,600 6168,8kg	8,700 3940 kg	16,800 7620,3kg	9,600 4350 kg
2	3,900 3129 8kg	12,200 5538 8kg	7,800 3520 kg	15,200 6894 6kg	19,000 6618 3kg	20,400 9253,4kg	12,200 5520 kg	23,500 10659 6kg	13,400 6060 kg	27,200 12337 9kg	17,400 7880 kg	33,600 15240 9kg	19,200 8700 kg
3	10,400 4717 4kg	18,300 8300 7kg	11,700 5280 kg	22,800 10341 9kg	28 500 12972 7kg	30,600 13880 1kg	18,300 8280 kg	35,300 16012kg	20,10C 9090 kg	40,800 18506,8kg	26,100 11820 kg	50,400 22861 kg	28 800 13050 kg
4	13,900 6304,9kg	24,400 11067 6kg	15,600 7040 kg	30,400 13789 2kg	38,100 17282 1kg	40,900 18552,2kg	24,400 11040 kg	47,000 21319, kg	26,800 12120 kg	54,400 24675,8kg	34,800 15760 kg	67,200 30481,9kg	38,400 17400 kg
5	17,400 7892 5kg	30,500 13834 5kg	19 500 8800 kg	38,000 17236 5kg	47,700 21636 7kg	51,100 23178 9kg	30,500 13,800 kg	58,800 26671 7kg	33,500 15150 kg	68,000 30844 8kg	43,500 14700 kg	84,000 38102 4kg	48,000 21750 kg
6	20,900 9480kg	36,000 16329 3kg	23,400 10560 kg	45,600 20683 8kg	57,200 25945 9kg	61,300 27805,7kg	36,600 16560 kg	70,600 32024 2kg	40 200 18180 kg	81,600 37013 7kg	52,200 23640 kg	100,800 45722 8kg	57,600 26100 kg
7	24,400 11067 65kg	42,800 19413,7kg	27,300 12,320 kg	53 200 24131 1kg	66,800 30300 4kg	71,600 32477,6kg	42,700 19320 kg	82,400 37376 6kg	46,900 21210 kg	95,200 43182 7kg	60,900 27580 kg	117,600 53343 3kg	67,200 30450 kg
8	27,800 12609 9kg	48,900 22180,6kg	31,200 14080 kg	60,800 27578 8kg	76,300 34609,6kg	81,800 37104 5kg	48,800 22080 kg	94,100 42683,7kg	53 600 24240 kg	108 800 49351,7kg	69,600 31520 kg	134,400 60963,8kg	76,800 34800kg
9	31,300 14197 0kg	55,000 24947 6kg	35,100 15840 kg	68,400 31026 2kg	85 800 38918 9kg	92,000 41731 2kg	54,900 24840 kg	105,900 48036 2kg	60,300 27220 kg	122,400 55520 5kg	78,300 35460 kg	151,200 68584 3kg	86,400 39150 kg
10	34,800 15785 01kg	61,100 27714 5kg	39,000 17600kg	76 000 34473 6kg	95,400 43273 4kg	102,200 46357,9kg	61,000 27600 kg	117,700 53388 7kg	67,000 36300 kg	136,000 61689 6kg	87,000 39400 kg	168,000 76204 8kg	96 000 43500 kg
11													
12													

Parts Of Line	7/8" Dia. (22 22mm)				1" Dia. (25 4mm)		1-1/8" Dia. (28 57mm)		1-1/4" Dia (31 75mm)			
	Type F	K	N	P	Type N	P	Type N	P	Type M	N	P	T
1	19,700 8935,9kg	11,800 5350 kg	22,700 10296,7kg	13,000 5890 kg	29,500 13381,2kg	16,800 7620 kg	37,100 16828,6kg	21,200 9610 kg	45,600 20684,1kg	45,600 20684 1kg	26,000 11790 kg	48,000 21772,8kg
2	39,500 17917 2kg	23,600 1070 kg	45,400 20593 4kg	26,000 11780 kg	59,000 26762,4kg	33,600 15240 kg	47,200 21409 9kg	42,400 19220 kg	91,200 41368 3kg	91,200 41368 3kg	52,000 23580 kg	96,000 43545 6kg
3	59,300 26898,5kg	35,400 16050 kg	68,200 30935,5kg	39 000 17670 kg	88,600 40188,9kg	50,400 22860 kg	111,400 50531 kg	63,600 28830 kg	136,800 62052 5kg	136,800 62052,5kg	78 000 35370 kg	144,000 65318,4kg
4	79,000 35834 4kg	47,200 21400 kg	90,900 41232 2kg	52,000 23560 kg	118,100 53570,1kg	67,200 30480 kg	148 500 67359,6kg	84,800 38440 kg	182,400 82736 6kg	182,400 82736,6kg	104,000 47160 kg	192,000 87091,2kg
5	98,800 44815 7kg	69,000 26750 kg	113,700 51574 3kg	65,000 29450 kg	147,700 66996 7kg	84,000 38100 kg	185,700 84233kg	106,000 48050 kg	228,000 103420 8kg	228,000 103420 8kg	130 000 58950 kg	240,000 108864 0kg
6	118,600 53796 9kg	70,800 32100 kg	136,400 61871 1kg	78,000 35340 kg	177,200 80377,9kg	100,800 45720 kg	222,800 101062 kg	127,200 57600 kg	273,600 124104,96kg	273,600 124104 9kg	156,000 70740 kg	288,000 130636,8kg
7	138,400 62778 2kg	82 600 37450 kg	159,200 72213,1kg	91,000 41230 kg	206,800 93804,4kg	117,600 53340 kg	260,000 117936 kg	148,400 67270 kg	319,200 144789kg	319,200 144789,1kg	182,000 82530 kg	336,000 152409,6kg
8	158,100 71714 2kg	94,400 42800 kg	181,900 82509 8kg	104 000 47120 kg	236,300 107185 6kg	134,400 60960 kg	297,100 134764kg	169 600 76880kg	364,800 165433 3kg	364,800 165473 3kg	208,000 94320 kg	384,000 174182,4kg
9	177,900 80695 4kg	106,200 48150 kg	204,600 92806 5kg	117,000 53010 kg	265,800 120566 8kg	151,200 68580 kg	334,200 151593kg	190,800 86490 kg	410,400 186157 4kg	410,400 186157 4kg	234,000 106110 kg	432,000 195955,2kg
10	197,700 89676 7kg	118 000 53500 kg	227,400 103148 6kg	130 000 58900 kg	295,400 133993 4kg	168,000 76200 kg	371,400 168467 kg	212,000 96100 kg	456,000 206841,6kg	456,000 206841,6kg	260,000 117900 kg	480,000 217728 0kg
11					324,900 147374 5kg	184,800 83820 kg	408,500 185295 6kg	233,200 105710 kg	501,600 227525 kg	501,600 227525,8kg	286,000 129690 kg	528,000 239500,8kg
12					354,500 160798 5kg	201,600 91440 kg	445,700 202166 1kg	254,400 115320 kg	547,200 248205 7kg	547,200 248205,7kg	310,000 141480 kg	576,000 261273 6kg

FMC Type	Description
A	6 x 24 (6 x 19 Class) - Filler wire - improved plow steel - preformed - fiber center - right lay - regular lay
F	6 x 25 (6 x 19 Class) - Filler wire - improved plow steel - preformed - I W R C. - right lay - regular lay
K	19 x 7 Rotation Resistant - Extra improved plow steel - preformed - wire center core
M	6 x 25 (6 x 19 Class) - Filler wire - extra improved plow steel - preformed - wire I W R C. - right lay - lang lay
N	6 x 25 (6 x 19 Class) - Filler wire - extra improved plow steel - preformed - - I.W.R.C. - right lay - regular lay
P	19 x 7 Rotation Resistant - extra improved plow steel - preformed - wire center core
T	6 x 30 Flattened Strand - Extra improved plow steel - preformed - I W R.C. - right lay - lang lay - style G

Capacities shown on crane capacity plate must not be exceeded. Capacities on this chart are shown in both pounds and kilograms. Study operator's manual for wire rope inspection procedures and consult parts manual for wire rope size and type requirements.

SECTION 00

INTRODUCTION

00-1. Scope. This publication applies to Department of the Army units, organizations, and activities that use and/or support the Crane, Mobile, Container Handling, 140-ton, Truck Mounted, FMC Link-Belt Model, HC-238A.

00-2. Description. The crane is a truck mounted, 140-ton capacity crane unit. It is mounted on an 8 x 4 chassis and is diesel engine driven. It has a 50 foot lattice boom which is capable of being supplemented/adjusted with the use of various length boom extensions. The crane is a basic commercial model with minor ancillary items added for military use.

00-3. Maintenance Forms and Records. Operational, maintenance, and historical records will be maintained as required by the current TM 38-750.

00-4. Reporting of Errors. For correction of errors or recommended improvements to this publication, use DA Form 2028 (Recommended Changes to Publications and Blank Forms) and mail direct to: Commander, US Army Tank-Automotive Command, ATTN: DRSTA-MB, Warren, MI 48090. A reply will be furnished directly to you.

00-5. Equipment Improvement Recommendations (EIR). Equipment Improvement Recommendations will be submitted IAW TM 38-750.

00-6. Equipment Readiness Reporting. Readiness reporting will be accomplished as required by the current TM 38-750.

00-7. Shipment and Storage.

a. Shipment and Storage. Refer to TB 740-97-2 for procedures covering preservation of equipment for shipment and storage. General procedures for shipment are found in FM 5-15. Refer to Appendix E for further transportation guidance.

b. Administrative Storage. Refer to TM 740-90-1 for instructions covering administrative storage of equipment.

c. Weight Classification. The gross vehicle weight of the 140-ton Crane in a fully operational configuration is approximately 303,350 lbs. For component weight breakdown, see page 9-4.

00-8. Maintenance of New Vehicles. Upon delivery of the 140-ton Mobile Crane, perform the checks and services listed on page 1-6, paragraphs 1-5, 1-6, and 1-7.

NOTE:

For your protection, make a thorough inspection of the vehicle immediately upon delivery. If any discrepancies are noted, notify the transit agent and have delivering carrier make a notation on the freight Bill of Lading AT ONCE.

00-9. Destruction to Prevent Enemy Use. Refer to TM 750-244-3 for procedures covering destruction of equipment to prevent enemy use.

Operator's Manual Section 1 - Operating Instructions

Index, Section 1

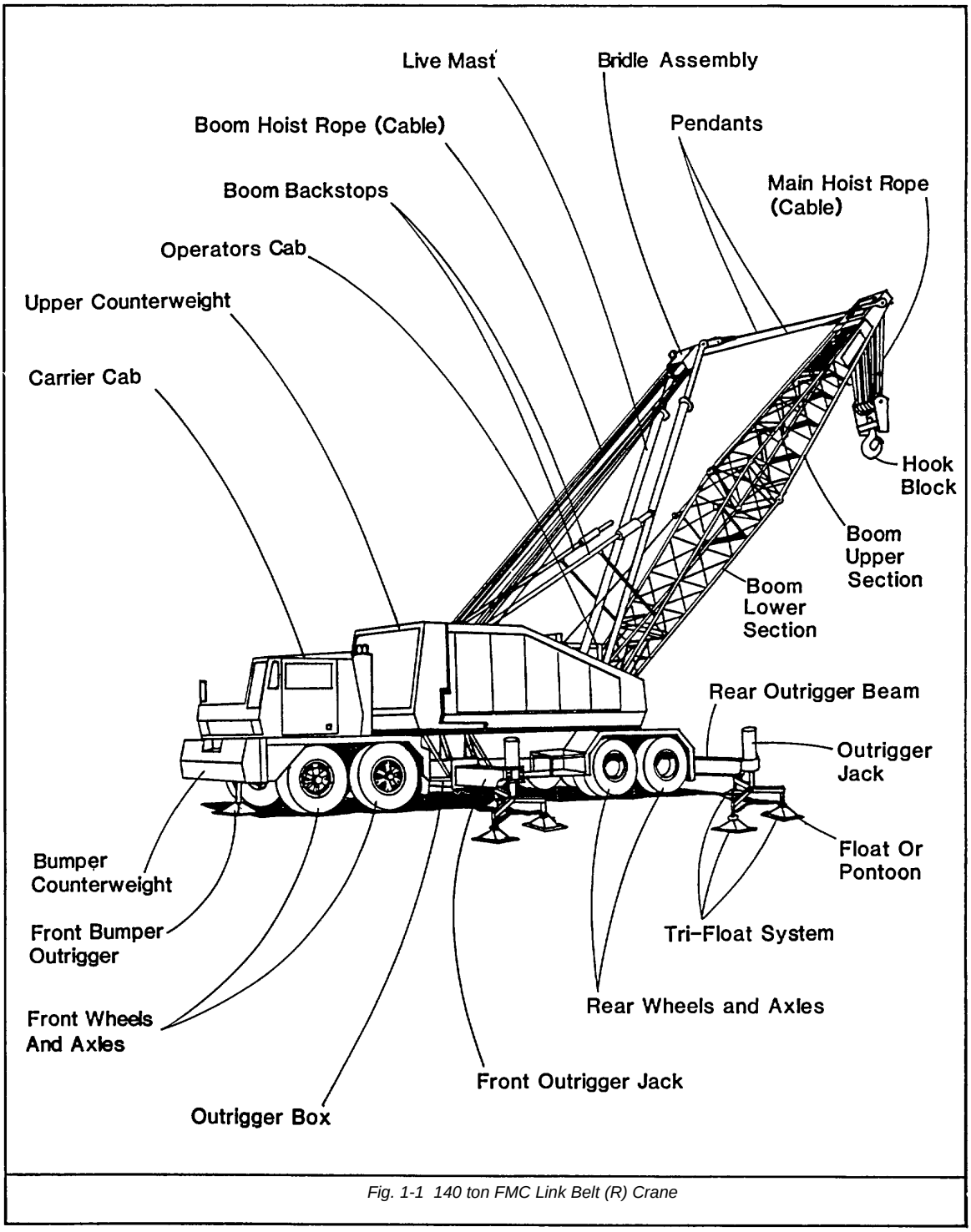


Fig. 1-1 140 ton FMC Link Belt (R) Crane

1-1 General Information

This manual contains operating and maintenance instructions for an FMC Link-Belt® HC238A, 140 ton capacity crane. The machine is manufactured by FMC Corporation in Bowling Green, Kentucky.

The HC238A is a truck mounted crane. It is designed to lift, handle, and place loads, of up to 140 tons.

1-2 Truck Carrier Assembly: The truck carrier uses 8 X 4 drive. A one man cab, offset to the left is used. All controls and instruments necessary to drive the carrier are inside the cab.

The carrier is powered by a Detroit Diesel 6V92TC engine. The engine is a two stroke cycle design. A blower is used to force air into the cylinders to expel exhaust gases and supply the cylinders with fresh air from combustion.

Power from the engine is delivered to a Fuller Road Ranger RTO 915 transmission. A Lipe Rollway double disc clutch connects the two.

The transmission has a 5 speed front section, and a two speed rear section which enables the driver to select 10 forward speeds, evenly and progressively spaced. An additional 5 ratios are obtained with a deep reduction gear. The 5 deep reduction gears are evenly and progressively spaced, however they overlap the low range ratios.

Output from the transmission is delivered to a two speed creeper transmission through a drive tube. The high gear ratio in the creeper transmission is 1 to 1, and is used for all normal driving situations. The second ratio is lower, and is only used when driving (creeping) the carrier into position on a job site with the crane boom in place.

Output from the creeper transmission is delivered to the two rear axles by drive tubes. The rear axles are double reduction Clark planetary units. The primary reduction is in the differential. The secondary reduction is in the planetary wheel hubs.

The front axles are Shuler tubular axles. The axles are connected by a steering linkage. The steering is mechanical, with hydraulic power assist. A Vickers power steering pump, driven off the carrier engine, a Ross steering gear and two hydraulic cylinders comprise the power steering system.

Air brakes are used on all four axles. They are powered by a compressor driven from the carrier engine. The actuators on the two rear axles are two section. One section provides service brakes, and the other provides a park or emergency brake. The park or emergency brake section contains a mechanical lock. This lock keeps the park or emergency brake applied even if air pressure is lost.

The carrier uses hydraulic outriggers. They are used to lift the machine clear of the ground, and to level it, when picking up heavy loads.

A hydraulic system consisting of a pump, sump tank, valves, and cylinders operate the outriggers.

The Vickers pump is driven off the main transmission by a Tulsa products power take off.

The pump delivers oil under pressure to two control valve stacks. One valve stack controls the outrigger beam cylinders. The other controls the outrigger jack cylinders. The valves are electrically actuated from control panels on the carrier. Four control panels are used, with one located near each hydraulic outrigger jack.

The beam cylinders extend or retract the outrigger beams horizontally. The jack cylinders raise or lower the machine vertically.

1-3 Upper Machinery: The upper machinery is powered by a Detroit Diesel 6-71 series engine. The engine is a two stroke cycle design, inline, 6 cylinder. A blower is used to force air into the cylinders to expel exhaust gases and supply the cylinders with fresh air for combustion.

Power from the engine is delivered to an Allison single stage torque convertor. The torque convertor supplies power to drive the upper machinery.

A pinion on the convertor is connected to a chain wheel on the upper machinery with a roller chain. The chain is enclosed in a chain case which contains oil for lubrication of the chain and gear teeth.

The chain wheel is connected to a reduction shaft, which has two pinions. One pinion drives the R.H. gear train. The other pinion drives a countershaft. A pinion on the countershaft drives the L.H. gear train.

Four horizontal shafts are used in the upper machinery. Two are used for lifting loads, the front drum and rear drum shaft. One is used to raise or lower the boom, the boom hoist shaft. The fourth is used to swing the machine, the reverse shaft.

The upper machinery swings on a large ball bearing, the turntable bearing. A pinion on the vertical swing shaft engages teeth on the turntable bearing to swing the machine. The vertical swing shaft is powered by the reverse shaft through a pair of bevel gears. Mechanical brakes are used on the load shafts. An external band brake operates on a drum mounted on the shaft. The brakes are applied and released by pedals in the operators cab through linkage.

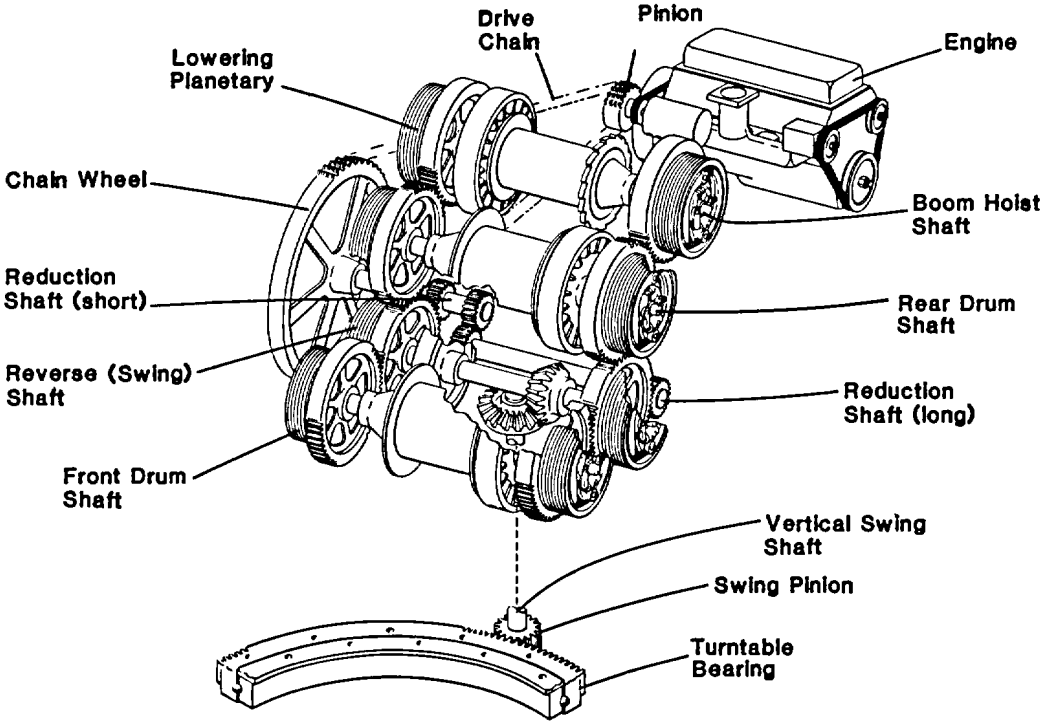


Fig. 1-2 Upper Machinery

A spring applied hydraulically released brake is used on the boom hoist shaft, and on the reverse shaft for a swing brake.

A mechanical swing lock is used to lock the upper to the turntable bearing to prevent swinging. A pawl mounted on the upper engages the teeth on the bearing. It is engaged and disengaged through linkage and a control lever from the operators cab.

An S-o-M (Speed-o-Matic) hydraulic control system is used on the upper. A pump, belt driven by the engine, provides hydraulic pressure for the system. It circulates oil from a sump tank to the hydraulic power supply. Oil is stored in an accumulator in the hydraulic power supply, under pressure. This pressurized oil is directed to control valves in the operator's cab. The control valves meter oil under pressure to clutches on the horizontal shafts to engage them, to lift a load.

1-4 Upper Operating Theory: Refer to Fig. 1-4. Each of the three main shafts operate in the same manner. The shaft is mounted on bearings in the upper frame. A cable drum (lagging) and brake drum are splined to the shaft, between the two sides of the upper frame.

A clutch drum, spur gear assembly is mounted on each end of each shaft, except the R.H. end of the boom hoist shaft. A planetary speed reducer and gear are mounted there.

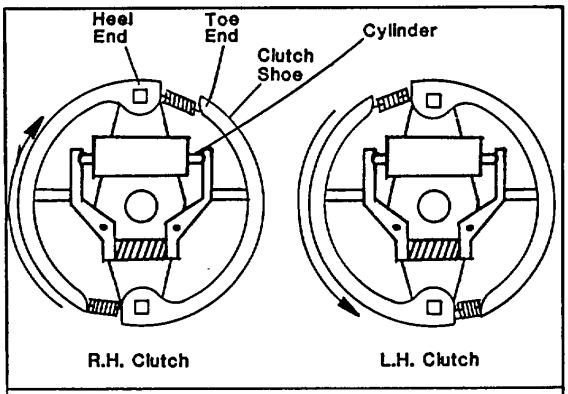


Fig. 1-3 Clutch Schematic

The gear/drum assemblies ride on the shaft on bearings. They are not connected to the shaft.

All of the gears on the R.H. side of the frame are in mesh. All of the gears on the L.H. side of the frame are in mesh also.

A clutch assembly is mounted on each end of each shaft (except the R.H. side of the boom hoist) inside the clutch drum. Although we call the assembly a clutch, it actually resembles an automotive brake with two shoes. The clutch is connected to the shaft by splines.

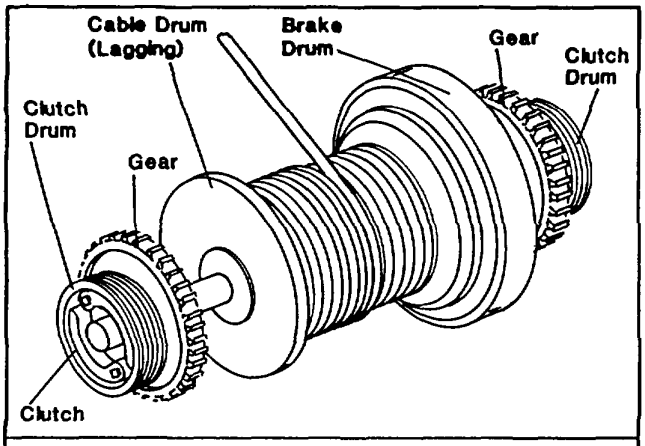


Fig. 1-4 Shaft Schematic

When the engine is running with the master clutch engaged, all of the gears in the gear train will turn. The shafts remain stationary, held in place by a brake.

When the operator wants to rotate a shaft, to raise/lower a load, or the boom, or to swing the machine, he releases the brake on that shaft, and engages the control lever.

When he engages the control lever, oil under pressure from the S-o-M system enters the clutch cylinder (See Fig. 1-3). The cylinder extends, forcing the clutch shoes into contact with the clutch drum. This couples the drum and gear, which are moving, to the shaft and cable drum, forcing them to move.

The gear/drum on each end of the shaft turn in opposite directions. By engaging one clutch or the other, the direction of rotation of the shaft changes, to either raise or lower a load or the boom, or to swing right and left.

All clutches used on Link-Belt® machines operate in the same way. Each has two shoes which are hydraulically applied, and spring released. The clutches are controlled by a hand lever on the operator's control stand. Actuating the lever opens a control valve allowing Speed-o-Matic oil under pressure to flow to the clutch cylinder and apply the clutch. When the control lever is returned to neutral, porting is opened in the valve allowing oil in the clutch cylinder to flow back to sump tank. The clutch return springs then disengage the clutch.
The clutch assemblies on any given machine may be assembled for right or left hand rotation depending upon their use on the machine.

Clutch assemblies of the same size and type are interchangeable from one location to another, but may or may not be assembled for the right rotation.
To define L.H. and R.H. clutches two other terms must be defined: toe and heel end. The toe is the end of the clutch shoe which first engages the clutch drum. The heel is the pivoting point of the clutch shoe and engages after the toe.

A R.H. clutch may now be defined as one, which when assembled and an arrow drawn from toe of shoe to heel of shoe, it will point in a clockwise direction. A L.H. clutch is one where an arrow drawn from toe to heel would point in a counter-clockwise direction.

To further clarify proper clutch installation, all clutches must be installed in an energized position. That is, so the drum rotates from the "toe" or live end of the clutch shoe to the "heel" or dead end of the clutch shoe. In this way the clutches will be self energized (energized by clutch drum rotation).

There are several applications where the load is actually the driving force and acts to energize the clutch. In this case, the clutch must be installed with the drum rotating from heel to toe.

These applications are:
(a) Front drum lowering clutch when used in crane work.
(b) The rear drum lowering clutch.

On the R.H. (lowering side) of the boom hoist shaft, a low speed planetary is used. This is a planetary speed reducer, to allow for low speed and fine control when lowering the boom.

When the operator pushes on the control lever to lower the boom, an external brake on the planetary case applies, holding the case stationary. The spur gear on the shaft drives the planet gears inside the unit. The planet gears drive the boom hoist shaft to lower the boom.

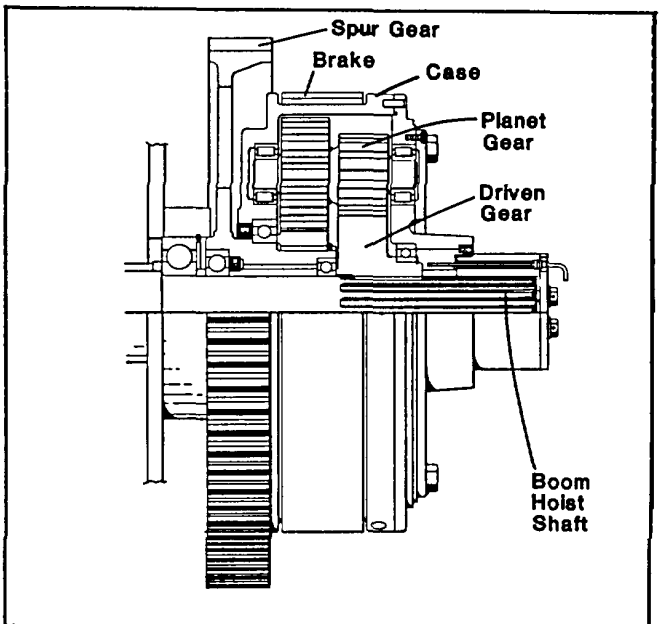


Fig. 1-5 Boom Lowering Planetary

1-5 On Delivery

On delivery of a new machine, make the following checks:

(a) General (Upper and Carrier)
  (1) Check for any shortages or damages that may have occurred during transit. If any, notify the transportation company involved immediately.
  (2) Clean dirt, paint, or any other foreign material from the machine. Remove all wires, wire ropes, and other hold downs used during shipping.
  (3) Check all gear compartments for the proper weight and level of lubricants. If necessary, change to meet local conditions. (See section 2 of this manual).

(b) Engine (Upper and Carrier)
  (1) Check the fuel, oil, water levels. Start the engine and check the oil pressure, water temperature, ammeter, etc. For more information, consult pages 1-8, 1-9, and 1-18.

(c) Brake System (Carrier only)
  (1) Check air pressure, 115-125 psi. (792861 kPa) maximum.
  (2) Check low air pressure warning device for operation at 60 psi (413 kPa).
  (3) Check foot brake operation.
  (4) Check emergency brake operation.

(d) Clutches and Brakes (Upper only)
  (1) Check adjustment of all clutches and brakes before operating the machine.
  (2) Inspect clutches and brakes for loose or damaged cotter pins, bolts, nuts, jam nuts, misalignment, damage, foreign matter, oil or grease on friction surfaces, etc. If any, repair or correct before operating.

(e) Hydraulic System (Upper and Carrier)
  (1) Check for leaks or damage.
  (2) Check for correct operating pressures.
  (3) Check pump belt tension. (S-o-M pump).
  (4) Check for proper oil level in all sump tanks.

(f) Torque Converter Sump (Upper) (1) Check for leaks or damage.
  (2) Check for proper oil level.

(g) Electrical Systems
  (1) Check headlights, clearance lights, turn signals, parking lights, windshield wipers, horn, etc.
  (2) Check all instrument panel gauges.
  (3) Check battery water level. Fill as required.

(h) Master Clutch (Upper only)
  (1) Before engaging the master clutch, read this manual in its entirety. Inspect the machine for anything that interferes with moving parts before engaging the master clutch.

(i) Lubrication
  (1) Fully lubricate the machine as explained in section 2 of this manual.

1-6 Break In Period: Operate a new machine at half throttle for the first 16 hours (two shifts) of operation. A break in period under moderate loads will assist in providing long, trouble free performance.

1-7 Before Starting Operations: Before starting daily operations, make the following checks:

(a) Engine (Upper and Carrier)
  (1) Check the fuel, oil, and water levels.
  (2) Fill as required.

(b) Hydraulic System (S-o-M and Outrigger)
  (1) Check all hoses for chafing, bulging, or other damage. Replace if necessary before operating.
  (2) Check for external leaks. Repair them before operating.
  (3) Check oil level. Add oil if necessary.

(c) Gear Cases (Upper and Carrier)
  (1) Visually inspect all gear cases for leak age or damage. If any, repair before operating.
  (2) If leakage is evident, fill the case to proper level before operating.

(d) Controls (Upper and Carrier)
  (1) Check all controls for proper operation.
  (2) Adjust or repair if necessary before operating.

(e) Tires and Wheels (Carrier only)
  (1) Test for proper tire inflation for operating conditions. Consult tire inflation chart in carrier cab or section 3 of this manual.
  (2) Check wheel nuts. Tighten evenly as necessary.

(f) Brakes (Carrier only)
  (1) Check air pressure 115-125 psi (792-861 kPa) maximum.
  (2) Check low air pressure warning device for operation at 60 psi (413 kPa).
  (3) Check foot brake operation.
  (4) Check emergency brake operation.

(g) Electrical System (Carrier and Upper)
  (1) Check headlights, clearance lights, turn signals, parking lights, tail and stop lights, windshield wipers, horn, etc.
  (2) Check all instrument panel gauges.

(h) General:
  (1) Visually inspect the entire machine for loose or missing bolts or cotter pins, cracked welds, frayed, worn, or damaged ropes, dented or damaged boom chords or lattice, etc. Repair or replace any damaged, worn, or missing components before operating the machine.
  (2) Visually inspect all clutch and brake linings for evidence of wear, or grease and oil on the linings. If any, replace before operating.

(i) Torque Converter Sump (Upper only)
  (1) Check the oil level. Add oil if necessary.
  (2) Check for external leaks. Repair them before operation.

(j) Lubrication:
  (1) Lubricate the machine as specified in section 2 of this manual.

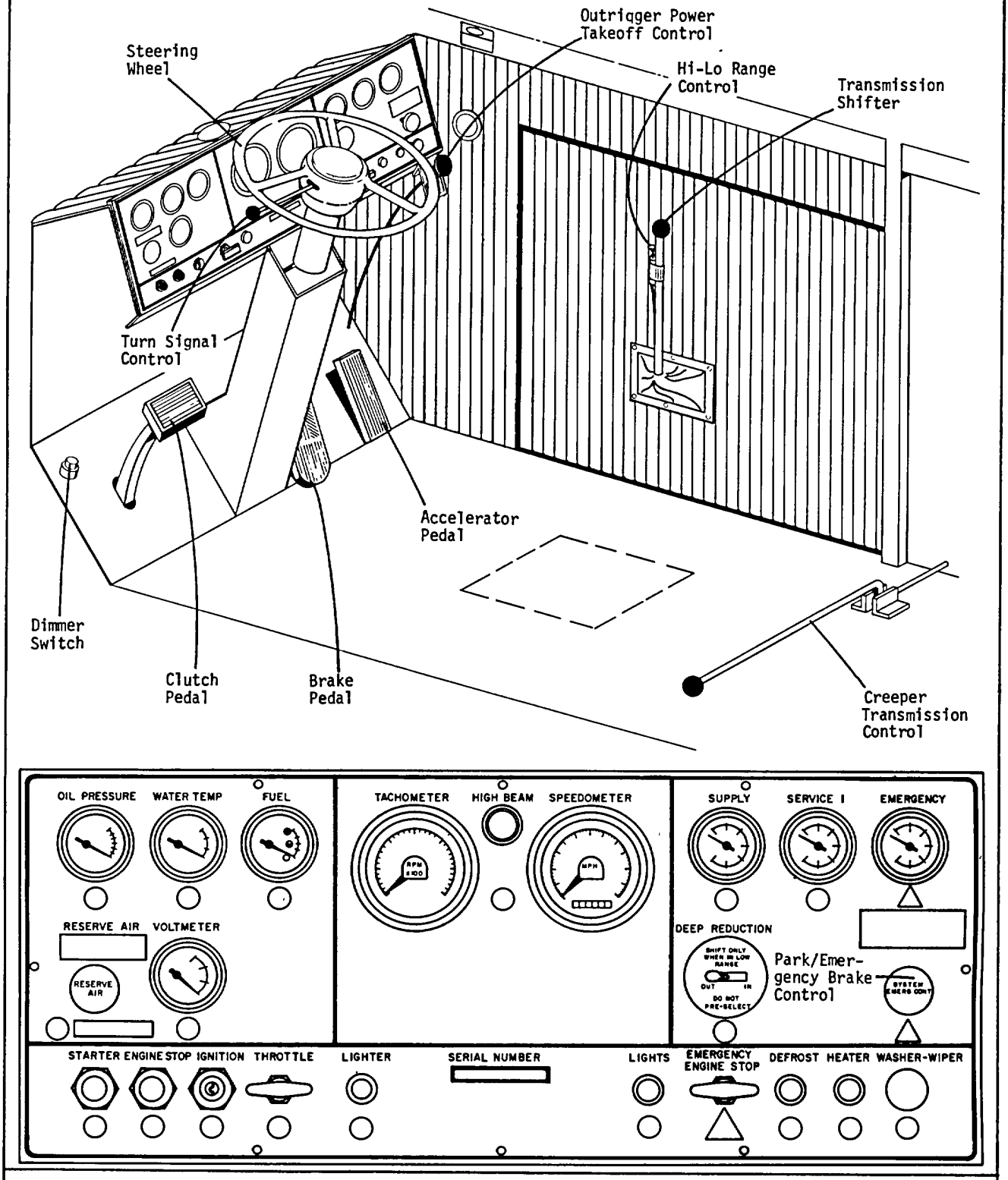


Figure 1-6
Carrier Controls

NA213-B,NA230-D

Note: Even though the operator may have nothing to do with lubrication or maintenance of the machine, it would be advantageous for him to read the maintenance sections of this manual. Knowledge of protective maintenance may allow the operator to spot a malfunction in the machine so repairs may be made with a minimum of downtime.

1-8 Carrier Operation:

The following series of paragraphs explain the operation of the various controls on the carrier. Read the information before operating the carrier.

1-9 Starting And Stopping The Engine:

The ignition switch is operated with a key. This prevents unauthorized persons starting the engine. Turn the key to the on position before starting the engine. Push starter button while depressing accelerator to start the engine.

Note: Don't operate the starter more than 15 seconds at a time when starting the engine.

The key must be in the on position for accessories to work.

Run the engine at part throttle and no load for about 5 minutes, allowing it to warm up, before applying a load.

During long engine idling periods, the engine coolant temperature may fall below the normal operating range. The incomplete combustion of fuel in a cold engine will cause crankcase dilution, formation of lacquer or gummy deposits on the valves, pistons and rings and rapid accumulation of sludge in the engine.

Note: When prolonged engine idling is necessary, maintain at least 800 RPM.

To stop the engine, turn key to off position. Depress engine stop button until engine stops running.

After engine stops running, remove key and take it with you to prevent starting by unauthorized persons.

1-10 Service Brake Pressure Gauge: This gauge indicates the air pressure available to operate the service brakes. The gauge should read between 115 and 125 psi (792-861 kPa). If the gauge doesn't show the correct pressure, repair the system before operating the carrier. Otherwise sufficient braking force may not be developed and a serious accident may occur.

1-11 Supply Air Pressure: This gauge indicates the pressure, available from the compressor, before it is reduced to operate the service brakes. The gauge should register 140 to 150 psi (965-1034 kPa). A tire inflation hose may be plugged into the air brake system to use this pressure to inflate carrier tires. See tire inflation chart in section 3 of this manual.

1-12 Emergency Air Pressure: This gauge indicates the amount of air pressure available to operate the park or emergency brake. The gauge should register 115 to 125 psi (792-861 kPa). If the gauges do not register the correct pressure, correct the problem before driving the carrier or sufficient emergency braking force may not be developed and a serious accident may occur.

Note: There must be at least 60 psi (413 kPa) pressure in both service and emergency brake systems before the carrier will move. Otherwise the park brake will not release.

If air pressure is lost while roading the machine, the emergency brakes will automatically apply when air pressure drops to approximately 40 psi (275.8 kPa).

1-13 Park And Emergency Brake Control: When the park or emergency brake control is actuated, air under pressure from the emergency brake system is directed to the park or emergency brake diaphragm in the rear actuators, applying the rear brakes. At the same time, a mechanical lock locks the actuator in place so the brakes can't release. To unlock the brake, air pressure must be exhausted from the park or emergency diaphragm and air pressure must be applied to the locking mechanism. To apply the park or emergency brake, pull the control out. To release the brakes, push the control in and at the same time apply the service brake (depress the pedal) to full system pressure for 10 seconds. Release the pedal and brakes will unlock.

If air pressure is lost in the brake system, the park or emergency control trips at 40 psi (275.8 kPa) and applies the brakes.

1-14 Reserve Air Control: If air pressure is lost from the service brake system while the carrier is being operated, the emergency brakes will apply. Pushing on the reserve air control will route air from the emergency reservoirs to the park or emergency brake control on the cab dash. Pushing this control will release the brakes long enough to move the carrier off the road. Pulling on the park or emergency brake will apply the brakes one last time. There is only enough pressure available to release and then apply the brakes once.

1-15 Low Pressure Warning System: There is a warning buzzer under the cab dash. If air pressure drops below 60 psi (275.8 kPa) in the service brake system, the buzzer will sound. If buzzer sounds while driving the carrier, stop the carrier immediately and determine what is wrong. Repair the problem before driving the carrier again or an accident may occur.

1-16 Engine Oil Pressure: This gauge registers the pressure of the lubricating oil in the engine. As soon as the engine starts the gauge should begin to register. If the gauge does not register pressure listed in the chart below, stop the engine and determine why. Correct the problem before running the engine again or engine damage may result.

1200 RPM	18 p.s.i. (124 kPa) Min. 30-60 p.s.i. (207-414 kPa) Normal
2100 RPM & Up	30 p.s.i. (207 kPa) Min. 40-60 p.s.i. (276-414 kPa) Normal

1-17 Water Temperature: The engine coolant temperature is registered on this gauge.

Normal running temperatures are 160 to 185° F (71 to 850 C).

If the temperature exceeds this, shut down the engine and determine the cause. Correct the problem before running the engine again or engine damage may result.

1-18 Voltmeter: The engine voltmeter measures the voltage produced by the alternator, and indicates the condition of the battery. Refer to Fig. 1-18 for voltmeter readings.

1-19 Fuel Gauge: The fuel gauge indicates the amount of fuel in the carrier tanks. Refill when it nears "E" to avoid running out of fuel.

1-20 Tachometer: The tachometer indicates the number of RPM's the carrier engine is turning.

1-21 Speedometer: The speedometer indicates the speed in MPH that the carrier is traveling. It also contains an odometer which indicates the number of miles the carrier has traveled.

1-22 Throttle: Pulling out on the throttle decreases engine speed. The throttle control can be left in any position if it is necessary to run the engine above idle speed without holding down on the accelerator. Throttle should be fully pushed in when driving the carrier. Otherwise speed setting may be too high for safe handling under traffic or emergency conditions.

1-23 Emergency Shutdown: If an emergency or if after turning key switch off the engine continues to run, pull this control to stop the engine. After the engine stops running, push the control back in and reset the emergency valve on the engine manifold. Correct the malfunction in the engine before starting engine again.

Don't use this control for normal engine stopping. Continued use will damage seals in the blower, causing expensive repairs.

1-24 Headlight Switch: The push pull switch turns on all lights except the headlights when pulled out to the first position. When pulled out to the second position, all lights operate.

1-25 Windshield Wiper Switch: Turning the switch clockwise turns on the wipers. The first position is for low speed, and the second is for high speed.

1-26 Heater and Defroster Switch: Turn switches clockwise to turn on the fan motor. Turn all the way counterclockwise to shut off the fan motors.

1-27 Accelerator: The accelerator controls the rate of fuel flow to the engine through the engine governor. To increase engine speed depress the pedal. To decrease engine speed, release the pedal.

1-28 Brake Pedal: Depressing the brake pedal actuates two valves which meter air pressure to the brake actuators. The farther the pedal is depressed the more air pressure is admitted to the actuators and the harder the brakes are applied. Releasing the brake pedal releases the air pressure from the actuators, allowing the brake shoe springs to release the brakes.

1-29 Clutch Pedal: Fully depressing the clutch pedal disengages the carrier clutch through linkage, clutch rod arrangement.

Raising the clutch pedal allows clutch to engage.

1-30 Dimmer Switch: The dimmer switch located on the floor to the left of the operator controls the high and low beams. When the switch is in the high beam position, all four headlights are on. An indicator light on the dash comes on when the headlights are on high.

1-31 Creeper Transmission Shift Lever: A two speed creeper transmission is used in the carrier to provide both low gear ratios for slow, careful machine movement around the Job site, and higher ratios for normal use. The low ratio is not for extra tractive effort to get out of areas requiring heavy pulls. Using it for such conditions may damage the transmission or drive line.

For normal use the lever must be in the "down" position. For creeper use, the lever must be in the "up" position.

Note: Shift the lever only when the carrier is not in motion to avoid damage to transmission.

1-32 Main Transmission Controls: The main transmission has a 5 speed front section and a high-low range section which allows the operator to select 10 evenly spaced forward speeds with a single control lever and a range control switch. An additional 5 deep reduction speeds may be selected by using a deep reduction valve mounted on the carrier dash.

The five deep reduction speeds, overlap the low range speeds, resulting in a total of 12 evenly spaced forward speeds. The 5 deep reduction speeds are for off highway use, and only when the transmission is in low range. (Range control button down).

The transmission also contains 3 reverse speeds.

1-33 Important Procedures: Do not pre select. When making the shift from a deep reduction ratio to a low range ratio, move the deep reduction valve from in to out immediately before making the shift. This is not a pre select valve and only torque will hold the deep reduction gear after the lever is moved to out. The shift cylinder will make the shift by air as soon as torque is released.

Never move the deep reduction valve lever with the transmission in high range (Range control button up) as the reduction gear by-passes both the low and high range sections regardless of the position of the range control button.

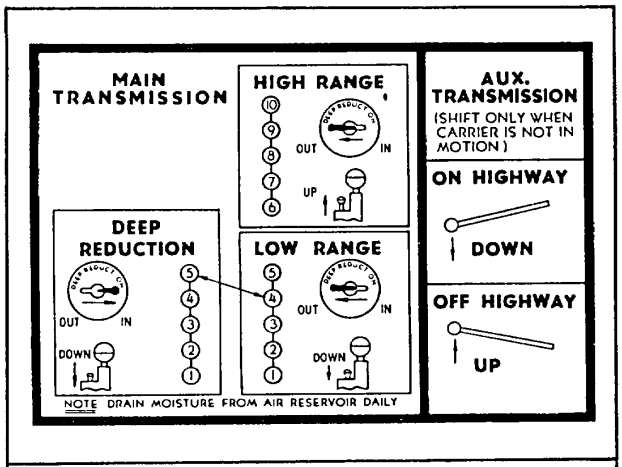


Figure 1-7 Transmission Shift Decal

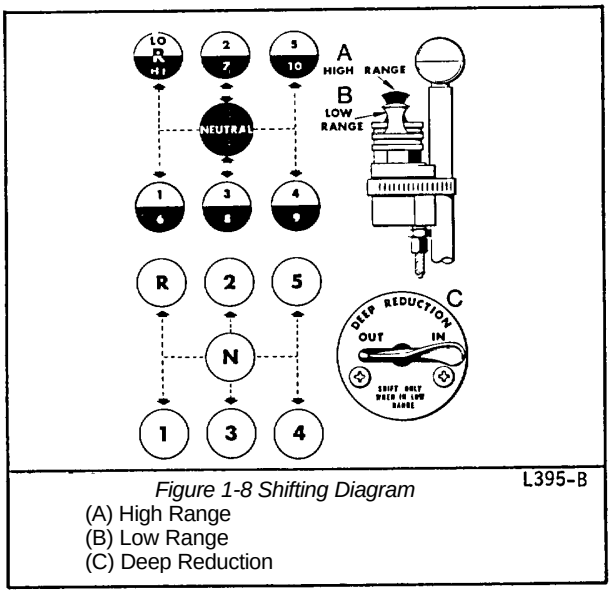


Figure 1-8 Shifting Diagram
(A) High Range
(B) Low Range
(C) Deep Reduction

1-34 Upshifting: There are several patterns of upshifting depending upon conditions of road and load. Check gear ratios to determine the best ratio progression for your particular condition. The following instructions are recommended for normal conditions:

(a) With the gear shift lever in neutral, the engine started, and the air system pressure normal, push the range control button to the down position.

(b) Move the deep reduction valve to the "in" position to engage the deep reduction gears.

(c) Start the vehicle in 1st position of the deep reduction shaft pattern. Once the carrier is moving and adequate momentum has been obtained, the transmission can be shifted from 1st through 2nd, 3rd, 4th, 5th while In deep reduction range.

(d) When ready to upshift from 5th in deep reduction, move the deep reduction valve to the out position and move the gear shift lever to the 4th speed position, thus shifting out of 5th in deep reduction into 4th in low range. Torque will keep the gear engaged until the shift out of deep reduction is made. Remember a shift from deep reduction to low range is an upshift and the accelerator must be moved accordingly. Always declutch when shifting from the deep reduction range.

(e) Shift from 4th to the 5th speed position while in low range.

(f) When ready for the next upshift, pull the range control button up, while in the 5th speed position, and shift the lever to the 1st speed position of the shift pattern, thus shifting from 5th in low range to 6th in high range. As the shift lever passes through neutral, the transmission will automatically shift from low to high range.

1-35 Alternative Shift Procedures: The shift from the deep reduction range to low range can be made from the 2nd, 3rd, or 4th speed gear positions, while in deep reduction, shifting from 2nd in deep reduction to 1st low range, or from 3rd deep reduction to 2nd low range, etc.

1-36 Speed Progression: Where operating conditions warrant, the transmission can be shifted from 1st speed deep reduction to 1st speed in low range. This is a 43% upshift step and the vehicle must have sufficient momentum to accomplish shift. This is a shift usually used in on highway vehicles.

1-37 Down Shifting:

(a) Shift from 10th speed through 9th, 8th, and 7th, to the 6th speed position of high range.

(b) When ready for the next down shift, push the range button to the down position and shift the lever to the 5th speed position. As the shift lever passes through neutral, the transmission will automatically shift from low to high range.

(c) Shift down from 5th through 4th, 3rd, and 2nd, to the first speed position.

When down shifting it should not be necessary to shift into deep reduction ratios. The reduction in low range should be sufficient in most operating conditions.

1-38 Skip Shifting: After becoming proficient shifting the transmission, the operator may want to skip some shifts. Skip shifting may be done going up providing the range button is pulled up before the shift which passes 5th. Skip shifting is possible going down, provided the range button is pushed down to the low range position before the shift which passes 6th.

1-39 Outrigger System: The hydraulic outriggers operate with pressure from a vane type pump, driven by a power take off on the main transmission. This power take off is shifted in and

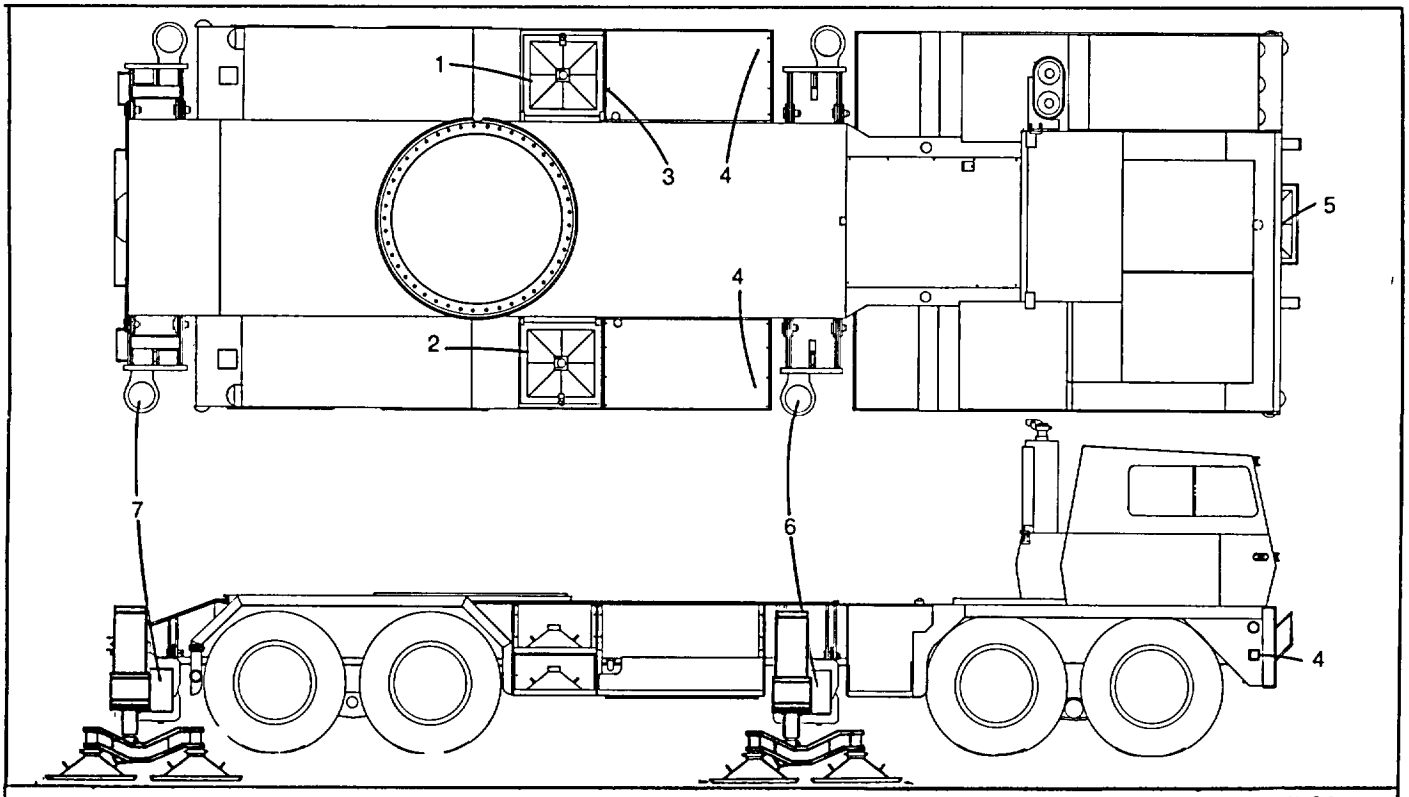


Figure 1-9
Machine Top And Side View

(1) L.H. Pontoon Storage
(2) R.H. Pontoon Storage
(3) Front Outrigger Pontoon Storage
(4) Outrigger Controls
(5) Front Bumper Outrigger
(6) Front Outriggers

out of gear by a pull cable under the carrier dash. (See Fig. 1-6).

Always disengage pump before traveling to prevent damage to outrigger system.

The pressure is routed to the outrigger jack and beam cylinders through a pair of solenoid valve stacks mounted on the carrier.

The valve stacks are actuated by toggle switch on the outrigger control panels.

A second control is located on the R.H. side of the machine near the front bumper(See Fig. 1-10). This switch operates the front bumper outrigger.

Square steel pontoons are used with each outrigger jack. One pontoon is used with the front bumper jack. Three pontoons and an adaptor are used with each of the four side jacks. There are racks on the carrier to store five of the pontoons when roading the carrier. The other pontoons can be carried on the carrier luggage racks. Fasten them securely. If a pontoon should fall off a machine, it could cause a serious accident. Transport the adaptors on an auxiliary truck when roading the machine.

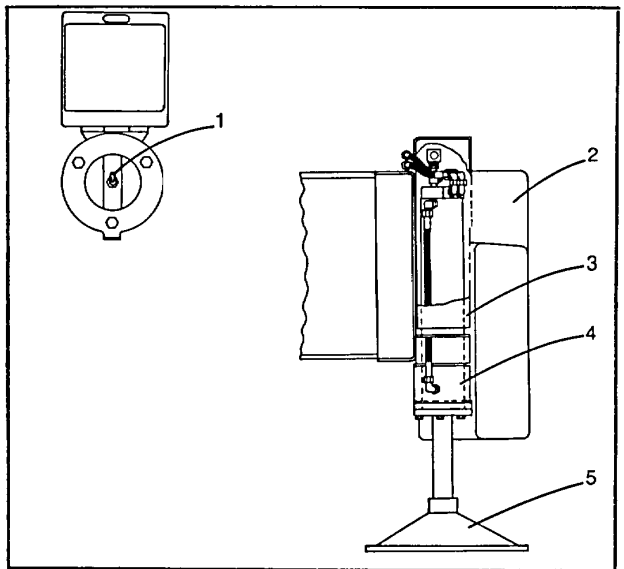


Fig. 1-10
Bumper Outrigger Assembly
(1) Control Switch
(2) Bumper Ctwt.
(3) Outrigger Box
(4) Outrigger Jack
(5) Pontoon

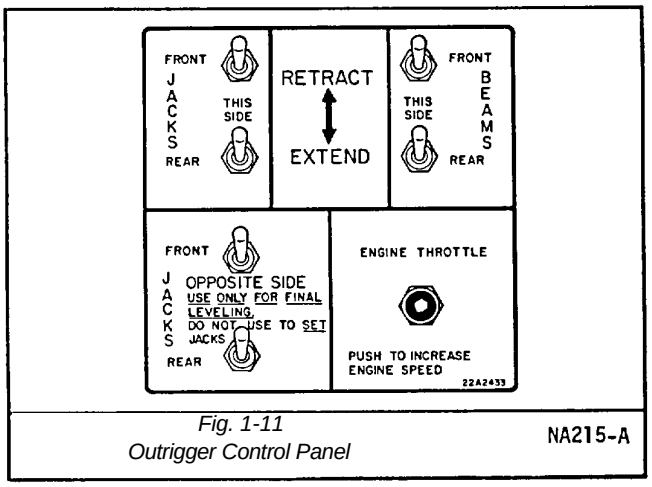


Fig. 1-11
Outrigger Control Panel

The machine has 360° capacities when all outriggers are properly set. There are two columns on the capacity chart, one for 360°, and one for working over the end. Always make sure you refer to the correct column when making a lift. Use of the wrong capacities can result in machine damage or injury.

1-40 Overload Warning System: An overload warning system is incorporated into the front bumper outrigger. If the jack is overloaded for any reason, the carrier horn will sound. This system is not intended to be used for load weighing. Under normal circumstances, the horn will not sound during operation as long as you are operating within the correct capacities for your machine. If the front outriggers settle, throwing increased loading into the jack, the horn will sound. If the machine is overloaded when working over the front, the horn may or may not sound. If the horn sounds when you are working the machine, immediately land your load. Reset the outriggers as explained previously before continuing operation. Continuing to work with the jack overloaded can result in machine damage or injury.

1-41 Outrigger Operation: The hydraulic outriggers are operated as follows:

(a) Shift the carrier transmission into neutral. Apply the digging brake. Shut down the engine.

Note: Never engage or disengage the power take off with the engine running. Damage to the transmission or take off will result.

(b) Pull out on the control cable under the dash to engage the power take off.

(c) Install a pontoon on the front bumper jack. Install an adaptor on each of the four side outrigger jacks. Install three pontoons on each adaptor.

Remember, pontoons must rest on a smooth surface with full support. No unsupported pontoon area is permissible. Rough surface, rocks, etc. under pontoons will cause unequal loading, may break it or cause collapse.

Be sure that blocking or pontoons are set on firm surface, adequate to support the blocking or pontoon loading without settling, slipping, or collapse. Blocking or matting under pontoons must form a smooth level surface. Remember there are tremendous loading on pontoons and blocking, the weight of the entire machine plus any load.

(d) Start carrier engine. Let it idle with transmission in neutral. Allow the system to warm up for a few minutes before proceeding.

(e) Select the desired jack or beam switch on the control panel. Push the switch to extend or retract. If faster operation is desired, push the throttle button.

(f) Repeat step (e) for each jack and beam.

WARNING

Always Stand In Clear View Of The Jack Or Beam Being Operated. Make Sure Nothing Is In The Way When Operating A Jack Or Beam To Avoid Injury Or Damage.

(g) All capacities listed for the machine when on outriggers are based on all tires clear of the ground, the outrigger beams fully extended, and the machine sitting level. A level is mounted on each corner of the machine to assist in leveling the machine.

Serious reductions in lifting capacity will result if above is not followed. Use of outriggers with beam not fully extended may reduce capacities to those listed for "on rubber". If machine is not level, outswing or inswing of load, or side loading of boom will result. This will greatly reduce lifting capacities and may cause machine damage or accident.

Always check outrigger footing before and during operation, especially before making lifts at or near maximum rated capacity. Reset outriggers before a lift if necessary. If outrigger pontoons are allowed to settle into the ground, they lose their effectiveness, making continued operation unsafe.

(h) If you are going to work over the front, set the front bumper outrigger. Push down on the control switch to lower the outrigger. Pull up on the switch to raise the outrigger. Lower it with engine running at an idle. Always raise and level the machine with the four side outriggers before lowering the front bumper outrigger.

If the outriggers must be reset, raise the front bumper outrigger first. After resetting side outriggers lower front bumper outrigger. When lowering the machine off outriggers, always raise the front bumper outrigger first. It is not strong enough to support the machine by itself. The outrigger or carrier frame may be damaged if these instructions are not closely followed.

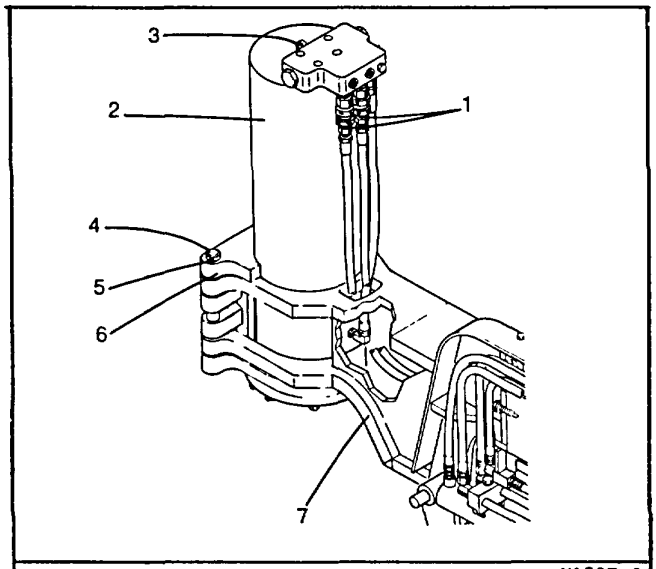


Fig. 1-12
Front Outrigger Box Removal

(1) Quick Disconnects
(2) Jack Cylinder
(3) Eye Bolt
(4) Pin
(5) Rod End/Capscrew
(6) Removable Beam End
(7) Outrigger Beam

1-42 Jack Cylinder Removal:

(a) Disconnect the lines leading to the jack cylinder check valve, at the quick disconnects. Install dust plugs or caps on each quick disconnect.

(b) Install an eye bolt in the threaded hole in top of the jack cylinder. Connect a chain or wire rope sling to the eye bolt on top of the jack cylinder. Connect to sling with hook block from crane. Hoist on hook block to support the weight of the jack cylinder assembly. Apply hoist brake.

(c) Remove rod end and capscrew from pins. Remove pins.

(d) Remove jack assembly from end of outrigger beam.

1-43 Jack Cylinder Installation:

(a) Attach a chain or wire rope sling to eye bolt on top of jack cylinder. Connect to sling with hook block from helper crane or live mast reeved as a short boom.

(b) Lift jack assembly and set in place on end of outrigger beam.

Install the two mounting pins. Install rod ends and capscrews to retain mounting pins.

(c) Remove dust caps and plugs from quick disconnects. Connect quick disconnects.

(d) Remove sling from eye bolt.

1-44 Outrigger Box Removal: The outrigger boxes can be removed under the machine's own power with the live mast reeved as a boom, or with a helper crane. The procedure is as follows:

(a) Connect a chain or wire rope sling to the lifting lugs on the outrigger boxes.

(b) Connect hook block to sling. Lift to support weight of outrigger box and secure by setting hoist brake.

(c) Remove outrigger box connecting pins.

(d) Disconnect hydraulic lines leading to outrigger box at quick disconnects. Install dust caps and plugs on all quick disconnects.

(e) Lower assembly to the ground and slide it out from under the carrier. Left front jack must be removed from front outriggers as explained previously before assembly will slide out from under carrier.

1-45 Replacing Outrigger Box:

(a) Connect a chain or wire rope sling to the lifting lugs on the outrigger box.

(b) Connect the slings with hook block. Lift outrigger box, and set in place under carrier.

(c) Lift outrigger box until mounting lugs on box, enter mounting lugs on carrier. Set hoist brakes to secure load.

(d) Connect all outrigger hoses at quick disconnects.

(e) Operate outrigger jacks, as explained on Page 1-12 to raise or lower boxes until pin holes line up.

(f) Install mounting pins and keepers.

(g) Fully retract jacks before traveling machine.

(h) Remove and store lifting slings.

1-46 Outrigger Pin Remover System

An outrigger box pin remover system is available as an option. A hydraulic cylinder is mounted between each pair of outrigger box mounting pins. These cylinders use hydraulic oil under pressure from the hydraulic outrigger system to remove the outrigger box pins.

1-47 Outrigger Box Removal:

(a) Outrigger boxes can be removed by using a helper crane, or the machine's live mast used as a short boom.

(b) Fully retract all jacks and beams. Remove left front jack cylinder as explained earlier in this section.

(c) Connect a chain or wire rope sling to the lifting lugs on top of the outrigger box. Hoist to support the weight of the outrigger box. Set the hoist brake.

(d) Unhook quick disconnects in lines leading from carrier to outrigger box. (Both sides of carrier). Install dust caps or plugs in all quick disconnects.

(e) cylinder hose disconnects to beam quick disconnects.

(f) Attach a chain or wire rope sling to lifting lugs at each end of outrigger box. Connect to sling with hook block from helper crane or live mast reeved as a short boom. Hoist to support the weight of the outrigger box. Apply the hoist brake.

(g) Remove the pins as follows:

(1) Engage outrigger pump by pulling out on control under carrier dash. Shift carrier transmission to neutral. Start carrier engine. Allow engine to idle.

(2) Retract cylinder to remove pins by moving toggle switch on control panel to retract position. Increase carrier en-

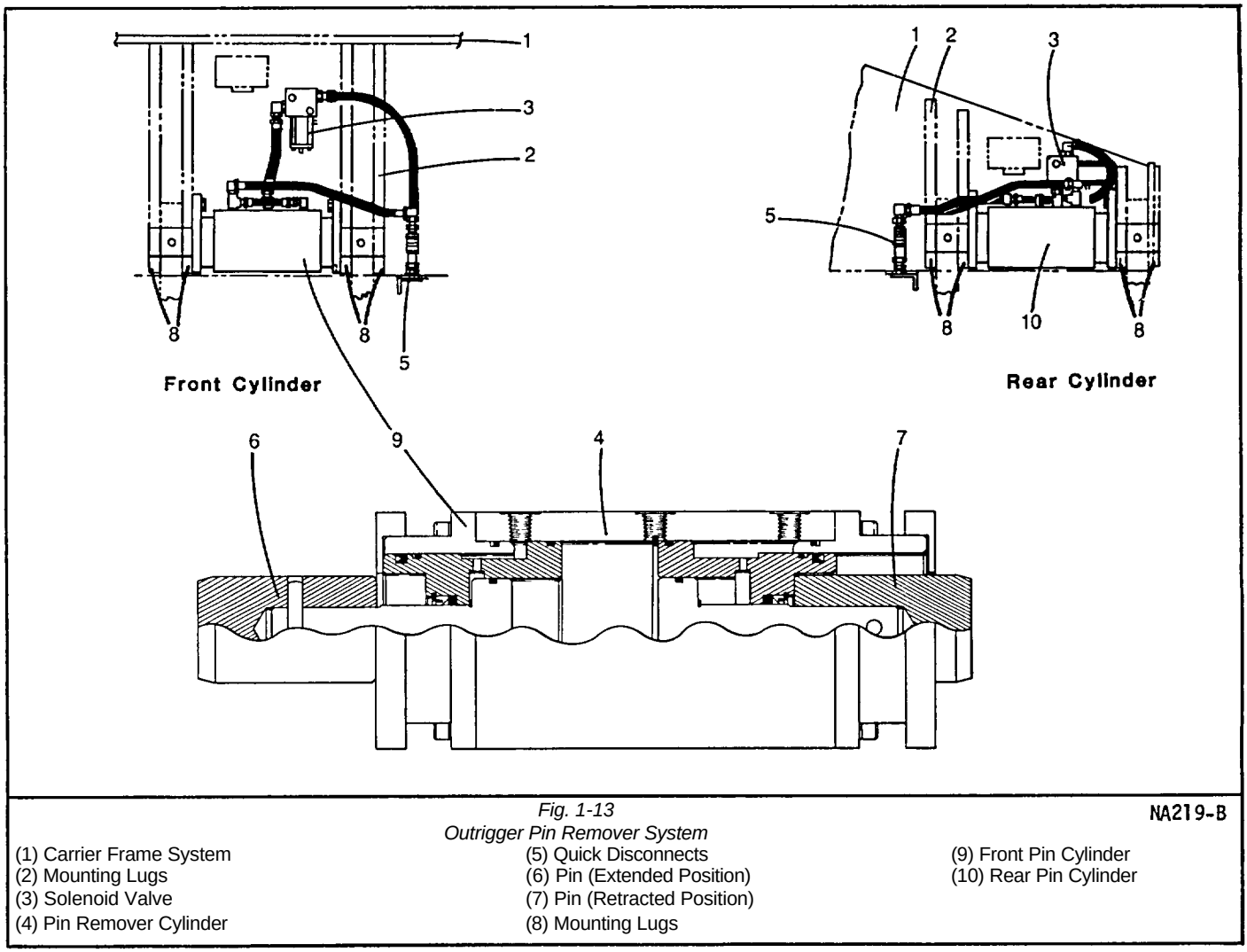


Fig. 1-13
Outrigger Pin Remover System

NA219-B

(1) Carrier Frame System
(2) Mounting Lugs
(3) Solenoid Valve
(4) Pin Remover Cylinder
(5) Quick Disconnects
(6) Pin (Extended Position)
(7) Pin (Retracted Position)
(8) Mounting Lugs
(9) Front Pin Cylinder
(10) Rear Pin Cylinder

gine speed if necessary by pushing throttle button.

(3) Repeat procedure for other side of outrigger box.

(h) If removing rear outrigger box, lower until mounting lugs clear carrier frame and swing out from under carrier. Load on trailer, rail car, etc. for transportation.

(i) If removing front outrigger box:

(1) Lower box onto skids.
(2) Disconnect slings.
(3) Pull box out from under carrier, on skids.
(4) Reconnect slings. Load on trailer, rail car, etc., for transportation.

1-48 Replacing Outrigger Boxes:

(a) Engage outrigger pump by pulling out on control under carrier dash. Shift carrier transmission to neutral. Start carrier engine. Allow engine to idle.

(b) If replacing front bumper box assembly, place on skids, and slide underneath carrier.

(c) Connect a sling to lifting lugs on top of outrigger box. Hook to sling with helper crane, or live mast reeved as a short boom.

(d) Lift outrigger box until lugs on box enter lugs on carrier frame. Set hoist brakes to secure load.

(e) Connect jack cylinder hoses at quick disconnects.

(f) Operate outrigger jacks, as explained previously in this section, to raise or lower boxes until pin holes line up.

(g) Extend pin cylinders to install pins by moving toggle switch on control panel to extend position. Increase carrier speed if necessary by pushing throttle button.

(h) Repeat procedure for other side of outrigger box.

(i) Unhook pin remover cylinder hoses at quick disconnects. Connect outrigger beam cylinder hoses.

(j) Install dust plugs or caps on quick disconnects on pin remover cylinder hoses.

(k) Install left front outrigger jack on machine as explained earlier in this section.

(l) Remove slings.

1-49 Operators Cab

The operators cab is equipped with a sliding door. To open cab side door:

(a) Install carrier ladder in holes provided in carrier fender. Stand on this ladder to open the cab door.
(b) Unlock the door with the door key.
(c) Twist the outside handle to the right to unlatch the door.
(d) Slide to the rear to open.
(e) Machine can be operated with the door open or closed. To close the door, slide it forward, after entering, until it latches.

To open from the inside:

(a) Squeeze inside handle to unlatch.
(b) Pull the door to the rear to open.

Note: Always position upper so you can step out onto non-skid surfaces on carrier fenders and deck or onto carrier ladder when you leave the cab. Grab bars are provided for the operator's use when entering or leaving the cab. Use them to help prevent accidents.

1-50 Starting The Upper Engine:

(a) Insert key in ignition switch. Turn to "on" position.
(b) Make sure master clutch is disengaged.
(c) On machines with Detroit Diesel engine, push in on shutdown control.
(d) Open the engine throttle to just above idle.
(e) Push the throttle control forward to about 1/4 throttle. Push the starter button until the engine starts. Release the button, and throttle back to an idle.

Note: Don't operate the starter more than 15 seconds at a time when starting the engine.

(f) Run the engine at part throttle and no load for about 5 minutes, allowing it to warm up, before applying a load.
(g) With the engine running just above idle, engage the master clutch.
(h) Run the engine slowly until the S-o-M system, torque converter, and gearing are warmed up. This is especially important in cold weather.
(i) For maximum line speed and pull during operation, the engine must be run at full load speed. (A 16 hour or two shift break in period at reduced throttle should be followed on a new machine.)
(j) During long engine idling periods, the engine coolant temperature may fall below the normal operating range. The incomplete combustion of fuel in a cold engine will cause crankcase dilution, formation of lacquer or gummy deposits on the valves, pistons, and rings, and rapid accumulation of sludge in the engine.

Note: When prolonged engine idling is necessary, maintain at least 800 RPM.

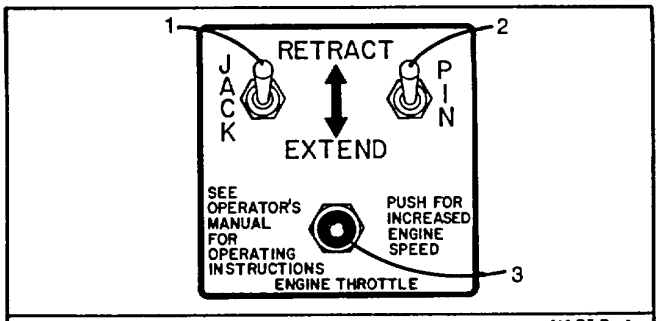


Fig. 1-14 Pin Remover Controls
(1) Jack Controls
(2) Pin Control
(3) Throttle Control

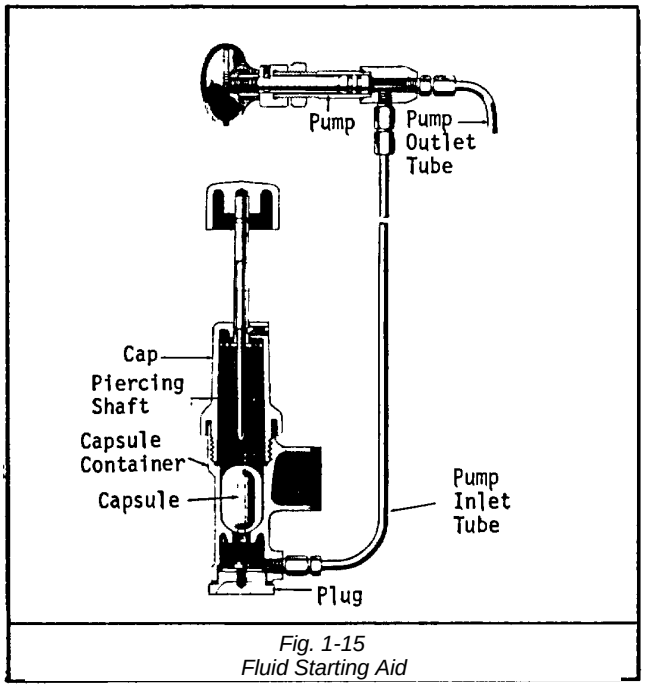


Fig. 1-15
Fluid Starting Aid

1-51 Stopping The Upper Engine

(a) Throttle the engine back to an idle.
(b) Disengage the master clutch.
(c) Allow the engine to idle for a few minutes to cool down.
(d) Move the fuel shutdown control switch to the "off" position.
(e) Pull out on shut down control with Detroit Diesel engine.
(f) Turn the key ignition switch to the "off" position. Remove the key to prevent starting by unauthorized persons.

1-52 Fluid Starting Aid: The fluid starting aid injects a highly volatile fluid into the air intake system at low temperatures to assist in starting the engine. The fluid is in a metal capsule for ease of handling.

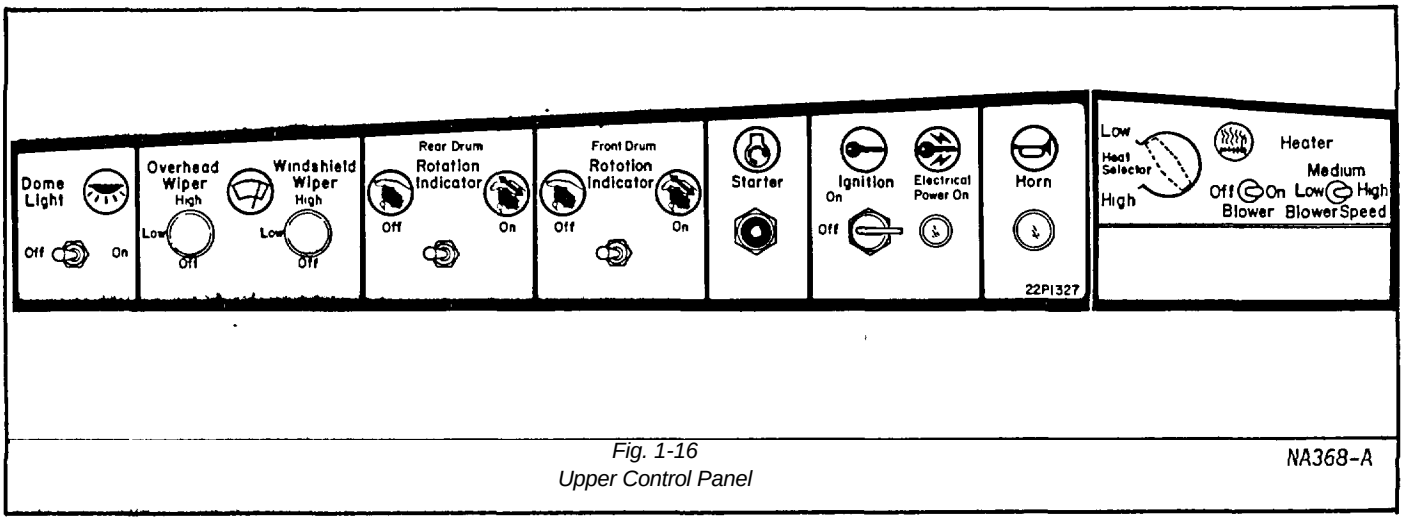


Fig. 1-16
Upper Control Panel

The starting aid consists of a cylindrical container and a screw cap. A sliding piercing shaft is mounted in the cap. A tube leads from the container to a hand operated pump.

Another tube leads from the pump to an atomizing nozzle in the engine air intake.

The container is mounted vertically, away from any heat.

Use the fluid starting aid as follows:

(a) Remove the threaded cap. Insert a fluid capsule in the container.

WARNING

Handle With Care. The Starting Fluid Is Toxic, And Flammable.

(b) Pull the piercing shaft all the way out of the cap. Install and tighten the cap on the container.

(c) Push the piercing shaft all the way down. This ruptures the capsule, and fills the container with starting fluid.

(d) Move the engine throttle to-the full speed position.

(e) Engage the starter while pulling the pump plunger all the way out. Push the plunger In slowly, forcing starting fluid into the engine. Continue to push on the pump until the engine starts. Push the plunger in slowly until it locks in the in position.

(f) Remove and discard the capsule. Never leave an empty capsule in the container.

(g) Replace the cap on the container. Make sure the piercing shaft is all the way down.

1-53 During Operation: the operator should remain alert to possible malfunctioning of the machine while operating. If the machine does malfunction, shut it down until the problem is found and corrected. During operation the operator should:

(a) Remain alert to any unusual noises, loss of power, or bad response to control of the engine. Consult the engine manufacturer or his nearest dealer for engine repair work.

(b) Watch the gauges. Make sure they show the correct readings. If any of the gauges show incorrect readings, shut the machine down and determine the cause.

(c) Check the master clutch for slipping, or jumping out of engagement. Adjust if necessary.

(d) Make sure all controls work freely and easily with no sticking or binding. Lubricate or adjust as necessary.

(e) Listen for any unusual noises from the hydraulic system, or the gear train. If any, shut the machine down until the problem is found and corrected.

(f) Watch for oil leaks. If any develop, correct them before continued operation.

(g) Inspect the wire rope, pendants, and any other rigging as explained in section 5. Replace them if inspection shows that it is necessary.

CAUTION

Operation With A Machine Not In First Class Working Order In Any Respect May Be Hazardous And Can Result In Unnecessary Wear Or Breakage, Or May Result In Immediate Or Eventual Accident.

1-54 Upper Control Panel

The control panel shown in Fig. 1-16 is mounted in the ceiling of the operators cab near the R.H. cab wall.

1-55 Ignition Switch: Turn the key clockwise to turn on. The switch must be "on" for the starter button to operate. Turn the switch "off" and remove the key when machine is not in use to prevent starting by unauthorized person.

1-56 Starter Button: Depressing the starter button actuates the engine starter. The button should not be actuated over 15 seconds at a time when starting the engine. If the engine doesn't start in this length of time something is usually wrong. Continued grinding on the starter causes unnecessary wear, and discharges the battery.

1-57 Engine Shutdown: The engine shutdown is cable operated with Detroit Diesel engines. Pull out on the control until the engine stops, then push the control back in.

1-58 Emergency Shutdown: On machines equipped with Detroit Diesel engines pull out on this control, if the engine shutdown does not function, until the engine stops running. After use, reset manual reset on the engine before restarting. This should not be used as normal engine shut off, as it can damage blower seals.

1-59 Windshield Wiper: The machine is equipped with two speed electric windshield wipers. Turn the control to "low" for low speed operation, or to "high" for high speed operation. Turn the control to "off" to turn the wipers off. A wiper is provided on both the front and top windows.

1-60 Blower: A forced air blower is used to circulate air from the heater, or fresh air from outside, through the cab. To turn the blower on, push switch to on. Push blower speed switch to one of the three operating positions (low, medium, high). To turn the blower off, push the switch to the off position.

1-61 Drum Rotation: To actuate the drum rotation indicators push the switches to "engage". To turn off the rotation indicators, push the switches to "disengage". For more information on drum rotation indicators, see page 1-24.

1-62 Dome Light: To turn on the dome light, move the switch to "on". To turn off the dome light, move the switch to "off".

1-63 Live Mast Control: This control operates the hydraulic extendable live mast. See operating instructions page 1-32.

1-64 S-o-M Pressure Gauge: This gauge indicates the pressure available in the S-o-M control system. Under normal machine use the gauge will fluctuate between a low of 900 psi (6205 kPa) and a high of 1,050 psi (7239 kPa). If the system malfunctions and is, working over relief pressure, the gauge would indicate 1,250 psi (8618 kPa). If the gauge fluctuates rapidly, or reflect a reading other than described above, the S-o-M system is malfunctioning. Repair before further use.

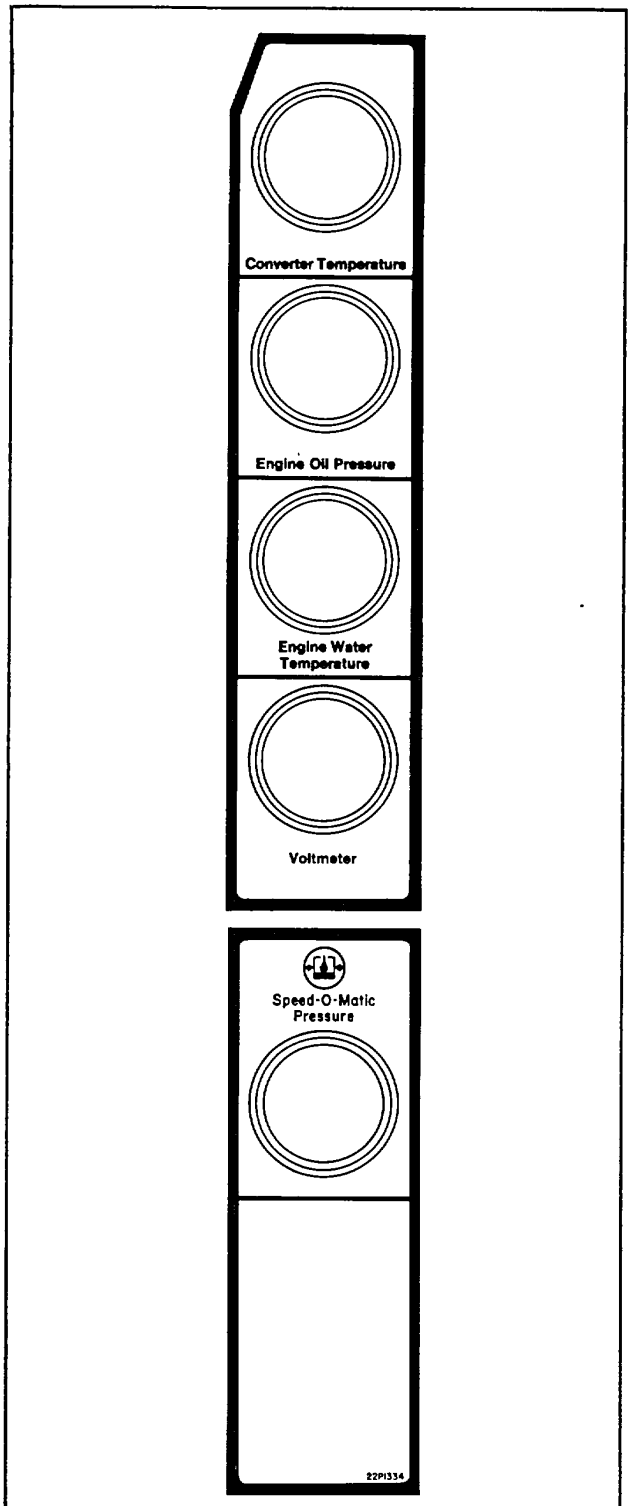


Fig. 1-17
Front Instrument Panel

NA212-A,NA209-B

1-65 Converter Temperature: This gauge indicates the operating temperature in the torque converter. The oil temperature should never exceed 250° F (121° C) when the machine is operating. If the temperature is too high, shut the machine down and determine the cause. See page 2-27 for more information. Operation at temperatures exceeding 250° F (121° C) can result in damage, explosion, and/or fire.

1-66 Engine Oil Pressure: This gauge registers the pressure of the lubricating oil in the engine. As soon as the engine starts the gauge should begin to register. If the gauge does not register at least the minimum pressure listed in the chart below stop the engine and determine why.

		P.S.I.	kPa
1200 RPM	Normal	30-60	207-414
	Minimum	18	124
1900 RPM	Normal	38-60	262-414
	Minimum	27	186

Correct the problem before running the engine again.

1-67 Engine Temperature: The engine coolant temperature is registered on this gauge. Normal running temperatures are 150 to 185° F. (65.5 to 85° C).

1-68 Engine Voltmeter: The engine voltmeter measures the voltage produced by the alternator, and indicates the condition of the battery. Refer to Fig. 1-18 for voltmeter readings.

1-69 Ignition On: This light is on whenever the ignition switch is on. The ignition switch must be turned off (light out) and key removed when the operator leaves the machine, to prevent starting by unauthorized persons.

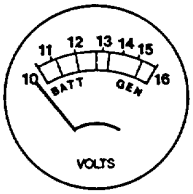
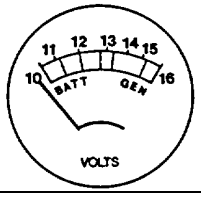
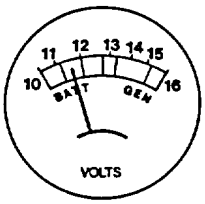
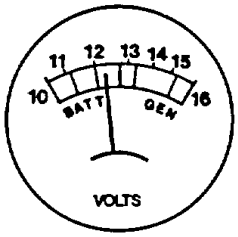
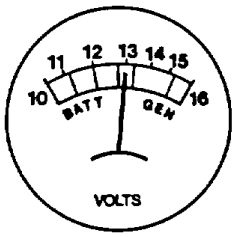
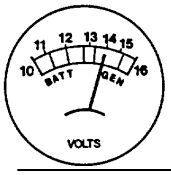
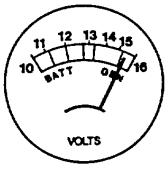
Engine not running or running at slow idle.		Engine running fast enough to make alternator produce,
1. Dead or disconnected battery. Disconnected or badly connected meter. battery unless circuit was completed around battery.		1. Disconnected meter. Engine could not run with dead or disconnected
2. Very low battery charge. Engine might not start.		2 3 When meter pointer stays below 13.3 V with the engine running fast enough to operate alternator, it shows that alternator is not operating or voltage regulator is out of adjustment, or that current being drawn from battery by lights, heater fan, or other load, exceeds alternator output.
3. Low battery charge. Constant reading in this area would indicate need for a check on the alternator and voltage regulator.		
4. Well charged battery. This indicates a good battery and also that alternator and voltage regulator are operating properly.		4 5 When engine is started, pointer may stay in this area temporarily but should gradually rise above 13.3 V as alternator reaches normal output,
5. The pointer might remain in this position temporarily when the engine has been stopped after considerable use, due to a "surface charge" in the battery. to get a correct reading, turn on the ignition for a few minutes		
		6 This is the area in which the pointer should be when alternator, voltage regulator and battery are all in good condition and working properly.
6 7 Under normal conditions, a 12 V Battery is fully charged at 12.8V. A Slightly higher reading may occur under the conditions outlined in no. 5 but, generally speaking, any reading above 12.8 V when the engine is stopped is not a true reading.		7 When the pointer goes above 15.2 V, the voltage regulator is set too high or is jammed and continued operation of the engine will burn out the battery.

Fig. 1-18
Voltmeter Readings

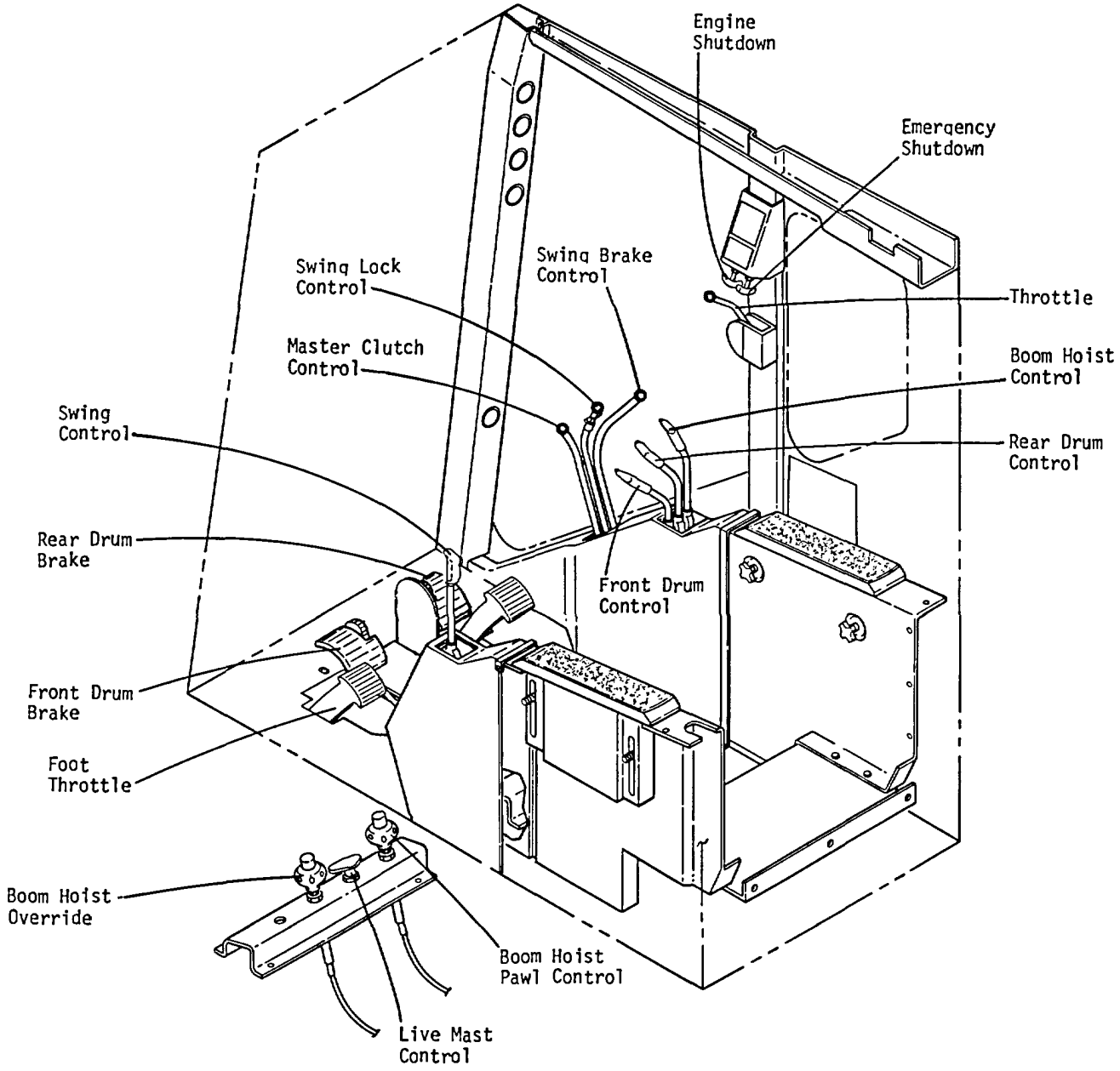


Fig. 1-19
Upper Control

NA233-C

The picture above shows the controls, found on the upper control stand. Each control is discussed individually on the following pages.

1-70 Master Clutch Control

The master clutch is disengaged by pulling the lever to the rear. Engage the clutch by pushing the lever forward. Always engage and disengage the clutch slowly, with the engine at idle.

WARNING

Always Disengage The Master Clutch When Leaving The Operators Seat For Any Reason, Or When Working On The Machine. Failure To Disengage Master Clutch May Result In An Accident.

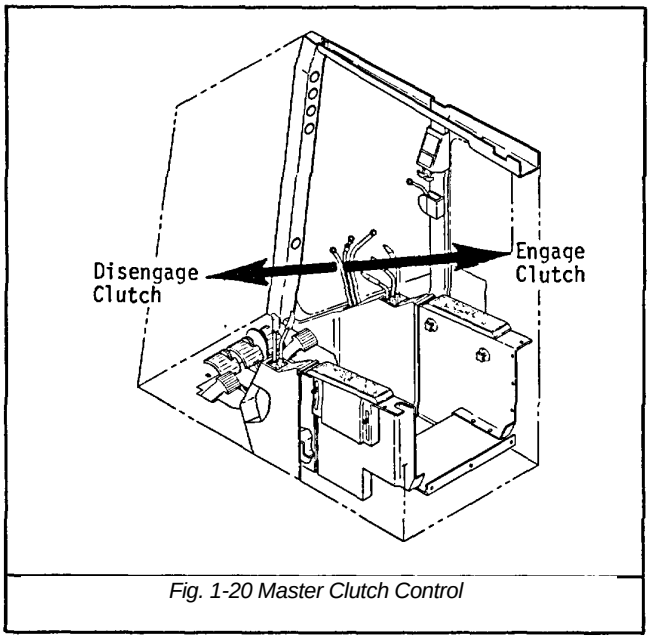


Fig. 1-20 Master Clutch Control

1-71 Swing Lock Control

The swing lock control engages a pawl with the teeth on the ring gear, locking the upper in place with respect to the carrier. The swing lock is operated as follows:

(a) Swing the upper to the desired position.
(b) Pull the detent handle on the control lever to unlock the lever.
(c) Pull the lever to the rear until it locks in position.
(d) To unlock, pull detent handle on the lever and push forward until lever locks in position.

CAUTION

Never Apply The Swing Lock When The Upper Is Swinging As Damage To The Machine May Result. Never Attempt To Swing The Upper With The Swing Lock Engaged.

Note: Engage the swing lock when leaving the machine for any reason. Engage the swing lock when traveling or transporting the machine to avoid uncontrolled swing of the upper.

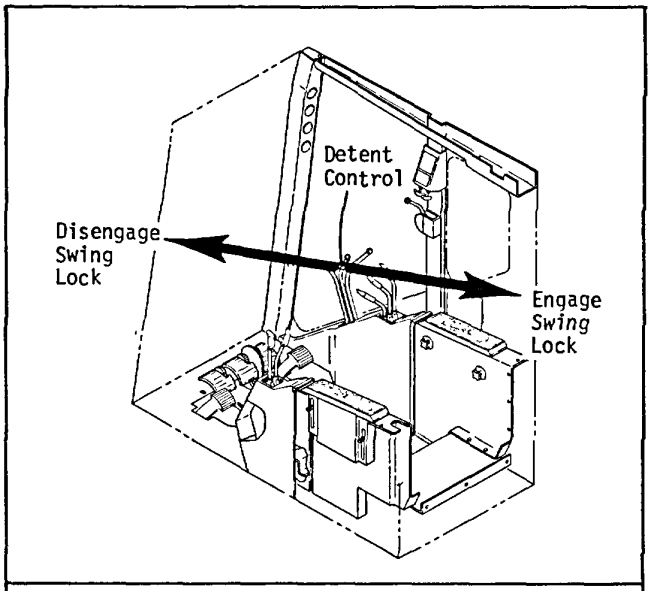


Fig. 1-21 Swing Lock Control

1-72 Swing Brake Control

The swing brake control actuates a hydraulic control valve which releases the spring applied swing brake. The swing brake is operated as follows:

(a) To release the swing brake push on the handle.
(b) To apply the swing brake pull on the control handle.
(c) The control may be left partially applied to allow some drag when working in tight quarters, or when spotting loads, where free swing is not desirable.

CAUTION

Never Use The Swing Brake As A Swing Lock When Traveling, Transporting, Or Leaving The Machine For Any Reason. It Is Designed As A Drag Brake, Not As A Lock. The Swing Lock Is Provided For Locking Use. Avoid Using The Swing Brake For Making Sudden Swing Stops, As Damage To The Upper Machinery May Result, Or Load May Get Out Of Control.

1-73 Swing Clutch Control

To swing the upper, disengage the swing lock (see page 1-21). Push the control lever forward to swing right, and pull the control lever to the rear to swing left. Stop the swing by easing the lever in the opposite direction to that which started the swing.

CAUTION

Attempting To Swing With The Swing Lock Engaged Can Result In Structural Damage To The Machine.

1-74 Front And Rear Drum Control Lever And Brake

The front and rear drum control levers actuate a variable pressure control valve which engages the front or rear drum raising or lowering clutch. The front drum unit is operated as follows:

(a) Pull the lever to the rear while simultaneously releasing the brake to spool on rope. (Raise a load).
(b) Disengage the drum pawl, push the lever forward while simultaneously releasing the brake, to power off rope. (Lower a load).
(c) Simultaneously return the control lever to neutral, and depress the brake to stop the unit and hold a load.

CAUTION

The Brake Pedal Locks Are Intended To Allow The Operator To Rest His Legs When Suspending A Load For A Short Period Of Time, But The Operator Must Remain In His Seat With His Feet On The Pedals. Failure To Follow These Instructions May Result In An Accident. Never Leave Machine With A Load In The Air. It May Fall.

(d) A load can be lowered on the brake. Release the brake with foot pedal and allow load to lower by gravity. Control rate of descent by partially applying brake. Loads can be lowered with lever engaged in hoist position by varying engine speed and letting gear train run backwards through slippage in the hoist converter. See page 1-29 for more information.

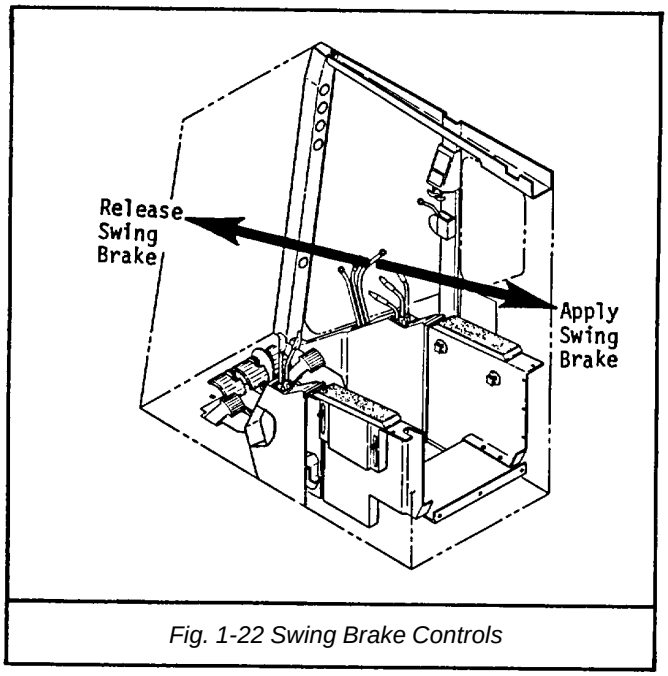


Fig. 1-22 Swing Brake Controls

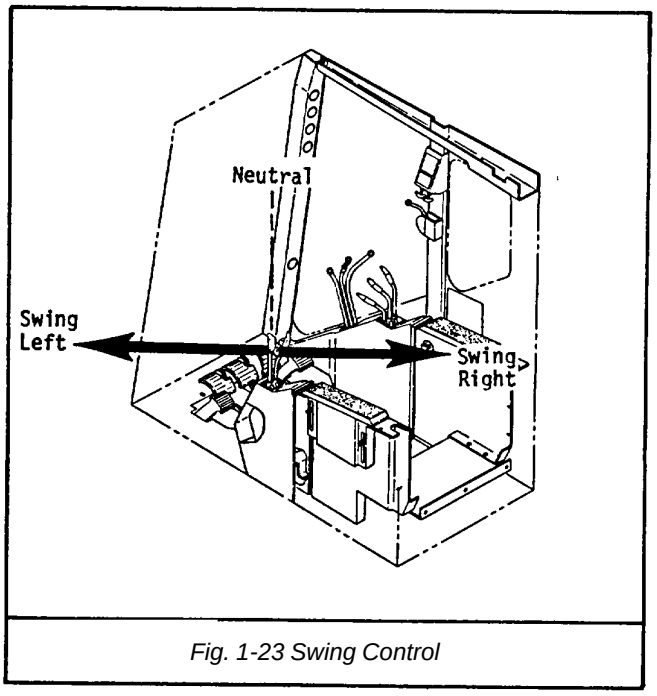


Fig. 1-23 Swing Control

1-75 Brake Pedal Locks

The brake pedal locks are operated as follows:

(a) Operator's foot is in position shown at A during normal machine operation. Foot holds latch in disengaged position.

(b) To latch pedal in place, depress pedal fully with foot in position (1). Pivot foot to position (2) while holding brake pedal down, to allow latch to engage.

(c) To disengage, position foot as shown in A. Depress latch and pedal at same time to disengage latch.

1-76 Drum Rotation Indicators

Drum rotation indicators are used on the front and rear drums. Two pins are mounted in the control handle. The rear pin operates when hoisting, and the front pin operates when lowering. The pins are solenoid actuated, and move in and out as the drum shaft rotates. The faster the drum shaft turns, the faster the pin moves in and out.

By placing a finger over the pin when operating the front or rear drum shaft, the operator can tell which direction the shaft is turning, and with experience will be able to tell how fast the shaft is rotating.

The rotation indicators work only when the rotation indicator switches are in the "engage" position. These switches are on the upper control panel above the operator's right shoulder.

There are two thumb wheel switches on the cover of the electronics box, one for front and one for rear drum. This box is located on R.H. side of revolving frame near mast foot lugs. These switches adjust the frequency of movement of the buttons to compensate for changes in number of parts of line being used. Determine how many parts of hoist line are being used and adjust these thumb wheels accordingly.

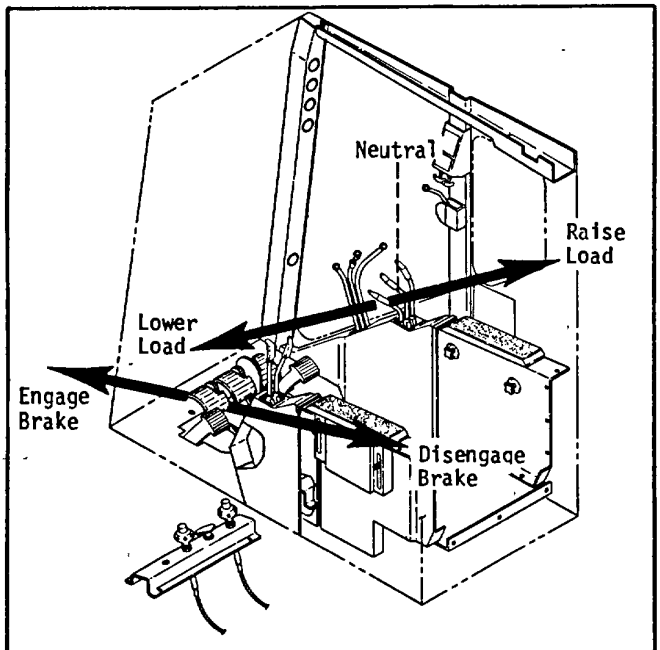


Fig. 1-24
Front Drum Control Lever And Brake

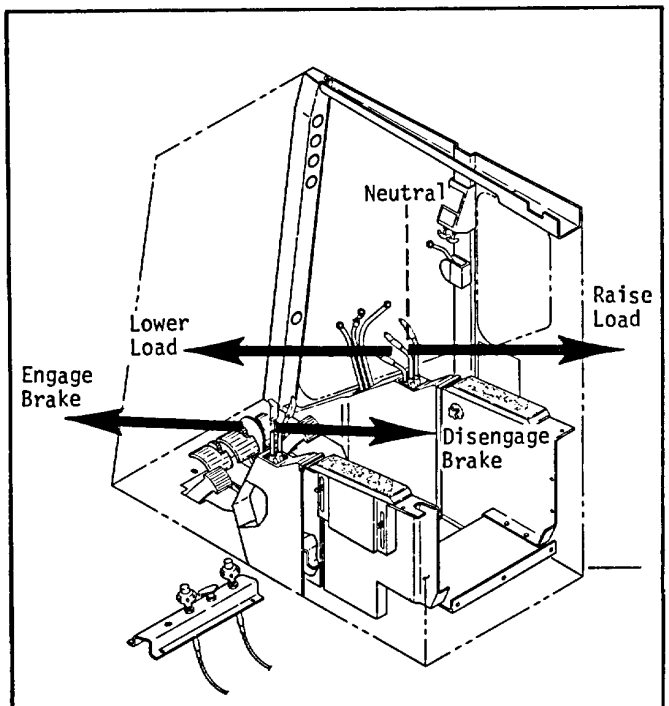


Fig. 1-25 Rear Drum Control Lever And Brake

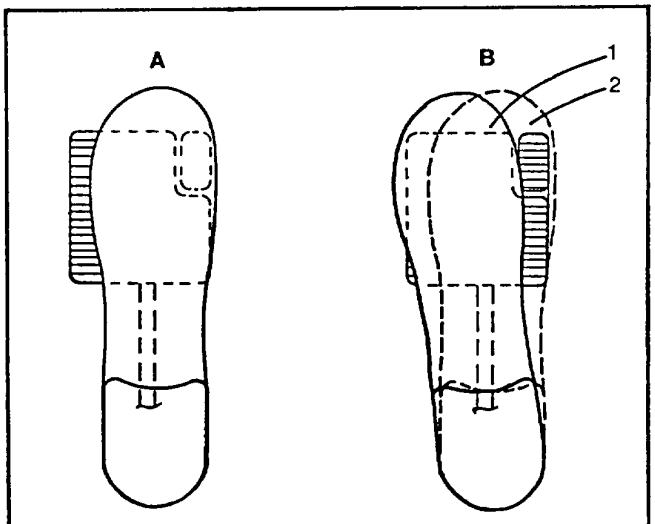


Fig. 1-26
Brake Pedal Locks

1-77 Boom Hoist Control

To raise the boom, proceed as follows:

(a) Pull the B.H. control lever to the rear to raise the boom. Control the speed of boom hoist by varying the engine throttle setting.

(b) When the boom reaches the desired angle, return the B.H. control lever to neutral.

CAUTION

Keep Boom Hoist Pawl Engaged At All Times Except When Lowering The Boom. This Device Is A Reserve Safety Feature To Cover Possibility Of Loss Of B.H. Brake Or Clutch Action.

Note: <u>The boom should be raised with the pawl engaged, but it must be disengaged to lower the boom</u>.

To lower the boom proceed as follows:

(a) Disengage B.H. pawl by pulling out on pawl control.

(b) Push the B.H. control lever forward to lower the boom. Control rate of descent by varying the engine throttle setting.

Note: <u>It may be necessary to boom up slightly to release B.H. pawl.</u>

(c) Re-engage B.H. pawl when lowering is complete.

1-78 B.H. Limiting Device Override

Sometimes it is necessary to boom up slightly after the boom hoist limiting device has functioned, to release the B.H. pawl. To boom up this slight amount, push the override control (located on the cab floor).

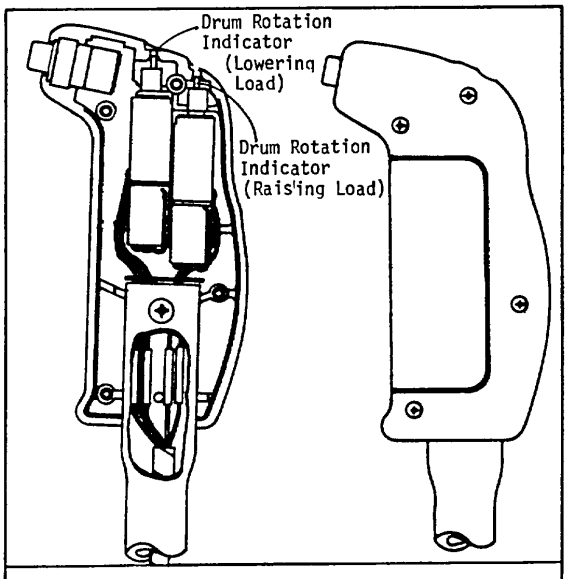


Fig. 1-27 Drum Rotation Indicators

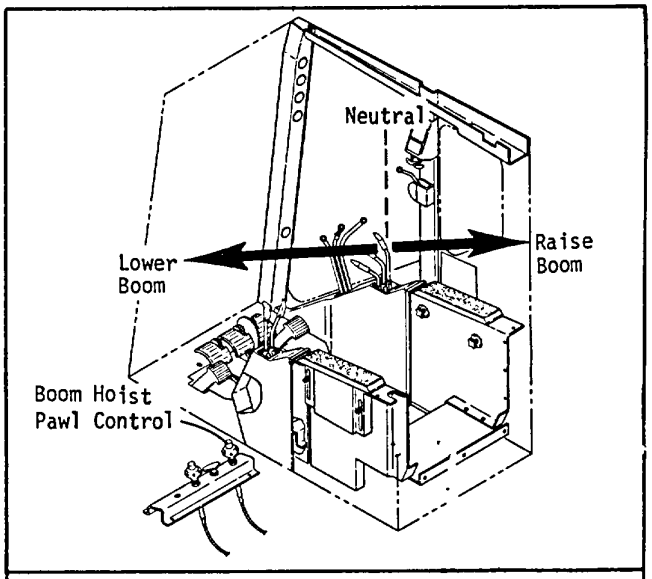


Fig. 1-28 Boom Hoist Control

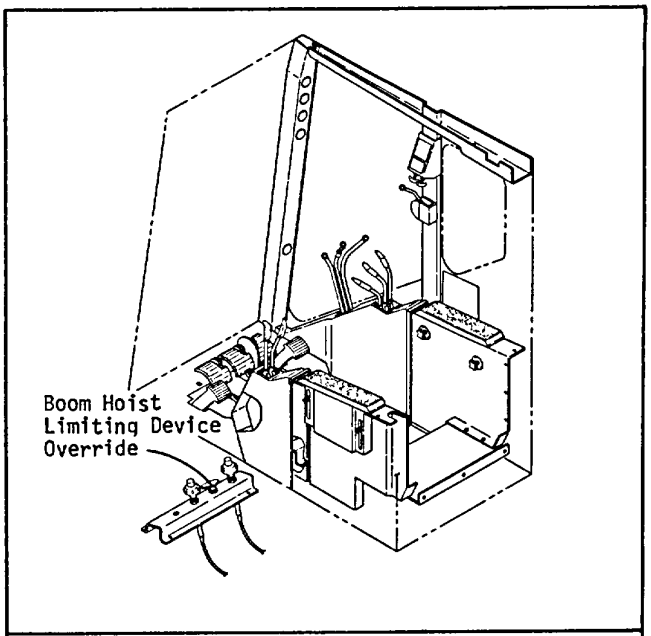


Fig. 1-29 B.H. Limiting Device Override

CAUTION

Use The Override With Extreme Caution As The Limiting Device Is Ineffective When The Override Is In Use. The Boom Can Be Hoisted Against The Backstops With Enough Force To Cause Damage To The Boom Or The Backstops. This May Result In Accident.

1-79 Engine Throttle Controls
The standard engine throttle is mounted to the R.H. cab wall. To increase engine speed, pull up on the control. To decrease engine speed, push down on the control. A small brake is included in the throttle control, to hold the throttle at any desired setting.

1-80 Foot Throttle: A foot throttle is mounted in the cab floor, on either side of drum brake pedals. To increase engine speed, push down on the throttle. To decrease engine speed let up on the throttle. Removing the foot completely will let the engine run at idle.

1-81 Crane Operation
The crane attachment is used primarily for hoisting, lowering, and positioning loads. In order to do this with a maximum amount of safety, certain procedures must be followed. The following is a suggested procedure for making a typical lift.

(a) Determine the weight to be lifted. Be sure to include the hook block, slings, grapples, chains or other rigging.

(b) Consult the capacity chart located in the upper cab, and find the shortest boom length and load radius that will accomplish the job. If machine already has a boom installed, check to see the maximum radius that can be used to lift the particular load and don't exceed it. The following facts about the capacity chart should be noted at all times.

(1) The lifting capacities are shown in pounds and are based on 85% of tip with the machine on firm, level ground, if stability establishes the ratings. Capacities marked with an asterisk are based upon factors other than tip. The most notable of these factors is strength of material. Exceeding the rated capacity overloads the machine and could result in boom or rope failure, or damage to the machine. It could also tip the machine over.

(2) The capacity chart lists ratings for operation under several different circumstances.

(a) With "A" or "AB" ctwt.

(b) 360° capacities on outriggers.

(c) 3 Side-rear capacities on outriggers.

(d) Side-rear capacities on tires.

The label shown in Fig. 5-2 defines the working areas for both on or off outriggers. 360° capacities (working over the front) is permissible only when all outriggers (including the front bumper outrigger) are properly set.

(3) Several attachments are available for use with this machine. Separate capacity charts are available for use with each attachment. The allowable capacities with this machine vary with type of attachment being used. Make sure you are using the correct capacity chart for the attachment your machine is equipped with.

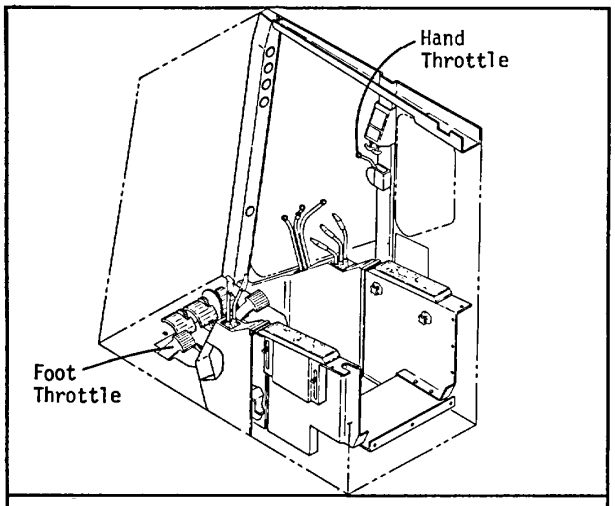


Fig. 1-30 Engine Throttle Controls

(c) Assemble the desired length of boom on the machine as explained on pages 5-6 through 5-10 in this manual.

(d) Position the machine so a minimum swing is necessary and load radius is within capacity limits as shown on capacity chart. Apply park brake.

(e) If the lift will be made on tires, they must be inflated to pressures shown on tire inflation chart, in carrier cab and section 3 of this manual.

(f) If outriggers are used, refer to page 1-12 for operation.

(g) Remember, all ratings on the capacity plate are based on the machine being level. A level is mounted at each corner of the carrier to assist in leveling the machine.

(h) Raise the boom and swing over the load.

(i) Drop the hook block down and fasten onto the load. The following points must be noted when picking the load.

(1) The boom peak must be directly above the load and at the proper radius. Booms are made to lift and should never be used to drag a load sideways, inward or outward.

(2) Always use chains, wire rope, or slings of ample size and make periodic checks of their condition.

(3) Always use sufficient parts of line. Consult the wire rope specifications in the parts book for proper size and type of wire rope to use. Consult wire rope capacity chart on page 1-27 for number of parts of line needed for a given lift.

(4) When lifting heavy loads, care should be taken to prevent sudden loading and unloading of the hoist line. Ease into the load.

(j) Lift the load to the desired height. Boom to the desired angle. Be careful when boom

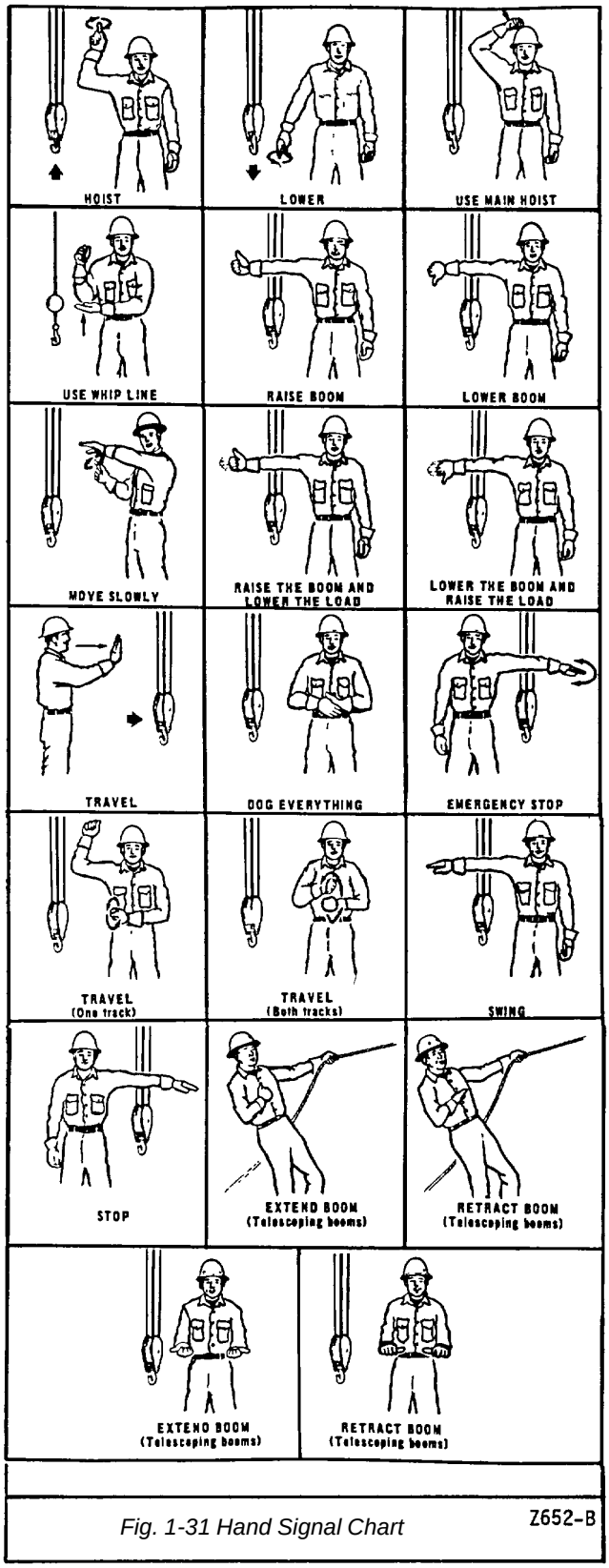


Fig. 1-31 Hand Signal Chart Z652-B

ing down, or swinging load (outswing from centrifugal force) as these increase load radius with a resultant decrease in capacity. Make sure the load being lifted remains within the lifting capacity of the machine at the boom length and load radius being used.

1-82 Hand Signal Chart

One workman on the job should be designated a signal man, and the operators should obey signals from him only. A signal to stop should be obeyed no matter who gives it. See hand signal chart, Fig. 1-31.

Note: Hand signal chart recommended by USA standards committee B30, safety codes for cranes, derricks, hoists, jacks, and slings, and reproduced from the USA standard safety code for crawler, locomotive, and truck cranes, USAS B30.5 with permission of the publishers, The American Society Of Mechanical Engineers.

1-83 Counterweight Removal Controls

The counterweight remover is actuated by two hydraulic cylinders which receive pressure for operation from the hydraulic power supply for the S-o-M system. The controls which operate the counterweight remover are located inside the left rear cab door, in front of the engine.

The function valve is a three position spring centered, lever operated type. This valve controls the oil flow to raise, or lower the counterweight. When in operating position counterweight is held by lock up of mechanical linkage.

The control valves (needle type) are for the purpose of controlling the oil flow to the counterweight cylinders, to control the rate at which the counterweight is raised or lowered, and to maintain the counterweight in a level condition. These valves are to be closed except when operating the mechanism.

The instruction label shown in Fig. 1-33 is located by the counterweight control valves. Follow its instructions at all times.

1-84 Removing The Counterweight

(a) Fully extend and set all outriggers on firm, level supporting surface. Machine must be level with all tires clear of the ground. If machine is not level, "AB" counterweight ,will tip into cab when lowered.

CAUTION

Machines Equipped With "AB" Ctwt. Can Not Be Swung Over The Side When On Rubber, As The Machine Will Tip Over.

(b) Swing the upper around until the counterweight is lined up with the positioning blocks located on the carrier.

Parts Of Line	1" (25.4mm) Diameter Type N	
	Pounds	Kilograms
1	29.500	13381.2
2	59,000	26762.4
3	88,600	40188.9
4	118,100	53570.1
5	147,700	66996.7
5	177,200	80377.9
7	206,800	93804.4
8	236,300	107185.6
9	265,800	120566.8
10	295,400	133993.4
11	324,900	147374.6
12	354,500	160798.5

Note: FMC Type N rope is 6x25 (6X19 Class) - filler wire - Extra Improved Plow Steel - Preformed. I.W.R.C. (Independent Wire Rope Center) - Right Lay - Regular Lay.

Capacities shown are maximum for 1" (25.4mm) diameter Type N rope per given parts of line. Working loads may be less, and must never exceed ratings on capacity chart.

Fig. 1-32 Z958-C
Wire Rope Capacity Chart

(c) Engage the swing lock.
(d) With the engine running, open the two control valves slightly.
(e) Pull the function lever to the lowering position. Keep counterweight level by adjusting control valves. Lower counterweight until it is supported by the blocks on the carrier bed, and the linkage Is clear of the counterweight.
(f) Return function lever to neutral. Close both control valves.
(g) Disengage swing lock. Swing the upper around out of the counterweight.

Note: There are two pairs of lifting lugs on top of the "B" counterweight. Use the outer Tugs to lift the "AB" counterweight assembly, Use the inner lugs to lift the "B" counterweight alone.

1-85 Replacing The Counterweight:

(a) Fully extend and set all outriggers on firm, level supporting surface. Machine must be level with all tires clear of the ground. If machine is not level, "AB" counterweight will tip into cab when raised.
(b) Pick the counterweight and set in place on the positioning blocks on the carrier frame. The counterweight may be lifted into place with the basic boom, or the Live Mast used as a boom. See page 5-2, Live Mast as a boom.
(c) Retract cylinders completely. Swing the upper around until the cones on the counterweight remover arms line up with the seats in the counterweight.
(d) Open the two control valves slightly:
(e) Move the function lever to the raising position. Make sure the remover linkage seats properly in the counterweight when raising. Keep the counterweight level by adjusting the control valves. Extend the cylinders to their maximum stroke.
(f) Close both control valves. Return the function lever to neutral.

See page 4-2 for counterweight remover adjustment procedures.

1-86 Counterweight Assemblies: Either an "A" or "AB" counterweight may be used on the upper of the machine, and the capacity chart lists capacities for machines equipped both ways.

1-87 Ctwt. Usage (Machine On Outriggers)

CAUTION

No Capacities Are Listed For "AB" Upper Ctwt. On Tires. When Machine Is Equipped With "AB" Upper Ctwt. When On Rubber, Upper Must Face Directly Rearward. If Machine Is Swung Over Side It May Tip Over.

Machine cannot be roaded with either "AB" ctwt. assembly installed. Machine can be roaded with either, or both, "A" ctwt. assemblies installed. Refer to charts in section 5, "Crane Boom Attachment" for more information.

1-88 "AB" Upper Counterweight Assembly:

(a) Fully extend and set all outriggers on firm supporting surface. Machine must be level with all tires clear of ground.

(b) Using the live mast as a short boom, or the basic boom, lift the "A" ctwt. and place on positioning blocks on carrier frame.

(c) Lift the "B" ctwt. and install the two connecting links. Start a nut on each link to hold them in place.

(d) Set the "B" ctwt. In place on top of the "A" ctwt., making sure the links enter the holes in too of the "A" ctwt.

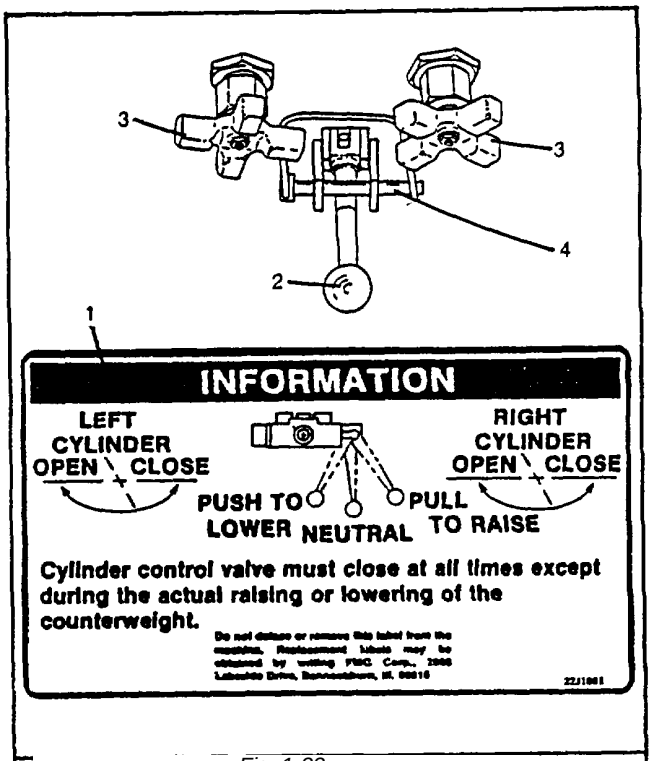


Fig. 1-33
Counterweight Removal Controls
NA263-A

(1) Decal
(2) Function Lever
(3) Control Valves
(4) Lock Pin

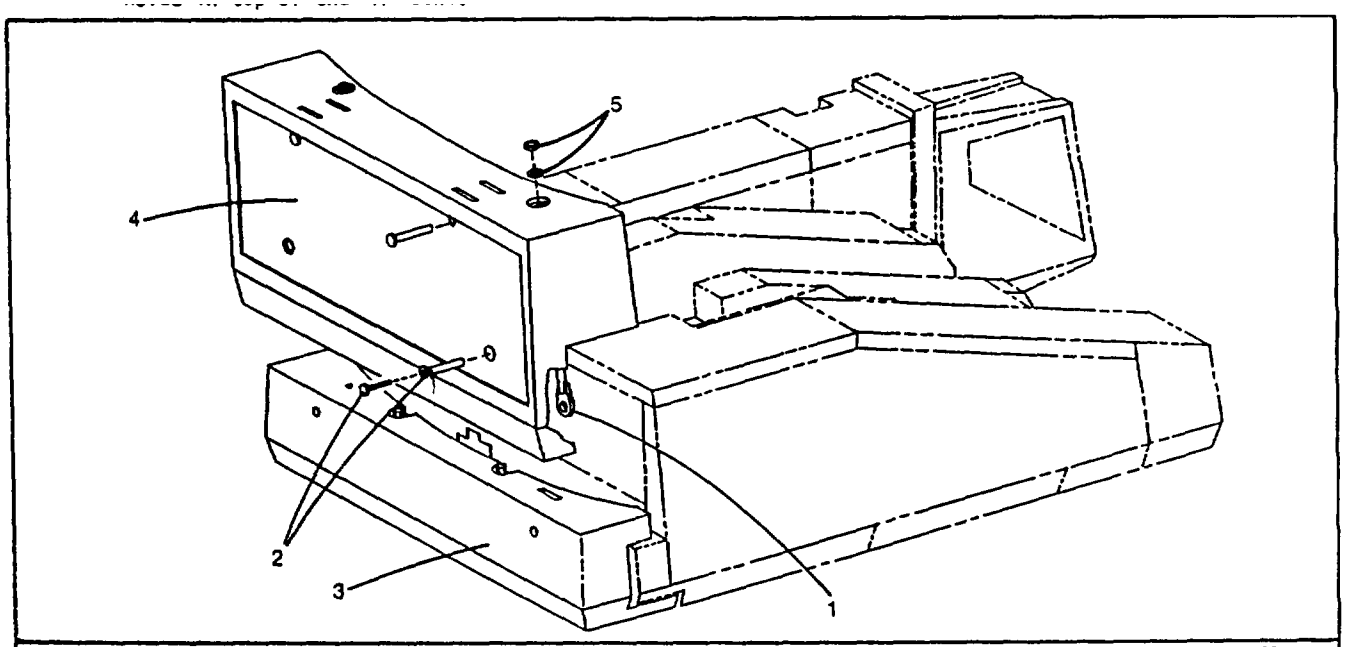


Fig. 1-34
"AB" Upper Counterweight
NA218-B

(1) Connecting Link
(2) Pin and Cotter
(3) "A" Counterweight
(4) "B" Counterweight
(5) Nut and Lockwasher

(e) Install the two ctwt. locking pins through the holes in the "A" ctwt. and in the connecting links. Install a cotter pin in each of the locking pins.

(f) Tighten down the nuts on the connecting links to hold the two counterweights together.

(g) To raise the counterweight assembly into place on the upper, refer to "Counterweight Removal Controls", earlier in this section.

1-89 "A" Bumper Counterweight Assembly:

(a) Fully extend and set all outriggers on firm supporting surface. Machine must be level, with all tires clear of ground.

(b) Lift the "A" bumper ctwt. with either the live mast reeved as a boom, or with basic boom.

(c) Set the ctwt. in place on the mounting lugs on the front bumper. Install the locking pin to secure the ctwt to the bumper.

1-90 Procedure For Shutting Down Crane

When a machine is to be shut down for overnight or similar periods, the following procedure is suggested:

(a) Land any loads, and secure against toppling.

(b) For boom lengths or boom plus jib lengths less than 40% of the maximum boom length permissible, it is usually unnecessary to lower such booms to the ground. However, should high winds be possible, lower boom to the ground if at all possible. If not possible, rest boom tip lightly against some adequate structure and securely tie off to prevent its being blown over. Longer booms must be lowered to the ground or tied off to prevent wind damage.

(c) When boom is in position as indicated in (b) above, the boom hoist lever must be placed in the neutral (off) position, and the boom locking pawl engaged.

(d) Anchor hooks and hook blocks securely to an adequate anchorage or part of the crane itself, the hoist lines drawn snug and hoist brakes set and latched in. This is to reduce likelihood of wind damage.

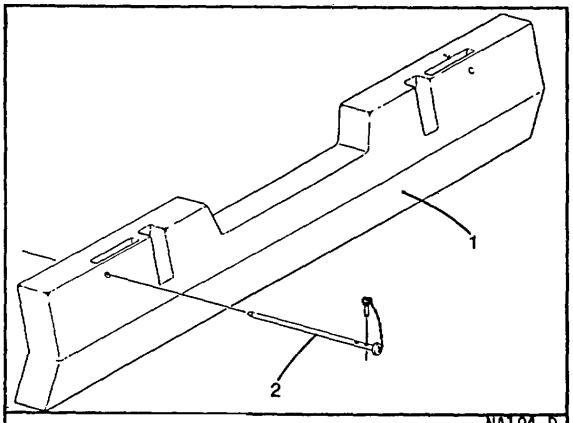


Fig. 1-35 Bumper Counterweight
(1) "A" Bumper Ctwt.
(2) Locking Pin

(e) Engage swing lock to prevent inadvertent swinging of the machine.

(f) If machine is wheel-mounted, set parking brakes and place chocks on wheels to prevent movement, or if on outriggers, outriggers must be fully extended or securely blocked up so that machine is level.

(g) Disengage-master clutch, shut down engine, turn off starting key switch and remove keys.

(h) By operating the swing lever run Speed-o-Matic system hydraulic pressure to zero to prevent inadvertent release of boom hoist brake.

(i) All doors, windows, and hatches should be closed and locked. Remove all keys to reduce danger of vandalism or injury.

(j) If the machine is located where it may pose a traffic hazard, necessary warning lights, flags and/or barricades should be placed in the proper locations.

For longer periods of shut-down, more complete storage procedures are recommended which may include lowering of boom on blocking or removal of boom, winding of wire ropes fully on drums and coating them with preservatives, boarding over or covering of windows and similar procedures to insure against unnecessary deterioration or damage.

1-91 Load Lowering With A Crane Equipped With Torque Converter And Lowering Clutches

When a FMC crane is equipped with a torque converter and lowering clutches, there are four different methods of lowering a load:

(a) The use of lowering clutches is very good for both light and heavy loads. A lowering clutch is mounted on the end of the drum shaft opposite the hoisting clutch. The power shaft in the hoisting clutch connects the load and drum carrying the load to gear train. The descent of the load is controlled by the speed of machinery which is controlled by engine speed. A sprag in the torque converter prevents the machinery from turning faster than the engine. Lowering heavy loads may cause the engine to turn faster as the load is now trying to drive the engine. The speed of descent can be controlled by the drum brake. To stop load, brake must be applied and clutch disengaged.

(b) By gravity, which is controlling the speed of descent with the brake. This method is allowable for light loads, high cycle or any occasional work.

(c) Lowering a load through the torque converter will work on heavy loads, (high line pulls) only. This is accomplished by leaving the hoist clutch engaged and regulating the engine speed to either hold the load suspended or by reducing the speed and allow the load to creep down. When this method is being used, the engine is turning normally and the machinery is turning backward.

The load can be stopped by either increasing the engine speed or applying the brake. To hold load suspended other than momentarily, the hoist brake should be applied and the hoist clutch disengaged. This method is recommended only for precise spotting of heavy loads.

(d) By gravity, but connecting the side housing gears to the drum. This is done by holding the load in the air with the drum brake, disengaging the engine master clutch, engaging the hoist clutch to whichever drum the load is attached, and then releasing the brake. This allows the machinery to turn backward as the load is lowered. On older machines prior to the use of antifriction bearings this method assisted the brake considerably in controlling speed of descent. This method is not recommended except in emergency conditions as speed can build up when line pull is high and control may become poor.

To better explain the operation of a torque converter in a crane we can make a direct comparison to a modern automobile equipped with an automatic transmission. As an example, an automobile can be headed up hill on a steep grade, gear selector placed in forward gear, and by regulating the engine speed the car can be made to move forward, stand still, or roll backwards. The same thing is happening with a load on a crane outlined in method c above.

It is not practical to give engine speeds required to handle various loads because of parts of line, single stage converter, versus three stage converter, size of drum, etc. Until the operator has gained familiarity with the machine, the loads to be lifted, the sounds of engine, and so forth it is necessary to understand and take the following steps:

(a) To prevent the load from coming down it is necessary to have the engine running fast enough to lift the load. With engine at an idle, release brake gradually while accelerating engine. As load starts up, increase engine speed as necessary.

CAUTION

Regardless Of The Method Used To Control The Load Always Keep Foot On Hoist Brake Pedal Ready To Take Over Control Of The Load As Necessary.

(b) In the case of the boom, a different method must be employed, because the clutch is engaged and the brake released with the same control lever. In this case the boom safety pawl must remain engaged until the engine speed is fast enough to raise the boom, Boom safety pawl must remain engaged at all times except when lowering boom.

Note: <u>When suspending, slowly lowering, or slowly hoisting loads using method c, engaging any other clutch function on the machine should be avoided</u>.

The reason for this instruction is that any additional load will cause further slippage of the torque converter. If a load is being hoisted slowly, it may stop or begin to lower if another clutch function is engaged. If the load is being suspended, it may begin to lower, and if it is being lowered, its lowering speed will increase. If load is being lowered, gear train

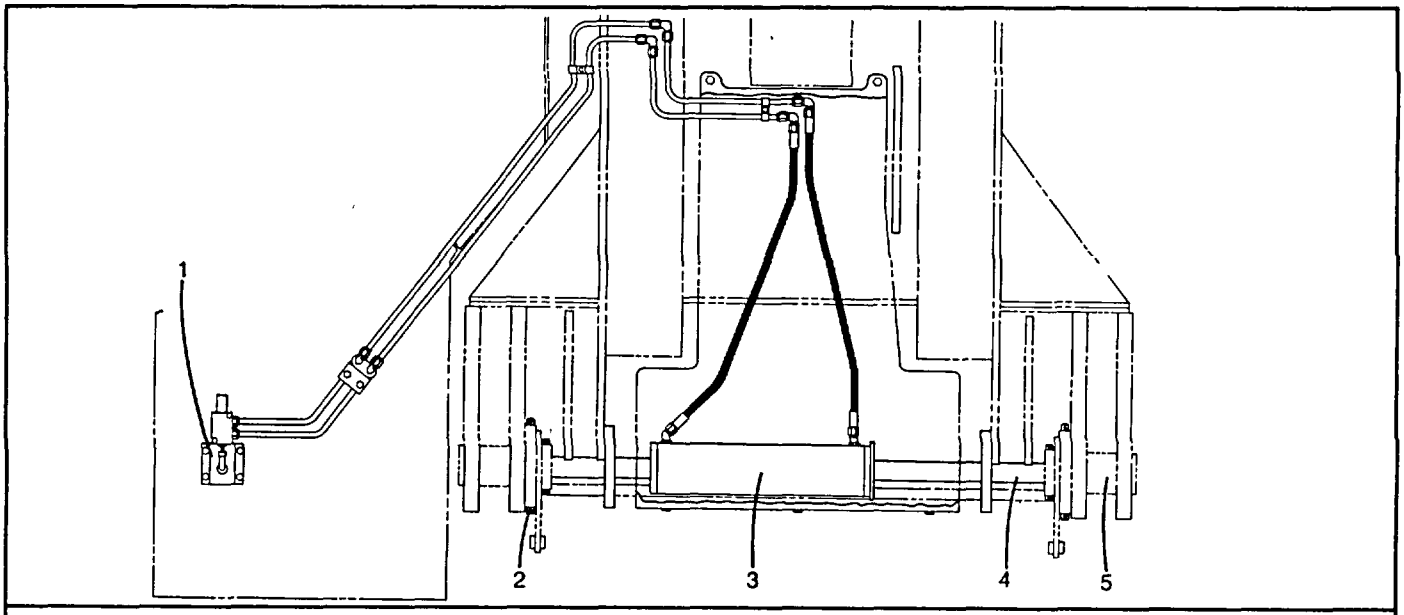


Fig. 1-36
Boom Foot Pin Removal System

(1) Control Valve
(2) Pin & Cotter Pins
(3) Pin Removal Cylinder
(4) Pin (Removed Position)
(5) Pin (Normal Position)

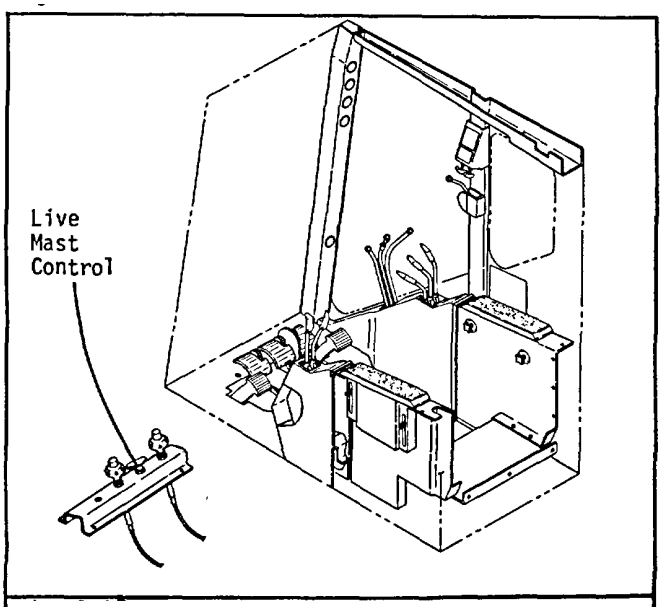


Fig. 1-37 Live Mast Control

will be turning in a direction that is the reverse of normal direction of rotation for that function or operation; thus if a clutch function is engaged, the operation will be backwards.

This same effect occurs when lowering or holding a boom by means of torque converter and throttle.

1-92 Boom Foot Pin Removal System: A hydraulic cylinder is mounted between the boom foot pins. This cylinder pulls the pins from the boom foot lugs for easy removal of the boom lower section. Pressure to operate the cylinder comes from the S-o-M system. A control valve mounted under the R.H. platform of the machine controls the cylinder.

1-93 Removing Boom Foot Pins:

(a) Remove all boom but lower section. Refer to section 5 of this manual.

(b) Position boom lower section directly over rear of carrier. Apply swing lock.

(c) End of boom lower section must be on the ground. Block securely between lower section and carrier frame under each chord so boom section cannot move when pins are removed.

(d) Remove cotter pins from boom foot pin keeper pins. Remove keeper pins.

(e) Start upper engine, let it run at an idle, with master clutch disengaged.

(f) Pull control lever (toward front of upper) to withdraw pins.

(g) Remove lower section from machine with helper crane or live mast used on short boom.

1-94 Replacing Boom Foot Pins:

(a) Withdraw pins as explained earlier.

(b) Using a helper crane, or live mast reeved as a short boom, lift lower section and set in place. Align holes in boom feet with boom foot lug holes.

(c) Push control lever (toward rear of upper) to push boom foot pins back into place.

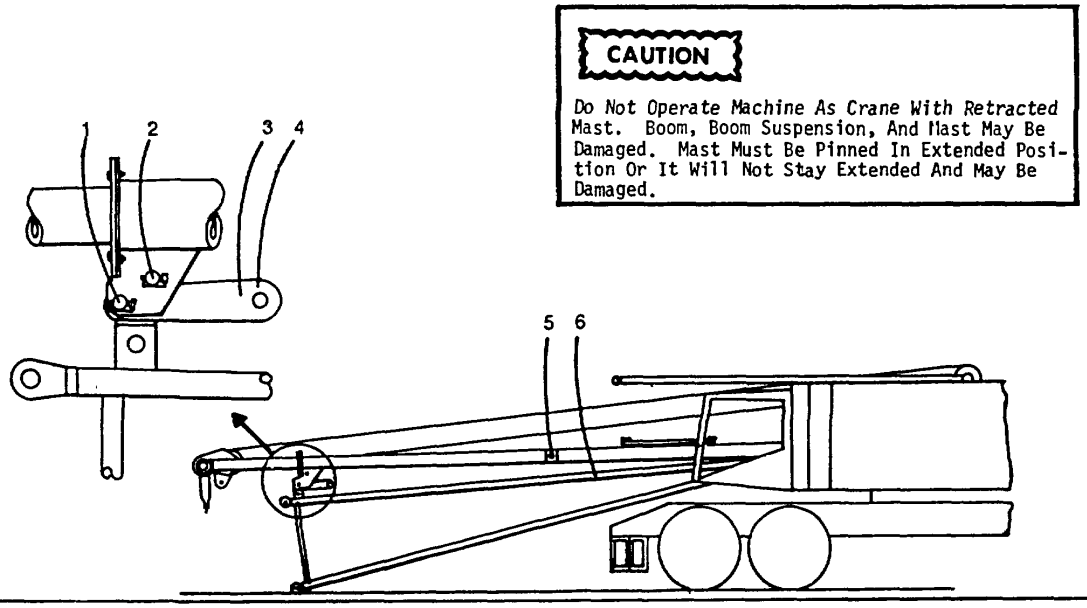


Fig. 1-38 Extending Or Retracting Live Mast

(1) Pin
(2) Pin
(3) Mast Standoff
(4) Raised Position
(5) Pin
(6) Boom Lower Section

HC238A

(d) Install lock pins on each boom foot pin. Install cotter pins in lock pins.

Note: Never remove pins unless boom is securely supported. Otherwise it may fall and cause damage or injury.

1-95 Live Mast Controls:

1-96 Extending The Live Mast: The live mast may be extended as follows:

(a) If the boom is on the machine, lower boom to ground, position the mast standoffs as shown in Fig. 1-38, then pay out B.H. ropes until the standoffs contact the lugs on the boom lower section.

(b) If the boom is not on the machine, block under the live mast near the standoffs to hold it horizontal.

Note: If mast goes below horizontal, a helper crane must be used to raise it.

(c) Pay out on B.H. ropes until they are slack.

(d) With the engine running, and master clutch disengaged, turn mast control valve knob to extend position. When the mast is fully extended, rotate the knob to the retract position.

(e) Pin the mast in position.

(f) Leave the control knob in retract position.

Note: The live mast may be pinned in the extended position, or fully retracted, See page 5-2 for more information.

1-97 Retracting The Live Mast:

(a) Boom down until the boom contacts the ground. If the boom isn't on the machine, block under the live mast near the standoffs to hold it horizontal.

(b) Position the mast standoffs as shown in Fig. 1-38, then pay out on B.H. rope until the standoffs contact the lugs on the boom lower section.

(c) Remove the two pins from the mast tubes.

(d) Control valve must be in retract position. Slowly take up on B.H. ropes to retract the mast.

1-98 General Information, Lifting Sling

The lifting sling assembly is designed to lift the entire machine after removal of the following equipment:

(a) Upper ctwt.

(b) Bumper ctwt.

(c) All boom sections and pendants except the lower section.

After these removals, the machine will weigh approximately 117,000 lbs.

Lifting equipment must be provided that can safely lift this weight. This equipment must be in good condition, properly adjusted and reeved before attempting to lift the machine.

Refer to the capacity chart in the lifting equipment, and make sure it can do the job before proceeding.

1-99 Lifting Sling Assembly: The lifting sling assembly consists of the following components.

(a) Lifting spreader. It consists of 4 lengths of H beam, bolted together into a rectangle. There are angle braces bolted across each corner of the rectangle for added strength.

(b) Front and rear slings. The slings consist of a pair of pendants connected to a link. The slings pin to lugs on top of the spreader. The front sling assembly is shorter than the rear sling assembly.

(c) Support pendants. Four of these are used. They connect to lugs on the bottom of the spreader. The other end of each pendant connects to the machine.

(d) Lifting arm assembly. One of these attaches to the bottom of the front and rear outrigger box, at each end of the box. The support pendants pin to them.

1-100 Inspection: Before using the lifting sling assembly, it must be thoroughly inspected. Look for the following:

(a) Cracked welds, cracks in the H beams, lugs, corner braces.

(b) Damage to the slings or pendants such as kinks, broken wires in the cables, corrosion, evidence of stretching.

(c) Damage to links or pins, such as cracks, scoring, evidence of stretching or bending.

If any components are damaged, replace them.

WARNING

Trying To Lift The Machine With Damaged Components In The Lifting Sling Can Cause An Accident. A Very Heavy Load Is Being Lifted. If It Falls, The Machine Will Be Damaged. Personnel Nearby May Be Injured Or Killed.

1-101 Lifting Sling Installation:

(a) Assemble the four beams which make up the lifting spreader. Each corner is connected by four capscrews and locknuts. Install the four corner braces. Each end of each brace is secured by a capscrew and locknut.

Install a turnbuckle assembly at each rear corner of the lifting spreader,

(b) Pin the front sling assembly to the lugs on the spreader. Pin the rear sling assembly to the turnbuckles. Install a keeper pin in each mounting pin.

Pin the two sling assemblies to the lugs on top of the spreader assembly. Install a keeper pin in each mounting pin.

(c) Pin a support pendant to each of the four sets of lugs on the bottom of the spreader assembly. Install a keeper pin in each mounting pin.

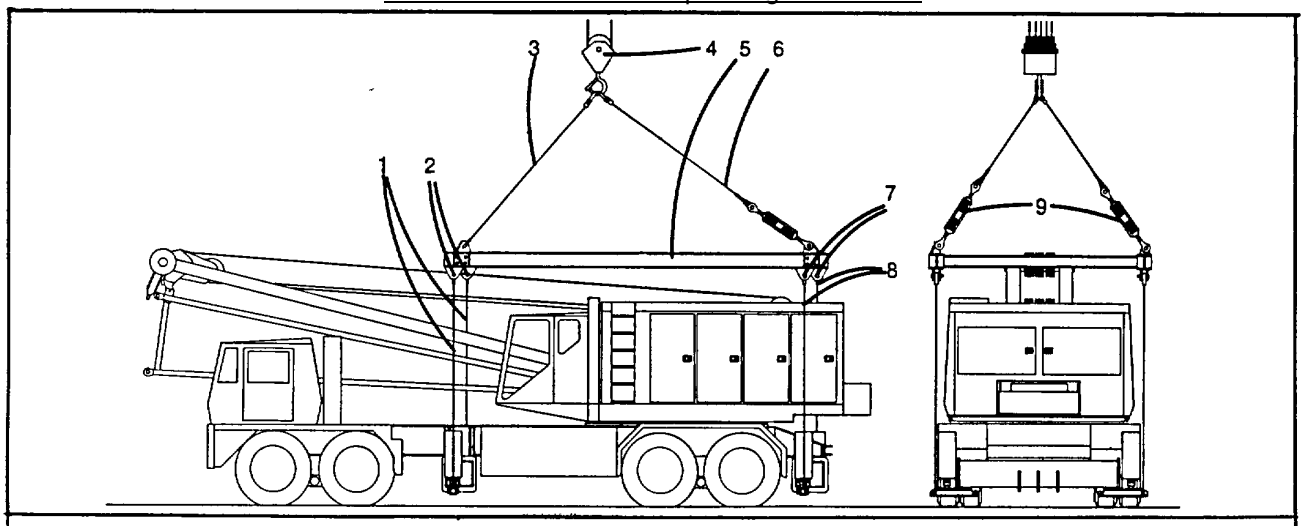


Fig. 1-39 Lifting Sling Installation

(1) Support Pendants, Front
(2) Connecting Pins
(3) Front Slings
(4) Hook Block From Lifting Equipment
(5) Lifting Spreader
(6) Rear Slings
(7) Connecting Pins
(8) Support Pendants, Rear
(9) Turnbuckles

(d) Refer to Figure 1-40. Install the lifting arm assemblies on the outrigger boxes.

Connect the arm to the lugs on the bottom of the outrigger box with a pin. Install a keeper pin in the mounting pin.

(e) Lift the arm until the socket on the arm contacts the outrigger jack cylinder rod. Move the outrigger beam in or out as necessary, to center the jack cylinder rod in the pocket. Install two hitch pins through holes in the pocket. This holds the lifting arm on the jack cylinder rod.

(f) Before attaching the sling to the crane, check the following:

(1) Counterweight must be off the machine.
(2) All boom except the lower section must be off the machine.
(3) Any gear that is on the luggage carriers on deck has to be removed.
(4) Swing the upper to face the front of the carrier. Engage the swing lock.

(g) Connect the hook block from the lifting equipment, to the slings. Lift the assembly, and position over the crane.

Note: <u>The short slings go to the front of the crane.</u>

Connect the four support pendants to the lifting arms with pins. Install keeper pins in each connecting pins.

WARNING

Before Lifting Crane, Inspect Lifting Sling Again. Make Sure Everything Is Assembled Right. Make Sure All Pins Have Keepers. Don't Let Anyone Near The Machine While It Is Being Lifted.

(h) Lift the crane slightly, and check for levelness. If not level, set the crane down and slack off on the slings. Adjust turnbuckles until crane hangs level.

Tighten jam nuts on turnbuckles. Insert a cotter pin in each threaded turnbuckle rod. Wrap the legs of the cotter around the turnbuckle body so it can't turn.

After the crane has been lifted and repositioned, lower the sling assembly until the support pendants are slack.

Unpin them from the lifting arms.

(i) Set the lifting spreader on the ground.

Remove the support pendants and slings.

(j) Disassemble the lifting spreader.

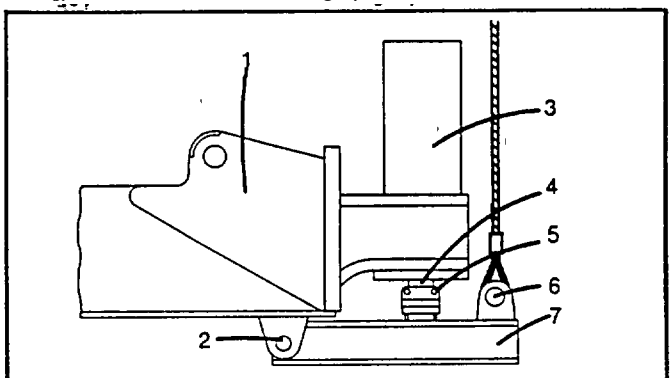


Fig. 1-40 Lifting Arm Assembly

(1) Outrigger Box
(2) Pin & Keeper
(3) Outrigger Jack
(4) Piston Rod
(5) Pins
(6) Pin
(7) Lifting Arm

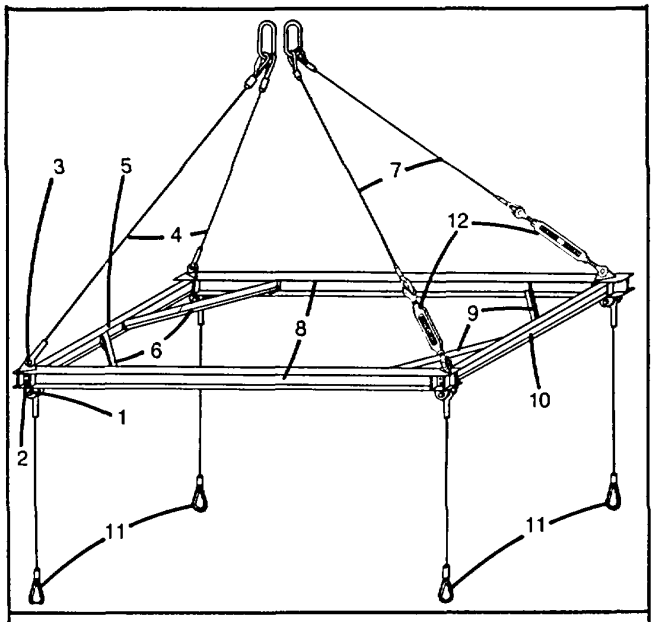


Fig. 1-41 Lifting Assembly

(1) Pin	(7) Sling, Rear
(2) Capscrew, Locknut	(8) H Beam
(3) Pin	(9) Corner Braces
(4) Sling, Front	(10) H Beam
(5) H Beam	(11) Support Pendants
(6) Corner Braces	(12) Trunbuckles

(k) Remove the lifting arms.

(l) Store all of the parts together so none of them become lost.

Coat the pins, and the inside of the pin holes with the preservative, so they won't rust.

1-102 Machine Tie Down: Two tiedown rings are provided at each end of the carrier. When the machine is being transported by ship or rail, it must be securely blocked in place and tied down.

(a) Refer to Figure 1-42. After positioning the machine, securely block one front wheel on each side of the machine, and one rear wheel on each side of the machine. Block in front and back of each wheel.

If blocking on a rail car, secure the blocks to the wood deck with nails.

If blocking on a metal surface (ship deck), connect the two blocks together by nailing planks to the sides of the blocking.

(b) After blocking, shift the carrier transmission into neutral. Make sure park/ emergency brakes are applied.

(c) Two tie down hooks are installed on each end of the carrier. The front two are on the frame under the bumper. The back two are on the rear of the frame on either side of the back up lights.

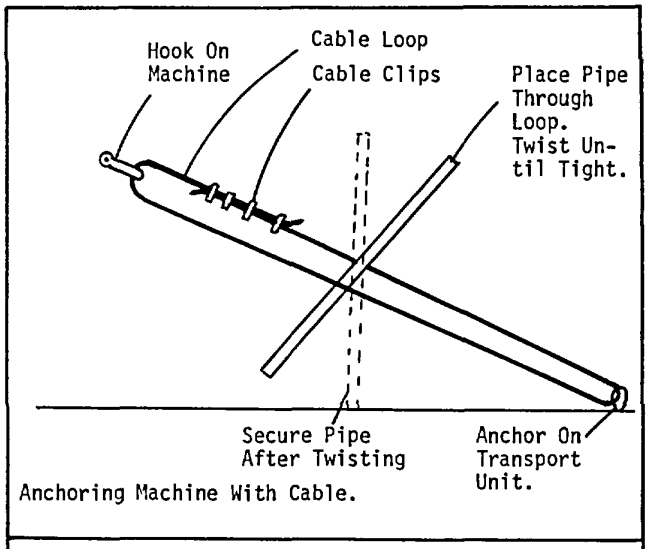
The machine must be secured to the transport unit from each of the four hooks.

Chain load binders should be used. Adjust them so the chains are taut when the load binder handle snaps over center. Wire the handle of the load binder to the body so it can't loosen.

Cable tie down can be used. Use at least 1/2" cable. Use new cable only. Never use discarded or used cable for tie downs.

Loop the cable through the tie down hook, and the anchor on the transport unit. Connect the ends of the cable with cable clips, to form a loop.

Stick a pipe through the loop. Twist the loop until it is tight. Secure the pipe to the transportation unit, or to the machine, so the loop won't untwist.



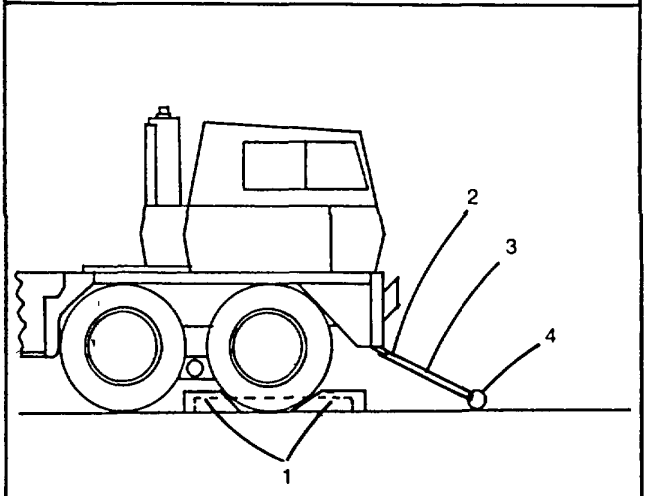


Fig. 1-42 Machine Tie Down

(1) Blocking - Each Side Of Each Wheel	(3) Cable Or Chain Tie Downs
(2) Hook - 2 Front, 2 Rear	(4) Attaching Point On Transportation Unit

Index Section 2

2-1 General Lubrication Information

Regularly and systematically lubricate the machine as shown on the lubrication charts later in this section of the manual. A copy of these charts are mounted in the upper cab of the machine. The time interval shown on the chart is a guide only. Under unusual working conditions, with the carrier in mud, water, etc., more frequent lubrication may be necessary. In these cases, good judgment must be used in working out a suitable schedule.

The following points are important. Follow them when lubricating the machine.

(a) Wipe the grease gun nozzle and grease fittings before lubricating. This helps keep grit from entering the bushing or bearing.

(b) Keep all grease, oil, containers and cans clean. Always replace the lid on containers when through to prevent entry of foreign material. Wipe off can covers before opening.

(c) Drain gear cases when hot. They will drain better, and grit will be more likely to be in suspension.

WARNING

Be Careful Not To Get Burned On Hot Oil When Draining Gear Cases.

(d) Watch for signs of incorrect lubrication such as failure of fittings to take grease, leakage from seals, cover plates, etc., accumulation of grease where it shouldn't be, etc.

(e) Disengage the master clutch before working on machine. Replace all guards before starting machine.

(f) Use a clean funnel equipped with a strainer for pouring lubricants. Clean an area around fill or check plugs before removing to prevent entry of foreign material.

Note: See PP. 2-14 through 2-17 later in this section of the operators manual for lubrication check and change procedures.

2-2 Carrier Maintenance And Lubrication Schedule

2-3 Daily

Operation	Remarks
General	(1) Keep the carrier clean. (2) Check for loose or broken bolts, nuts, cotter pins, and other fasteners. If any, tighten or replace before operating. (3) Inspect all welds for cracking. If any are noted consult manufacturer. Do not operate until properly repaired.
Engine	(1) Check oil level. Add oil as necessary.
Radiator	(1) Check and fill if necessary. (2) Check anti-freeze in winter.
Fuel Tank	(1) Check fuel level. Add fuel as necessary. (2) Don't smoke when fueling or fuel up a machine near an open flame. Keep the nozzle in contact with the filler neck to prevent static electric sparks. Shut off the engine when fueling.
Battery	(1) Check electrolyte level. Fill with distilled water if necessary. (2) Keep battery clean at all times. Corroded posts or accumulation of grit, electrolyte, etc., on top of a battery can cause it to become discharged. **WARNING** **Be Careful Not To Get Battery Electrolyte On Your Skin, Or Clothing, Or Especially In Your Eyes. It Is Acid And Can Cause Injury.** **Don't Smoke Or Use Open Flame Near A Battery, Battery Gas Is Explosive.**
Tires	(1) Check for proper tire pressures for type of operation. See tire inflation chart in Section 3 of this manual. (2) Inspect tires for wear, cracks, bulges, breaks, or other damage. Replace damaged tires before roading the machine, or operating on rubber. (3) See shop manual SM1-69-2.0 for more information.

Daily - Continued	
Operation	Remarks
Brake System	(1) Check air pressure, 15-125 PSI (792-861 kPa) maximum. (2) Check low air pressure warning devices for proper operation at 60 PSI (413 kPa). (3) Check foot brake operation. (4) Check digging brake operation. (5) Check emergency brake operation.
Air Reservoirs	(1) Drain accumulated water.
Power Steer System	(1) Check oil level. It should be one inch from top of reservoir when oil is at operating temperature. (2) Inspect the hydraulic fluid for foreign material. If contaminated, drain and refill system. (3) Inspect system for loose fittings, worn or chafed hoses, leaks etc. Repair before operating.
2-4 Weekly	
Operation	Remarks
First perform all operations listed under "Daily".	
Clutch Linkage	(1) Lubricate the fittings on the clutch cross shaft, one fitting for the clutch release bearing, and one fitting on clutch shaft block. Lubricate sparingly to prevent grease reaching the clutch facing. (2) Lubricate pivot points on the clutch pedal and linkage with engine oil.
Wheel Nuts	(1) Check lug nuts weekly and tighten as necessary. (2) Inspect wheel, rims, lug nuts, etc., for damage. Repair any damage before roading the machine or operating.
2-5 Monthly or 1000 Miles (1609.3km)	
Operation	Remarks
First perform all operations listed under "Weekly".	
Main Transmission Creeper Transmission Rear Axle Differentials Planetary Wheel Ends	(1) Check lubricant level as explained later in this section. Add lubricant. (2) Inspect for missing components, loose bolts, leakage, or other damage. Repair any damage before roading the machine or operating.
Chassis Lubrication (Drag Links, King Pins, Tie Rod Ends, Etc.)	(1) Provide complete chassis lubrication. Force lubrication into fittings until old lubricant, dirt, and water are expelled.
Universal And Slip Joints	(1) Lubricate with a low pressure gun to avoid seal damage.
Control Linkage	(1) Lubricate "U" joints on main transmission shifter with a grease gun. (2) Lubricate master shifter control with a grease gun. Pump in grease until it extrudes around the boot on shift lever. (3) Lubricate all pivot points on transmission, creeper transmission, and throttle control linkages with engine oil.
Steering Gear	(1) Check lubricant level. Fill if necessary. (2) Inspect for leakage or damage. Repair any damage before roading or operating the machine.
Rear Axle Vents	(1) Clean.

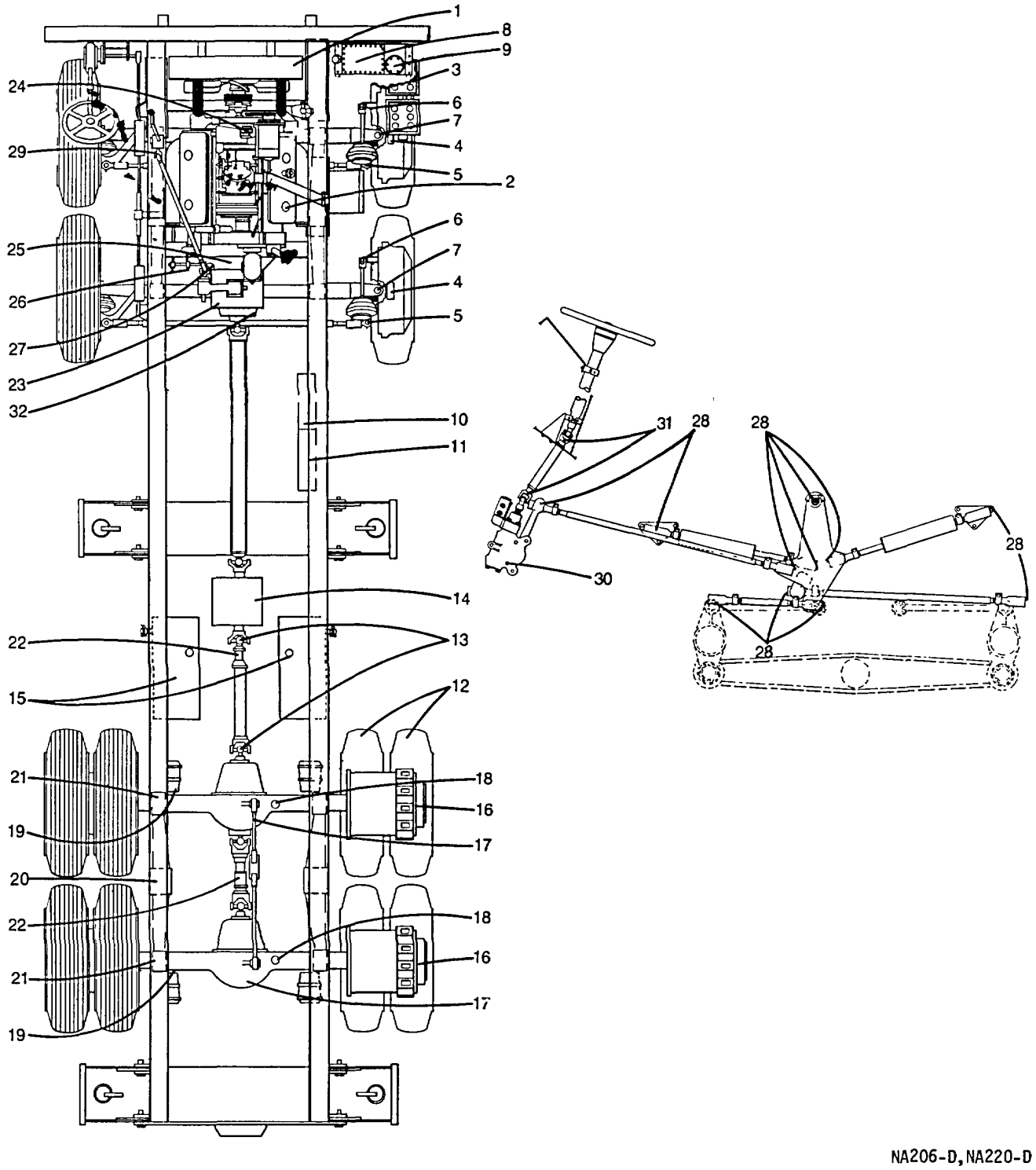
2-6 Semi-Annually or 5,000 Miles (8046.7 km)

Operation	Remarks
First perform all operations listed under "Monthly Or 1,000 (1609.3 km) Miles"	
Main Transmission Creeper Transmission Rear Axle Differentials Planetary Wheel Ends	(1) Drain, flush, and refill as explained later in this section. (2) Refer to capacity chart on page 2-3 for proper type and amount of lubricant to use.
Front Wheel Bearings	(1) Repack with grease. (2) Inspect. Replace any worn parts.

2-7 Carrier Capacity Chart

Location	Capacity				Lubricant
Rear Axle Differential (Each)	35 Pints	-	16.5	Liters	E
Rear Axle Planetary Hub (Each)	8 Pints	-	3.78	Liters	E
Main Transmission	28 Pints	-	13.2	Liters	D
Creeper Transmission	12 Pints	-	5.6	Liters	D
Steering Gear	2.5 Pints	-	1.3	Liters	E
Power Steering System	3 Gal. Approx.	-	11.3	Liters	F
Engine Crank Case(w/Filter Change G.M.C.)	6.25 Gal.	-	23.6	Liters	
Outrigger Sump Tank	20 Gal.	-	75.7	Liters	S-o-M Oil
Outrigger System	35 Gal. Approx.	-	132.4	Liters	S-o-M Oil
All Lubrication Fittings	As Required				

Key
A,C,D,E,F,H,J, - See lubrication specifications on page 2-13.



Shut down engine. Engage park brake before working on carrier. Keep grease, oil, guns, and containers clean. Wipe all fittings before lubrication.

Fig. 2-1
Carrier Lubrication Chart

2-8 Carrier Lubrication Chart

Ref. No.	Description	No. Points	Daily	Weekly	Monthly Or 1000 Miles (1609.3 km)	Semi Annual Or 5000 Miles (3046.7 km)
1	Radiator	1	*			
2	Engine	A11	See	Chart p 2-20		
3	Battery	A11	*			
4	Wheel Bearings	4				Repack A
5	Tie Rod Ends	4			A	
6	Brake Cam Shafts	4			A	
7	King Pins	8			A	
8	Hyd. Outrigger Sump Tank	1	*	Change Seasonally, or Every 1000 Operating Hrs.		
9	Hyd. Outrigger Filter	1	Change Every 250 Operating Hours			
10	Outrigger Strainer	1	Clean When Sump Tank Is Drained			
11	Air Reservoirs	A11	Drain Water Daily			
12	Tires	A11	*			
13	"U" Joints	6			A	
14	Creeper Transmission	1			*	CH-D
15	Fuel Tanks	2	*			
16	Planetary Hubs	4			*	CH-E
17	Differentials	2			*	CH-E
18	Rear Axle Vents	2			CL	
19	Brake Cam Shaft	4		A		
20	Center Bogie Beam Bushing	2			A	
21	End Bogie Beam Bushing	4			A	
22	Slip Joints	3			A	
23	Main Transmission	1			*	CH-D
24	Power Steer Reservoir	1	*			CH-F
25	Clutch Release Bearing	1		A		
26	Clutch Shaft Support	1		A		
27	Clutch Cross Shaft	1		A		
28	Steering Linkage	11			A	
29	Trans. Shifter "U" Joints	2			A	
30	Steering Gear	1			*	
31	Steering Column "U" Joints	2			A	
32	Transmission Air Filter	1				CH

Key
A,D,E,F, = See Lube Specifications Page 2-13
* = Check And Fill If Necessary
CH = Change
CL = Clean

2-9 Upper Maintenance And Lubrication Schedule

2-10 Every 10 Hours

Operation	Remarks
General	(1) Keep the upper clean. (2) Check for loose or broken bolts, nuts, cotter pins, and other fasteners. If any, tighten or replace before operating. (3) Inspect all welds for cracking. If any are noted consult manufacturer. Do not operate until properly repaired.
Engine	(1) Check oil level. Add oil as necessary.
Master Clutch	(1) Lubricate throwout collar, sparingly, so grease won't get on the clutch linings. (2) Lubricate fittings on clutch cross shaft.
Torque Converter	(1) Check oil level. Add oil as necessary.
Chain Case	(1) Check oil level. Add oil as necessary. (2) Check for leakage. Repair if any before operating the machine.
Wire Rope (Cable)	(1) Inspect wire rope and fittings daily as explained in Section 5 of this manual.
S-o-M Sump Tank Outrigger Sump Tank	(1) Check oil level. Add oil as necessary. (2) Inspect the system for leaks, wear, or other damage. Repair before operation.
WARNING **Do not service, maintain, or lubricate open gears unless upper engine is shut down and swing lock is engaged.**	
Open Gears	(1) Maintain a thin film of grease on all open gears (including swing pinion and turntable bearing) at all times. Upper engine must be shut down and swing lock engaged when applying the grease.
Fuel Tank	(1) Check fuel level. Add fuel as necessary. (2) Don't smoke when fueling, or fuel up a machine near an open flame. Keep the nozzle in contact with the filler neck to prevent static electric sparks. Shut off the engine when fueling.
Radiator	(1) Check and fill if necessary. (2) Check anti-freeze in winter.
Batteries	(1) Check electrolyte level. Fill with distilled water if necessary. (2) Keep batteries clean at all times. Corroded posts or accumulation of grit, electrolyte, etc., on top of a battery can cause it to become discharged. **WARNING** **Be Careful Not To Get Battery Electrolyte On Your Skin, Or Clothing, Or Especially In Your Eyes. It Is Acid And Can Cause Injury.** **Don't Smoke Or Use Open Flame Near A Battery. Battery Gas Is Explosive.**
Boom Chords And Lattice	(1) Inspect all parts of the attachment, paying particular attention to the boom chords and lattice. If damaged, the boom may collapse. If a lattice or diagonal bracing member is broken replace it. If bent, straighten it. Refer to Shop Manual 9-1-2.0 for repair information. If a main chord is damaged or bent, even a small amount, don't use it. Don't try to repair it. These members are so vital that it is not practical to attempt repair. Replace the entire boom section. (2) If the live mast is damaged, repair or replace before using.

2-11 Every 50 Hours

Operation	Remarks
First perform all operations listed under "Every 10 Hours".	
Torque Converter	(1) Inspect and clean exterior of converter. (2) Repair any oil leaks or other damage before operating.
Reduction Pinion Gear Case Reverse Bevel Gear Case Planetary Gear Case	(1) Check lubricant level. Add lubricant if necessary. (2) Inspect for leakage or other damage. Repair if any before operating machine.
Master Clutch	(1) Remove hand hole cover and inspect clutch for wear or damage. Pay particular attention to the throwout collar, and the grease hose and fittings leading to it. If the hose breaks or works loose, the throwout collar will not receive adequate lubrication. This may cause damage to the clutch assembly.
Side Housing Bearings (All Horizontal Shafts)	(1) Pump in 8 to 10 shots of grease at each lubrication. Three bearings are being lubricated thru one fitting. (2) Wipe up any excess grease to keep it off the clutch linings.
S-o-M Filter Outrigger System Filter (On Carrier)	(1) Change the filters after the first 50 hours of operation on a new machine. The procedure is explained later in this section.
Air Box Drains	(1) Drain accumulated oil and water as explained later in this section.
Clutch Heel Blocks Control Lever Linkage Swing Lock Linkage Swing Brake Linkage And Pins S-o-M Valve Spools	(1) Lubricate all pivot points with engine oil. (2) Check valve caps for rust or corrosion - clean if any is apparent. Lubricate with clean S-o-M oil.
Clutches Brakes	(1) Check all clutches and brakes for proper adjustment. Adjust as explained later in this manual if necessary. See Section 4. (2) Greasy, aged, or worn linings should be replaced because continued operation may be unsafe. (3) Check linings for foreign particles which may score the drums. If any particles are evident, replace linings before continued operation.
General, Upper And Attachment	(1) Lubricate all remaining 50 hour points as listed on the lubrication chart.
Turntable Bearing	(1) This bearing must be kept full of grease for proper lubrication and long life. Pump grease into each fitting until clear grease appears around the bearing shield. Rotate the upper and again pump grease into each fitting. Repeat this procedure until clean grease appears all around the bearing.
S-o-M Control Valves	(1) Inspect valve spools and linkage for rust or corrosion. If any appears, clean it off. (2) Lubricate valve spools with clean S-o-M oil.

2-12 Every 250 Hours

Operation	Remarks
First perform all operations listed under "Every 50 Hours".	
S-o-M Filter Outrigger System Filter	(1) Change the filters every 250 operating hours. The procedure is explained later in this section.
Master Clutch	(1) Check adjustment. Adjust if necessary.
Boom Hoist Brake Front Drum Brake Rear Drum Brake	(1) Visually check band connecting lugs, actuating linkage, related pins, and the mounting bracket pin hole for any signs of wear or damage. Repair or replace if required. (2) Visually check "and for any indications of bending, interference, or unusual linkage wear which would indicate excessive wear of the brake parts. Repair or replace is required. (3) Check condition of the band adjusting bolt and nut. Make sure the locking nut will hold against rotation during operation.

2-13 Every 500 Hours

Operation	Remarks
First perform all operations listed under "Every 250 Hours".	
Boom Hoist Brake Front Drum Brake Rear Drum Brake	(1) Remove the band and all related parts for a detailed visual inspection. If any of the parts show signs of undue wear, cracks, or other distress, replace them. Reassemble and adjust the mechanism.

2-14 Every 1000 Hours or Seasonal

Operation	Remarks	1,000 Hours	Seasonal
First perform all operations listed under “Every 500 Hours”.			
Reverse Bevel Gear Case Reduction Pinion Gear Case Chain Case Planetary Gear Case	(1) Drain, clean, and refill with specified lubricant. See capacity chart on page 2-12.	*	*
Bevel Gears Engine Drive Chains	(1) Inspect for wear or damage. Repair or replace if required. (2) Adjust bevel gear back lash and chain tension as necessary.	*	
S-o-M System	(1) Drain, clean, and refill with proper S-o-M oil. See capacity chart on page 2-12.	*	*
Torque Converter	(1) Change oil and filters.	*	
Turntable Gear Swing Pinion Gear Train	(1) Inspect all open gears for wear or damage. Repair or replace the part if required before further operation.	*	

2-15 Machine Storage Suggestions

Listed below are a number of important points which should be followed when putting a machine into storage. Machines stored outside must be thoroughly protected or serious deterioration will result.

(1) Lower boom to ground, and slack off on boom suspension, or remove boom entirely. Tie down all ropes and pendants to prevent whipping in the wind, etc.

(2) Machines should be stored under cover to reduce the possibility of rust and deterioration.

If stored outside, certain procedures must be followed to protect the machine as much as possible from the elements.

(1) Clean the unit thoroughly, removing all dirt and other foreign material.

(2) Lubricate the entire machine as outlined in this section.

(3) Touch up any spots where paint has been knocked off to reduce rust and deterioration.

(4) Cover all unpainted machined surfaces, except friction surfaces such as clutch and drum brake surfaces with a coating of heavy grease to reduce rusting. Cover all clutch and brake friction surfaces with a cover of water proof paper or plastic to protect these surfaces from rust.

(5) Bring all tires up to proper operating pressure. Check periodically while stored to make sure tires don't go flat. If possible block machine up so tires are clear of the ground. Do not use outriggers for this purpose. Use sound blocking and place so machine cannot fall off or topple blocking. If this is not possible, set machine on planks so tires will not sink into around.

(6) Apply parking brakes. Leave digging brakes released.

(7) Drain accumulated water and sludge from air brake reservoirs to reduce rust and deterioration.

(8) Cover intake and exhaust openings on both carrier and upper engine to reduce moisture entry.

(9) Fully retract all outrigger beams and Jacks.

(10) If anti-freeze is not to be used, completely drain the cooling systems (both upper and lower engines). Leave all drains open.

(11) Remove batteries and store them where they will not freeze. Charge them periodically during storage.

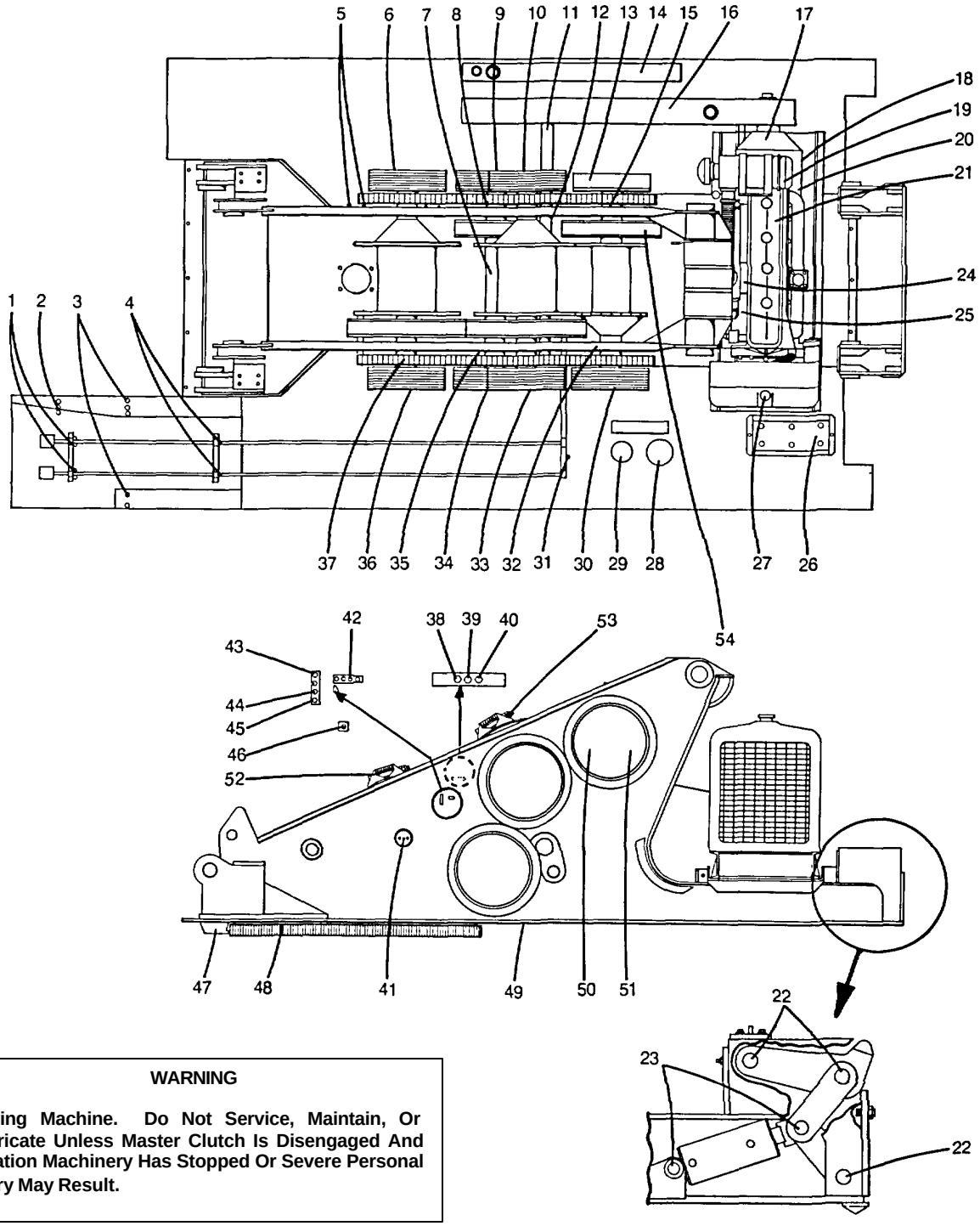
(12) Cover open spaces around boom hoist bail or drums with waterproof paper or plastic to keep rain and snow off machinery. Cover entire upper with a tarp if available.

(13) Leave all control levers in neutral position. Leave foot brake pedals in released position.

(14) Refer to clutch, engine, and torque convertor manuals for information on storing these units.

(15) Lock all doors on machine, and cover all window glass with metal or wood covers to guard against vandalism and unauthorized entry.

Note: Store machine so it doesn't provide a plaything for children. Such a unit can be an attractive nuisance for children to play on. If they fall off or get entangled serious injury may result.



WARNING

Moving Machine. Do Not Service, Maintain, Or Lubricate Unless Master Clutch Is Disengaged And Rotation Machinery Has Stopped Or Severe Personal Injury May Result.

Keep grease, oil, guns, and containers clean. Wipe all fittings before lubricating. Disengage master clutch and shut down engine before working on machine. Replace all guards and panels before operating machine.

Fig. 2-2
Upper Lubrication Chart

2-16 Upper Lubrication Chart

Ref. No.	Description	No. Points	10 Hours	50 Hours	250 Hours	500 Hours	1000 Hrs. Or Seasonal
1	Front, Rear, Drum Brake Pedal	2 Each		A			
2	Master Clutch, Swing Lock, Swing Brake Linkage	A11		M			
3	Control Stand Linkage	A11		M			
4	Drum Brake Linkage Pivots	3		A			
5	Turntable Bearing	2	A				
6	RH Front Drum Shaft Brg.	1		A			
7	Reverse Bevel Gear Case	1		*			CH-J
8	Swing Brake Pivot	1		A			
9	RH Rev. Shaft Bearings	1		A			
10	RH R.D. Shaft Bearings	1		A			
11	Outboard Bearing	1		A			
12	Red. Shaft Bearing Housing	1		*			CH-M
13	Two Speed Planetary	A11		*			CH-J or E
14	Fuel Tank	1	*				
15	BH Brake Pivot	1		A			
16	Chain Case	1	*				CH-C
17	Throwout Collar	1	A				
18	Clutch Cross Shaft	2		A			
19	Air Cleaner	1	See Chart pg. 2-20				
20	Torque Converter	A11	See Chart pg. 2-20				
21	Engine	A11	See Chart pg. 2-20				
22	Ctwt. Remover Linkage	8				A	
23	Ctwt. Remover Cylinder	4				A	
24	Oil Filter	A11	See Chart pg. 2-20				
25	Fuel Filter	A11	See Chart pg. 2-20				
26	Battery	1	*				
27	Radiator	1	*				
28	S-o-M Sump Tank	1	*				CH
29	S-o-M Filter	1			CH		
30	L.H. BH Shaft Brgs.	1		A			
31	Drum Brake Cross Shaft	1		A			
32	RD Brake Pivot	1		A			
33	LH RD Shaft Bearings	1		A	1	Dismantle and inspect	
34	LH Rev. Shaft Bearings	1		A		brakes and actuating	
35	FD Brake Pivot	1		A		mechanisms as explained	
36	LH RD Shaft Bearings	1		A		in lubrication timetable	
37	Gear Train	1		A			
38	Red. Shaft Bearing	1		A			
39	BH Shaft Brg. (W/Planetary)	1		A			
40	Red. Shaft Brg.	1		A			
41	LH FD Drum Shaft (W/O Clutch)	1		A			
42	BH Brake Bell Crank	1		A			
43	FD Brake Bell Crank	1		A			
44	Turntable Bearing	1		A			
45	Turntable Bearing	1		A			
46	LH Lower Red. Shaft Brg.	1		A			
47	Swing Lock			A			
48	Turntable Gear Teeth		H				
49	Lower Swing Shaft Bearing			A			
50	Clutch Arms	2 Per Clutch		A			
51	Clutch Pivot Points	A11		M			
52	Front Drum Brake	A11		Insp.			Insp. 1
53	Rear Drum Brake	A11		Insp.			Insp. 1
54	B.H. Brake	A11		Insp.			Insp. 1

Key
* = Check and fill if required.
CH = Change
Insp. = Inspect
A,H,M = See lubrication specifications later in this section.

2-17 Upper Capacity Chart		
Location	Capacity	Lubricant
Chain Case	1.5 Gal. - 5.6L	C
Reverse Bevel Gear Compartments	40 Pins - 18.9L	J
Planetary Gear Case	2.5 Qts. - 2.36L	E above 32° F, J below 32° F (0°C)
S-o-M Sump Tank	11.9 Qt - 11.2L	S-o-M Oil
Red. Shaft Pinion Housing	1.5 Qt. - 1.41L	M
Open Gears	As Required	H
Zerk Fittings	As Required	A
Pivot Points	As Required	M

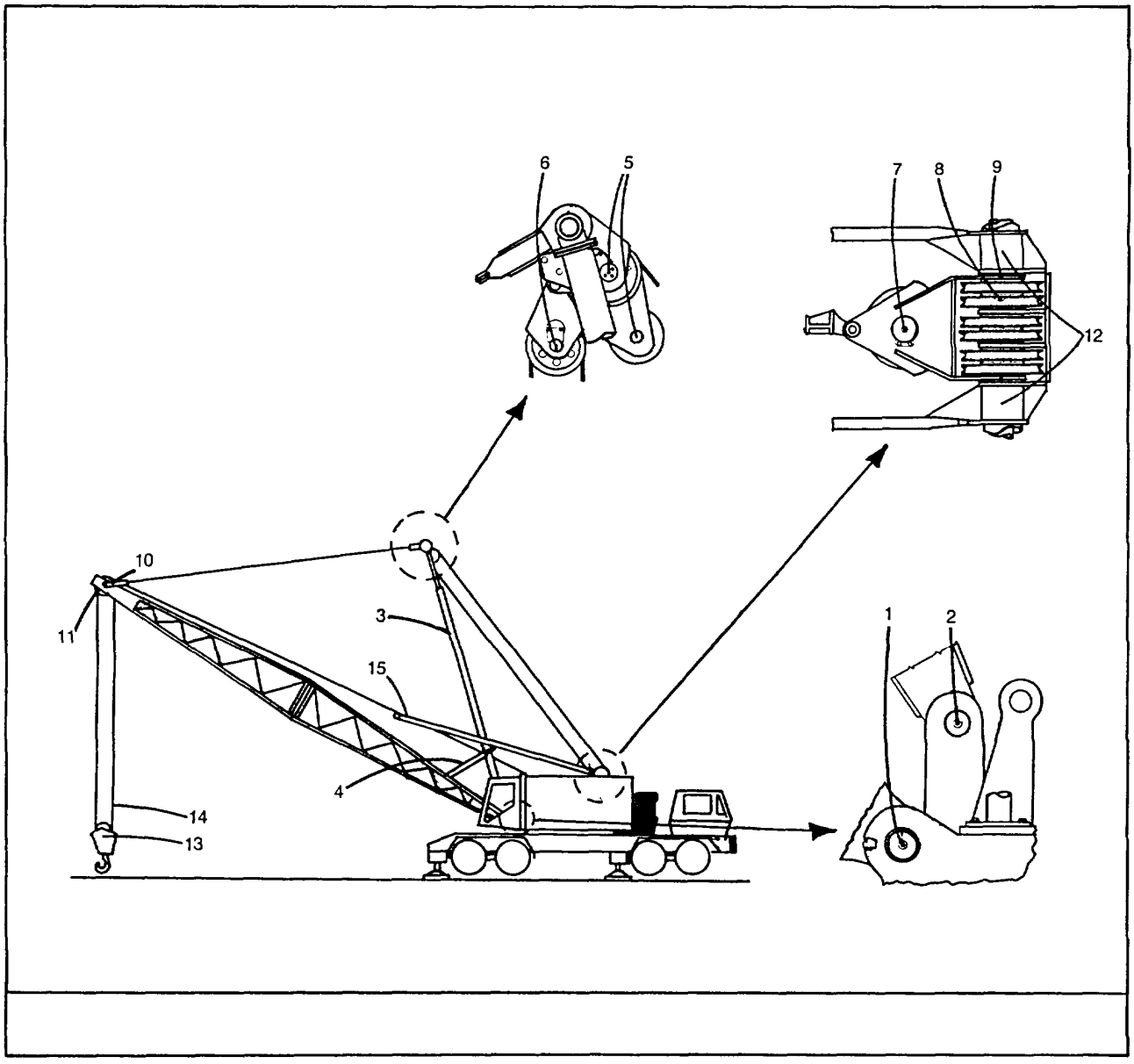


Fig. 2-3
Attachment Lubrication Chart

2-18 Attachment Lubrication Chart

Ref. No.	Description	No. Points	10 Hours	50 Hours	250 Hours
1	Boom Foot Pins	2	A		
2	Mast Foot Pins	2	A		
3	Live Mast Tubes	4		A*	
4	Telescoping Backstop Supports	2		A	
5	Bridle Sheaves	9		A	
6	Aux. Lifting Sheaves	2		A**	
7	Horizontal Bail Sheave	1		A	
8	Vertical Bail Sheaves	6		A	
9	BH Bail Frame	2		A	
10	Pendant Links	2		A	
11	Boom Head Sheaves	2,5,6		A	
12	Boom Backstop Struts	2		A	
13	Hook Block Sheaves	A11		A	
	BH Limiting Actuator	1		A	
14	Wire Rope	A11	Inspect		
15	Boom Backstops	2		A	

* After 5 extend retract cycles, or every 3 months (whichever comes first) lubricate mast tubes.
** Auxiliary lifting sheaves - every 50 hours if used regularly - every 3 months otherwise.

2-19 Lubrication Specifications

NOTE: The following manufacturer recommended lubricants are provided for reference only. For actual lubrication see Appendix G, page A-33.

A Heavy Duty E.P. Bearing Grease (NLGI Grade #2)

This grease shall be a homogeneous combination of refined mineral oil and lithium soap. This grease shall not contain any fillers which adversely affect the lubricating qualities of the product. It may have additives that give a high degree of protection against corrosion of metals and oxidation of the grease. It shall be free of any disagreeable odor.

The product shall be a non-corrosive, short fiber grease of excellent mechanical and storage stability.

The mineral oil shall meet the following specifications:

Viscosity at 2100 F (S.U.S.)	80-100
Viscosity Index	65 Min.
Timken Test Lever Load	40 Min.
Pour Point	+15° F Max.

The grease shall have the following physical and chemical properties:

Penetration, Worked 770 F (60 Strokes) Units	265-295
Penetration Change After 10,000 Strokes	15% Max.
Dropping Point	+350° F Min.
Lithium Soap	6-14%
Water	0-10% Max.

Applications: Bearings

C SAE 10W30 Detergent Engine Oil

A heavy duty refined petroleum product, (with detergent and anti-oxidant additives), to meet internal combustion-engine supplement one specifications.

API Gravity	27.0 Min.
Flash Point	425 Min.
Viscosity at 210o F (S.U.S)	61-70
Carbon Residue % (Includes Ash From Additives)	1.8 Max.
Viscosity Index	90 Min.

D SAE 90 Gear Lubricant

A straight mineral gear oil. Meets MIL-L-VV-765a Amend. 1, M90.

API Gravity 21.7 Min.	
Flash Point	425° F
S U Viscosity at 210° F	80
Viscosity Index	60
Channel Point	0° F Max

E SAE 80W/90 Multigear Lubricant

An extreme pressure gear lubricant containing defoament additives. Meets or exceeds MIL-L-2104C.

API Gravity	25.1
Flash Point	400° F
SU Viscosity at 210° F	80
Viscosity Index	97
Channel Point	0° F Max.
Timken Test	50 Lb.

Containing Defoamant Additives

F Automatic Transmission Fluid
Type A - Suffix A (Armour Research Qualified)

A high grade, heavy duty, refined mineral oil lubricant. Analine point must be between 200° F- 250° F (Test method ASTM text #D611).

H Open Gear Grease

This grease shall be homogeneous combination of carefully blended mineral oil and calcium soap.

Mineral oil specifications:

API Gravity	18.9
Flash, COC ° F	410
Viscosity at 210° F (S.U.S.)	178

Grease specifications:

Penetration, ASTM (Worked at 77° F)	276
(Unworked at 77° F)	242
Dropping Point	224° F
Calcium Soap	9.1%

J SAE 140 Extreme Pressure Gear Lubricant

An extreme pressure gear lubricant containing defoamant additives. It must meet or exceed U.S.A. Government specifications No. MIL-L-2105.

API Gravity	17.0 Min.
Flash Point	380°F. Min.
S.U. Viscosity at 210°F	125-180
Viscosity Index	65 Min.
Channel Point	0°F. Max.
Timken Test	70 Lb.

Containing Defoamant Additives.

M SAE 50 Oil

A refined petroleum base product with anti-rust and anti-oxidation inhibitors meeting the following specifications:

Viscosity at 100° F	1050 SUV Approx.
Viscosity at 210° F	88-92 SUV
Pour Point	+10°F

Note: Use in temperatures above 32° F.

2-20 Gear Case Check And Change Procedures

2-21 Main Transmission, Creeper Transmission, Steering Gear, Rear End Differentials:

2-22 To Check:

(a) Park machine on level ground. Set the parking brake. Shut off the carrier engine

(b) Clean an area around the check plug hole to prevent entry of foreign material. Use the upper plug on top of the housing when checking the steering pear.

(c) Remove the check plug. The unit should be full of lubricant to the level of the check plug hole.

Add lubricant if necessary through this same hole. See capacity chart on page 2-3, for the correct lubricant. Replace and tighten the check plug.

2-23 To change:

(a) Change the lubricant after the carrier has been driven so the lubricant will be warm, and foreign materials in the lubricant will be in suspension. The lubricant will drain better if warm.

(b) Park the machine on level ground. Set the parking brake. Shut off the carrier engine.

(c) Remove the drain plug from the bottom of the unit. Allow old lubricant to drain thoroughly.

(d) Install the drain plug. Remove the check plug. Fill the unit with kerosene, or light flushing oil. Install the check plug.

(e) Operate the unit for a few minutes, then drain the flushing oil or kerosene.

(f) Install the drain plug. Remove the check plug. Fill the unit with the specified lubricant. Install the check plug.

See capacity chart on page 2-3 for the proper lubricant.

2-24 Planetary Wheel Hub

2-25 To check:

(a) Run the machine, then park on level ground for about 5 minutes before checking.

(b) Rotate the wheel end until the arrow on the thrust cap is down as shown in Fig. 2-4. Set the parking brake. Shut off the engine.

(c) Remove the lubricant level check plug from the thrust cap. The wheel end lubricant must be even with the bottom of the check hole. Add lubricant as necessary through the fill/drain plug hole in the top of the hub. Install the check plug and fill/drain plug.

See capacity chart on page 2-3 for the proper lubricant.

2-26 To change:

(a) Operate the carrier to warm up and stir up the lubricant. Park the machine on level ground.

(b) Rotate the wheel until the fill/drain plug is at bottom dead center. Set the park brake. Shut off the carrier engine.

(c) Remove the plug, and allow the lubricant to drain thoroughly.

(d) After draining, the wheel ends should be flushed. Install the fill/drain plug and fill the hub to the proper level with a light flushing oil or kerosene. Release park brake. Operate the wheel end for a short period of time, then drain the flushing oil.

(e) Rotate the wheel until the fill/drain plug is on top and the arrow on the thrust cap is pointing straight down. Set the park brake. Remove the check plug.

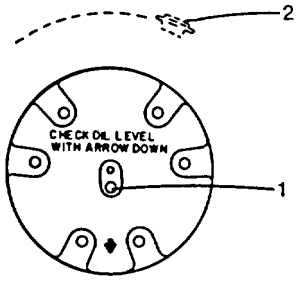


Fig. 2-4 NA354-A
Planetary Wheel Hub
(1) Oil Level
(2) Wheel Hub Fill/Drain Hold In This Area

(f) Fill the wheel end with lubricant until it is level with the check plug hole. See capacity chart on page 2-3 for the proper lubricant.
(g) Clean and install the fill/drain plug and check plug.

2-27 Outrigger Sump Tank (Fig. 2-6)

2-28 To check:
(a) Fully retract all outrigger beams and jacks.
(b) Park the machine on level ground. Set the parking brake. Shut off the carrier engine.
(c) Remove and wipe off the dipstick. Insert the dipstick fully into the tank then remove and read oil level. Add oil if necessary.

See capacity chart on page 2-3 for the proper oil.

2-29 To Change Filter: Change the filter after the first 50 hours of operation on a new machine and every 250 operating hours thereafter as follows:
(a) Thoroughly clean the filter cover plate and area of the tank around it to prevent entry of foreign material.
(b) Unbolt and remove the cover plate.
(c) Remove and discard the filter element. Remove the spring and by-pass valve from the filter and install in the new element.
(d) Install the new element in the filter compartment. Push the element over the pipe nipple which extends into the filter compartment.
(e) Replace the filter cover and gasket, and tighten down evenly.

2-30 To Change Oil: Change the oil in the outrigger system every 1,000 hours, or seasonally, as follows:
(a) Park the machine on level ground. Set the parking brake. Fully retract all outrigger beams and jacks. Shut off the carrier engine.
(b) Remove the drain plug. Allow the oil to drain thoroughly.
(c) Remove the filter element as explained earlier in this section.
(d) Remove inspection plate from the tank.

WARNING

Use Fuel Oil Or Cleaning Solvent In A Well Ventilated Area, Away From Flames.

(e) Remove the strainer from the tank. Thoroughly clean the strainer with approved low toxicity solvent.
(f) Remove the magnetic drain plug in the bottom of the tank. Thoroughly clean the plug and magnets.
(g) Remove the breather. Clean the breather in approved low toxicity solvent.
(h) Thoroughly clean the inside of the sump tank with approved low toxicity solvent.
(i) Replace the drain plug. Replace the suction strainer. Replace the inspection plate. Replace the filter element and cover plate as explained earlier in this section.
(j) Fill the tank with oil. See capacity chart on page 2-3, for the proper oil.
(k) Install the breather. Jack the carrier up on solid blocking so an outrigger jack can be fully extended without raising the carrier.
(m) Disconnect the hose leading to the lower port on an outrigger jack cylinder at the quick disconnects near the carrier frame. Remove the quick disconnects from the end of this hose. Hold the hose in a can, and completely extend the jack cylinder (see operation instructions, page 1-12) to force as much oil as possible from the jack cylinder.
(n) Replace the quick disconnect on the hose. Connect it to the other half of the quick disconnect.
(o) Disconnect the hose leading to the upper port on the same jack cylinder at the quick disconnects. Remove the disconnect from the hose. Hold the end of the hose in a can. Fully retract the jack cylinder to force the remaining old oil from the jack cylinder.
(p) Replace the quick disconnect on the hose. Connect it to the other half of the quick disconnect.
(q) Recheck the sump tank level. Add oil as necessary.
(r) Repeat steps (j) through (q) above for each of the other jack cylinders.

WARNING

Do not service, maintain, or lubricate chain case unless engine is shut down and swing lock is engaged

2-31 Chain Case (Fig. 2-5)

2-32 To check:
(a) Park the machine on level ground. Set the parking brake. Engage swing lock. Disengage the master clutch. Shut off the upper engine.
(b) Clean an area around the check plug to prevent entry of foreign material.
(c) Remove the check plug. The unit should be full of lubricant to the level of the check plug hole.

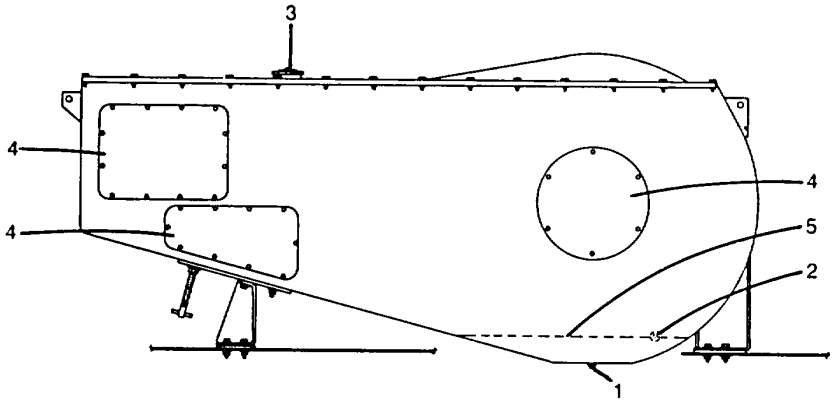


Fig. 2-5 N39-C
Chain Case

(1) Drain Plug
(2) Check Plug
(3) Fill Hole
(4) Inspection Plate
(5) Oil Level

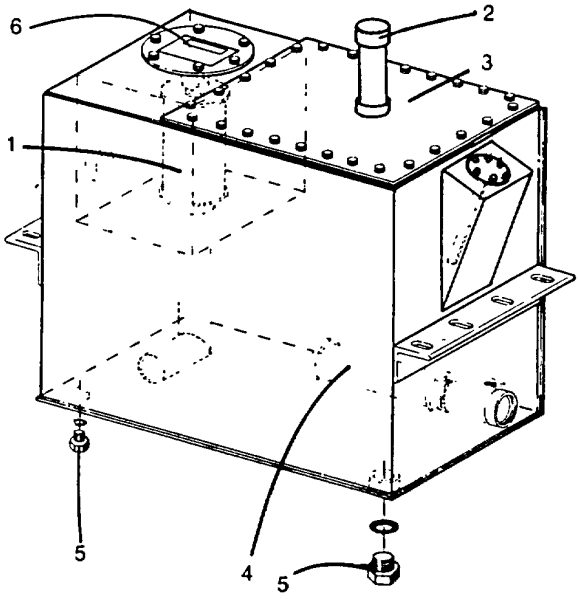


Fig. 2-6 NA190-C
Outrigger Sump Tank

(1) Filter
(2) Dipstick/Breather
(3) Inspection Plate
(4) Strainer
(5) Drain Plug
(6) Filter Cover Plate

Add lubricant if necessary thru the fill hole. See capacity chart on page 2-12 for correct lubricant. Install and tighten the check plug.

2-33 To change:

(a) Operate the machine to warm up and stir up the oil.

(b) Park machine on level ground. Set the parking brake. Engage swing lock. Disengage the master clutch. Shut off the upper engine.

(c) Remove the drain plug from the bottom of the case. Allow the old oil to drain thoroughly.

(d) Install and tighten drain plug. Fill the chain case with lubricant through the fill hole on top of the chain case. Replace the fill cap.

See capacity chart on page 2-12 for the proper lubricant.

WARNING

Do not service, maintain, or lubricate planetary speed reducer unless engine is shut down and swing lock is engaged.

2-34 Planetary Speed Reducer (Fig. 2-7)

2-35 To check:

(a) Park the machine on level ground. Set the parking brake. Engage the swing lock.

(b) Rotate the planetary until the plug marked "fill" is at top dead center.

(c) Disengage master clutch. Shut down engine.

(d) Clean an area around the check plug, to prevent entry of foreign material. Remove the check plug. The unit should be full of lubricant to the level of the check plug hole.

Add lubricant if necessary through the fill hole. See capacity chart on page 2-12 for the right lubricant. Install and tighten fill and check plug.

2-36 To change:

(a) Operate the machine for a few minutes to warm up and stir up the lubricant.

(b) Park the machine on level ground. Set parking brake. Engage swing lock.

(c) Rotate the case until one of the plugs is at bottom dead center. Disengage the master clutch. Shut down engine.

(d) Remove both plugs for f aster draining. Allow the oil to drain thoroughly.

(e) Rotate the planetary case until the plug marked "fill" is at top dead center. Disengage the master clutch. Shut down the engine.

(f) Pour lubricant in the fill hole until the oil level is even with the check plug hole. Install and tighten both plugs.

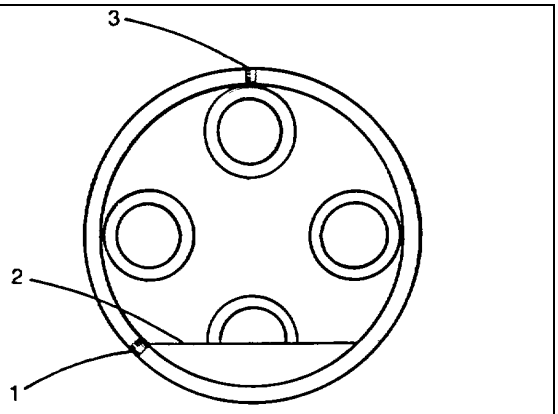


Fig. 2-7 Z224-A
Planetary Speed Reducer
(1) Check Hole (3) Fill Hole
(2) Oil Level

See capacity chart on page 2-12 for the correct lubricant.

WARNING

Do not service, maintain or lubricate swing bevel gear case unless engine is shut down and swing lock is engaged.

2-37 Swing Bevel Gear Case (Fig. 2-8)

2-38 To check:
(a) Park the machine on level ground. Set parking brake. Engage swing lock. Disengage master clutch. Shut down upper engine.
(b) Clean an area around check plug on rear of gear case.
(c) Remove the plug. The case should be full of oil to the level of the plug hole.

Add lubricant if necessary. See capacity chart on page 2-12 for proper lubricant. Install pipe plug.

2-39 To change:
(a) Operate the machine to warm up and stir up the oil.
(b) Park the machine on level ground. Set the parking brake. Engage swing lock. Disengage master clutch. Shut down upper engine.
(c) Remove the drain plug from the bottom of the case. Allow the old oil to drain thoroughly.
(d) Install the drain plug and remove the check plug. Remove the fill plug. Fill the case with oil through the fill plug hole until oil is level with check plug hole. Install pipe check and fill pipe plugs.

WARNING

Do not service, maintain or lubricate reduction shaft pinion case unless engine is shut down and swing lock is engaged.

See capacity chart on page 2-12 for the proper lubricant.

2-40 Reduction Shaft Pinion Case (Fig. 2-9)

2-41 To check:
(a) Park the machine on level ground. Set the parking brake. Engage swing lock. Disengage master clutch. Shut down upper engine.
(b) Clean an area around check plug on side of case.
(c) Remove the plug. The case should be full of lubricant to the level of the check plug hole.

2-42 To change:
(a) Operate the machine to warm up and stir up the lubricant.
(b) Park the machine on level ground. Set the parking brake. Engage swing lock. Disengage the master clutch. Shut down upper engine.
(c) Remove the drain plug from the bottom of the case. Allow the old lubricant to drain thoroughly.
(d) Install the drain plug and remove the check plug. Remove the fill plug. Fill the case with lubricant through the fill elbow until lubricant is level with the check plug hole. Install pipe plug on fill elbow and check plug.

See capacity chart on page 2-12 for the proper lubricant.

2-43 Air Box Drain Tank (Fig. 2-10)

An air box drain tank is installed on machines with a Detroit Diesel engine in the upper. The tank collects water and sediment discharged from the engine air box so it won't run down onto the carrier. The tank must be drained periodically.

2-44 Draining The Tank: Drain the tank every 50 operating hours, as follows:
(a) Position upper crosswise to carrier.
(b) Hold a can under the drain hose. Open the drain cock. Allow tank to drain thoroughly. Close the drain cock.

WARNING

Warn Personnel In The Immediate Area Before Using Compressed Air For Cleaning. Wear Safety Glasses. Compressed Air, Coming Into Contact With The Human Skin Or Causing Flying Metal Chips Can Cause Injury.

(c) If no drainage occurs, remove the drain hose. Blow out the drain hose with compressed air. Disconnect hoses from top of tank. With engine running, place a finger over end of hose and feel for air flow. If none is felt, the drains and hoses are plugged and need cleaning.
(d) Every 500 operating hours, remove the cylinder block hand hole covers and check for an accumulation of liquid or sludge on the air box floor. Clean out air box.

Remove hoses and clean them out.

Remove cover from the tank and clean it and the fittings on the cover out with approved, low toxicity solvent.

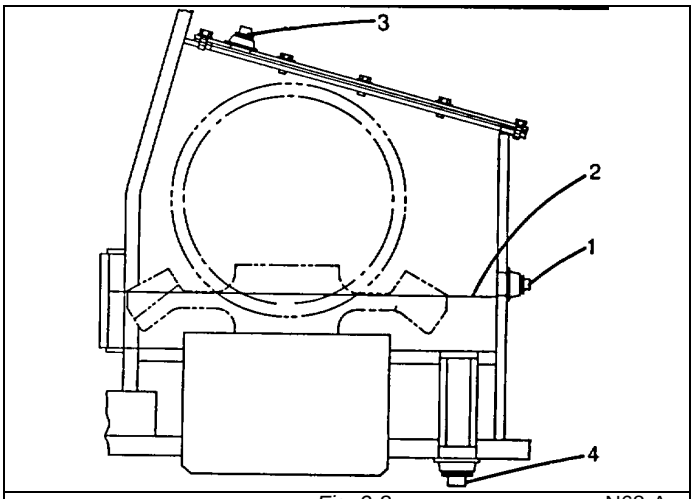


Fig. 2-8 N68-A
Swing Bevel Gear Case

(1) Check Plug (3) Fill Plug
(2) Lubricant Level (4) Drain Plug

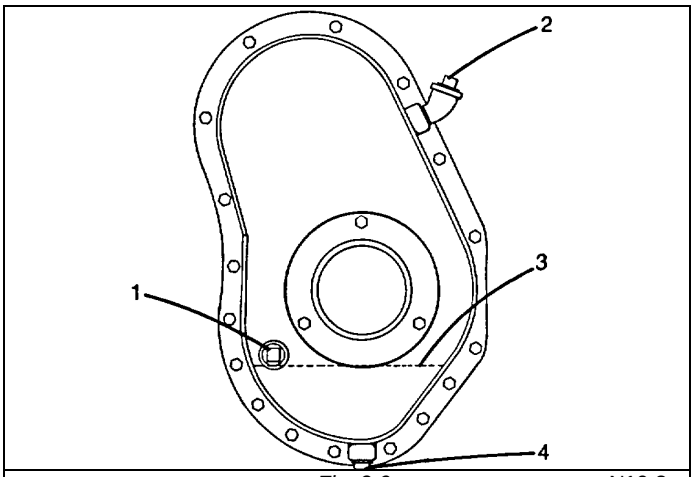


Fig. 2-9 N10-8
Reduction Shaft Pinion Case

(1) Check Plug (3) Lubricant Level
(2) Fill Plug (4) Drain Plug

2-45 Engine Air Cleaner

Although air cleaner elements are normally considered expendable, proper and careful cleaning can extend their life. Service intervals may vary from once a day to once a year, depending upon the dust conditions the engine is working in. Work out a schedule which is frequent enough to avoid down time for service on the job. Over servicing is common, and can be costly. The air cleaner should be serviced as follows:

(a) Empty the dust cap at regular intervals. These intervals may vary from 4 to 600 hours depending upon dust condition. Do not allow the dust level in the cup to build up closer than 1/2 inch (12.7mm) from the slot in the dust cup baffle.

Stop the engine and remove the dust cup. Remove the baffle from the dust cup and empty the dust. Replace the baffle in the dust cup, making sure the baffle is properly seated. Check the dust cup sealing edge for damage. Check the dust cup gasket if so equipped. Replace the dust cup to make sure it is properly positioned on the air cleaner body. On horizontally mounted models, the proper cup position is indicated by the arrows located on the bottom of the cup. Also, the slot in the dust cup baffle must be at the top.

WARNING

Warn Personnel In The Immediate Area Before Using Compressed Air For Cleaning. Wear Safety Glasses. Compressed Air, Coming Into Contact With The Human Skin Or Causing Flying Metal Chips Can Cause Injury.

(b) Remove the main element from the air cleaner. Washing in water of blowing with compressed air are two accepted methods of cleaning the element. If the element regularly contains amounts of soot or oil, washing in water is best. If the contaminant is mostly dust, either method

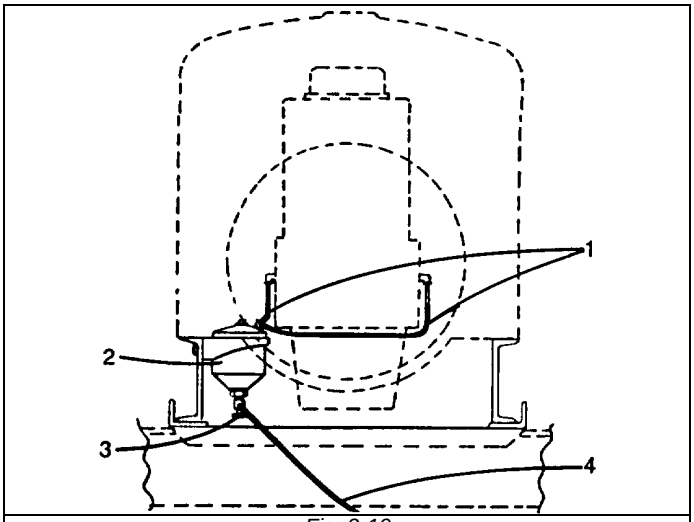


Fig. 2-10
Air Box Drain Tank

(1) Hose (3) Drain Cock
(2) Tank (4) Drain Hose

works well. Elements cleaned with air can be put back in service immediately. Washed elements must be dried before use.

Some elements are partially covered by plastic sleeve and fins. The covered portion of the filter can be cleaned with air or water without removing the sleeve. Use a stiff fiber (not wire) brush to remove oil and grease deposits from the fins. Do not remove the plastic sleeve and fins from the element.

(1) Cleaning with compressed air: Direct a jet of clean, dry air from the inside of the element, perpendicular to the pleats. Pressure at air nozzle must not exceed 30 PSI (206 kPa).

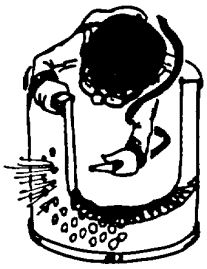


Fig. 2-11 Z664-A
Cleaning With Compressed Air

Move the air Jet up and down along the pleats, slowly rotating the element until no more dust is being removed. Be careful not to rupture the element with the nozzle of the air Jet.

(2) Cleaning with water: Filter elements can be cleaned by washing with water and a good non sudsing detergent. If compressed air is available, first direct a jet of clean, dry air from the inside of the filter element. When the loose dust and soot is removed the element is ready to be washed.

Use 2 ounces (55g) of detergent per gallon of water for washing elements. Dissolve the detergent in a small amount of cool water. Then add warm (100^{o} F, 37.7^{o}C) water until the proper mixture is reached.

Soak the element in the solution for at least 15 minutes. Agitate the element for 2 minutes to loosen and remove the dirt.

Rinse the element with clean water until the water coming through the element is clean. The water pressure should not be over 40 (206 kPa) PSI. Thoroughly air dry the element before using.

(c) After cleaning the filter element, inspect for damage. Look for dust on the clean air side, the slightest rupture or damaged gaskets. A good way to detect ruptures in the element is to place a lighted light bulb inside the element and look toward the light from the outside. Any hole in the element, even a tiny one, will pass dirt to the engine and cause unnecessary wear.

(d) Inspect the air cleaner when servicing the elements. Replace any parts that are missing, worn, or damaged. Inspect the following items:

(1) Air cleaner mounting hands (loose, missing nuts and bolts, breaks).

(2) Welded Joints and seams on air cleaner body and inlet and outlet tubes.

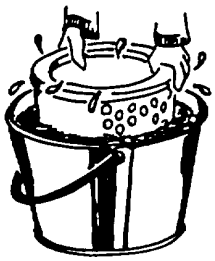


Fig. 2-12 Z664-A
Cleaning Element With Water

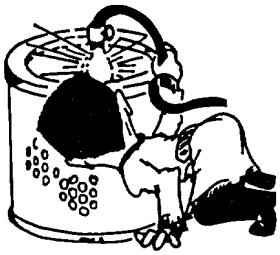


Fig. 2-13 Z664-A
Inspecting The Element

(3) Connections between air cleaner and engine.

(4) Restriction tap plug, (loose or missing).

(5) Dust cup or end cover, (holes, dents, sealing edge damaged).

(6) Dust cup retaining clamp, (broken, threads stripped).

(7) Dust cup gasket (if used) damaged.

(8) Gasket washer on element wing nut or bolt (missing, worn, or installed backwards).

(9) Gasket on main element, (damaged).

(10) Plastic sleeve and fins, (plugged, damaged).

(e) The following general rules on service and care of air filters should be followed at all times.

(1) The elements should be replaced after one year or six cleanings, whichever occurs first.

(2) Store filter elements where they are protected from dust and potential damage.

(3) If the sealing surface of the elements open end is damaged to the extent that a good air seal cannot be guaranteed, discard the element and install a new or cleaned element.

(4) Keep spare elements (new or cleaned) on hand to reduce vehicle downtime for servicing.

(5) When replacing filter elements, be absolutely sure that the proper size and model element is used.

2-46 Preventive Maintenance And Lubrication - Engines And Torque Converter

The lubrication and preventive maintenance schedule is intended as a guide for establishing a preventive maintenance schedule. The suggestions and recommendations for preventive maintenance should be followed as closely as possible to obtain long life and best performance from a Detroit Diesel engine. The intervals indicated on the chart are time or miles (in thousands) of actual operation.

Maintenance Schedule Explanation

The time and mileage increments shown apply only to the maintenance function described. These functions should be coordinated with other regularly scheduled maintenance.

The daily instructions pertain to routine or daily starting of an engine and not to a new engine or one that has not been operated for a considerable period of time. For new or stored engines, carry out the instructions given under Preparation for Starting Engine First Time under Operating Instructions in Section 1.

INDUSTRIAL OFF HIGHWAY AND MARINE	**HRS.** / **MILES**	**TIME INTERVALS**									
		8	50	100	150	200	300	500	700	1,000	2,000
	DLY.	240	1.500	3,000	4,500	6,000	9,000	15,000	20,000	30,000	60,000
1. - Lubricating Oil	X				X						
2. - Fuel Tank	X							X			
3. - Fuel Lines	X										
4. - Cooling System	X							X		X	
5. - Turbocharger	X										
6. - Battery				X							
7. - Tachometer Drive				X							
8. - Air Cleaners		X						X			
9. - Drive Belts		X				X					
10. - Air Compressor						X					
11. - Throttle and Clutch Controls						X					
12. - Lubricating Oil Filter								X		X	
13. - Fuel Strainer and Filter							X				
14. -Coolant Filter								X			
15. - Starting Motor											
16. - Air System									X		
17. - Exhaust System									X		
18. - Air Box Drain Tube										X	
19. - Emergency Shutdown							X				
21. - Radiator										X	
22. - Shutter Operation									X		
23. - Oil Pressure									X		
24. - Overspeed Governor								X			
26. -Throttle Delay								X			
27. - Battery-Charging Alternator						X					
28. - Engine and Transmission Mounts											X
29. -Crankcase Pressure											X
30. - Air Box Check Valves											
31. -Fan Hub									X		
32. - Thermostats and Seals									X		
33. - Blower Screen										X	
34. - Crankcase Breather										X	
36. - Engine Tune-Up											
37. - Heat Exchanger Electrodes								X		X	
38. - Row Water Pump	X										
39. - Power Take-Off		X	X					X			
40. - Torqmatic Converter	X		X					X		X	

2-47 Item 1 Lubricating Oil

Check the lubricating oil level with the engine stopped. If the engine has just been stopped, wait approximately twenty minutes to allow the oil to drain back to the oil pan. Add the proper grade oil as required to maintain the correct level on the dipstick.

Note: Oil may be blown out through the crankcase breather if the crankcase is overfilled.

Make a visual check for oil leaks around the filters and external oil lines.

It is recommended that new engines be started with 150 hour oil change periods. The oil drain intervals may be extended, if supported by used oil analysis (refer to Lubricating Oil Specifications).

2-48 Item 2 - Fuel Tank

Keep the fuel tank filled to reduce condensation to a minimum. Select the proper grade of fuel in accordance with the Diesel Fuel Oil Specifications.

Open the drain at the bottom of the fuel tank every 500 hours or 15,000 miles to drain off any water or sediment.

2-49 Diesel Fuel Contamination

The most common form of diesel fuel contamination is water. Water is harmful to fuel system in itself, but it also promotes the growth of microbiological organisms (microbes). These microbes clog fuel filters with a "slime" and restrict fuel flow.

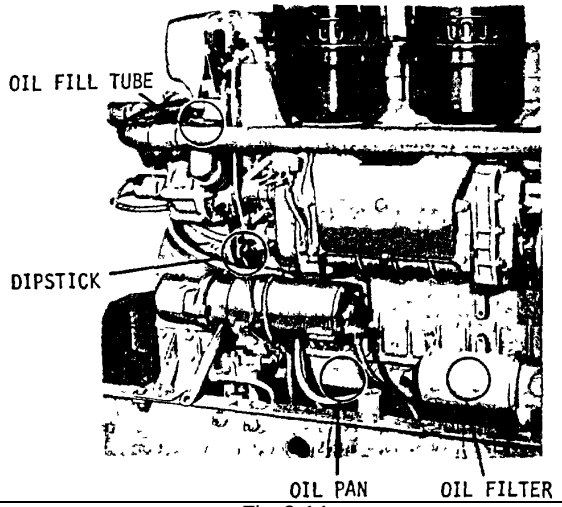


Fig. 2-14
Oil Check And Fill Item 1 (2-47)

Water can be introduced into the fuel supply through poor maintenance (loose or open fuel tank caps), contaminated fuel supply or condensation.

Condensation is particularly prevalent on units which stand idle for extended periods of time. Ambient temperature changes cause condensation in partially filled fuel tanks.

Water accumulation can be controlled by mixing isopropyl alcohol (dry gas) into the fuel oil at a ratio of one pint per 125 gallons fuel (or 0.10% by volume).

Microbe growth can be eliminated through the use of commercially available biocides. There are two basic types on the market.

The water soluble type treats only the tank where it is introduced. Microbe growth can start again if fuel is transferred from a treated to an untreated tank.

Diesel fuel soluble type, such as "Biobor" manufactured by U.S. Borax or equivalent, treats the fuel itself and therefore the entire fuel system.

Units going into storage should be treated as follows: Add the biocide according to the manufacturer's instructions. This operation is most effective when performed as the tank is being filled. Add dry gas in the correct proportions.

If the fuel tanks were previously filled, add the chemicals and stir with a clean rod.

2-50 Item 3 - Fuel Lines

Make a visual check for fuel leaks at the cross-over lines and at the fuel tank suction and return lines. Since fuel tanks are susceptible to road hazards, leaks in this area may best be detected by checking for accumulation of fuel under the tanks.

2-51 Item 4 - Cooling System

Check the coolant level daily and maintain it near the top of the heat exchanger tank or radiator upper tank.

Clean the cooling system every 1,000 hours or 30,000 miles using a good radiator cleaning compound in accordance with the instructions on the container. After the cleaning operation, rinse the cooling system thoroughly with fresh water. Then fill the system with soft water, adding a good grade of rust inhibitor or a high boiling point type antifreeze (refer to Engine Coolant). With the use of a proper antifreeze or rust inhibitor, this interval may be lengthened until, normally, this cleaning is done only in the spring or fall. The length of this interval will, however, depend upon an inspection for rust or other deposits on the internal walls of the cooling system. When a thorough cleaning of the cooling system

is required, it should be reverse-flushed.

Inspect all of the cooling system hoses at least once every 500 hours or 15,000 miles for signs of deterioration. Replace the hoses if necessary.

2-52 Item 5 - Turbocharger

Inspect the mountings, intake and exhaust ducting and connections for leaks. Check the oil inlet and outlet lines for leaks or restrictions to air flow. Check for unusual noise or vibration and, if excessive, remove the turbocharger and correct the cause.

2-53 Item 6 - Battery

Check the specific gravity of the electrolyte in each cell of the battery every 100 hours or 3,000 miles. In warm weather, however, it should be checked more frequently due to a more rapid loss of water from the electrolyte. The electrolyte level should be maintained in accordance with the battery manufacturer's recommendations.

2-54 Item 7 - Tachometer Drive

Lubricate the tachometer drive every 100 hours or 3,000 miles with an all purpose grease at the grease fitting. At temperatures above +30° F (-1°C), use a No. 2 grade grease. Use a No. 1 grade grease below this temperature.

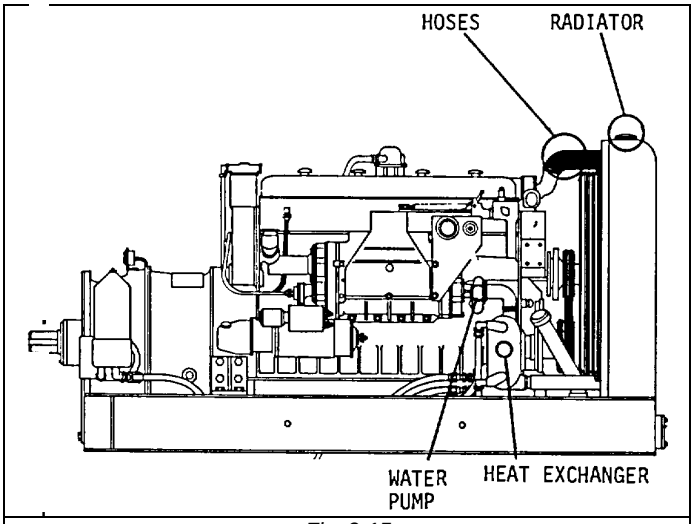


Fig. 2-15
Cooling System Item 4 (2-51)

2-55 Item 8 - Air Cleaners

Dry Type

Clean or replace the element in the dry type Donaldson "Cyclopac" air cleaner when the restriction indicator instrument indicates high restriction or when a water manometer reading at the air inlet housing indicates the maximum allowable air inlet restriction. Refer to the instructions in the Air System section for the servicing of the dry type air cleaner.

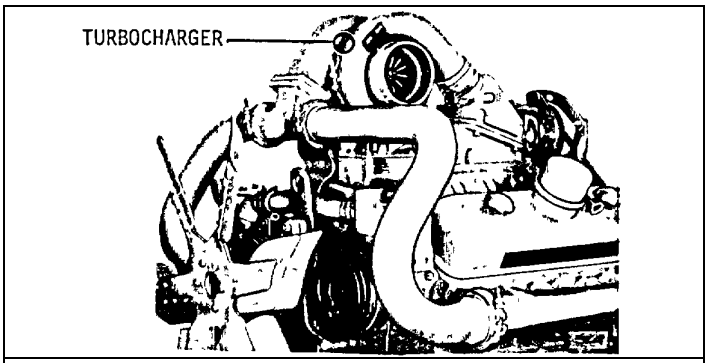


Fig. 2-16
Turbocharger Item 5 (2-52)

2-56 Item 9 - Drive Belts

New standard V-belts will stretch after the first few hours of operation. Run the engine for 15 seconds to seat the belts, then readjust the tension. Check the belts and tighten the fan drive, pump drive, battery charging alternator and other accessory drive belts after 1/2 hour or 15 miles and again after 8 hours or 240 miles of operation. Thereafter, check the tension of the drive belts every 200 hours or 6,000 miles and adjust, if necessary. Too tight a belt is destructive to the bearings of the driven part; a loose belt will slip.

Replace all belts in a set when one is worn. Single belts of similar size should not be used as a substitute for a matched belt set; premature belt wear can result because of belt length variation. All belts in a matched belt set are within .0320 of their specified center distances.

Adjust the belt tension so that a firm push with the thumb, at a point midway between the two pulleys, will depress the belt 1/2" to 3/4". If belt tension gauge BT-33-73FA or equivalent is available, adjust the belt tension as outlined in the chart.

Fan Drive			Generator Drive		
Model	2 of 3 Belts	Single Belt	Two 3/8" or 1/2" Belts	One 1/2" Belt	One Wide Belt
6V-92 6-71	60-80	80-100	40-50	50-70	40-50

Note: <u>When installing or adjusting an accessory drive belt, be sure the bolt at the accessory adjusting pivot point is properly tightened, as well as the bolt in the adjusting slot.</u>

Tighten the 7/16" -14 (300M) pivot bolt to 72-77 ft/lbs (98-104 N-m) torque. Tighten the 7/16" -14 (280M) pivot bolt to 46-50 ft/lbs.

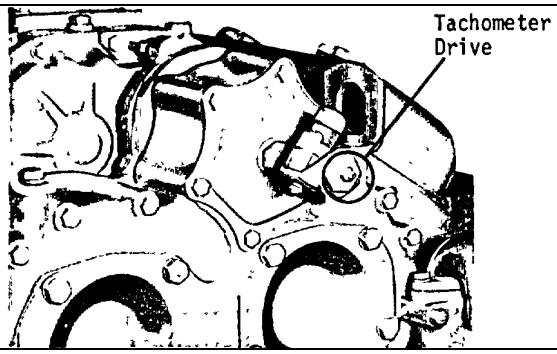


Fig. 2-17
Tachometer Drive Item 7 (2-54)

(62-68 N-m) torque.

2-57 Item 10 - Air Compressor

WARNING

Use Fuel Oil Or Cleaning Solvent In A Well Ventilated Area, Away From Flames.

To clean either the hair or polyurethane type air compressor air strainer element, saturate and squeeze it in fuel oil, or any other cleaning agent that would not be detrimental to the element, until dirt free. Then dip it in lubricating oil and squeeze it dry before placing it back in the air strainer.

For replacement of the air strainer element, contact the nearest Bendix Westinghouse dealer; replace with polyurethane element, if available.

2-58 Item 11 - Throttle And Clutch Controls

Every 200 hours or 6,000 miles lubricate the limiting speed governor control shaft. Remove the plug in the end of the shaft and install a temporary grease fitting. Then remove the governor cover to obtain a visual indication when greasing is complete. After greasing the shaft remove the fitting and install the plug and governor cover using a new cover gasket. Use an all purpose grease (No. 2 grade) at temperatures +30°F (-1°C) and above. At temperatures below this use a No. 1 grade grease.

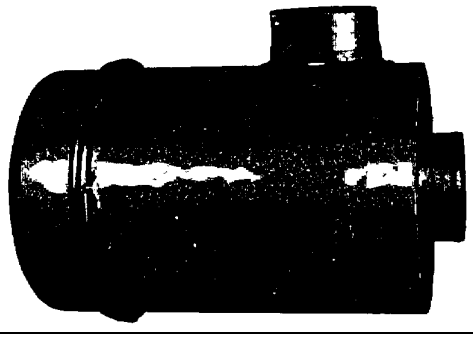


Fig. 2-18
Air Cleaners Item 8 (2-55)

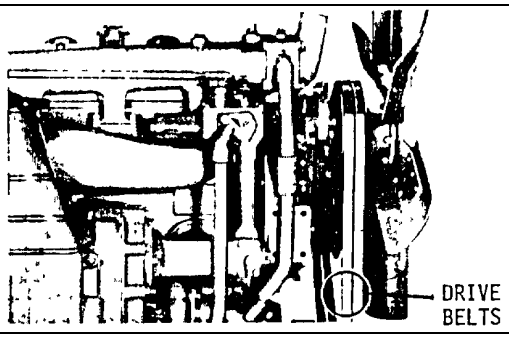


Fig. 2-19
Drive Belts Item 9 (2-56)

Lubricate the clutch control levers and all other control mechanisms, as required, with engine oil.

2-59 Item 12 - Lubricating Oil Filter

Install new oil filter elements and gaskets at a maximum of 500 hours or each time the engine oil is changed, whichever occurs first.

When the engine is equipped with a turbocharger:

(1) Disconnect the oil inlet (supply) line at the bearing (center) housing.
(2) Fill the bearing housing cavity with clean engine oil. Turn the rotating assembly by hand to coat all of the internal surfaces with oil.
(3) Add additional engine oil to completely fill the bearing housing cavity and reinstall the oil line. Clean off any spilled oil.
(4) Start and run the engine at idle until oil pressure and supply has reached all of the turbocharger moving parts. A good indicator that all the moving parts are getting lubrication is when the oil pressure gauge registers pressure (10 psig - 69 kPa at idle speed).

WARNING

Do Not Hold The Compressor Wheel, For Any Reason, While The Engine Is Running. This Could Result In Personal Injury.

If the engine is equipped with a governor oil filter, change the element every 1,000 hours.

Check for oil leaks after starting the engine.

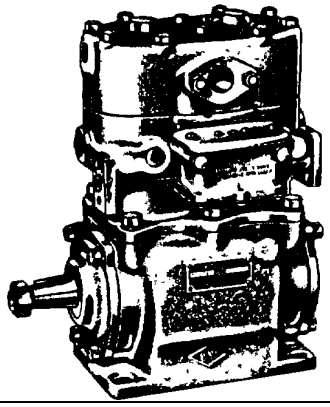


Fig. 2-20
Air Compressor Item 10 (2-57

2-60 Item 13 - Fuel Strainer And Filter

Install new elements every 300 hours or 9,000 miles or when plugging is indicated.

A method of determining when elements are plugged to the extent that they should be changed is based on the fuel pressure at the cylinder head fuel inlet manifold and the inlet restriction at the fuel pump. In a clean system, the maximum pump inlet restriction must not exceed 6 inches of mercury. At normal operating speeds (1600-2100 rpm), the fuel pressure is 45 to 70 psi (310 to 483 kPa). Change the fuel filter elements whenever the inlet restriction (suction) at the fuel pump reaches 12 inches of mercury at normal operating speeds and whenever the fuel pressure at the inlet manifold falls to 45 psi (310 kPa).

2-61 Item 14 - Coolant Filter

If the cooling system is protected by a coolant filter and conditioner, the filter element should be changed every 500 hours or 15,000 miles. After replacing the filter and cover gasket, start the engine and check for leaks.

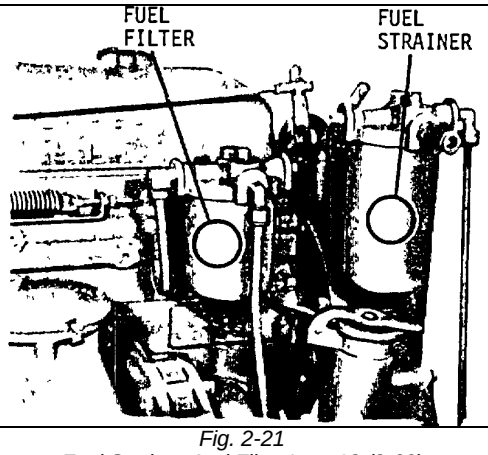


Fig. 2-21
Fuel Strainer And Filter Item 13 (2-60)

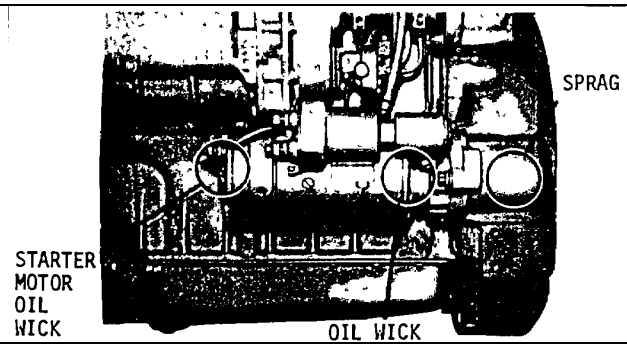


Fig. 2-22
Starting Motor Item 15 (2-62)

2-62 Item 15 - Starting Motor

The electrical starting motor is lubricated at the time of original assembly. Oil can be added to the oil wicks, which project through each bushing and contact the armature shaft, by removing the pipe plugs on the outside of the motor. The wicks should be lubricated whenever the starting motor is taken off the engine or disassembled.

The Sprag overrunning clutch drive mechanism should be lubricated with a few drops of light engine oil whenever the starting motor is overhauled.

2-63 Item 16 - Air System

Check all of the connections in the air system to be sure they are tight. Check all hoses for punctures or other damage and replace, if necessary.

2-64 Item 17 - Exhaust System

Check the exhaust manifold retaining nuts, exhaust flange clamp and other connections for tightness. Check for proper operation of the exhaust pipe rain cap, if one is used.

2-65 Item 18 - Air Box Drain Tube

With the engine running, check for flow of air from the air box drain tubes every 1,000 hours or 30,000 miles. If the tubes are clogged, remove, clean and reinstall the tubes. The air box drain tubes should be cleaned periodically even though a clogged condition is not apparent.

If the engine is equipped with an air box drain tank, drain the sediment periodically.

2-66 Item 19 - Emergency Shutdown

Check the shutdown system every 300 operating hours or each month to be sure it will function when needed.

2-67 Item 21 - Radiator

Inspect the exterior of the radiator core every 1,000 hours or 30,000 miles and, if necessary,

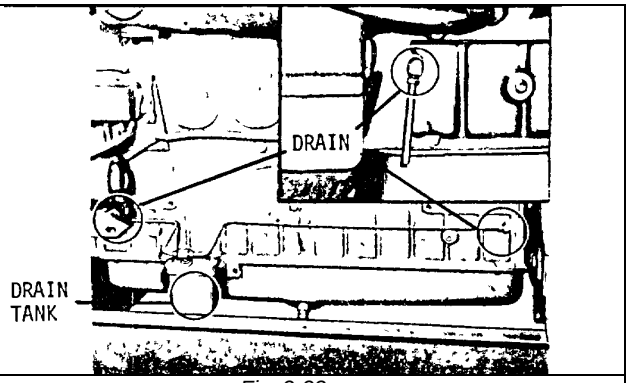


Fig. 2-23
Air Box Drains Item 18 (2-65)

clean it with a quality grease solvent such as mineral spirits and dry it with compressed air. Do not use fuel oil, kerosene or gasoline. It may be necessary to clean the radiator more frequently if the engine is being operated in extremely dusty or dirty areas.

2-68 Item 23 - Oil Pressure

Under normal operation, oil pressure is noted each time the engine is started. In the event the engine is equipped with warning lights rather than pressure indicators, the pressure should be checked and recorded at the interval indicated.

2-69 Item 24 - Overspeed Governor

Lubricate the overspeed governor, if it is equipped with a hinge-type cap oiler cup, with 5 or 6 drops of engine oil every 500 hours. Avoid excessive lubrication and do not lubricate the governor while the engine is running.

2-70 Item 26 - Throttle Delay

Inspect and adjust, if necessary.

The throttle delay system limits the amount of fuel injected during acceleration by limiting the rate of injector rack movement with a hydraulic cylinder. The initial location of this cylinder must be set with the proper gauge to achieve the appropriate time delay.

Inspect the check valve by filling the throttle delay cylinder with diesel fuel and watching for valve leakage while moving the throttle from the idle to the full-fuel position.

2-71 Item 27 - Battery-Charging Alternator

Lubricate the battery-charging alternator bearings or bushings with 5 or 6 drops of engine oil at the hinge cap oiler every 200 hours or 6,000 miles. Some alternators have a built-in supply of grease, while others use sealed bearings. In these latter two cases, additional lubrication is not necessary.

On alternators the slip rings and brushes can be inspected through the end frame assembly. If the slip rings are dirty, they should be cleaned with 400 grain or finer polishing cloth. Never use emery cloth to clean the slip rings. Hold the polishing cloth against the slip rings with the alternator in operation and blow away all dust after the cleaning operation. If the slip rings are rough or out of round, replace them.

Inspect the terminals for corrosion and loose connections and the wiring for frayed insulation.

2-72 Item 28 - Engine And Transmission Mounts

Check the engine and transmission mounting bolts and the condition of the mounting pads every 2000 hours. Tighten and repair as necessary.

2-73 Item 29 - Crankcase Pressure

Check and record the crankcase pressure every 2000 hours.

2-74 Item 30 - Air Box Check Valves

WARNING

Warn Personnel In The Immediate Area Before Using Compressed Air For Cleaning. Wear Safety Glasses. Compressed Air, Coming Into Contact With The Human Skin Or Causing Flying Metal Chips Can Cause Injury

WARNING

Use Fuel Oil Or Cleaning Solvent In A Well Ventilated Area, Away From Flames.

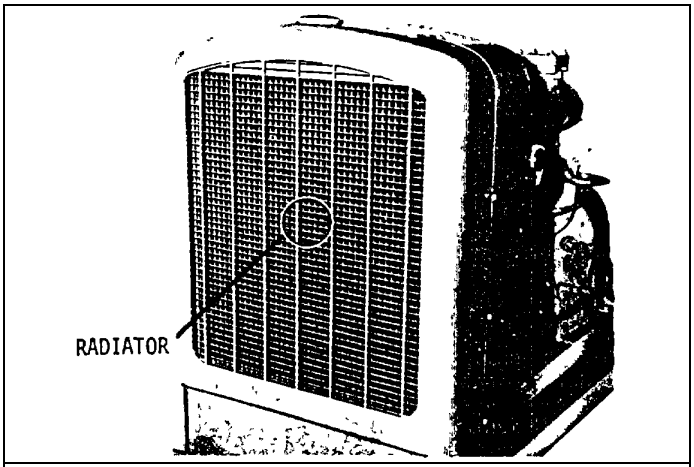


Fig. 2-24
Radiator Item 21 (2-67)

Every 3000 hours remove, clean in solvent and blow out lines with compressed air. Inspect for leaks after servicing.

2-75 Item 31 - Fan Hub

If the fan bearing hub assembly is provided with a grease fitting, use a hand grease gun and lubricate the bearings with one shot of Texaco Premium RB grease, or an equivalent Lithium base multi-purpose grease, every 700 hours.

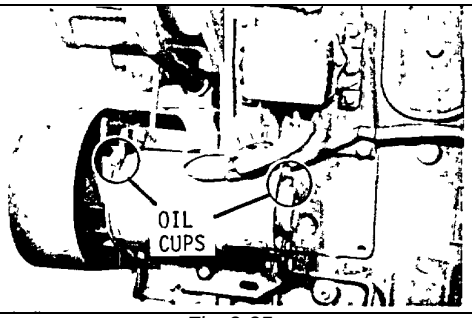


Fig. 2-25
Alternator Item 27 (2-71)

Every 4000 hours clean, inspect and repack the fan bearing hub assembly with the above recommended grease.

At a major engine overhaul, remove and discard the bearings in the fan hub assembly. Pack the hub assembly, using new bearings with Texaco Premium RB grease or an equivalent Lithium base multi-purpose grease.

2-76 Item 32 - Thermostats And Seals

Check the thermostats and seals (preferably at the time the cooling system is prepared for winter operation). Replace the seals if necessary.

2-77 Item 33 - Blower Screen

WARNING

Warn Personnel In The Immediate Area Before Using Compressed Air For Cleaning. Wear Safety Glasses. Compressed Air, Coming Into Contact With The Human Skin Or Causing Flying Metal Chips Can Cause Injury

WARNING

Use Fuel Oil Or Cleaning Solvent In A Well Ventilated Area, Away From Flames.

Inspect the blower screen and gasket assembly every 1,000 hours or 30,000 miles and, if necessary, clean the screen in fuel oil and dry it with compressed air. Install the screen and gasket assembly with the screen side of the assembly toward the blower. Inspect for evidence of blower seal leakage.

2-78 Item 34 - Crankcase Breather

Remove the externally mounted crankcase breather assembly every 1,000 hours or 30,000 miles and wash the steel mesh pad in clean fuel oil. This cleaning period may be reduced or lengthened according to severity of service.

Clean the breather cap, mounted on the valve rocker cover, in clean fuel oil every time the engine oil is changed.

2-79 Item 36 - Engine Tune-Up

There is no scheduled interval for performing an engine tune-up. As long as the engine performance is satisfactory, no tune-up should be needed. Minor adjustments in the valve and injector operating mechanisms, governor, etc., should only be required periodically to compensate for normal wear on parts.

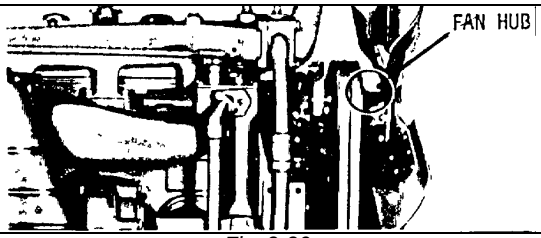


Fig. 2-26
Fan Hub Item 31 (2-75)

2-80 Item 39 - Power Take-Off

Lubricate all of the power take-off bearings with an all purpose grease such as Shell Alvania No. 2, or equivalent. Lubricate sparingly to avoid getting grease on the clutch facings.

On the 11-1/2" diameter clutch, lubricate the clutch release collar through the fitting on the side of the clutch housing every 8 hours.

The clutch drive shaft pilot bearing used with the 11-1/2" diameter clutch power take-off is prelubricated and does not require lubrication.

Lubricate the clutch drive shaft roller bearings through the grease fitting in the clutch housing every 50 hours under normal operating conditions (not continuous)and more often under severe operating conditions or continuous operation.

Lubricate the clutch release shaft through the fittings at the rear of the housing every 500 hours of operation.

Lubricate the clutch levers and links sparingly with engine oil every 500 hours of operation. Remove the inspection hole cover on the clutch housing and lubricate the clutch release levers and pins with a hand oiler. To avoid getting oil on the clutch facing, do not over lubricate the clutch release levers and pins.

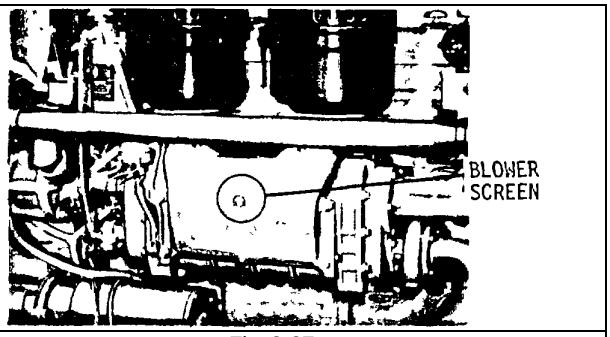


Fig. 2-27
Blower Screen Item 33 (2-77)

Check the clutch facing for wear every 500 hours. Adjust the clutch if necessary.

2-81 Item 40 - Torque Converter

Check the oil level in the torque converter and supply tank daily. The oil level must be checked while the converter is operating, the engine idling and the oil is up to operating temperature (approximately 200° F or 93°C). The clutch must be engaged.

Check the oil level after running the unit a few minutes. The oil level should be maintained at the proper level on the dipstick. If required, add hydraulic transmission fluid type "C-2" (see chart). Do not overfill the converter as too much oil will cause foaming and high oil temperature.

The oil should be changed every 1,000 hours. Also, the oil should be changed whenever it shows traces of dirt or effects of high operating temperature as evidenced by discoloration or strong odor. If the oil shows metal contamination, contact an authorized Detroit Diesel Allison Service Outlet as this usually requires disassembly. Under severe operating conditions, the oil should be changed more often.

The converter oil breather, located on the oil level indicator (dipstick), should be cleaned each time the converter oil is changed.

The full-flow oil filter element should be removed, the shell cleaned and a new element and gasket installed each time the converter oil is changed.

Lubricate the input clutch release bearing and ball bearing and the front disconnect clutch drive shaft bearing every 50 hours with an all purpose grease. Grease fittings are provided on the clutch housing. This time interval may vary depending upon the operating conditions. Over lubrication will cause grease to be thrown on the clutch facing, causing the clutch to slip.

The strainer (in the torque transmission) and the hydraulic system filters should be replaced or cleaned with every oil change.

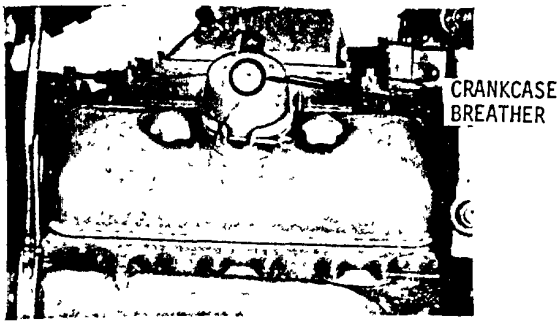


Fig. 2-28
Crankcase Breather Item 34 (2-78)

Prevailing Ambient Temperature	Recommended Oil Specification
Above -10° F (-12C)	Hydraulic Transmission Fluid, Type C-2.
Below -10° F (-12C)	Hydraulic Transmission Fluid, Type C-2. Auxiliary preheat required to raise temperature in the sump to a temperature above -10°F (-12C).

2-82 Engine Oil And Filter Change

(a) The lubricating oil should be drained when the engine is warm. Most of the sediment will be in suspension and will drain readily.

Supply a drain pan large enough to hold the oil without spilling over. Remove the pan plug and allow the oil to drain thoroughly.

WARNING

Hot Oil Can Cause Severe Burns. Be Careful When Draining The Oil

Clean the pan plug thoroughly, and replace.

(b) The full flow and by-pass filters should be replaced each time the engine oil is changed

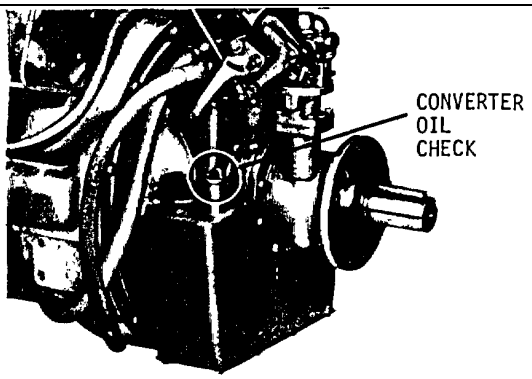


Fig. 2-29
Torque Converter Item 40 (2-81)

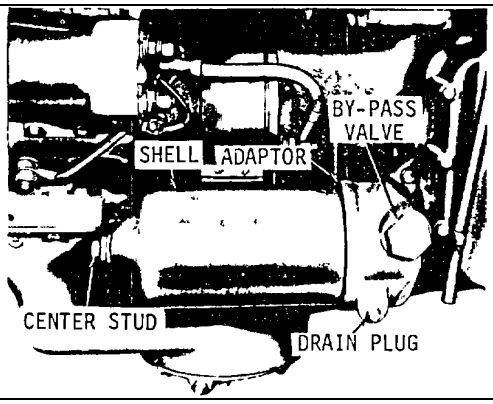


Fig. 2-30
Filter Mounting - Upper Engine

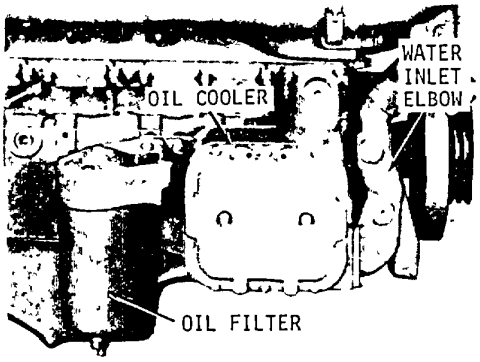


Fig. 2-31
Filter Mounting - Carrier Engine

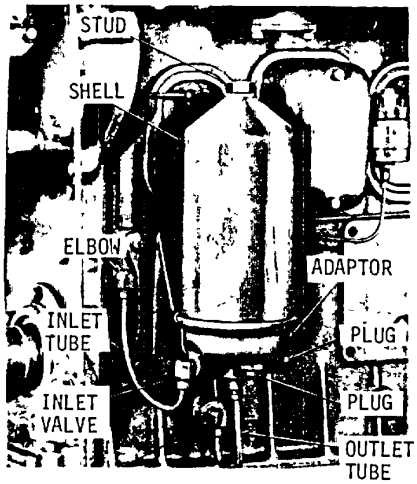


Fig. 2-32
Typical By-Pass Filter Mounting

Place a drain pan under the filter housing. Remove the drain plug, and drain the oil.

(c) The filter shell, element and stud may be detached as an assembly, after removing the center stud from the adaptor. Discard the gasket.

(d) Clean the filter adaptor.

(e) Discard the used element, wipe out the filter shell and install a new element on the center stud.

(f) Place a new gasket in the filter adaptor, position the shell and element assembly on the gasket and tighten the center stud carefully to prevent damaging the gasket or center stud.

(g) Install the drain plug refill engine with oil and, after the engine is started, check for oil leaks.

2-83 Fuel Strainer And Filter Replacement

A spin-on type fuel strainer and fuel filter is used on both engines. The spin-on filter cartridge consists of a shell, element and gasket combined into a unitized replacement assembly. No separate springs or seats are required to support the filters.

The filter covers incorporate a threaded sleeve to accept the spin-on filter cartridges. The word "Primary" is cast on the fuel strainer cover and the word "Secondary" is cast on the fuel filter cover for identification.

No drain cocks are provided on the spin-on filters. Where water is a problem, it is recommended that a water separator be installed. Otherwise, residue may be drained by removing and inverting the filter. Refill the filter with clean fuel oil before reinstalling it.

A 1" diameter twelve-point nut on the bottom of the filter is provided to facilitate removal and installation.

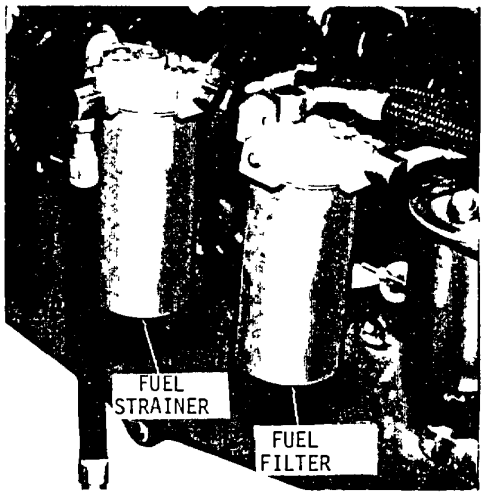


Fig. 2-33
Spin On Fuel Filter And Strainer

Replace the filter as follows:

(a) Unscrew the filter (or strainer) and discard it.

(b) Fill a new filter replacement cartridge about two-thirds full with clean fuel oil. Coat the seal gasket lightly with clean fuel oil.

(c) Install the new filter assembly and tighten it to two-thirds of a turn beyond gasket contact.

(d) Start the engine and check for leaks.

2-84 Fuel Tank

Refill the fuel tank at the end of each day's operation to prevent condensation from contaminating the fuel.

Note: A galvanized steel tank should never be used for fuel storage because the fuel oil reacts chemically with the zinc coating to form powdery flakes which quickly clog the fuel strainer and filter and damage the fuel pump and injectors.

2-85 Engine Out Of Fuel

The problem in restarting the engine after it has run out of fuel stems from the fact that after the fuel is exhausted from the fuel tank, fuel is then pumped from the primary fuel strainer and sometimes partially removed from the secondary fuel filter before the fuel supply becomes insufficient to sustain engine firing. Consequently, these components must be refilled with fuel and the fuel pipes rid of air in order for the system to provide adequate fuel for the injectors.

When an engine has run out of fuel, there is a definite procedure to follow for restarting the engine.

(a) Fill the fuel tank with the recommended grade of fuel oil. If only partial filling of the tank is possible, add a minimum of ten gallons (38 liters) of fuel.

(b) Remove the fuel strainer shell and element from the strainer cover and fill the shell with fuel oil. Install the shell and element.

(c) Remove and fill the fuel filter shell and element with fuel oil as in Step b.

(d) Start the engine. Check the filter and strainer for leaks.

Note: In some instances, it may be necessary to remove a valve rocker cover and loosen a fuel pipe nut in order to bleed trapped air from the fuel system. Be sure the fuel pipe is retightened securely before replacing the rocker cover.

Primer J 5956 may be used to prime the entire fuel system. Remove the filler plug in the fuel filter cover and install the primer. Prime the system. Remove the primer and install the filler plug.

2-86 Engine Cooling System Maintenance

2-87 Engine Coolant

The function of the engine coolant is to absorb the heat, developed as a result of the combustion process in the cylinders, from the component parts such as exhaust valves, cylinder liners, and pistons which are surrounded by water jackets. In addition, the heat absorbed by the oil is also removed by the engine coolant in the oil-to-water oil cooler.

For the recommended coolant, refer to the Engine Coolant section.

2-88 Cooling System Capacity

The capacity of the basic engine cooling system (cylinder block, cylinder head, thermostat housings, and oil cooler housing) is shown in the table below.

To ascertain the complete amount of coolant in the cooling system, the additional capacity of the radiator hoses and accessories, such as a heater, must be added to the capacity of the basic engine. The capacity of the radiator and related equipment should be obtained from the equipment supplier, or the capacity of a particular cooling system may be obtained by filling the system with water, then draining and measuring the amount required.

Cooling System Capacity Chart
(Basic Engine)

Engine	Gallons	Liters
6V92	7	27
6-71	5-1/2	21

2-89 Fill Cooling System

Before starting the engine, close all of the drain cocks and fill the cooling system with water. If the unit has a raw water pump, it should also be primed, since operation without water may cause impeller failure.

The use of clean, soft water will eliminate the need for de-scaling solutions to clean the cooling system. A hard, mineral-laden water should be made soft by using water softener chemicals before it is poured into the cooling system.

These water softeners modify the minerals in the water and greatly reduce or eliminate the formation of scale.

Start the engine and, after the normal operating temperature has been reached, allowing the coolant to expand to its maximum, check the coolant level. The coolant level should be within 2" of the top of the filler neck.

Should a daily loss of coolant be observed, and there are no apparent leaks, there is a possibility of gases leaking past the cylinder head water seal rings into the cooling system. The presence of air or gases in the cooling system may be detected by connecting a rubber tube from the overflow pipe to a water container. Bubbles in the water in the container during engine operation will indicate this leakage. Another method for observing air in the cooling system is by inserting a transparent tube in the water outlet line.

2-90 Drain Cooling System

Drain the coolant by opening the drain cocks in the water outlet elbow, oil cooler housing, the fresh water pump, heat exchanger, radiator and, on certain engines, the water hole cover located on the blower side toward the rear of the cylinder block. Components of the cooling system that do not have a drain cock, are drained through the oil cooler housing drain cock.

Remove the cooling system filler cap to permit the coolant to drain completely from the system.

To ensure that all of the coolant is drained completely from a unit, all cooling system drains should be opened. Should any water that may be trapped in the cylinder block or radiator freeze, it will expand and may cause damage. When freezing weather is expected, drain a unit not adequately protected by antifreeze. Leave all drain cocks open until refilling the cooling system.

Drain raw water pumps by loosening the cover attaching screws. It may be necessary to tap the raw water pump cover gently to loosen it. After the water has been drained, tighten the screws.

2-91 Flushing Cooling System

Flush the cooling system each spring and fall. The flushing operation cleans the system of antifreeze solution in the spring and removes the summer rust inhibitor in the fall, preparing the cooling system for a new solution. The flushing operation should be performed as follows:

(a) Drain the previous season's solution from the engine.
(b) Refill the cooling system with soft, clean water. If the engine is hot, fill slowly to prevent rapid cooling and distortion of the engine castings.
(c) Start the engine and operate it for 15 minutes to thoroughly circulate the water.
(d) Drain the cooling system completely.
(e) Refill the system with the solution required for the coming season.

2-92 Cooling System Cleaners

If the engine overheats and the water level and fan belt tension are satisfactory, it will be necessary to clean and flush the entire cooling system. Scale formation should be removed by using a quality de-scaling solvent. Immediately after using the solvent, neutralize the system with a neutralizer. It is important that the directions printed on the container of the descaling solvent be thoroughly read and followed.

After the solvent and neutralizer have been used, drain the engine and radiator and flush it with clean water. Then fill the system with the proper cooling solution.

Note: Whenever water is added to a hot engine, it must be done slowly to avoid rapid cooling which may cause distortion and possible cracking of engine castings.

2-93 Reverse-Flushing

After the engine and radiator have been thoroughly cleaned, they should be reverse-flushed. The water pump should be removed and the radiator and engine reverse-flushed separately to prevent dirt and scale deposits clogging the radiator tubes or being forced through the pump. Reverse-flushing is accomplished by hot water, under air pressure, being forced through the cooling system in a direction opposite to the normal flow of coolant, loosening and forcing scale deposits out.

The radiator is reverse-flushed as follows:

(a) Remove the radiator inlet and outlet hoses and replace the radiator cap.
(b) Attach a hose at the top of the radiator to lead water away from the engine.
(c) Attach a hose to the bottom of the radiator and insert a flushing gun in the hose.
(d) Connect the water hose of the gun to the water outlet and the air hose to the compressed air outlet.
(e) Turn on the water and, when the radiator is full, turn on the air in short blasts, allowing the radiator to fill between air blasts.

Note: Apply air gradually. Do not exert more than 20 psi (138 kPa) air pressure. Too great a pressure may rupture a radiator tube.

(f) Continue flushing until only clean water is expelled from the radiator.

The cylinder block and cylinder head water passages are reverse-flushed as follows:

(a) Remove the thermostat and the water pump.
(b) Attach a hose to the water inlet of the cylinder block to drain the water away from the engine.
(c) Attach a hose to the water outlet at the top of the cylinder block and insert the flushing gun in the hose.

(d) Turn on the water and, when the water jackets are filled, turn on the air in short blasts, allowing the engine to fill with water between air blasts.

(e) Continue flushing until the water from the engine runs clean.

If scale deposits in the radiator cannot be removed by chemical cleaners or reverse-flushing as outlined above, it may be necessary to remove the upper tank and rod out the individual radiator tubes with flat steel rods. Circulate water through the radiator core from the bottom to the top during this operation.

2-94 Fuel Oils For Detroit Diesel Engines

2-95 Diesel Fuel Oils General Considerations

The quality of fuel oil used for high-speed diesel engine operation is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust.

Fuel selected should be completely distilled material. That is, the fuel should show at least 98% by volume recovery when subjected to ASTM D-86 distillation. Fuels marketed to meet Federal Specification VV-F-800 (grades DF-1 and DF-2) and ASTM Designation-0D0975 (grades 1-D and 2-D) meet the completely distilled criteria. Some of the general properties of VV-F-800 and ASTM D-975 fuels are shown below.

2-96 Federal Specification & ASTM Diesel Fuel Properties

Specification or Classification Grade	VV-F-800 DF-1	ASTM D-975 1-D	VV-FO 800 DF-2	ASTM 0-975 2-D
Flash Point, min.	104°F 40°C	100°F 38°C	122°F 50°C	125°F 52°C
Carbon Residue(10° residuum). % max.	0.15	0.15	0.20	0.35
Water & Sediment % by vol., max.	0.01	trace	0.01	0.05
Ash. % by wt., max.	0.005	0.01	0.005	0.01
Distillation Temperature, 90% by vol. recovery, min.	--	--	--	540°F (282°C)
max.	572°°F 300°C	550°F 288°C	626°F 330°°C	640°F 338°C
End Point, max.	626°F 330°C	--	671°F 355°C	--
Viscosity 100°F(38°C) Kinematic, cs, min	1.4	1.4	2.0	2.0
Saybolt, SUS, min	--	--	--	32.6
Kinematic, cs, max	3.0	2.5	4.3	4.3
Saybolt, SUS, max	--	34.4	--	40.1
Sulfur, % by wt., max	0.50	0.50	0.50	0.50
Cetane No.	45	40	45	40

Residual fuels and domestic furnace oils are not considered satisfactory for Detroit Diesel engines; however, some may be acceptable. (See "Detroit Diesel Fuel Oil Specifications") Note: Detroit Diesel Allison does not recommend the use of drained lubricating oil as a diesel fuel oil. Furthermore. Detroit Diesel Allison will not be responsible for any engine detrimental effects which it determines resulted from this practice.

All diesel fuel oil contains a certain amount of sulfur. Too high a sulfur content results in excessive cylinder wear due to acid buildup in the lubricating oil. For most satisfactory engine life, fuels containing less than 0.5% sulfur should be used.

Fuel oil should be clean and free of contamination. Storage tanks should be inspected regularly for dirt, water or water-emulsion sludge, and cleaned if contaminated. Storage instability of the fuel can lead to the formation of varnish or sludge in the tank. The presence of these contaminants from storage instability must be resolved with the fuel supplier.

2-97 Detroit Diesel Fuel Oil Specifications

Detroit Diesel Allison designs, develops, and manufacturers commercial diesel engines to operate on diesel fuels classified by the ASTM as Designation D0975 (grades 1-D and 2-D).

These grades are very similar to grades DF-1 and DF-2 of Federal Specification VV-F-800.

Residual fuels and furnace oils, generally, are not considered satisfactory for Detroit Diesel engines. In some regions, however, fuel suppliers may distribute one fuel that is marketed as either diesel fuel (ASTM D-975) or domestic heating fuel (ASTM D-396) sometimes identified as furnace oil. In this case, the fuel should be investigated to determine whether the properties conform with those shown in the "Fuel Oil Selection Chart" presented in this specification.

The "Fuel Oil Selection Chart" also will serve as a guide in the selection of the proper fuel for various applications. The fuel used must be clean, completely distilled, stable, and noncorrosive. Distillation Range, Cetane Number, and Sulfur Content are three of the most important properties of diesel fuels that must be controlled to insure optimum combustion and minimum wear. Engine speed, load, and ambient temperature influence the selection of fuels with respect to distillation range and cetane number. The sulfur content of the fuel must be as low as possible to avoid excessive deposit formation, premature wear, and to minimize the sulfur dioxide exhausted into the atmosphere.

To assure that the fuel you use meets the required properties, enlist the aid of a reputable fuel oil supplier. The responsibility for clean fuel lies with the fuel supplier as well as the operator.

During cold weather engine operation, the cloud point (the temperature at which wax crystals begin to form in diesel fuel) should be 10° F (6°C) below the lowest expected fuel temperature to prevent clogging of the fuel filters by wax crystals.

At temperatures below -20° F (-29°C), consult an authorized Detroit Diesel Allison service outlet, since particular attention must be given to the cooling system, lubricating system, fuel system, electrical system, and cold weather starting aids for efficient engine starting and operation.

2-98 Fuel Oil Selection Chart

Typical Application	Classification	Final Boiling Point	Cetane No.	Sulfur Content
All Applica-tions	Winter No. 2-D	675°F	45	0.50%
	Summer No. 2-D	675°F (357°C)	40	0.50%

Note: When prolonged idling periods or cold weather conditions below 32°F (0°C) are encountered, the use of lighter distillate fuels may be more practical. The same consideration must be made when operating at altitudes above 5;000 ft.

2-99 Lubricating Oils For Detroit Diesel Engines

2-100 Diesel Lubricating Oils General Considerations

All diesel engines require heavy-duty lubricating oils. Basic requirements of such oils are lubricating quality, high heat resistance, and control of contaminants.

Lubricating Quality. The reduction of friction and wear by maintaining an oil film between moving parts is the primary requisite of a lubricant. Film thickness and its ability to prevent metal-to-metal contact of moving parts is related to oil viscosity. The optimums for Detroit Diesel engines are 15W-40, or SAE 40 or 30 weight.

High Heat Resistance. Temperature is the most important factor in determining the rate at which deterioration or oxidation of the lubricating oil will occur. The oil should have adequate thermal stability at elevated temperatures, thereby precluding formation of harmful carbonaceous and/or ash deposits.

Control Of Contaminants. The piston and compression rings must ride on a film of oil to minimize wear and prevent cylinder seizure. At normal rates of consumption, oil reaches a temperature zone at the upper part of the piston where rapid oxidation and carbonization can occur. In addition, as oil circulates through the engine, it is continuously contaminated by soot, acids, and water originating from combustion. Until they are exhausted, detergent and dispersant additives aid in keeping sludge and varnish from depositing on engine parts. But such additives in excessive quantities can result in detrimental ash deposits. If abnormal amounts of insoluble deposits form, particularly on the piston in the compression ring area, early engine failure may result.

Oil that is carried up the cylinder liner wall is normally consumed during engine operation. The oil and additives leave carbonaceous and/or ash deposits when subjected to the elevated temperatures of the combustion chamber. The amount of deposits is influenced by the oil composition, additive content, engine temperature, and oil consumption rate.

2-101 Detroit Diesel Lubricating Oil Specifications

Oil Quality is the responsibility of the oil supplier. (The term oil supplier is applicable to refiners, blenders, and rebranders of petroleum products, and does not include distributors of such products).

There are hundreds of commercial crankcase oils marketed today. Obviously, engine manufacturers or users cannot completely evaluate the numberous commercial oils. The selection of a suitable lubricant in consultation with a reliable oil supplier, observance of his oil drain recommendations (based on used oil sample analysis and experience) and proper filter maintenance, will provide the best assurance of satisfactory oil performance.

Detroit Diesel Allison lubricant recommendations are based on general experience with current lubricants of various types and give consideration to the commercial lubricants presently available.

Recommendation

Detroit Diesel engines have given optimum performance and experienced the longest service life with the following oil performance levels having the ash limits and zinc requirements shown.

15W-40 Multigrade Lube Oil

Detroit Diesel Allison now approves and recommends the use of the new generation 15W-40 lubricating oils, providing the following ash limits, zinc requirements, oil performance levels, and conditions are met:

(1) The sulfated ash (ASTM D-874) content of the lubricant shall not exceed 1.000% by weight, except lubricants that contain only barium detergent-dispersant salts where 1.5% by weight is allowed. Lubricants having a sulfated ash content between 0.55 and .085 percent by weight have a history of excellent performance in Detroit Diesel engines. Lubricants having a sulfated ash content greater than 0.85 percent by weight are prone to produce greater deposit levels in the ring belt and exhaust valve areas of the engine.

(2) The lubricant shall meet the performance requirements shown in API Service Classification

CD/SE.

(3) The zinc content (xinc diogranodithiphosphate) of all the lubricants recommended for use in Detroit Diesel engines shall be a minimum of 0.07% by weight. However, the zinc requirement is waived where EMD lubricants are used.

(4) Evidence of satisfactory performance in Detroit Diesel engines has been shown to the customer and to Detroit Diesel Allison by the oil supplier.

10W-3D, 20W-40 & Other Multigrade Oils

Detroit Diesel Allison does NOT approve any multigrade oils, except the new generation 15W-40 lubricants previously described. Although lubricants such as 10W-30 and 20W-40 are commercially available, the performance of their additive systems has not been demonstrated in Detroit Diesel engines. Since properties such as sulfated ash are affected in formulating these multigrade compounds, their use cannot be approved.

SAE 40 & SAE-30 Single Grade Lubricants

Detroit Diesel Allison continues to approve SAE-40 and SAE-30 lube oils, providing they meet the 1.000% maximum sulfated ash limit, the 0.07% by weight minimum zinc content, and the following API Service Classifications:

API Letter Code Service Classification	Military Specification	SAE Grade
CB	MIL-L-2104A(Supplement 1)	40 or 30
CC	MIL-L-2104B	40 or 30
CD/SC	MIL-L-2104C	40 or 30
CD	MIL-L-45199B(Series 3)	40 or 30
C /SE	MIL-L-26152	40 or 30
Numerous	Universal	40 or 30

2-102 Used Lube Oil Analysis Warning Values

The presence of ethylene glycol in the oils is damaging to the engine. Its presence and need for an oil change and for corrective maintenance action may be confirmed by glycol detector kits which are commercially available.

Fuel dilution of the oil may result from loose fuel connections or from prolonged engine idling. A fuel dilution exceeding 2.5% of volume indicates an immediate need for an oil change and corrective maintenance action. Fuel dilution may be confirmed by ASTM D-322 test procedure performed by oil suppliers or independent laboratories.

In addition to the above considerations, if any of the following occur, the oil should be changed:

(1) The viscosity at 1000F, of a used oil sample is 40% greater than the viscosity of the unused oil measured at the same temperature (ASTM D-445 and D-2161).

(2) The iron content is greater than 150 parts per million.

(3) The coagulated pentane insolubles (total contamination) exceed 1.00% by weight (ASTM D-893).

(4) The total base number (TBN) is less than 1.0 (ASTM D-664).

Note: The sulfur content of the diesel fuel used will influence the alkalinity of the lube oil. With high sulfur fuels, F the oil drain interval will have to be shortened to avoid excessive acidity in the lube oil.

2-103 Statement Of Policy On Fuel And Lubricant Additives

In answer to request concerning the use of fuel and lubricating oil additives, the following excerpt has been taken from a policy statement of General Motors Corporation:

"It has been and continues to be General Motors policy to build motor vehicles that will operate satisfactorily on the commercial fuels and lubricants of good quality regularly provided by the petroleum industry through retail outlets."

Therefore, Detroit Diesel Allison does not recommend the use of any supplementary fuel or lubricant additives. These include all products marketed as fuel conditioners, smoke suppressants, masking agents, deodorants, tune-up compounds, top oils, break-in oils, graphitizers, and friction-reducing compounds.

Note: The manufacturer's warranty applicable to Detroit Diesel engines provides in part that the provisions of such warranty shall not apply to any engine unit which has been subjected to misuse, negligence or accident. Accordingly, malfunctions attributable to neglect or failure to follow the manufacturer's fuel or lubricating recommendations may not be within the coverage of the warranty.

2-104 Engine Coolant

Engine coolant is considered as any solution which is circulated through the engine to provide the means for heat transfer from the different engine components. In general, water containing various materials in solution is used for this purpose.

The function of the coolant is basic to the design and to the successful operation of the engine. Therefore, coolant must be carefully selected and properly maintained.

2-105 Coolant Requirements

A suitable coolant solution must meet the following basic requirements:

(1) Provide for adequate heat transfer.

(2) Provide a corrosion resistant environment within the cooling system.

(3) Prevent formation of scale or sludge

deposits in the cooling system.

(4) Be compatible with the cooling system hose and seal materials.

(5) Provide adequate freeze protection during cold weather operation.

The first four requirements are satisfied by combining a suitable water with reliable inhibitors. When operating conditions dictate the need for freeze protection, a solution of suitable water and a permanent antifreeze containing adequate inhibitors will provide a satisfactory coolant.

2-106 Water

Any water, whether of drinking quality or not, will produce a corrosive environment in the cooling system. Also, scale deposits may form on the internal surfaces of the cooling system due to the mineral content of the water. Therefore, water selected as a coolant must be properly treated with inhibitors to control corrosion and scale deposition.

To determine if a particular water is suitable for use as a coolant when properly inhibited, the following characteristics must be considered. The concentration of chlorides, sulfates, total hardness and dissolved solids. Chlorides and/or sulfates tend to accelerate corrosion, while hardness (percentage of magnesium and calcium present) causes deposits of scale. Total dissolved solids may cause scale deposits, sludge deposits, corrosion or a combination of these. Chlorides, sulfates, magnesium and calcium are among but not necessarily all the materials which make up dissolved solids. Water, within the limits specified in Tables 1 and 2 of Fig. 2-34, is satisfactory as an engine coolant when proper inhibitors are added.

2-107 Corrosion Inhibitors

A corrosion inhibitor is a water soluble chemical compound which protects the metallic surfaces of the cooling system against corrosive attack. Some of the more commonly used corrosion inhibitors are chromates, borates, nitrates, nitrites and soluble oil. Depletion of all types of inhibitors occurs through normal operation. Therefore, strength levels must be maintained by the addition of inhibitors at prescribed intervals. Always follow the supplier's recommendations on inhibitors usage and handling.

2-108 Chromates

Sodium chromate and potassium dichromate are two of the best and more commonly used water system corrosion inhibitors. However, the restrictive use of these materials, due to ecology considerations, has de-emphasized their use in favor of non-chromates. Care should be exercised in handling these materials due to their toxic nature.

Chromate inhibitors should not be used in permanent type antifreeze solutions. Chromium hydroxide, commonly called "green slime", can result from the use of chromate inhibitors with permanent type antifreeze. This material deposits on the cooling system passages, reducing the heat transfer rate (Fig. 2-35) and results in engine overheating. Engines which have operated with a chromate-inhibited water must be chemically cleaned before the addition of permanent antifreeze. A commercial heavy duty descaler should be used in accordance with the manufacturer's recommendation for this purpose.

Table 1

	PARTS PER MILLION	GRAINS PER GALLON
Chlorides (Maximum	40	2.5
Sulfates (Maximum)	100	5.8
Total Dissolved Solids (Maximum)	340	20
Total Hardness (Maximum)	170	10

Refer to Table 2 for evaluation of water intended for use in a coolant solution.

Table 2

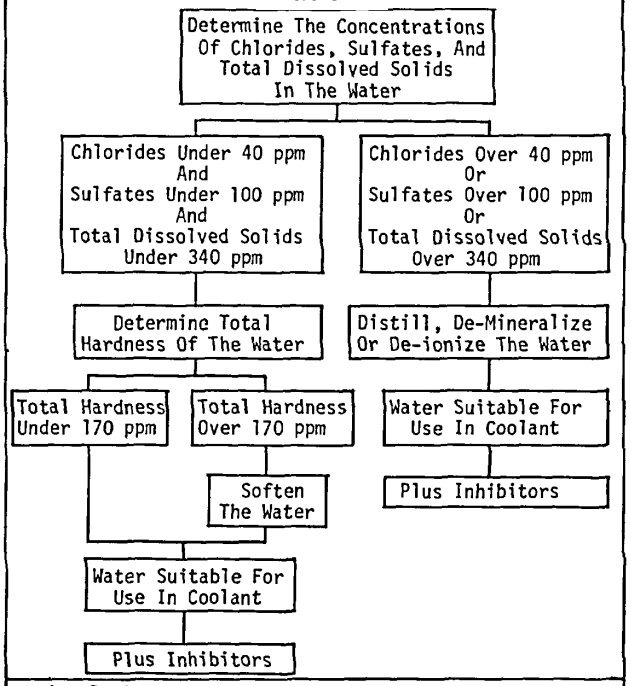


Fig. 2-34

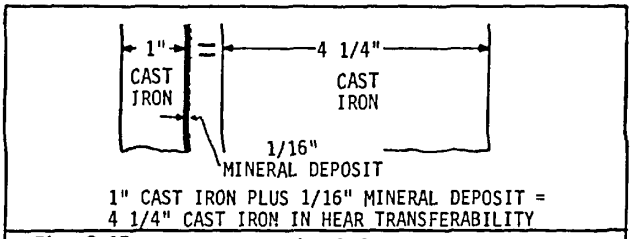


Fig. 2-35
Heat Transfer

2-109 Soluble Oil

Soluble oil has been used as a corrosion inhibitor for many years. It has, however, required very close attention relative to the concentration level due to adverse effects on heat transfer if the concentration exceeds 1% by volume. For example 1-1/4% of soluble oil in the cooling system increases fire deck temperature 6% and a 2-1/2% concentration raises fire deck temperature up to 15%. Soluble oil is not recommended as a corrosion inhibitor.

2-110 Non-Chromates

Non-chromate inhibitors (borates, nitrates, nitrites, etc.) provide corrosion protection in the cooling system with the basic advantage that they can be used with either water or a water and permanent antifreeze solution.

2-111 Inhibitor Systems

An inhibitor system (Fig. 2-36) is a combination of chemical compounds which provide corrosion protection, pH control and water softening ability. Corrosion protection is discussed under the heading Corrosion Inhibitors. The pH control is used to maintain an acid-free solution. The water softening ability deters formation of mineral deposits. Inhibitors systems are available in various forms such as coolant filter elements, liquid and dry bulk inhibitor additives, and as an integral part of permanent antifreeze.

2-112 Coolant Filter Elements

Replaceable elements are available with various chemical inhibitor systems. Compatibility of the element with other ingredients of the coolant solution cannot always be taken for granted.

Problems have developed from the use of the magnesium lower support plate used by some manufacturers in their coolant filters. The magnesium plate will be attacked by solutions which will not be detrimental to other metals in the cooling system. The dissolved magnesium will be deposited in the hottest zones of the engine where heat transfer is most critical. The use of an aluminum or zinc support plate in preference to magnesium is recommended to eliminate the potential of this type of deposit. High chloride coolants will have a detrimental effect on the water softening capabilities of systems using ion-exchange resins. Accumulations of calcium and magnesium ions removed from the coolant and held captive by the zeolite resin can be released into the coolant by a regenerative process caused by high chloride content solutions.

2-113 Bulk Inhibitor Additives

Commercially packaged inhibitor systems are available which can be added directly to the engine coolant or to bulk storage tanks containing coolant solution.

Both chromate and non-chromate systems are available and care should be taken regarding inhibitor compatibility with other coolant constituents.

Non-chromate inhibitor systems are recommended for use in Detroit Diesel engines. These systems can be used with either water or permanent type antifreeze solutions and provide corrosion protection, pH control and water softening. Some non-chromate inhibitor systems offer the additional advantage of a simple on-site test to determine protection level and, since they are added directly to the coolant, require no additional hardware or plumbing.

2-114 Antifreeze

When freeze protection is required, a permanent antifreeze must be used. An inhibitor system is included in this type of antifreeze and no additional inhibitors are required on initial fill if a minimum antifreeze concentration of 30% by volume is used. Solutions of less than 30% concentration do not provide sufficient corrosion protection. Concentrations over 67% adversely affect freeze protection and heat transfer rates (Fig. 2-37).

Methoxy propanol base antifreeze is not recommended for use in Detroit Diesel engines due to the presence of the fluoroelastomer (Viton '0') seals in the cooling system. Before installing ethylene glycol base antifreeze in an engine previously operated with methoxy propanol, flushed with clean water and examined for rust, scale, contaminants, etc. If deposits are present, the cooling system must be chemically cleaned with a commercial grade heavy-duty descaler.

Ethylene glycol base antifreeze is recommended for use in Detroit Diesel engines. Methyl alcohol antifreeze is not recommended because of its effect on the non-metallic components of the cooling system and because of its low boiling point.

The inhibitors in permanent antifreeze should be replenished at approximately 500 hours or 20,000 mile intervals with a non-chromate inhibitor system. Commercially available inhibitor systems may be used to re-inhibit antifreeze solutions.

COOLANT INHIBITOR CHART

Inhibitor or Inhibitor System	Corrosion Inhibitor Type	Complete Inhibitor System	Inhibitor Compatibility Ethylene Glycol Base Water	Antifreeze
Sodium chromate	Chromate	No	Yes	No
Potassium dichromate	Chromate	No	Yes	No
Perry filter elements:				
5020 (Type OS)	Chromate	Yes	Yes	No
S 453 (Spin-on)	Chromate	Yes	Yes	No
S-373 (Spin on)	Non-chromate	Yes	Yes	Yes
5070 (Type OS)	# Non-chromate	Yes	Yes	Yes
S 473 (Spin-on)	# Non chromate	Yes	Yes	Yes
Lenroc filter element	Non-chromate	Yes	Yes	Yes
Fleetguard filter elements:				
DCA (Canister)	Non-chromate	Yes	Yes	Yes
DCA (Spin-on)	Non-chromate	Yes	Yes	Yes
AC filter elements:				
DCA (Canister)	Non-chromate	Yes	Yes	Yes
DCA (Spin-on)	Non-chromate	Yes	Yes	Yes
Luber-Finer filter elements:				
LW-4739 (Canister)	Non-chromate	Yes	Yes	Yes
LFW 4744 (Spin-on)	Non chromate	Yes	Yes	Yes
Nalcool 2000 (Liquid)	Non-chromate	Yes	Yes	Yes
Perry LP-20 (Liquid)	Non-chromate	Yes	Yes	Yes
Sy Cool (Liquid)	Non-chromate	Yes	Yes	Yes
Lubercool (Liquid)	Non-chromate	Yes	Yes	Yes
DuBois Chemicals IWT-48 (Liquid)	Non chromate	Yes	Yes	Yes
Norman Chemicals C15 (Liquid)	Non chromate	Yes	Yes	Yes
Aqua-Tane (Liquid)	Non-chromate	Yes	Yes	Yes

Caution: Do not use methoxy propanol base antifreeze in Detroit Diesel engines

Fig. 2-36
Coolant Inhibitor Chart

2-115 Sealer Additives

Several brands of permanent antifreeze are available with sealer additives. The specific type of sealer varies with the manufacturer. Antifreeze with sealer additives is not recommended for use in Detroit Diesel engines due to possible plugging throughout various areas of the cooling system.

2-116 General Recommendations

All Detroit Diesel engines incorporate pressurized cooling systems which normally operate at temperatures higher than non-pressurized systems. It is essential that these systems be kept clean and leak-free, that filler caps and pressure relief mechanisms be correctly installed at all times and that coolant levels be properly maintained.

WARNING

Use Extreme Care When Removing A Radiator Pressure Control Cap From An Engine. The Sudden Release Of Pressure From A Heated Cooling System Can Result In A Loss Of Coolant And Possible Personal Injury (Scalding) From The Hot Liquid.

(1) Always use a properly inhibited coolant.
(2) Do not use soluble oil.
(3) Maintain the prescribed inhibitor strength.
(4) Always follow the manufacturer's recommendations on inhibitor usage and handling.

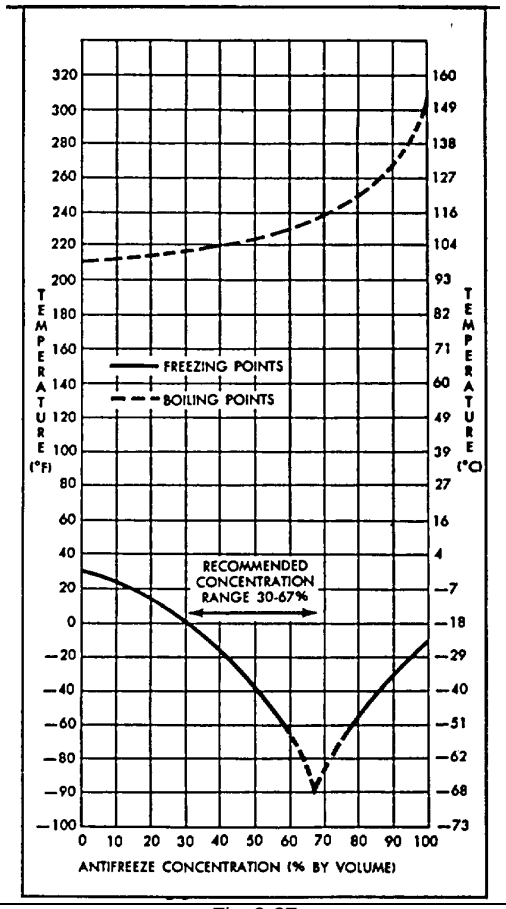


Fig. 2-37
Coolant Freezing And Boiling Temperatures vs. Antifreeze Concentration (Sea Level)

(5) If freeze protection is required, always use a permanent antifreeze.
(6) Re-inhibit antifreeze with a recommended non-chromate inhibitor system.
(7) Do not use a chromate inhibitor with permanent antifreeze.
(8) Do not use methoxy propanol base antifreeze in Detroit Diesel engines.
(9) Do not mix ethylene glycol base antifreeze with methoxy propanol base antifreeze in the cooling system.
(10) Do not use an antifreeze containing sealer additives.
(11) Do not use methyl alcohol base antifreeze.
(12) Use extreme care when removing the radiator pressure control cap.

2-117 Torque Converter

2-118 Oil Level Checks, General

The correct amount of oil in the reservoir, or transmission sump, is important to converter operation. Poor or erratic performance, overheating, and possible damage can occur when the oil level is not within the specific limits.

To ensure that the oil level is properly-maintained, two check procedures are recommended - the cold check and hot check. Although different means of checking - dipstick, level plugs, or petcocks - the procedures remain the same.

2-119 Cold Check

Before starting the engine, check the oil level in the reservoir. If the level is at the Add line, the engine can be started safely. If it is necessary to add oil - DO NOT fill above the Add line.

2-120 Hot Check

After the oil reaches operating temperature 180-200°F (82 to 93° C), idle the engine, and check the oil level. Add or drain oil as necessary to bring the oil level to the Full line. If the converter is equipped with an input disconnect clutch, engage the clutch before making the hot check.

2-121 Oil Specifications

Only Type C-2 hydraulic transmission fluid is recommended for use in these converters.

When the ambient temperature is below -10°F (-23°C), an auxiliary preheat is required to raise the temperature in the sump (reservoir) to at least -10°F (-23°C).

Note: Only certain C-2 fluids have been approved for use in Allison converters. Check with Detroit Diesel Distributor In your area to make sure you are using an approved brand.

2-122 Oil and Filter Check

Generally, the oil and filter should be changed every 1000 hours of operation. However, if the equipment operates under severe dust and dirt conditions, the oil and filter should be changed more frequently. Change the oil immediately if it has been subjected to severe overheating. Change the oil any time it shows evidence of contamination.

2-123 Oil Contamination

2-124 Water In Oil

At each oil change examine the oil which is drained for evidence of dirt or water. A normal amount of condensation will emulsify in the oil during operation of the transmission.

However, if there is evidence of water, check the cooler (heat exchanger) for leakage between the water and oil areas. Oil in the water side of the cooler (or vehicle radiator) is another sign of leakage. This, however, may indicate leakage from the engine oil system.

2-125 Metal Particles

Metal particles in the oil (except for the minute particles normally trapped in the oil filter) indicate damage has occurred in the converter. When these particles are found in the sump, the converter must be disassembled and closely inspected to find the source. Metal contamination will require complete disassembly of the converter and cleaning oil out of all internal and external circuits, cooler, filter, and all other areas where the particles could lodge.

2-126 Ethylene Glycol

If engine coolant containing ethylene glycol leaks into the converter oil system, immediate action must be taken to prevent malfunction and possible serious damage. The converter must be completely disassembled, inspected and cleaned. All traces of the coolant, and varnish deposits resulting from coolant contamination, must be removed.

2-127 Draining, Converter, General

The equipment should be at operating temperature when the oil is drained. While the oil is draining, check for evidence of contamination.

2-128 Torque Converter Oil Change

Remove the reservoir (sump) drain plug from the reservoir. To remove the remaining 3 to 4 gallons (11 to 15 liters) from within the converter, remove the converter-in line and start the engine. Run the engine 20 to 30 seconds at 1000 rpm. Remove strainers and filters, if used.

CAUTION

Due To Lack Of Lubrication, Do Not Run The Converter More Than 30 Seconds.

Clean oil strainers and screens by agitating them in mineral spirits or solvents. Flush all residue and particles from the screen mesh. Dry the strainer or screen with compressed air - do not use linty shop towels.

Should it become necessary to use a different transmission fluid, thoroughly flush the system with the fluid to be used before refilling.

2-129 Filling The Oil System

Install reservoir (sump) drain plug and tighten if sufficiently to prevent leakage. Install or replace filters and strainers, if used.

Check to ensure that all drain plugs, oil filters, and oil lines have been installed or replaced and secured sufficiently to prevent leakage. Fill the converter reservoirs with 9 gallons. Start the engine and bring the unit to operating temperature, 180-200°F (82-93°C). Check the oil level again and add or drain enough oil to bring the level to the Full mark.

2-130 Overcenter Disconnect Clutch

2-131 Lubrication

Lubricate the throw-out bearing and shaft bearing with high-temperature grease (300°F [150°C] minimum melting point) every 60 hours of operation. This time interval may vary due to specific operating conditions. Using a grease gun inject 1 "shot" into each grease fitting located on the top of the clutch housing.

CAUTION

Over lubrication Of Either Bearing Will Cause Grease To Be Thrown Onto The Clutch Facing, Causing The Clutch To Slip Or Grab.

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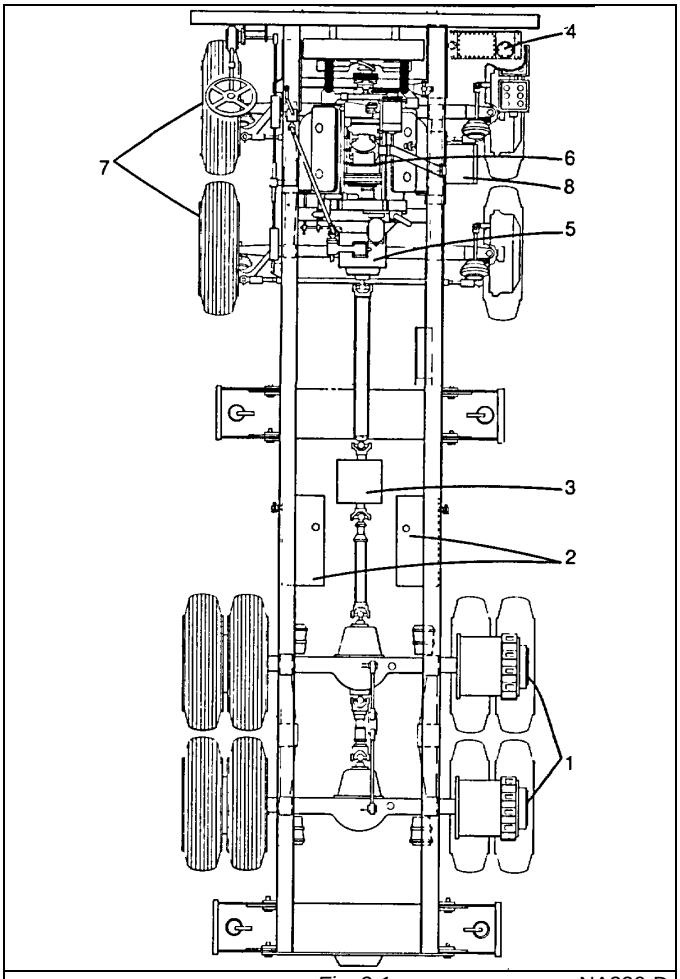

Fig. 3-1 NA220-D
Carrier Assembly

(1) Rear Axles
(2) Fuel Tank
(3) Creeper Transmission
(4) Outrigger Sump Tank
(5) Main Transmission
(6) Engine
(7) Front Axles
(8) Engine Air Cleaner

3-1 Carrier General

The 8 x 4 carrier is designed and manufactured by FMC Corporation. Power from the engine is transferred through a clutch to the main transmission. The main transmission provides 15 forward speeds, and 3 in reverse. Power from the main transmission is transferred to a creeper transmission near the center of the carrier. The creeper transmission has two speeds; direct drive and a lower speed. The creeper transmission is used in direct drive for travel both on and off the highway. The lower (creep) speed is used for slower movement around the job site, but should not be used when high tractive effort is required or drive line damage may occur. Power from the creeper transmission is transferred to the two rear drive axles. Each axle is a double reduction type, with one gear reduction in the differential, and a second in the planetary hub, at each end of the axle.

Two steering axles are used at the front of the carrier. Steering is accomplished manually with hydraulic assist. Air brakes are used on all axles. The rear axle brake actuators contain emergency and parking brakes.

3-2 Clutch Assembly

The carrier clutch is a push type, double dry disc. Pushing on the clutch pedal pushes the release bearing against the release fingers, disengaging the clutch.

Releasing the clutch pedal allows the release bearing to move away from the release fingers. Springs in the clutch pressure plate engage the clutch.

3-3 Clutch Adjustment: When the clutch linkage is properly adjusted, there will be a small amount of free pedal travel. This free pedal travel results from clearance between the clutch release bearing and the clutch release fingers. This clearance is necessary to remove all loadings from the release bearing when the clutch is disengaged. On this clutch, the clearance must be 1/8" (3.17mm). As the clutch facing wears, this clearance will decrease. If allowed to decrease excessively, the release bearing may contact the release fingers, and cause the clutch to slip, resulting in eventual clutch failure.

Never wait for a clutch to start slipping before adjusting it. Once the clutch starts to slip, it is too late to make an adjustment. Once the facings are burned by slippage, they quickly wear out.

The clutch is adjusted as follows:

(a) Disconnect the reach rod.
(b) Place cross shaft in its most forward position.
(c) Check the overall length of the reach rod. It must be adjusted so the clutch pedal is tight against the floorboard when the cross shaft lever is in its most forward position.
(d) Reconnect the reach rod and check the return spring tension. Make sure the tension is such that the clutch pedal remains tight against the floorboard.
(e) Remove the clutch cover plate from the clutch housing.
(f) Check the release bearing clearance. It should be 1/8" (3.17mm).
(g) To increase this clearance back off on the adjusting screw.

Note: Excessive release bearing clearance may prevent complete clutch engagement. On the other hand, insufficient clearance may cause slippage and shorten clutch life.

One of the most abusive practices which cause clutch failures is riding the clutch pedal.

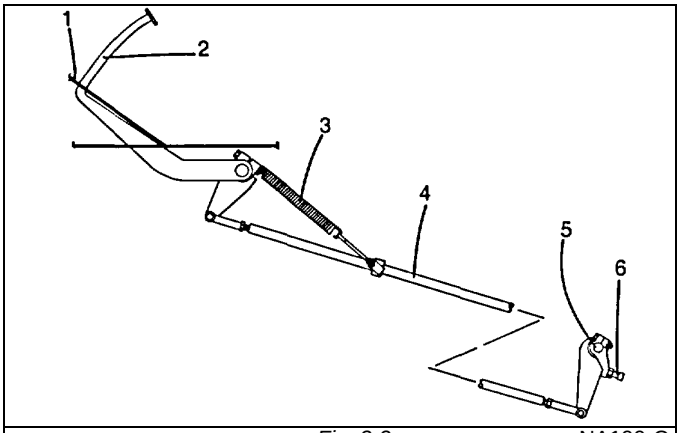

Fig. 3-2 NA199-C
Clutch Linkage

(1) Floor Board
(2) Clutch Pedal
(3) Return Spring
(4) Reach Rod
(5) Cross Shaft & Lever
(6) Adjusting Screw

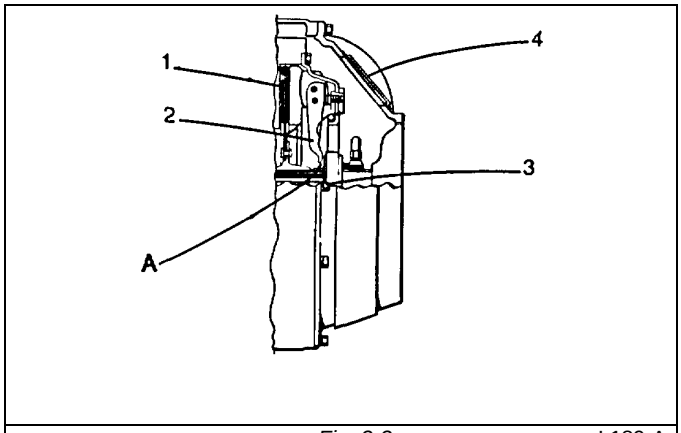

Fig. 3-3 L189-A
Carrier Clutch

(A) = 1/8" (3.17mm)
(1) Clutch
(2) Release Finger
(3) Release Bearing
(4) Cover Plate

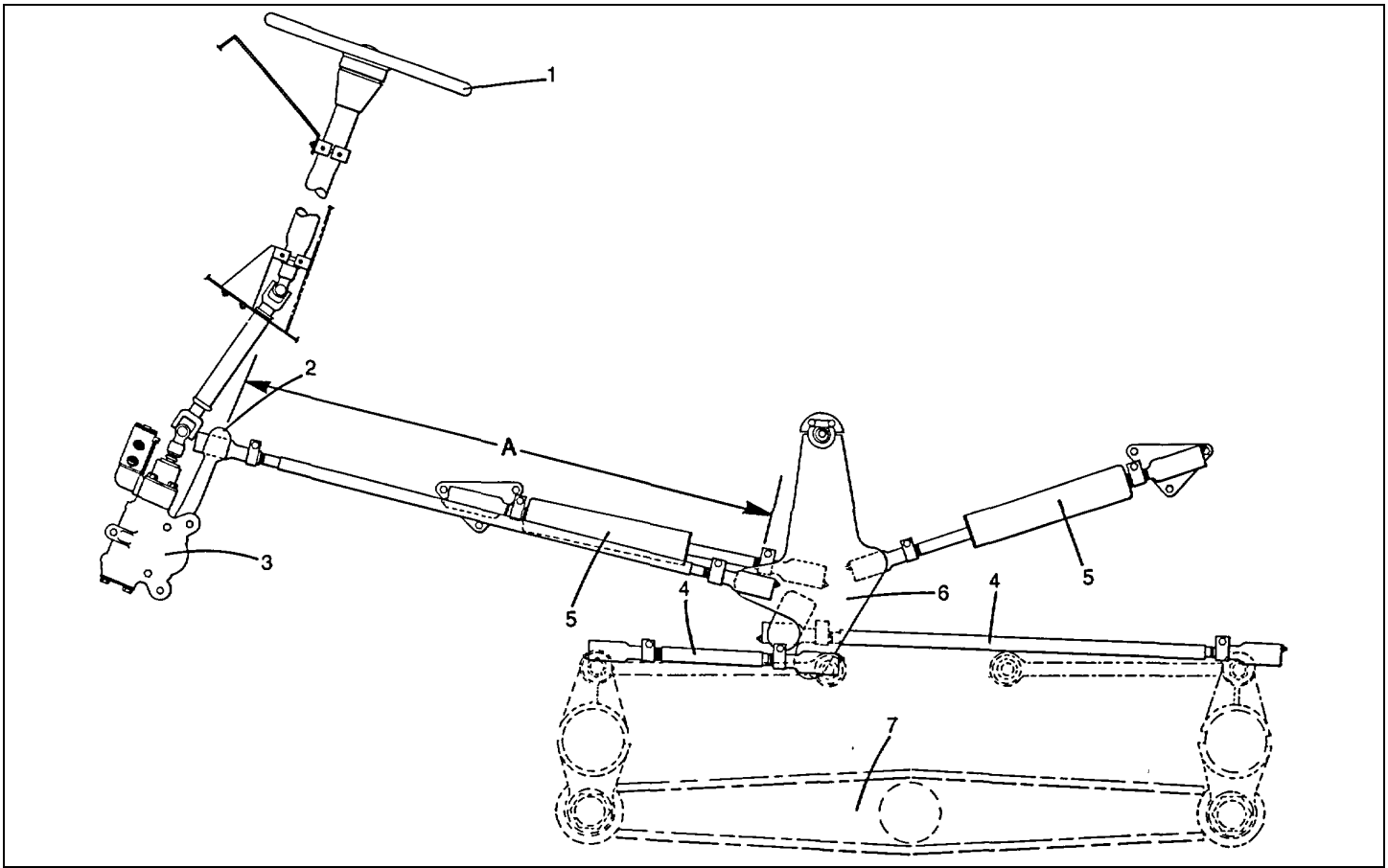

Fig. 3-4 NS206-D
Steering Mechanism

(1) Steering Wheel
(2) Pitman Arm
(3) Steering Gear
(4) Drag Links
(5) Steer Cylinders
(6) Idler Arm
(7) Equalizer Beam
(A) Adjust To 49 15/16" Length (127cm)

This practice consists of applying pressure to the clutch pedal either when there is no need to declutch, or prematurely in preparation for a gear change. Sustained pressure on the clutch without a declutch and gear change results in rapid wear, and failure of the clutch release bearing.

3-4 Front Axles

Two front axles are used under the carrier. The axles are mounted to the carrier by bogie beams. The beams attach to shafts mounted on the carrier frame. The axles are attached to the bogie beams. The bogie beams serve two purposes:

(1) They reduce the effects of bumps and road irregularities.
(2) They distribute loading between the two axles.

The front axles are also supported by four torque rods, - two each side. As the name implies the torque rods absorb any torque caused by the tendency of the axles to turn forwards or backwards on their axis due to starting or stopping inertia or road shocks.

3-5 Front Wheel Alignment: For maximum tire life and ease of steering, front wheel alignment must be checked periodically. This is more critical on a two-axle arrangement than on a single front axle. The two front axles must be properly aligned with respect to each other or excessive tire wear will result. The following steps outline the procedure for checking front wheel alignment:
(Refer to Figs. 3-4 and 3-5)

(a) Jack up the carrier with the hydraulic outriggers until the wheels clear the ground.
(b) Turn the steering wheel until the front left two tires are lined up with each other and are straight ahead with respect to the carrier.

Note: Fig. 3-5 illustrates one means of checking step (6). This involves placing a straight edge parallel to the carrier by measuring a distance (A) at each end of the straight edge. Once the proper position of the straight edge is obtained, measure the distance between the straight edge and the milled surface on the wheel hub used to locate the tire lugs. These four dimensions are represented by the letters (B) and (C), in Fig. 3-5, Distance (B) must equal (B) and (C) must equal (B) does not necessarily have to equal (C). A drag link adjustment may be necessary to correct any misalignment. Be sure to tighten all drag link clamping bolts when adjustment is correct.

(c) Once the left front tires are lined up, check for proper toe in. Toe in can be checked by scribing a line around the circumference of the tire tread at the center-line of the tread. The difference between the distances (D) on the front of the tire and (E) on the back indicate the amount of "toe in" and should equal 1/8" + 1/32" (3.17mm - .78mm). A tie rod adjustment will correct any "toe in" variation. Be sure to tighten all tie rod clamping bolts when adjustment is correct.

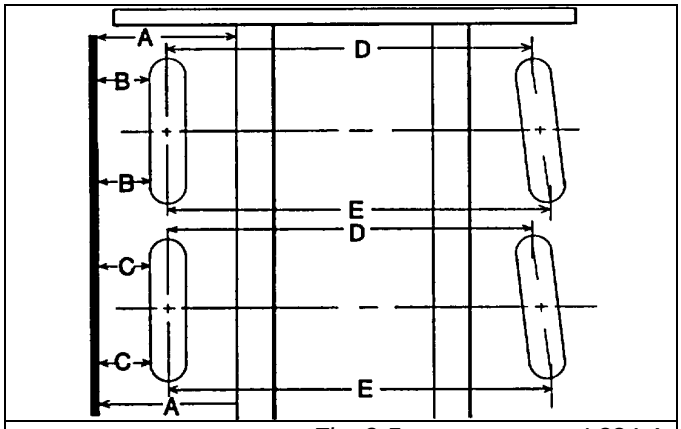

Fig. 3-5 L234-A
Front Wheel Alignment

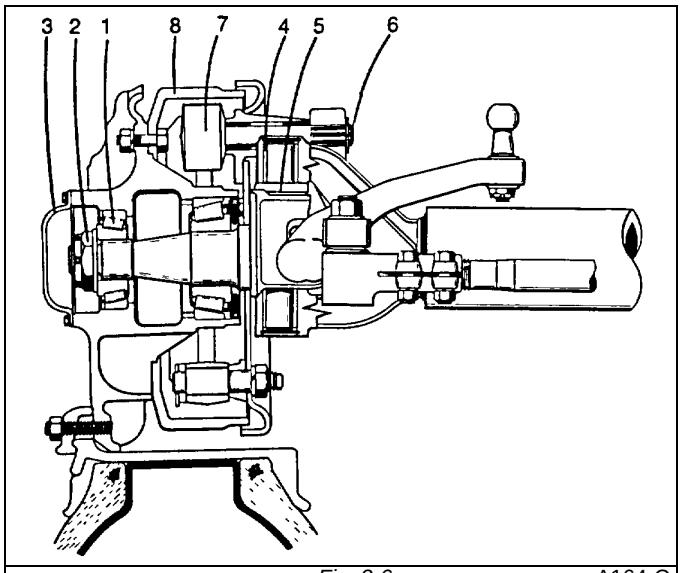

Fig. 3-6 A164-C
Front Axle Assembly

(1) Bearings
(2) Adjusting Nut
(3) Hub Cap
(4) Bushing
(5) Thrust Bearing
(6) Anchor Pin
(7) Brake Cam
(8) Brake Drum

(d) Check the strokes of the power steering cylinders and make sure they are centered when the left wheels are straight ahead as established in step (b). A ball socket adjustment on one or both ends of the cylinder may be required.
(e) To establish a position of the steering wheel when the wheels are straight ahead, mark the steering wheel with respect to some reference point.
(f) Now count the revolutions of the steering wheel from extreme left to the extreme right. Center the steering wheel. Note the position of the mark made in step (e). It should be

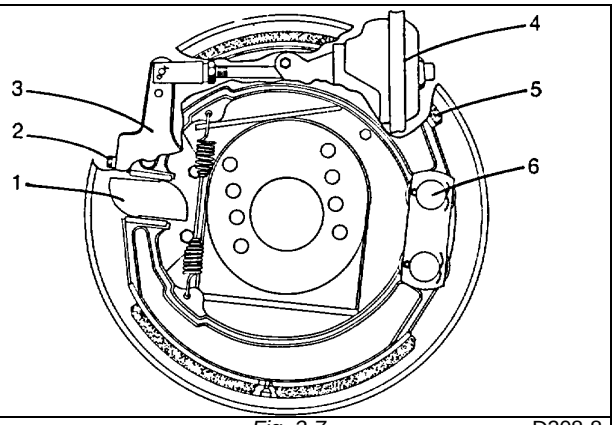

Fig. 3-7 D208-8
Brake Assembly

(1) Brake Cam
(2) Adjusting Screw
(3) Slack Adjustor
(4) Brake Actuator
(5) Brake Shoe
(6) Anchor Pin

within one halt a revolution of its established mark. If not, return the steering wheel to its reference point. (This again aligns the left front wheels straight ahead). Remove the pitman arm from the steering gear, center the steering wheel, reinstall the pitman arm on the steering gear, and fully tighten retaining nut.

3-6 Front Wheel Brake Adj. (Fig. 3-7)

Adjust the brakes periodically to compensate for lining wear and also to provide the most efficient braking. Adjust the front wheel brakes as follows:

(a) Block carrier wheels so carrier cannot move.
(b) Jack up the axle until the tire clears the ground on the brake being adjusted.
(c) Turn the adjusting screw (2 in Fig. 3-7) on the slack adjuster until the brake shoes contact the drum and prevent wheel rotation.
(d) Back the adjusting screw off just enough to free the wheel.
(e) Repeat the procedure for each front wheel.

3-7 Wheel Torque Procedure (Fig. 3-8)

Incorrectly tightened wheels, when mounted on cast spoked rims, may wobble up to 3/4". The recommended procedure for tightening is by triangulation, as follows: (See Fig. 3-8).

(a) Turn nut #1 until snug.
(b) Rotate the wheel-rim assembly until nut #2 is in the top position. Turn the nut until snug.
(c) Rotate the wheel assembly until nut #3 is in the top position. Turn the nut until snug. Since the entire weight of the tire-wheel assembly is on the top spoke position, this procedure allows even application of force against three points of the rim for alignment.
(d) Repeat the triangle procedure, this time bringing each nut up to the recommended torque. (See torque chart later in this manual).
(e) Bring the remaining nuts up to proper torque.

Note: <u>After 50 to 100 miles (80.4 to 160.9km) of operation tighten the nuts to recommended torque once again. The wheel rim assembly will then remain tight barring accident such as stud breakage or clamp failure.</u>

3-8 Tires And Tire Inflation

Dual wheels and tires are installed so the valve stem of the inner tire is 180° opposite the valve stem of the outer tire. All tires of the same size and weight are interchangeable. Inspect wheel rim, clamps, nuts, studs, etc., on weekly basis. If any damage is apparent repair or replace before operating the carrier or making lifts on tires.

Check the tires daily for proper inflation pressures for type of operation. The inflation chart (Fig. 3-9) lists the recommended pressure for different operating conditions. Check pressures with the tires cool.

A tire inflation hose assembly is available. This hose assembly can be connected to the carrier air brake system and used to inflate the tires. A gauge is included in the inflation hose assembly to check pressures. The hose is equipped with a clip on chuck, and is long enough to allow the person checking or inflating tires to stand to one side, away from the lock ring. A guard should be provided to protect against a lock ring flying off when inflating or deflating tires.

To assure best vehicle performance and increased tire life, use highway pressures as much as possible. When making lifts on rubber, use static maximum lift pressures shown. The carrier should not be driven, other than around the job site at creep speed, with the tires inflated for maximum static lifts.

The eight rear tires and four front tires must be maintained at the same inflation pressure to eliminate roll and to assure even tire wear

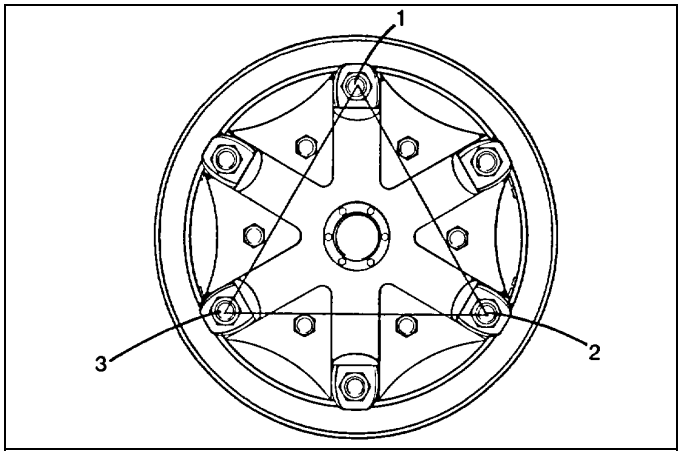

Fig. 3-8 K18-B
Wheel Torque Procedure

Size	Load Range	Ply Rating	(Static Use Only) Inflation	5 Miles Per Hour Inflation	50 M.P.H. Maximum Inflation
14:00 X 24*	L	20 (793 kPa)	115 psi (690 kPa)	100 psi (690 kPa)	100 psi
* For maximum tire life, a 30 minute rest period is recommended every 50 miles of continuous travel.					

Fig. 3-9
Tire Inflation Chart

3-9 Rear Wheel Brake Adjustment

Adjust the brakes periodically to compensate for lining wear, and also to provide the most efficient braking. Adjust the rear wheel brakes as follows:

(a) Block the carrier wheels so the carrier cannot move.

(b) Adjust the brake slack adjuster (See Fig. 3-10) to change position of the slack adjuster with respect to the brake camshaft. Turning the adjusting screw clockwise will decrease clearance between brake lining and drum.

(c) Adjust the brakes to give full brake application with 1" (25.4mm) of brake chamber push rod travel.

(d) Adjust all rear slack adjusters for the same amount of push rod travel.

3-10 Outrigger System Operation (Fig. 3-11)

Two solenoid valve stacks are used to operate the outriggers. A small 3/8" valve stack operates the beam extend, retract cylinder, and the front bumper outrigger. A larger 3/4" valve stack operates the four side outriggers.

When the system is operating and no control switches are actuated, a 10 G.P.M. priority flow of oil from the pump is directed to the 3/8" valve stack. If no solenoids are actuated, the oil flows through the valve, and goes to the 3/4" valve stack. It joins the secondary flow of oil from the pump. The secondary flow can be as little as zero or as much as 7 G.P.M., depending on pump speed. The combined flow of oil, with a maximum flow of 17 G.P.M., flows through the 3/4" valve stack, if no solenoids are actuated, and into a blocking valve at the end of the assembly. The blocking valve directs the flow of oil to the sump tank.

When a beam control switch is actuated, a solenoid on the 3/8" valve stack shifts a spool in the valve stack. This directs a 10 G.P.M. flow of oil into a beam or the front jack cylinder. As the cylinder extends or retracts, oil returning from the other side of the piston in the beam or front jack cylinder flows into a port on the solenoid valve stack, and is directed to the sump tank through the 3/4" valve stack as explained previously.

When a jack control switch is actuated, a solenoid on the 3/4" valve stack shifts a spool in the valve stack. At the same time, the blocking valve closes. This causes oil to flow to the jack cylinder, instead of to the sump. As the jack extends or retracts, oil returning from the other side of the piston in the jack cylinder is returned to the sump tank through porting in the solenoid valve stack.

The priority flow (10 G.P.M.) and secondary flow (7 G.P.M.) combine to operate the outrigger jacks.

3-11 Relief Valve Adjustment: There are three relief valves in the system. One is in the pump, one in the 3/8" valve stack, and one in the 3/4" valve stack. The relief valve in the pump controls pressure in the outrigger beam extend/retract system. It is preset, and nonadjustable. The one in the 3/8" valve stack controls pressure in the front bumper outrigger circuit. The one in the 3/4" valve stack controls pressure in the jack raise/lower circuit. Adjust the relief valves as follows:

WARNING

Fully Retract All Jacks And Beams Before Attempting To Set Pressures. Never Work On A Carrier Outrigger System When It Is Elevated On Outriggers Unless You Thoroughly Block The Machine First. It May Come Down And Cause Injury Or Damage.

(a) Use a 2500 psi pressure gauge to adjust the relief valves. This gauge should be protected against pressure surges by an orifice or a nearly closed needle valve. Refer to Fig. 3-12 for examples of gauge assemblies with orifices and quick disconnects.

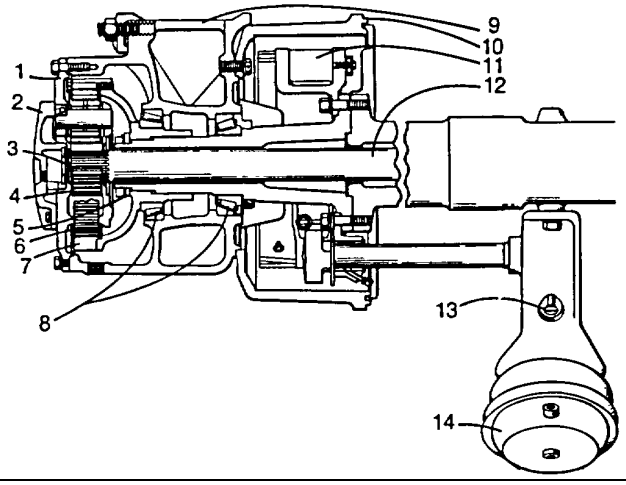

Fig. 3-10 L250-B
Rear Axle Assembly

(1) Planetary Carrier
(2) Thrust Cap
(3) Snap Ring
(4) Sun Gear
(5) Locknut
(6) Pinion
(7) Gear And Hub
(8) Bearings
(9) Wheel Hub
(10) Brake Drum
(11) Brake Shoes
(12) Axle Shaft
(13) Slack Adjustor
(14) Brake Chamber

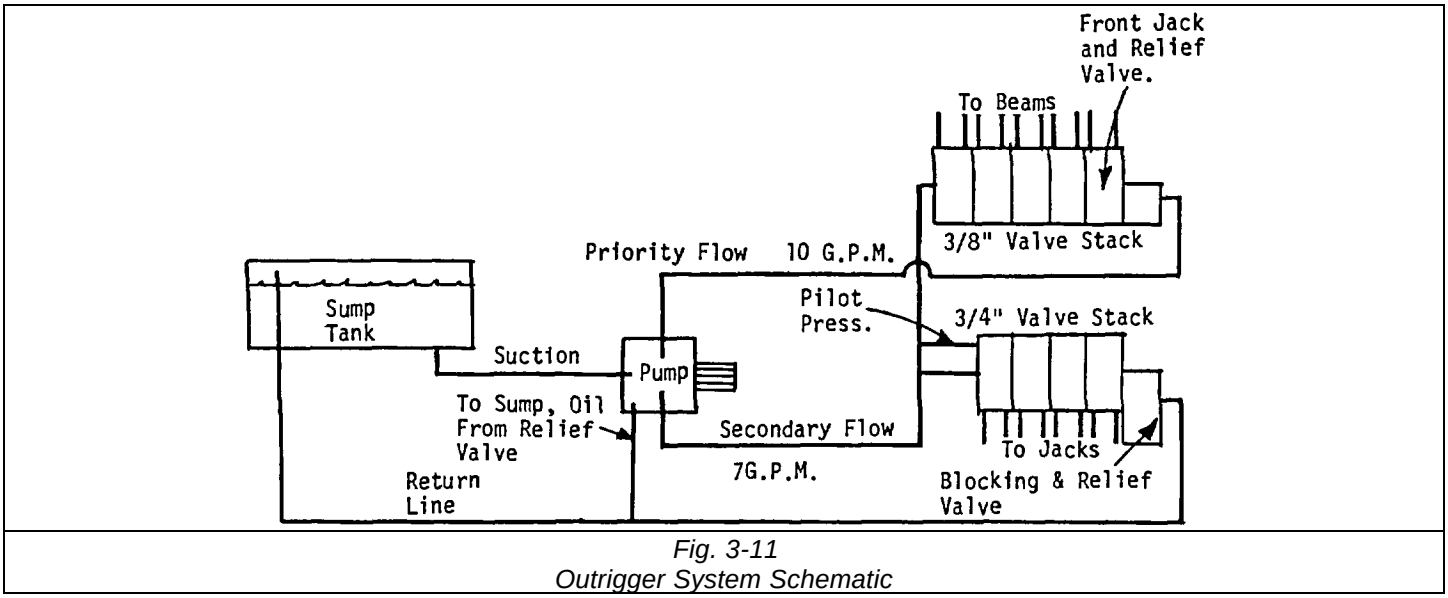

Fig. 3-11
Outrigger System Schematic

The gauge quick disconnects plug into the carrier quick disconnects near the outrigger boxes.

(b) Install a pressure gauge into the right front jack retract control line quick disconnect.

(c) Operate the jack switches to bottom out the cylinder.

(d) Increase the carrier engine speed by depressing the outrigger throttle control button.

Read the gauge. It should read 1550 ±50 psi (10,867 ±545 kPa).

If the pressure is incorrect, set it. The relief valve is set screw adjusted. Loosen the jam nut, turn the set screw out, than back in until the correct pressure is reached. Tighten the jam nut.

(e) Install a pressure gauge in the front bumper outrigger pressure top port. It is located in a tee connected to the lock valve.

Note: Always set pressures at full engine throttle. Push the throttle switch on outrigger control panel to "fast" position when setting the pressures. Obtain final pressures by bringing the pressure up to the final setting, not by backing down.

(f) Extend the jack. Read the gauge. It should read 500 psi (3447.5 kPa).

If the pressure is incorrect, set it. The relief valve is set screw adjusted. Loosen the jam nut, turn the set screw out, than back in until the correct pressure is reached. Tighten the jam nut.

(g) Check operation of the front bumper jack pressure switch by fully extending all 5 jacks. Then retract the mid ships jacks until the carrier horn honks. If the horn doesn't honk by the time the mid ship jacks are no longer touching the pontoons, immediately extend the jacks and correct the problem.

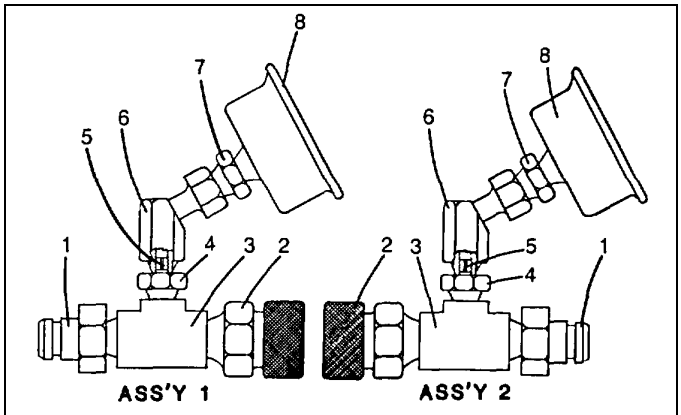

Fig. 3-12 Z200-A
Test Gauge Assembly

(1) 18A2061, 1/2" QD Nipple	(1) 18A788, 3/4" QD Nipple
(2) 18A2062, 1/2" QD Coupler	(2) 18A786, 3/4" QD Coupler
(3) 1X2260, 1/2" Street Tee	(3) 1X3318, 3/4" Street Tee
(4) 1X1319, 1/2" x 3/8" Bushing	(4) 1X907, 3/4" x 3/8" Bushing
(5) #80 Orifice (Drill 1/8" Pipe Plug)	(5) #80 Orifice (Drill 1/8" Pipe Plug)
(6) 1J189 *Drill & Tap 1/8" NPT for Installation of Orifice)	(6) 1J189 (Drill & Tap 1/8" NPT for Installation of Orifice)
(7) 1X152, 3/8" x 1/4" Bushing	(7) 1X1852, 3/8" x 1/4" Bushing
(8) Pressure Gauge	(8) Pressure Gauge

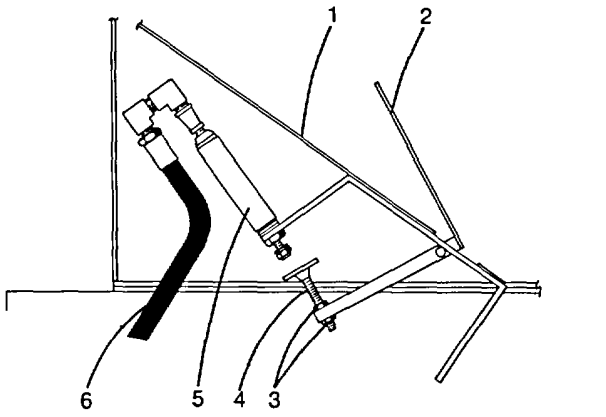

Fig. 3-13 N171-C
Outrigger Throttle Control

(1) Floorboard
(2) Accelerator Pedal
(3) Jam Nuts
(4) Target
(5) Air Cylinder
(6) Air Line

3-12 Outrigger Throttle Control

The outrigger throttle control is actuated by a button on the outrigger control panels and the toggle switch at the front bumper outrigger control station. They actuate a solenoid valve in the carrier air brake system which admits air under pressure to the cylinder (5) in Fig. 3-13. The cylinder depresses the accelerator pedal in the carrier cab to increase the engine speed and provide faster outrigger operation.

3-13 Outrigger Throttle Control Adjustment: Adjust the throttle control to give an engine speed of 1550 ± R.P.M.'s with the air cylinder fully extended as follows:

(a) With carrier transmission in neutral, and parking brake applied, start the engine.
(b) Depress the throttle button. Wait until engine accelerates fully and read the speed off the tachometer in the carrier cab.
(c) Loosen jam nuts (3) on target (4). Turn targets in or out until engine runs at proper speed with button depressed.
(d) Tighten the jam nuts.

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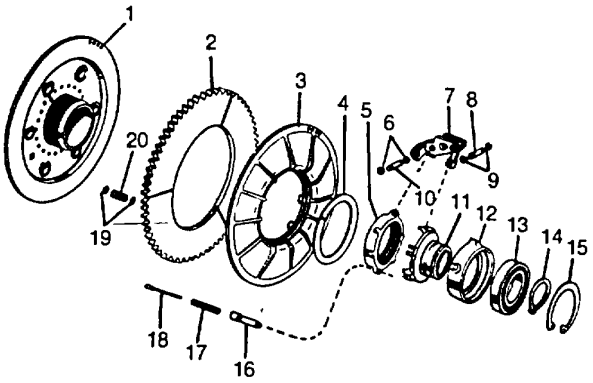


Fig. 4-1 Vendor

Master Clutch Assembly

(1) Hub Plate
(2) Clutch Disc
(3) Back Plate
(4) Thrust Ring
(5) Adjust Collar
(6) Snap Ring
(7) Toggle Assembly
(8) Toggle Liner Pin
(9) Snap Ring
(10) Toggle Strap Pin
(11) Shift Sleeve
(12) Shift Collar
(13) Ball Bearing
(14) Snap Ring
(15) Snap Ring
(16) Lock Pin Sleeve
(17) Lock Spring
(18) Lock Pin
(19) Washer
(20) Spring

4-1 Engine and Power Takeoff

Information on lubrication and protective maintenance of the engine and torque convertor are found in section 2 of this manual.

Information on engine tune up is found in area 6 of the shop manual.

4-2 Adjusting Master Clutch: It will be necessary to adjust the master clutch occasionally to compensate for normal wear. This check should be made every 500 hours of operation, or more frequently, depending on frequency of operation and operating conditions.

When properly adjusted 55-75 ft/lbs. of torque are required to drop the clutch into engagement.

One way to check this torque, is to weld a large nut on the end of the clutch shaft. Attach a torque wrench to this nut. Use it to engage the clutch while reading the torque required.

Adjust the clutch as follows: (Fig. 4-1)

(a) Remove the access cover from the top of the clutch housing.
(b) Rotate the engine with the starter until the clutch collar lock pin is visible.
(c) Disconnect the clutch actuating linkage.
(d) Remove the lock pin. Rotate the adjustment collar clockwise (facing engine flywheel) to increase the engagement force.

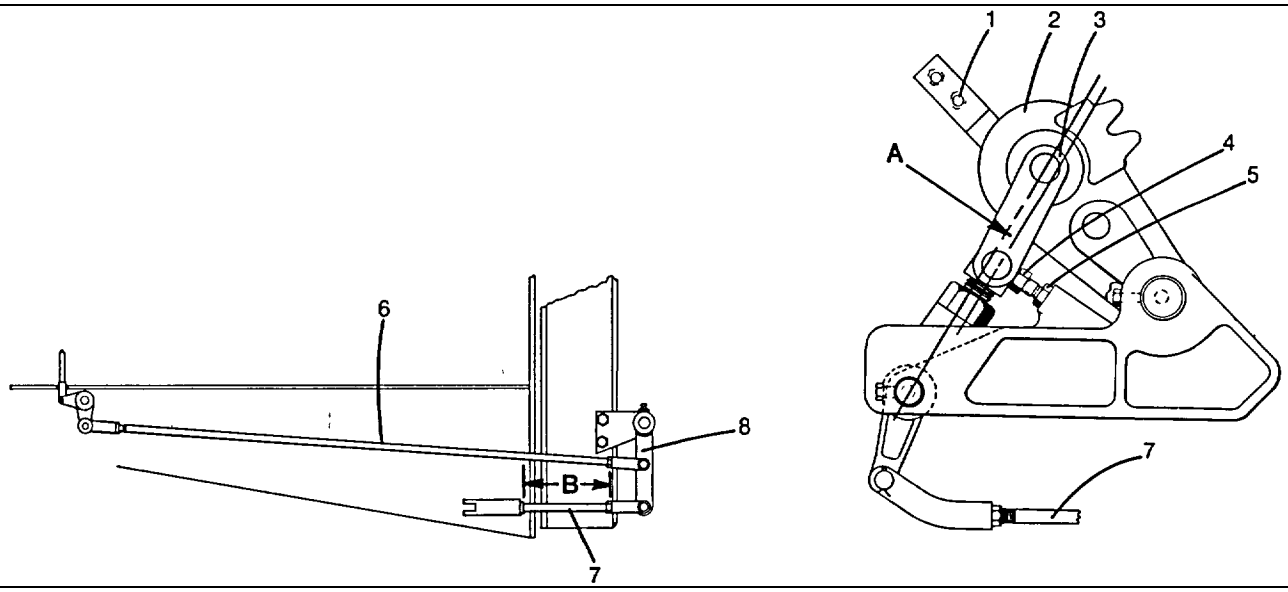


Fig. 4-2 NA299-C

Swing Lock Assembly

(A) 3/8" to 1/2" (9.5 to 12.7mm)
(1) Centering Bracket
(2) Pawl
(3) Linkage
(4) Stop Bolt
(B) 8-1/4" (209.5mm)
(5) Nut
(6) Linkage Rod
(7) Linkage Rod
(8) Bell Crank

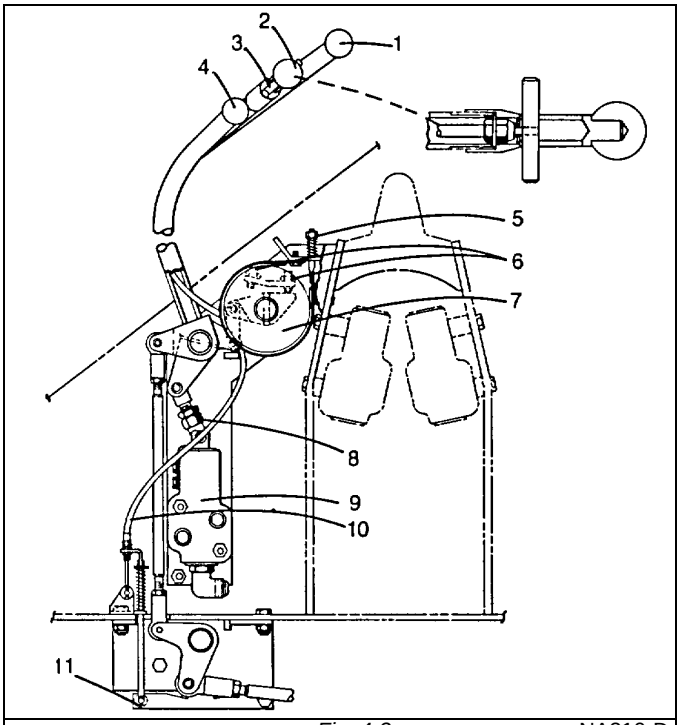


Fig. 4-3 NA210-D

Swing Lock, Swing Brake, Master Clutch Controls

(1) Swing Brake Control
(2) Swing Lock Control
(3) Detent Control
(4) Master Clutch Control
(5) Set Screws
(7) Brake Drum
(8) Toggle Link Assy.
(9) Control Valve
(10) Push Pull Cable
(11) Detent Lever

(e) Replace the lock pin. Make sure the pin has engaged one of the 24 holes in the hub plate. Failure to engage the pin securely will allow the clutch to lose adjustment.

4-3 Swing Lock(Fig. 4-2)

The swing lock is engaged and disengaged with a control lever on the RH control stand. A detent on the control lever, latches it in the engaged or disengaged position.

4-4 Swing Lock Adjustment: The swing lock must be kept adjusted as follows:

(a) Adjust the linkage (3) to a maximum length to provide firm tooth engagement with the control lever locked in its detent. Back off adjustment one full turn for proper clearance. Tighten nut (5).

(b) Adjust rod length at (B) to 8-1/4" (209.5mm).

(c) Adjust the stop bolt (4) to allow linkage (5) to toggle over center 3/8 to 1/2" (9.5 to 12.7 mm) when the pawl is engaged and the lever is locked in its detent.

(d) Adjust the linkage (6) until the pawl teeth will clear the ring gear teeth by 3/16" (4.76mm) with the pawl disengaged and the lever in its detent.

WARNING

Anchor The Upper Machinery Against Rotation By Lowering The Attachment To The Ground Before Working On Swing Lock.

4-5 Swing Brake (Fig. 4-4)

The swing brake is an external band brake which clamps against a drum splined to the reverse shaft to resist swinging of the upper. The brake is spring applied and hydraulically released.

If adjusted properly, it will apply if control pressure is lost.

A small brake drum and band assembly is connected to the swing brake control. This brake will hold the control in any desired position to enable the operator to work with the brake partially applied to retard swinging of the upper.

4-6 Swing Brake Adjustment: Check the adjustment of the swing brake on delivery of a new machine, and every 50 hours thereafter as follows:

(a) The brake must be adjusted if the cylinder piston is flush with the edge of the cylinder when the brake is applied. To adjust the brake, back off on the locknut and tighten the adjusting nut until the spring length (A) is 13-5/8" (346.1mm) with the brake applied. This dimension is spring length only, and does not include the spring guides.

4-7 Swing Brake Control Adjustment: (See Fig. 4-3). The brake band tension may be adjusted by tightening the spring loaded nut (5) on the band.

Adjust the control valve linkage as follows:

(a) Adjust toggle link assembly so that valve cap is just short of bottoming when toggle link assembly is on center.

(b) Adjust set screw (6) so that linkage can toggle slightly over center when lever is fully engaged.

(c) Adjust rear set screw and jam nut to stop lever travel in line with swing lock and master clutch when lever is in rear position. Make sure control valve is fully releasing.

4-8 Counterweight Remover (Fig. 4-5)

The counterweight remover consists of two hydraulic cylinders connected to linkage

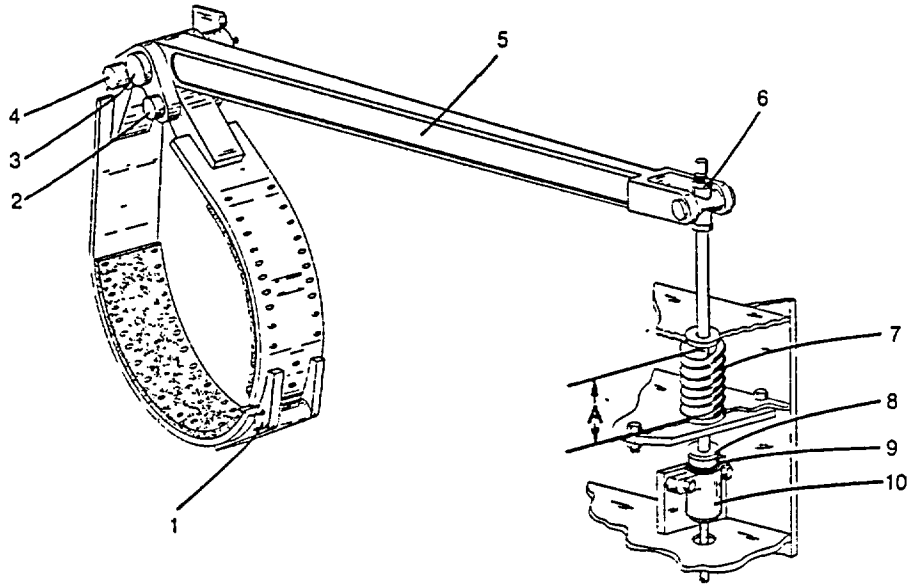


Fig. 4-4
Swing Brake

L118-D

(A) 13-5/8" (346.1mm) Brake Applied
(1) Connecting Pin
(2) Pin
(3) Pivot Pin
(4) Pin
(5) Lever Arm
(6) Adjusting Nut
(7) Spring
(8) Piston Stop
(9) Cylinder Piston
(10) Cylinder Body

at the rear of the upper frame. The remover system is used to set the counterweight on the carrier deck or to lift it into place from the carrier deck. It also holds the counterweight in place on the machine during operation.

4-9 Counterweight Remover Adjustment: The counterweight remover is adjusted as follows:

4-10 Preliminary Adjustment: (Must be made with counterweight off the machine.) (Fig. 4-5)

(a) Before placing the counterweight on the positioning blocks, fully extend the hydraulic cylinders. Refer to page 1-26. Adjust the set screw (7) until the linkage toggles over center 1/4" (6.6mm). This adjustment is very important. Toggling over center provides a mechanical lock up which eliminates the requirement of hydraulic pressure to hold the counterweight in place. All down forces are transmitted into the linkage and set screw instead of into the hydraulic cylinders. Tighten jam nuts on the set screws after adjustment.

(b) The counterweight may now be positioned on the blocks on the carrier bed.

(c) Check dimension "A" in Fig. 4-5. Dimension "A" measures 26-1/2" (673.1mm) from the bottom of the adjusting screw (11) to the inside surface of the counterweight. Refer to Fig. 4-5. To set dimension "A", loosen the jam nuts (9). Next add or remove shims (12) on the adjusting screws (11). After you set dimension "A", tighten the jam nuts (9).

4-11 Final Adjustment: (Must be made with counterweight on machine.) (Fig. 4-5)

(a) Raise the counterweight until the linkage is at top dead center position. (The three linkage pins are in line and the counterweight is in maximum up position). Refer to page 1-26 for operating instructions.

(b) To level the counterweight when it is in the raised position (correct any forward or backward tilt), move shims from one side of the bearing lock to the other. Adjust each bearing block as necessary. It may be necessary to readjust set screws (7) after changing shims.

Note: <u>The counterweight must be lowered to the carrier deck before moving the bearing block and shims</u>.

4-12 Planetary Brake Adjustment (Fig. 4-6)

The planetary brake is hydraulically applied and spring released. As lining wear takes place, the initial dimension at "A" (Fig. 4-6) gradually decreases. When the dimension reaches zero,

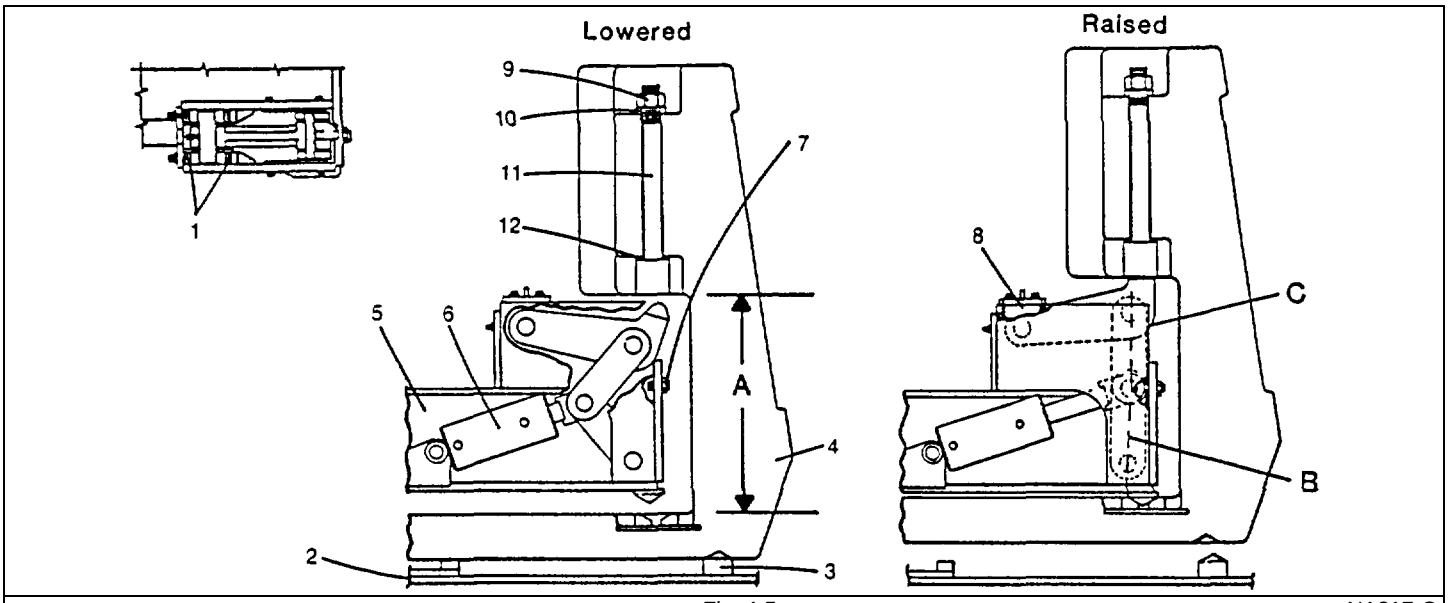


Fig. 4-5 NA217-C
Counterweight Remover Assembly

(A) 26-1/2" (673.1mm)
(B) Position Of Linkage - Toggled 1/4" (6.6mm) Over Center
(C) Position Of Linkage - Top Dead Center

(1) Shims
(2) Carrier Frame
(3) Positioning Block
(4) Counterweight
(5) Upper Frame
(6) Cylinder
(7) Set Screw (W/Nut)
(8) Bearing Block
(9) Jam Nut
(10) Spacer
(11) Adjusting Screw
(12) Shims

the brake must be readjusted. Before adjusting, check to make sure that the lining rivets are not worn through and riding on the drum. To adjust, tighten the band bolt nut until the dimension at "A" equals 3/8" (9.5mm) with the brake applied.

4-13 Front And Rear Drum Brake Adjustment(Fig. 4-7)

Check the front and rear drum brake adjustment upon delivery of a new machine and every 50 hours thereafter, as follows:

(a) Brake lining wear is taken up by means of an adjusting bolt and nut located at the split in the band. Tightening this bolt will take up on the band, while loosening will increase clearance between the drum and the band.

The band should be adjusted tight enough to hold the load when the pedal is operated in the lower half of its travel. By adjusting the band in this manner, the maximum available leverage is being used. Over tightening the band will result in a much harder working brake, improper brake release, abnormal lining wear, and will make it difficult to lock the pedal in the fully applied position.

(b) Adjust the stand off bolts so there is even clearance between the band and the brake drum when the brake is released, all the way around the drum. This is required for maximum brake band cooling, and to prevent

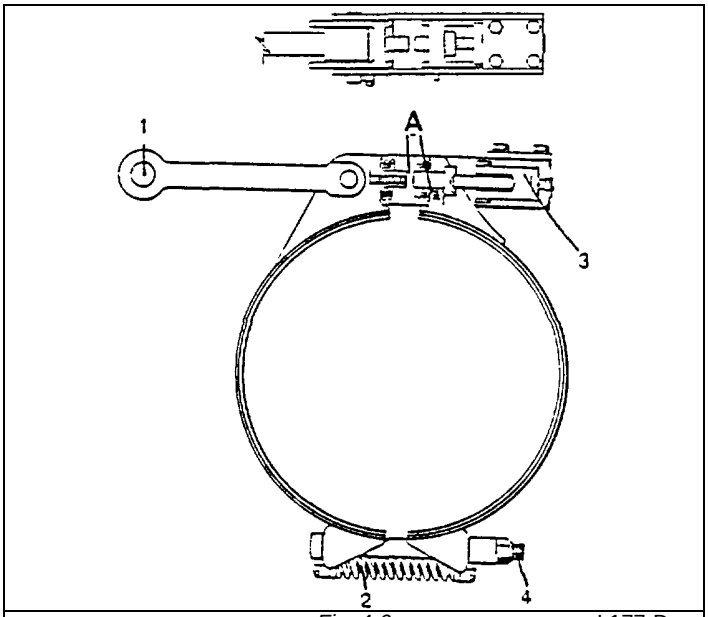


Fig. 4-6 L177-D
Planetary Brake

(A) = 3/8" Clearance (9.5mm)
(1) Rotation Anchor
(2) Brake Spring
(3) Brake Cylinder
(4) Band Bold

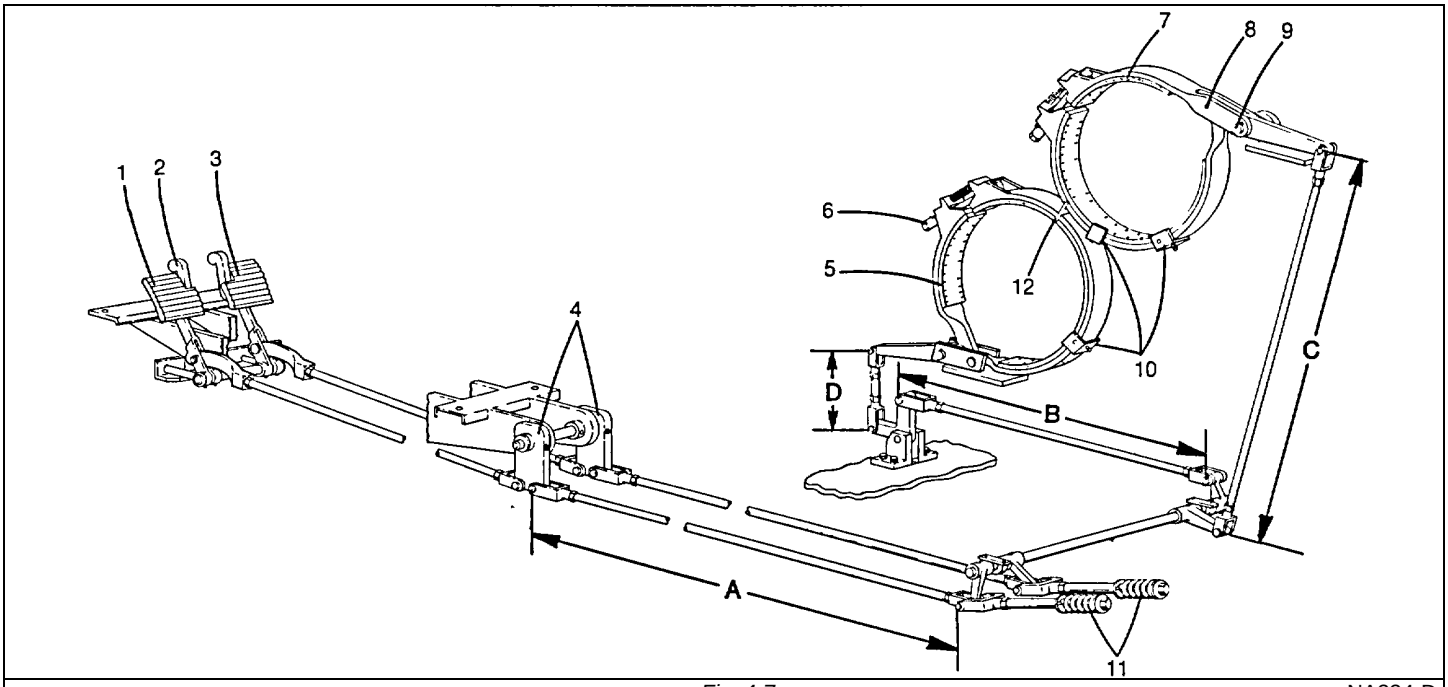


Fig. 4-7
Front And Rear Drum Brakes
NA224-D

(A) 122-3/8" (3.34m)
(B) 73-7/16" (1.86m)
(C) 49-15/16" (1.26mm)
(D) 10-1/4" (260mm)
(1) Front Drum Pedal
(2) Pedal Latch
(3) Rear Drum Pedal
(4) Bell Crank
(5) Front Drum Brake
(6) Band Bolts
(7) Rear Drum Brake
(8) Live End Pins
(9) Dead End Pins
(10) Standoff Bolts
(11) Return Spring
(12) Band Centering Bracket

brake band drag when powering down a load.

(c) The brake band should be centered with the brake drum. The middle area of each band is centered with the drum by means of a centering bracket (item 12 in Fig. 4-7). The rest of each band is centered with the brake drum by shimming between the dead end lug, and the dead end mounting bracket on the frame. The following shims are available for use at this point:
(1) 1D144 .....10 Ga. (3.41mm)
(2) 1D145 .....22 Ga. (.759mm)
(3) 1J218 .....16 Ga. (1.51mm)

(d) Adjust the pedal return spring to return the pedal to its extreme upward position when unlatched. This will completely release the brakes if the band and standoffs are in correct adjustment. Adjust the stop nut on the pedal return spring bolt to limit spring stroke to 1-15/32" (37.3mm).

Note: <u>Reach rod dimensions don't need checking unless rod has been replaced, or satisfactory brake adjustment cannot be accomplished through above procedure</u>.

4-14 Boom Hoist Brake (Fig. 4-8)

The boom hoist brake is spring applied and hydraulically released. If S-o-M pressure should be lost, and the boom hoist brake was adjusted properly, it would automatically apply.

When the boom hoist control is actuated to raise or lower the boom, oil under pressure is also admitted to the boom hoist brake cylinder (6) to release the brake. When the control lever is returned to neutral, the oil in the cylinder (6) flows directly to the S-o-M sump tank. The spring (11) then applies the brake.

4-15 Boom Hoist Brake Adjustment: Check the boom hoist brake adjustment upon delivery of a new machine, and every 50 hours thereafter as follows:

(a) Boom down until boom is lying on ground, and boom hoist ropes are slack before working on B.H. brake.

(b) The band must be centered with the B.H. brake drums by adding or subtracting shims between the dead end lug and the dead end bracket on the revolving frame. The following shims are available for use at this point:
(1) VB92.....16 Ga. (1.51mm)
(2) 1A1275.....22 Ga. (.759mm)

(c) With brake applied, the bell crank (2) arm must be parallel to the upper frame horizontal members as shown by dimensions C and D. These dimensions must be equal. If not, adjust brake band bolt until they are.

(d) The brake must be adjusted when dimension "B" (the amount the piston protrudes

HC238A

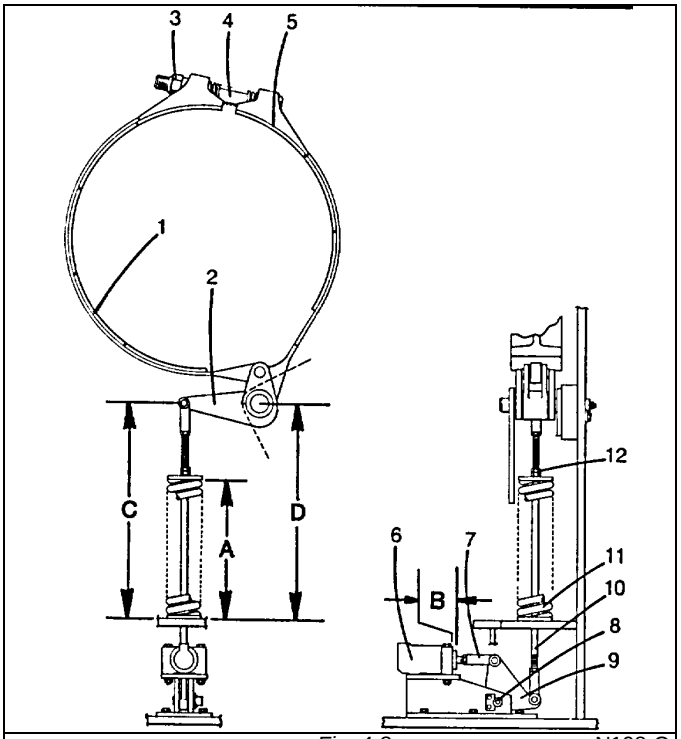


Fig. 4-8 N198-C

Boom Hoist Brake

(A) 14-5/8" (371.4mm) Brake Applied
(B) 7/16" (11.1mm) Brake Applied (Adjust When Flush Or Less)
(C,D) 23-1/4" (590.5mm) Brake Applied

(1) Long Band Section	(7) Push Rod
(2) Bell Crank	(8) Grease Fitting
(3) Adjusting Nut	(9) Bell Crank
(4) Band Bolt	(10) Spring Rod
(5) Short Band Section	(11) Spring
(6) Cylinder	(12) Adj. Nut & Jam Nut

from the cylinder) is zero (piston flush with cylinder). Tighten the band bolt until dimension "B" equals 7/16" (11.1mm).

(e) Check the spring length. It must equal 14-5/8" (371.4mm) measured inside the spring seats. If not, adjust the spring length with the adjusting nut and jam nut (12).

Note: <u>Adjustments made necessary by lining wear should be made with the adjusting nuts on the band bolt only, providing Step "C" above has been established. The centering adjustment and adjustment of the spring bolt nut are ordinarily necessary only when the band has been removed.</u>

4-16 Clutch Adjustment (Fig. 4-9)

The clutch adjustment must be checked on delivery of a new machine, and every 50 hours thereafter as follows:

(a) Loosen the locknut on the adjusting bolt.
(b) Turn the adjusting bolt until the toe of the lining just contacts the clutch drum.
(c) Remove the cotter pin and shim cover from the dead end of the shoe.
(d) Add shims as necessary between the bottom of the dead end block and the shoe, until the head of the shoe contacts the drum.
(e) Turn the adjusting bolt and check for .015 to .025" (.38 to .63mm) clearance. It may be necessary to add or subtract shims in conjunction with turning the bolt to obtain even clearance of .015 to .025" (.38 to .63 mm) the length of the shoe. The following shims are available for use at this point.
  (1) 22C51 .....12 Ga. (2.65mm)
  (2) 22C52 .....16 Ga. (1.51mm)
  (3) 22C53 .....28 Ga. (.378mm)
(f) Oil the dead end pin being careful not to get oil on the clutch shoes.
(g) Replace the shim cover and cotter pin.
(h) Tighten the locknut.
(i) Repeat the above procedure for each shoe in each clutch assembly.

4-17 Air Box Drains (Fig. 4-10)

An air box drain tank is used on the upper. The purpose of the drain tank is to collect water and sediment discharged from the engine air box to prevent spillage on the carrier. The tank must be drained every 50 hours as follows:

(a) Open the drain cock and collect any sediment which drains from the hose under the R.H. deck plate.
(b) If no drainage is evident, blow out the tank and drain hose with compressed air.
(c) Disconnect the hoses from the air box drain. With the engine running, place a finger over the drain. If no air flow is felt, the drains are plugged and must be cleaned.

Every 500 hours, check and clean the system as follows:

(a) Remove the cylinder block hand hole covers and check for an accumulation of liquid or sludge on the air box floor. Clean if necessary.
(b) Remove the drain tubes and blow out with compressed air.
(c) Clean out the drain tank, hose and fittings.

4-18 Control Lever Adjustment (Fig. 4-11)

Adjustment of the control levers should be checked occasionally to assure full operating pressure at the operating cylinders. To adjust the linkage, proceed as follows:

(a) With the master clutch lever disengaged, toggle in the control lever.
(b) Loosen the jam nut. (See Fig. 4-11).
(c) Tighten the adjusting nut until resistance to turn is felt. Do not overtighten.
(d) At this point the control lever may not be returned to neutral.
(e) Back off on the adjusting nut until the lever may just be returned to the neutral position.
(f) Tighten the jam nut.

Note: <u>Adjustment of the linkage must always permit maximum pressure in the operating cylinder, otherwise, clutch slippage may result.</u>

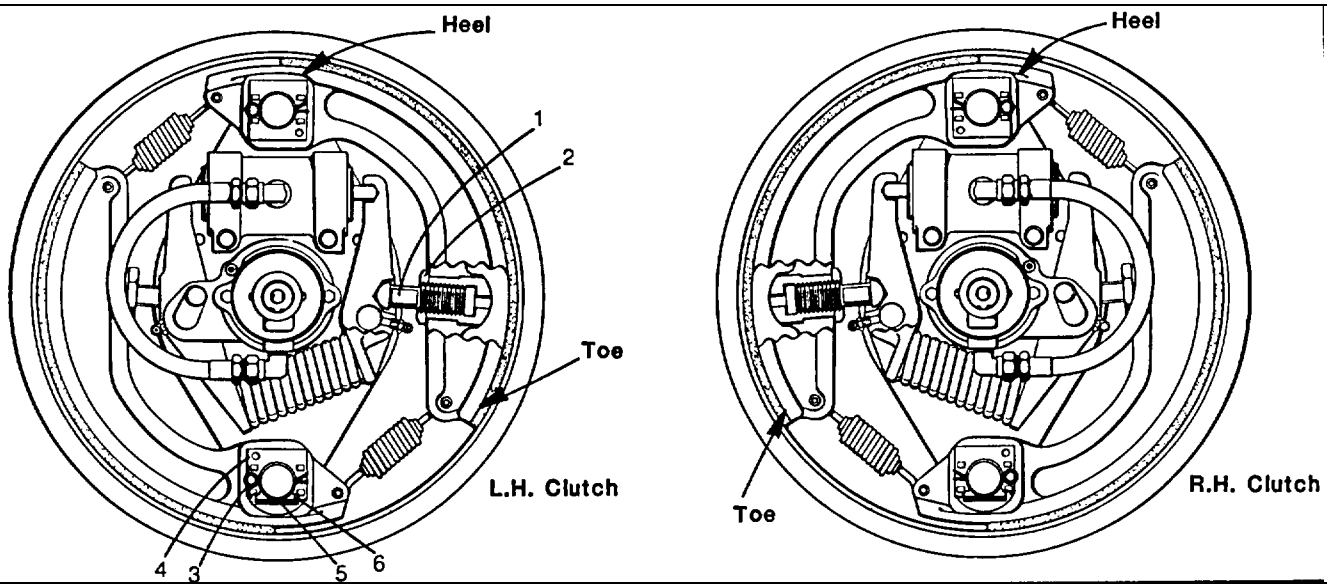


Fig. 4-9
Clutch Assembly
B351-C

(1) Adjusting Bolt
(2) Locknut
(3) Cotter Pin
(4) Shim Cover
(5) Shims
(6) Dead End Block

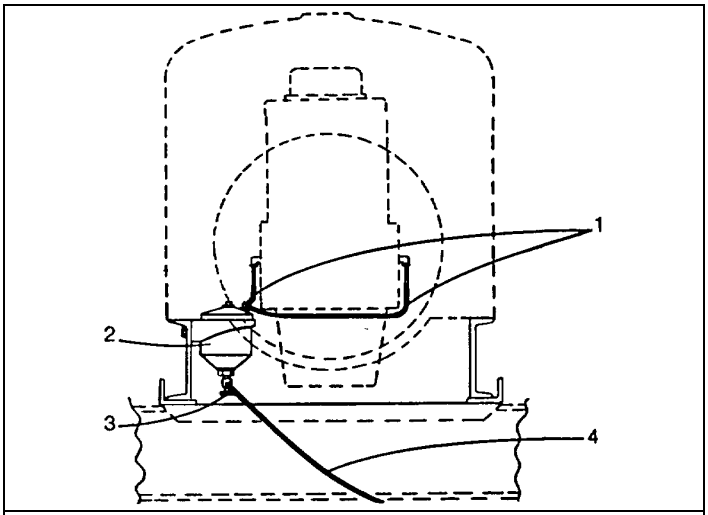


Fig. 4-10
Air Box Drains (GMC Engines)
(1) Air Box Drain
(2) Sediment Tank
(3) Drain Cock
(4) Drain Hose

4-19 Chain Case With Chain Adjuster (Fig. 4-12)

A chain case with a built in adjuster is used. With this chain case, it is not necessary to move the engine back and forth to adjust chain tension. The chain dips into oil in the bottom of the case for lubrication.

4-20 Chain Adjustment: Chain tension is adjusted by lowering or raising adjusting arm and pinion (4) with adjusting screw (3). Adjust the chain as follows:

(a) Remove plug (1) from top of chain case.
{b) Loosen jam nut on adjusting screw (3). Turn in on adjusting screw until chain is taut.
(c) Measure from the lip where the plug mounts to the top strand of the chain. Back off on the adjusting screw until there is 5/8" (15.8mm) sag in the top span of the chain. It will be necessary to push down on the top span of the chain with a stick or bar to make sure the bottom span of the chain is tight when measuring the sag.
(d) Tighten jam nut on adjusting screw.
(e) Replace plug (1).

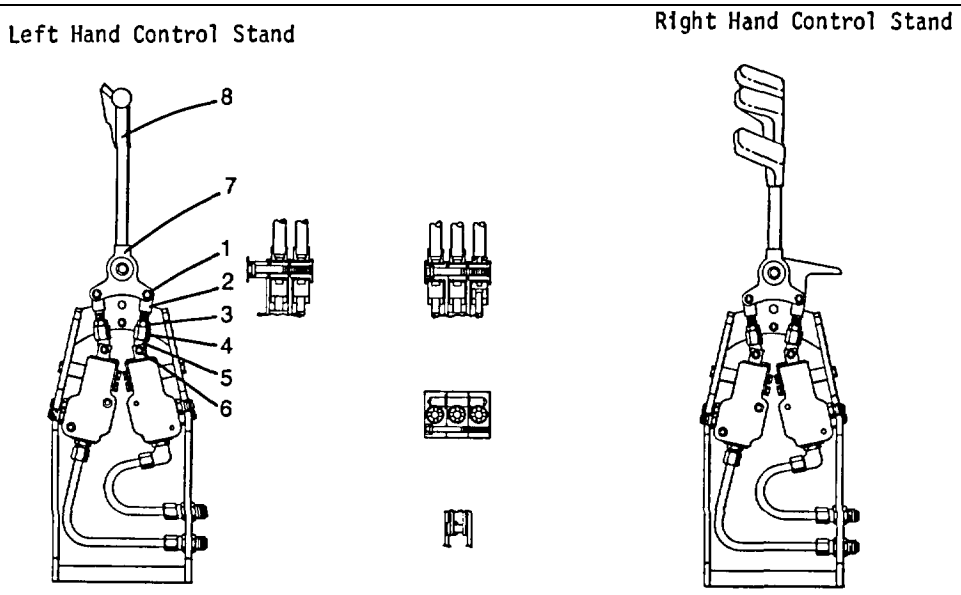


Fig. 4-11 NA 232-C

Control Lever Adjustment

(1) Rollpin
(2) Toggle Link
(3) Jam Nut
(4) Adjusting Nut
(5) Toggle Link
(6) Rollpin
(7) Toggle Lever
(8) Lever

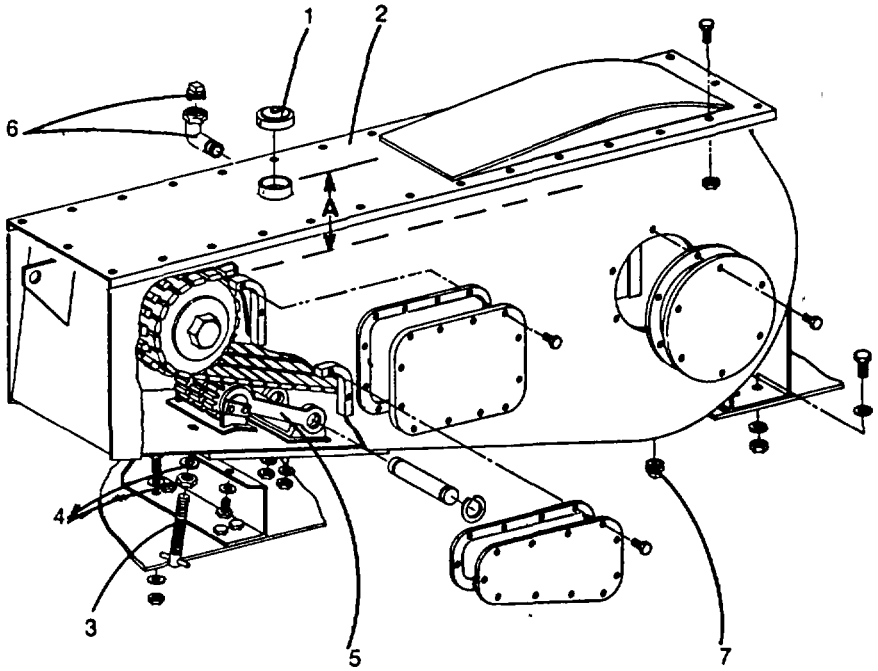


Fig. 4-12 KA 254-B

Chain Case With Adjuster

(1) Fill Plug
(2) Cover
(A) Measure Here
(3) Adjusting Screw
(4) Jam Nut/Lockwasher
(5) Adjusting Arm & Pinion
(6) Check Elbow And Plug
(7) Drain Plug

Index - Section 5

Notes

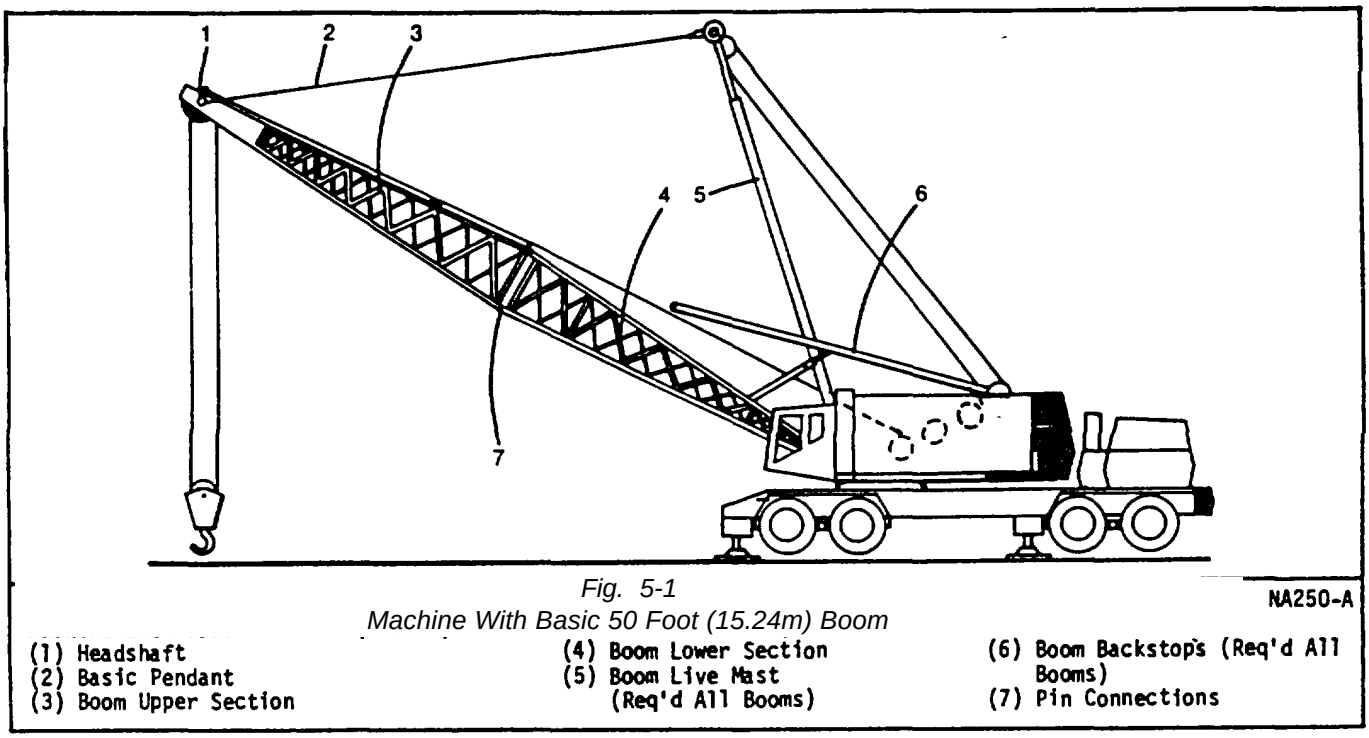


Fig. 5-1
Machine With Basic 50 Foot (15.24m) Boom

5-1 Tubular Boom

The basic tubular boom is 50 feet (15.24m) in length, and consists of a 25 foot (7.62m) lower section and a 25 foot (7.62m) upper section. The sections are connected by four pins, which are in line with the boom chords. Straight boom extensions are available in 10, 20, 30 (3.05m, 6.1m, 9.14m)foot lengths, and may be combined with the basic boom to form an Overall Boom Length of 130 feet (39.6m).

5-2 Lifting Capacity: The lifting capacity of a machine is based upon several factors:

(a) Boom length used.
(b) Load radius.
(c) Number of parts of line used to lift load.
(d) Diameter and type of wire rope used.
(e) On or off outriggers.
(f) Over the side or rear of the carrier. (See Fig. 5-2).
(g) Machine weight and stability.
(h) Some lifts on strength of material.
(i) When lifting on tires - tires must be inflated to pressure on tire charts on carrier.
(j) Amount of counterweight on machine.

Maximum rated capacity is based upon:

(a) Basic boom (50 feet, 15.24m).
(b) Minimum radius.
(c) On outriggers - tires clear of ground.
(d) Twelve parts of specified size and type of rope, on front or rear drum. (See parts book for wire rope size).
(e) Picking over the side or rear. (See Fig. 5-2).
(f) Machine on firm, level supporting surface.
(g) Machine unaltered, in first class working condition, and equipped as when originally shipped from factory.
(h) Correct counterweight installed.

Before making any lifts, consult the capacity chart located in the upper cab. Make sure the load being lifted is within the rated capacity of the machine under the existing conditions. (Boom length, load radius, etc.).

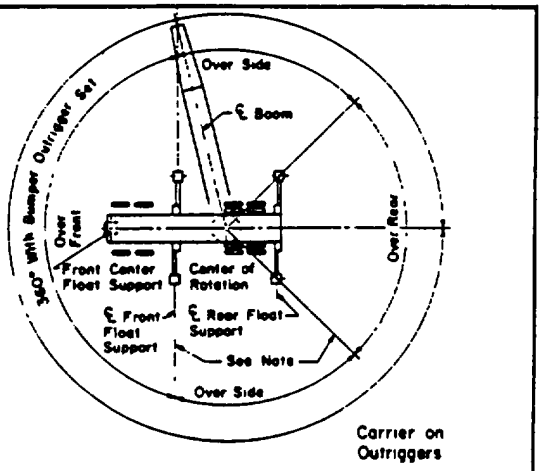
Inspect the boom periodically to make sure it has not been damaged. If a boom or jib section is damaged it must be repaired or replaced before the boom is used. Damaged lattice may be replaced. If a main chord is bent or damaged, the boom section Must Be replaced before making any lifts. See shop manual 9-1-2.0.

5-3 Boom Live Mast

The telescoping boom live mast Must Be Used with all boom lengths. The mast has two positions; a fully retracted (25' 6", 7.7m) position, and a fully extended (30' 0", 9.14m) position. The mast is hydraulically extended, and pins in position. The two positions are used as follows:

(a) The 30' 0" (9.14m) extended position is used for assembling or disassembling the boom, or raising, lowering, or normal crane boom operation. It is also used when using live mast as a short boom.
(b) The 25' 6" (7.7m) position is used when transporting 50 thru 130 feet (15.2 - 39.6m) of boom horizontally over the rear of the carrier, but not for normal crane boom operation.

Note: See page 1-32. "Operating Instructions" for live mast extend and retract instructions.



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

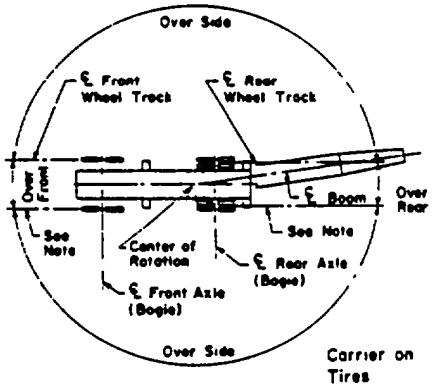


Fig. 5-2 Working Area Definition Label Z629-A

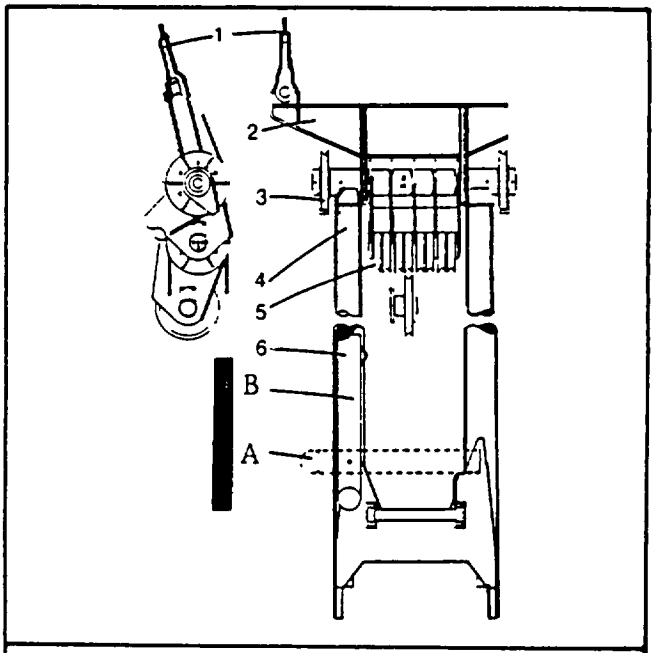


Fig. 5-3 Boom Live Mast N45-D

(A) Position Of Live Mast Backstop Targets When Mast Is Used As A Short Boom.
(B) Position Of Live Mast Backstop Targets For Normal Crane Boom Operation.
(1) Main Pendant
(2) Spreader Bar
(3) Mid-Point Sheave
(4) Mast Tubes
(5) Bridle
(6) Mast Backstop Target

5-4 Using Live Mast As A Short Boom: The live mast may be used as a short boom to remove or replace the main boom, the upper counterweight or the outrigger boxes. The procedure is as follows:

(a) Fully extend the mast to the 30' 0" (9.14m) position as explained in Section 1, "Operating Instructions".
(b) Use 3 parts 7/8" (22.2mm) wire rope for a hoist line. The rope may be on either the front or the rear drum.
(c) The live mast backstop bumper Must Be bolted in the horizontal position (A In Fig. 5-3).
(d) The boom backstops (Fig. 5-4 & 5-6) must be in their supports. The anchor links (6 in Fig. 5-4) must be connected between the backstop standoffs and the boom backstops.
(e) The mast used as a short boom Must Be operated between a Minimum Radius of 10' 0" (3.05m) and a Maximum Radius of 27' 0" (8.2m). A maximum of 60,000 pounds (27,216 kg) may be lifted at a radius between 10' 0" and 19' 0" (3.05m and 5.79m).
(f) Counterweight may be handled as follows:

Carrier	Live Mast Radius	Maximum Counterweight Size
On Tires	10 to 19 ft. (3.05 to 5.79n)	30,000 lbs. (13603 kg)
On Outriggers With All Tires Off The Ground	10 to 19 ft. (3.05 to 5.79m)	60,000 lbs. (27716 kg)
On Outriggers With All Tires Off The Ground	19 to 27 ft. (5.79 to 8.2m)	30,000 lbs. (13608 kg)

5-5 Boom And Mast Foot Assembly

When installing the boom lower section or the live mast on their mounting lugs, the foot pin must be installed with the arrow on the pin head pointing up. This aligns the grease hole in the pin with grease groove in the bushing so the bushing can be lubed with the boom in the air. The pins are retained by a pin driven through the mounting lug and the pin. This pin is retained by a cotter pin at each end.

5-6 Boom Backstops

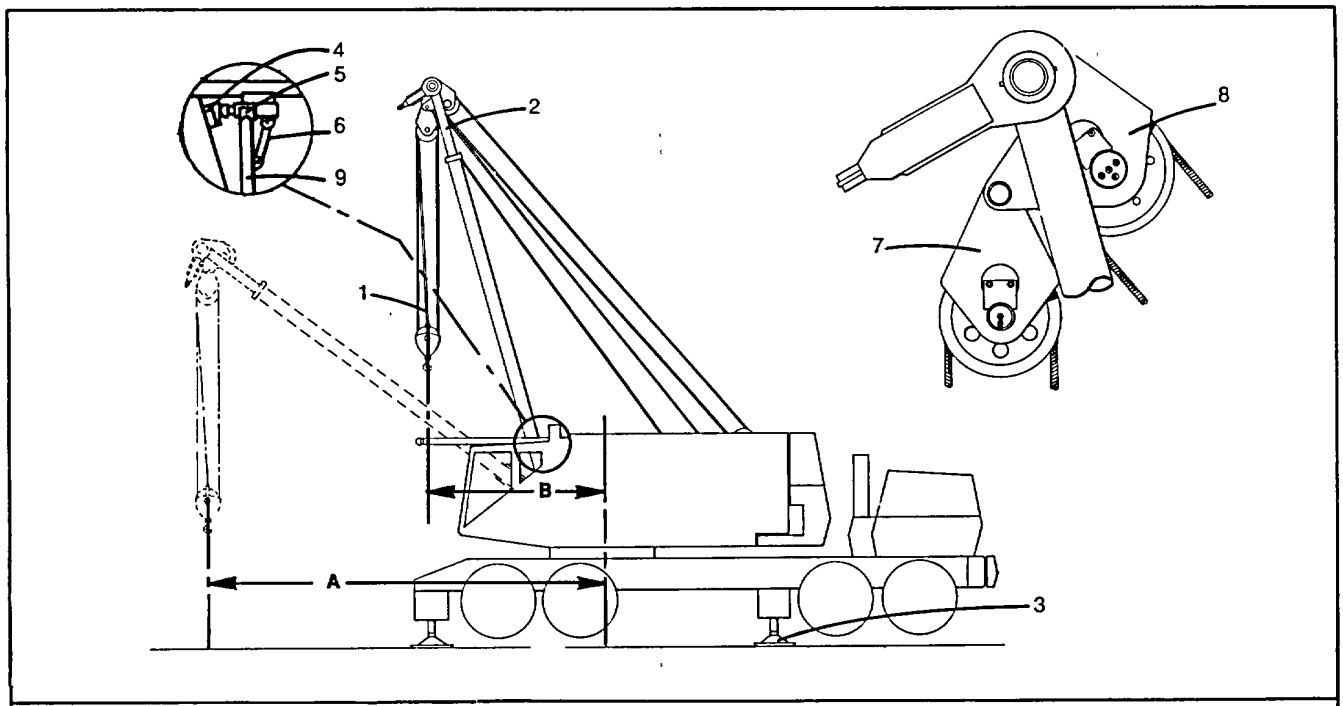


Fig. 5-4 Live Mast Used As A Short Boom

(A) Maximum Radius 27' 0" (8.2m)
(B) Minimum Radius 10' 0" (3.05m),
(1) 3 Parts, 7/8" (22.2mm) or 1" (25.4mm) Rope
(2) Mast Extended (30' 0", 9.14m)
(3) Carrier On Outriggers
(4) Target Horizontal
(5) Boom Backstops In Rest
(6) Link Connected
(7) Hoist Bail
(8) Boom Hoist Bridle
(9) Backstop Standoffs

NA251-B

Two sets of boom backstops are used on the machine. The main boom backstops and the live mast backstops (Fig. 5-6).

The main boom backstops are long tubes with spring loaded bumpers at one end. The other end of each tube is anchored to the gantry headshaft at the rear of the machine. There are a pair of telescoping struts pinned between the boom lower section and the backstop tubes. As the boom is raised, these struts raise the tubes into the air. As the boom nears minimum radius, the spring loaded bumpers on the backstop tubes enter a pair of targets welded to the upper chords of the boom lower section.

When the boom is lowered, the backstops come to rest in a pair of supports which are bolted to the upper revolving frame. The backstop struts telescope (lengthen), to allow the boom to be lowered to the ground after the backstop tubes contact the supports.

The live mast backstops are smaller tubes, welded to the under side of the boom backstop tubes. They also have a spring loaded bumper at one end. These bumpers mate with a target bolted to the live mast (See Fig. 5-3) and are only used when using the live mast as a short boom.

Tie down links (5 in Fig. 5-6) are used to attach the backstop tubes to the supports during transportation, and when using the live mast as a short boom.

CAUTION

Disconnect These Links When Main Boom Is On Machine. If Boom Is Raised With Links Attached, Boom Backstops, Struts, And Boom Lower Section Will Be Damaged.

5-7 Boom Backstop Adjustment: The main boom backstops may be adjusted to properly contact the targets on the boom lower section. This adjustment is made by adding or subtracting spacers on the backstop struts. (7 in Fig. 5-6). The following spacers are available for this adjustment:

(1) 18M951 ..... 1/2" Thick (12.7mm)
(2) 18M952 ..... 3/4" Thick (19.05mm)

To install or remove spacers, proceed as follows:

(a) Boom down until boom is on ground, and pendants are slack.
(b) Unpin the inner strut pipes from the backstops, one at a time, allowing the inner pipes to slide into the outer pipe.
(c) Push the assembly forward and lay it on the boom.
(d) Remove the inner pipe from the outer pipe. Add or subtract spacers as necessary, then replace inner pipe.
(e) Lift assembly until inner pipe may be slid out of outer pipe and connected to backstop.
(f) Connect other inner pipe to backstop tube.
g) Boom up and check adjustment.

5-8 Main Pendants And Links

A 19' 8" (5.99m) long basic pendant is used with all boom lengths, and remains pinned to the bridle spreader bar. On booms 90 feet (27.43m) in length and over a 5 foot (1.52m) pendant is added to the pendant system, and remains pinned to the headshaft links. On booms shorter than 90 feet (27.43m) use of the 5 foot (1.52m) pendants will cause the weight of the live mast to pull the unloaded boom into the backstops when minimum radius is reached and require boom to be pulled away from backstops (by hanging load on hook). When booming down to minimum radius on booms 90 feet (27.43m) and longer, failure to use the 5 foot (1.52m) pendants will reduce effectiveness of live mast and over load boom, mast, pendants, and boom hoist system when handling near capacity loads.

The main pendants connect to a two position link which mounts over the boom headshaft. The links are pinned in the 2'6" (76.2cm) position at all times except when transporting boom horizontally over the rear of the carrier. At this time, the links are pinned in the 4' 0" (121.9cm) position. Additional pendants are available in 10, 20, 30 foot (3.05, 6.1, 9.14) lengths, to match the straight boom extension available.

5-9 Deflector Rollers

The deflector rollers are 3" (76.2mm) diameter rollers, that are mounted in pillow block bearings bolted to the top of the boom. They are used to guide the hoist rope over the top of the boom. The number and location of rollers required will vary with the boom length being used. (See Fig. 5-9).

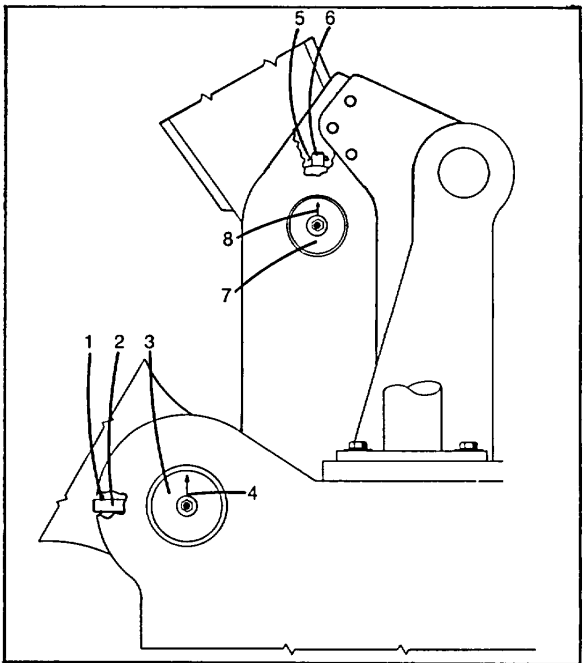


Fig. 5-5 Boom and Mast Foot Assemblies N47-D

(1) Cotter Pin
(2) Pin
(3) Boom Foot Pin
(4) Arrow
(5) Cotter Pin
(6) Pin
(7) Mast Foot Pin
(8) Arrow

Note: Assemble pins with arrow pointing up.

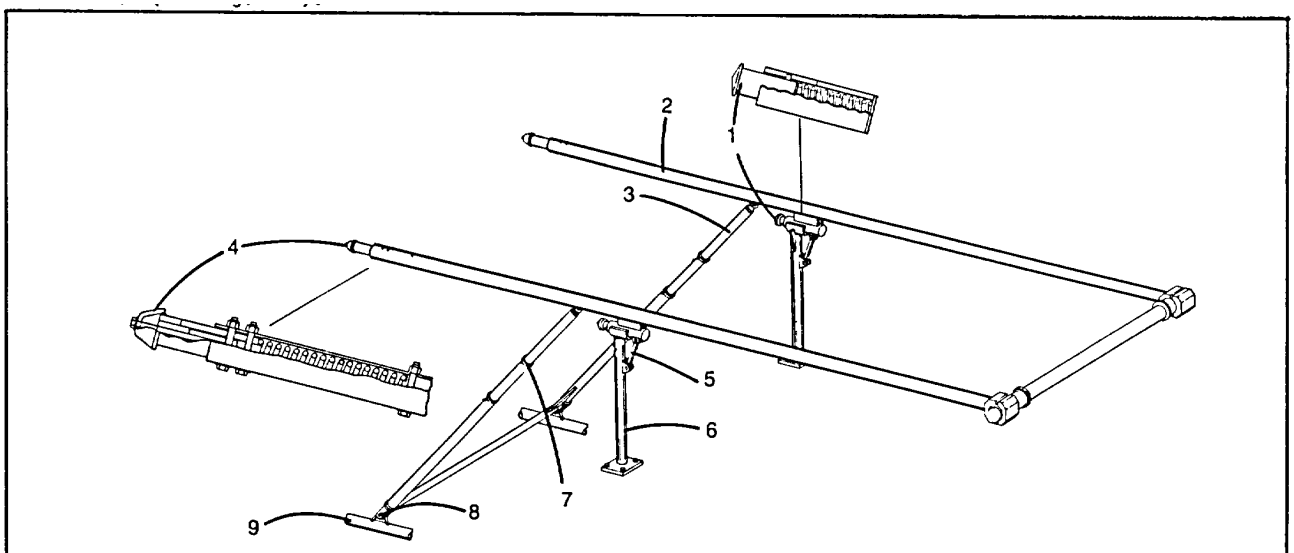
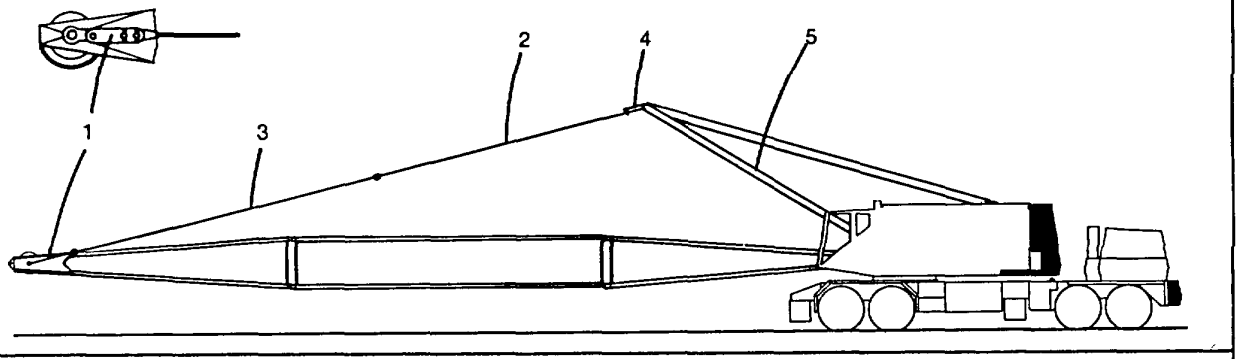


Fig. 5-6 Boom Backstop Assemblies N50-D

(1) Live Mast Backstops
(2) Main Boom Backstops
(3) Struts
(4) Bumpers
(5) Tie Down Links
(6) Backstop Supports
(7) Spacers
(8) Pin
(9) Boom Lower Section



NA243-D

Fig. 5-7 Main Pendants and Links (70 Ft. - 21.3m Boom Shown)

(1) Two Position Link (2'6" Position) (76.2cm)
(2) 19'8" Basic Pendant (Req'd All Booms (5.99m)
(3) 20 Foot (6.10m) Pendant
(4) 25 Inch (63.5cm) Spreader Bar
(5) 30'0" (9.14m) Mast (Req'd All Boom Lengths)

Note: On booms 90 feet (27.43m) and over, a 5 foot (1.52m) pendant is used in addition to the 19'8" (5.99m) basic pendant. The 5 foot (1.52m) pendant connects to the headshaft links.

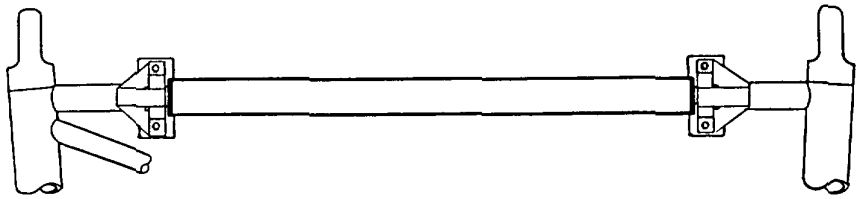
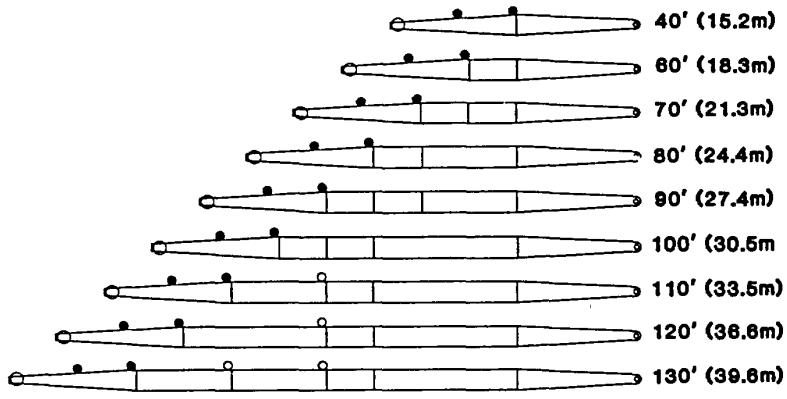


Fig. 5-8 Deflector Roller Assembly N71-A



N69-D

Fig. 5-9 Deflector Roller Location

○ Roller required when using front drum for hoist
● Roller required under all circumstances.

5-10 Assembly of crane booms 50 to 110 feet (1524- 33.5m) in length.

Note: "A" bumper ctwt. required on carrier.

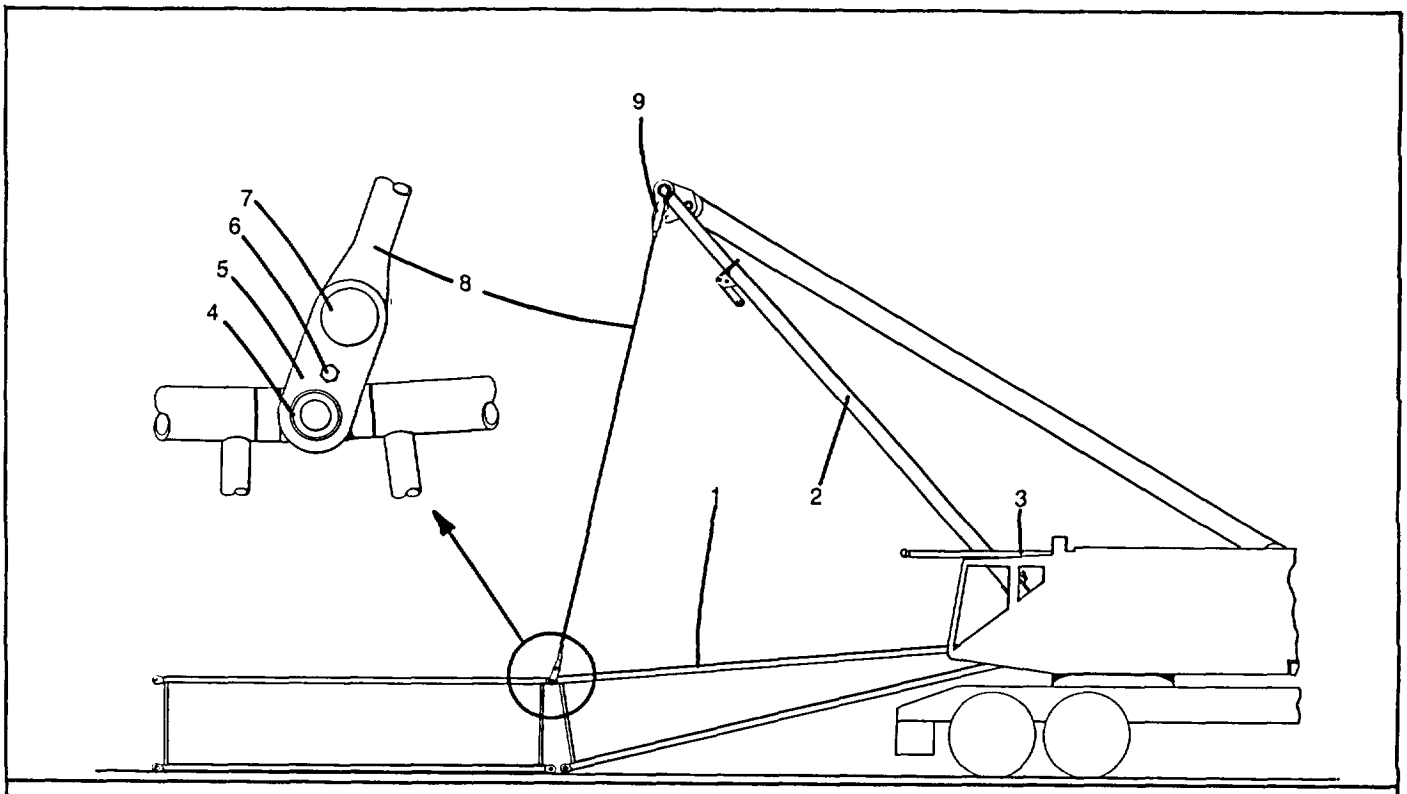


Fig. 5-10 Boom Assembly - Step 1 NA252-D

(1) Boom Lower Section
(2) Live Mast (Extended 30', 9.14m Position)
(3) Boom Backstops (Tie Down Link Unpinned)
(4) Upper Pin Connection Hub
(5) Boom Assembly Link
(6) Capscrew, Spacer, Lockwasher, Hex Nut
(7) Pendant Pin & Cotter Pin
(8) 19'8" (5.99m) Pendant (Used In Pairs)
(9) Bridle Spreader Bar

5-11 Boom Assembly Step 1: Reeve live mast as a short boom (See Fig. 5-4). Use the short boom to install the boom lower section on the machine.

Reposition the live mast backstop target (Fig. 5-3) to the vertical position. Unpin the backstop tie down links (Fig. 5-4). Install the backstop struts (Fig. 5-7) between the boom lower section and the backstop tubes.

Install the assembly links over the pin connection hubs at the end of the boom lower section. Install the spacer, capscrew, hex nut, and lockwasher, which hold links together.

Connect a 19'8" (5.99m) basic pendant pair to these links. Connect the other ends of these pendants to the bridle spreader bar. (See Figs. 5-3 and 5-10).

Note: All boom assembly and disassembly must be done with the upper swung to face directly over the rear of the carrier.

WARNING

Don't Get Under Any Part Of The Boom, Especially When Boom Sections Are Being Raised, Lowered, Or Positioned.

5-12 Boom Assembly Step 2: A maximum of 85 feet (25.9m) of boom, including the upper section may be cantilevered (extended beyond point of suspension) with pendants connected as shown in Fig. 5-11. Any boom length from 50 to 110 feet (15.24-33.5m) may be assembled by varying the length of boom added to the lower section. The following points Must Be noted before proceeding:

(1) Whenever possible, assemble boom with short sections close to the boom foot. Two short sections will weigh more per equivalent length than one long section, so keeping short sections close to boom foot will improve machine stability.

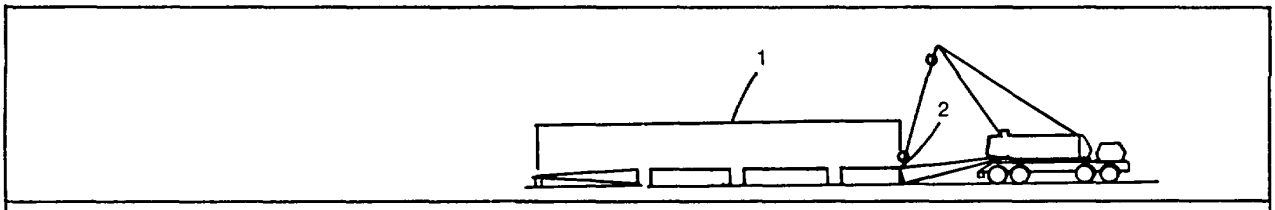


Fig. 5-11 Boom Assembly - Step 2

(1) 85' (25.9m) Maximum Additional Boom (2) Top Boom Pins

(b) All boom assembly must be done with the upper swung to face directly over the rear of the carrier.

Proceed to add on a maximum of 85 feet (25.9m) of boom, including the upper section as follows:

(a) Line up the two upper pin connection holes between the two sections being pinned together. Insert the two top boom pins. Install keeper pins in each boom pin.

(b) Boom up until the boom pin holes line up. Install the two bottom boom pins. Install a keeper pin in each connecting pin.

(c) Repeat steps a and b above until desired boom length (maximum 110 feet, 33.5m) is reached.

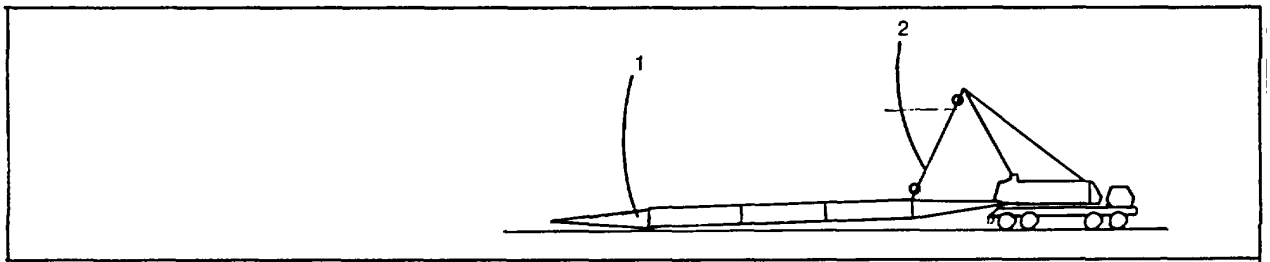


Fig. 5-12 Boom Assembly - Step 3

(1) Boom Resting On Ground (2) Pendant Connected To Assembly Links

5-13 Boom Assembly - Step 3: Boom down until boom peak is-resting on ground. Continue to boom down until pendants are slack.

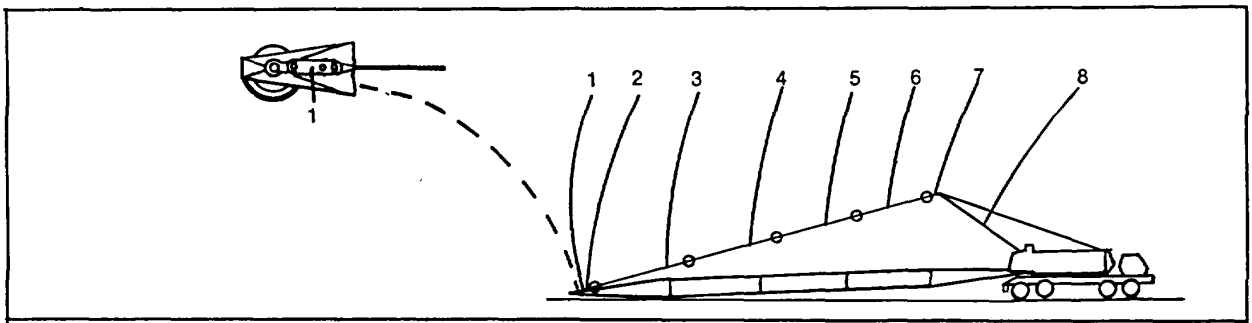


Fig. 5-13 Boom Assembly - Step 4 (110 Foot, 33.53m Boom Shown) N142-A

(1) 2 Position Headshaft Link (2'6", 76.2cm Position)
(2) 5' (1.52m) Basic Pendant (Req'd 90', 27.4m Booms & Over)
(3) 20' Pendant (6.1m)
(4) 20 Pendant (6.1m)
(5) 20' Pendant (6.1m)
(6) 19'8" Basic Pendant (5.99m)
(7) 25" (63.5cm) Spreader Bar
(8) Live Mast (Fully Extended)

5-14 Boom Assembly Step 4: Assemble the necessary lengths of main pendants to connect between the headshaft link and the bridle spreader bar.: Use the 19'8" (5.99m) basic pendants in all boom make-ups. They remain connected to the bridle spreader bar. On booms 90 feet (27.43m) in length and over, a pair of 5 foot (1.52m) pendants are also used. These pendants remain connected to the headshaft links. Refer to Chart A for proper pendant length per boom

length. Install a cotter pin in each pendant pin.

CHART A

Boom Length		
Ft.	M	Pendant Length Required
50	15.24	19'8" (5.99m) Basic
60	18.29	Basic + 10' (3.05m)
70	21.34	Basic + 20' (6.10m)
80	24.38	Basic + 30' (9.14m)
90	27.43	Basic + 40' (12.19m) + 5' (1.52m)
100	30.48	Basic + 50' (15.24m) + 5' (1.52m)
110	33.53	Basic + 60' (18.29m) + 5' (1.52m)
120	36.58	Basic + 70' (21.34m) + 5' (1.52m)
130	39.62	Basic + 80' (28.38m) + 5' (1.52m)
* Mid point suspension required.		

CAUTION

Always Use Correct Pendant Lengths. Use Of Incorrect Pendant Lengths Can Cause Boom Or Boom Suspension Failure.

5-15 Assembly Of Crane Boom 120 to 130 (36.5m to 39.6m) Feet In Length

5-16 Boom Assembly Step 1: Reeve the live mast as a short boom (See Fig. 5-4). Use the short boom to install the boom lower section on the machine.

Reposition the live mast backstop target (Fig. 5-3) to the vertical position. Unpin the backstop tie down links (Fig. 5-4). Install the backstop struts (Fig. 5-6) between the boom lower section and the backstop tubes.

Install the assembly links over the pin connection hubs at the end of the boom lower section. Install the spacer, capscrew, hex nut, and lockwasher, which holds links together. Connect a 19'8" (5.99m) basic pendant pair to these links. Connect the other ends of these pendants to the bridle spreader bar. See Figs. 5-3 and 5-4.

The following points Must Be noted before proceeding:

(a) Whenever possible, assemble boom with short sections close to the boom foot. Two short

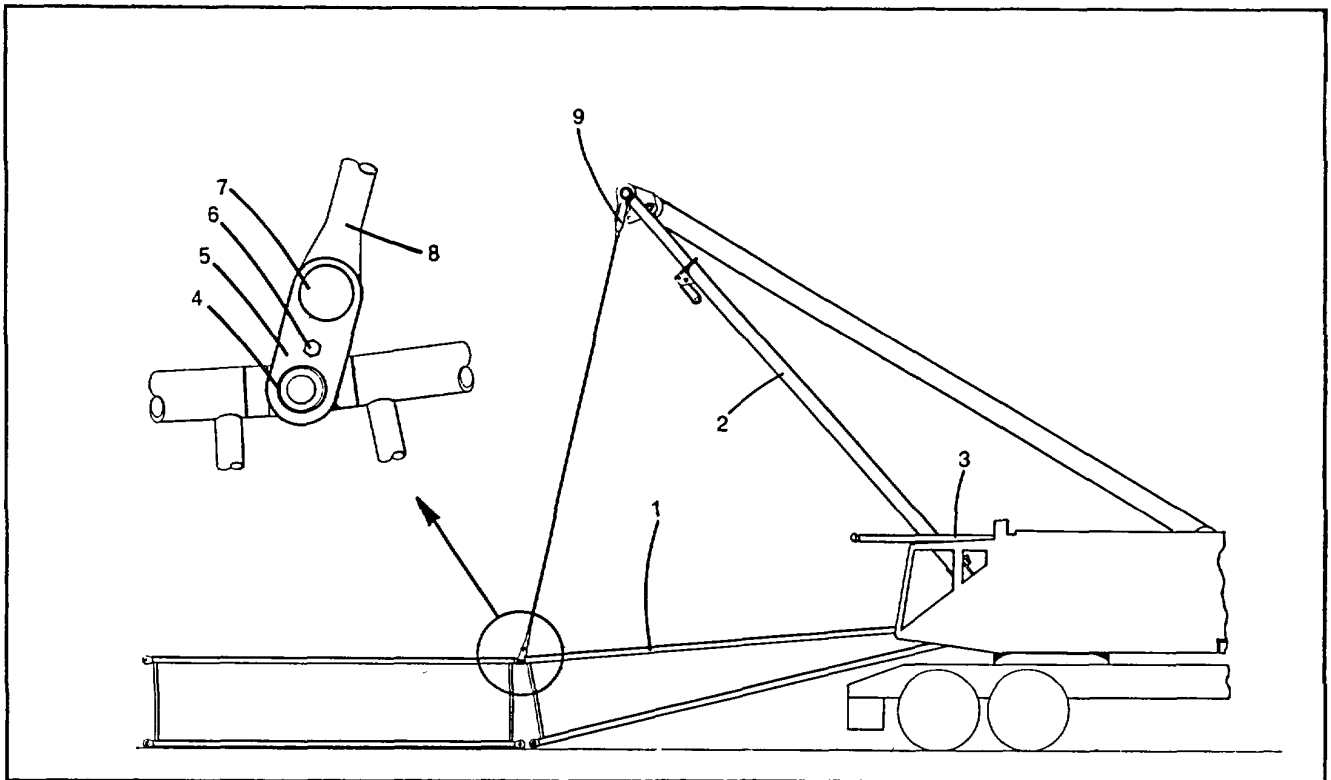


Fig. 5-14 Boom Assembly - Step 1 NA252-D

(1) Boom Lower Section
(2) Live Mast (Extended 30',9.14m, Position)
(3) Boom Backstops (Tie Down Link Disconnected)
(4) Upper Pin Connection Link
(5) Boom Assembly Link
(6) Capscrew, Spacer, Lock-washer, Hex. Nut
(7) Pendant Pin & Cotter Pin
(8) 19'8" Pendant (5.99m), Use a pair.
(9) Bridle Spreader Bar

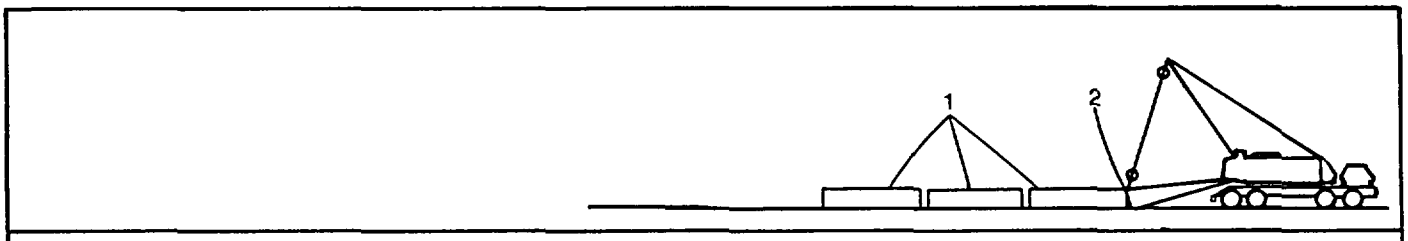


Fig. 5-15 Boom Assembly - Step 2

(1) 60' (18.92m) Additional Boom
(2) Top Boom Pins

sections weigh more per equivalent length than one long section, so keeping short sections close to boom foot will improve machine stability.

(b) All boom assembly must be done with the upper swung to face directly over the rear of the carrier.

WARNING
Do Not Get Under Any Part Of Boom, Especially While Boom Sections Are Being Raised, Lowered, Or Positioned.

5-17 Boom Assembly Step 2: Add on 60 feet (18.29m) of additional boom. (See Fig. 5-15). This will leave a boom connection at the 85 foot (25.9m) point for installation of the assembly links. The boom extensions are added on as follows:

(a) Line up two upper pin connection holes between the two sections being pinned together. Insert the two top boom pins. Install keeper pins in each boom pin.

(b) Boom up until the bottom boom pin holes line up. Install the two bottom boom pins. Install a keeper pin in each connection pin.

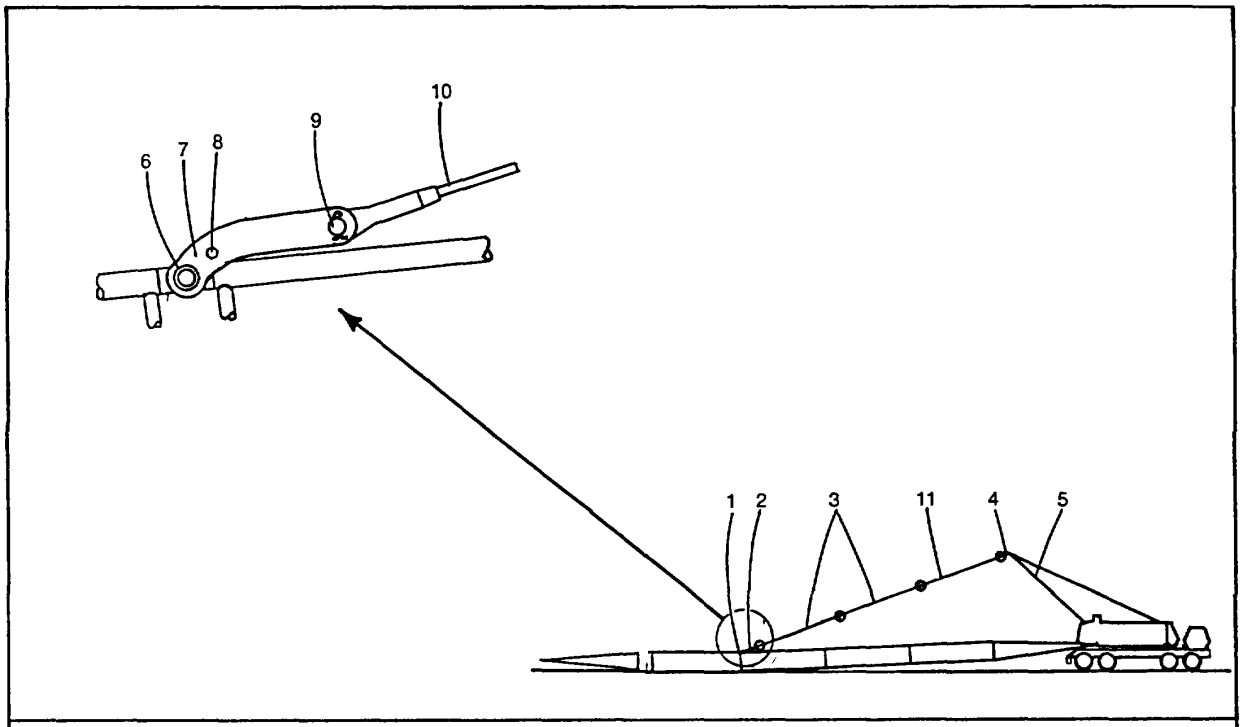


Fig. 5-16 Boom Assembly - Step 3

(1) 85 Foot Point (25.9m)
(2) Assembly Links
(3) 20 Foot Pendants (6.1m)
(4) 25" Spreader Bar (63.5cm)
(5) Live Mast (Extended 30'0" 9.14m, Position)
(6) Upper Pin Connection Lug
(7) Mid-Point Links
(8) Spacer, Capscrew, Washer, Hex Nut
(9) Pendant Pin & Cotter Pin
(10) Main Pendant
(11) 19'8"(5.99m) Basic Pendant

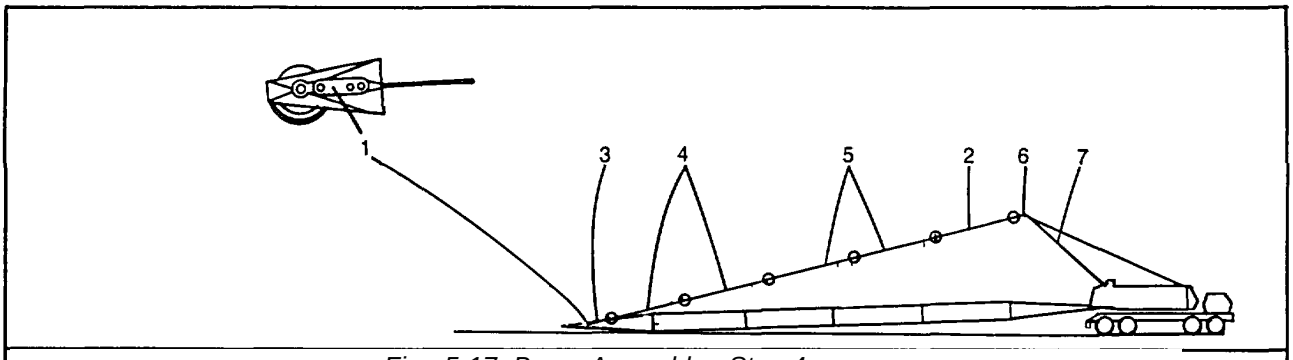


Fig. 5-17 Boom Assembly - Step 4

(1) Two Position Headshaft Link (2'6", 76.2cm, Position)
(2) 19'8" (5.99m) Basic Pendant Pair
(3) 5' (1.52m) Pendant Pair (Must Be Used On All Booms 90 Feet (27.32m and Longer)
(4) 20' Pendants (6.10m)
(5) 20' (6.10m) Pendants
(6) 25" (63.5cm) Bridle Spreader Bar
(7) Live Mast (Fully Extended (30'0", 9.14m)

(c) Repeat steps a and b above until 60 feet (18.29m) of additional boom is connected to the boom lower section.

5-18 Boom Assembly Step 3: Boom down until the 19'8" (5.99m) pendants are slack. Disconnect the pendants from the assembly links. Assemble two more 20 foot (6.10m) pendant pairs to the 19'8" (5.99m) pendant pair already connected to the bridle spreader bar. (Total pendant length must be 59'8", (18.1m). Insert cotter pin in each pendant pin. (See Fig. 5-16), Install the assembly links over the top pin connection hubs at a point 85 feet (25.9m) from the boom foot. (See Fig. 5-16). Install the spacer, capscrew, lockwasher, and hex nut, which holds the two link halves together. Pin the main pendants to these links. Insert a cotter pin in each end of link pin.

A maximum 45 feet (13.7m) of boom including the upper section, may be added on from the 85 foot (25.9m) point, for a total maximum boom length of 130 feet (39.6m). Booms from 120 to 130 feet (36.5 to 39.6m) in length may be assembled by varying the length of boom added on. The boom extensions are installed as follows:

(a) Line up the two upper pin connecting holes between the two sections being pinned together. Insert the two top boom pins. Install keeper pins in each boom pin.
(b) Boom up until the bottom boom pin holes line up. Install the two bottom boom pins. Install a keeper pin in each connection.
(c) Repeat steps a and b above until a maximum of 45 feet (13.7m) of additional boom is connected to the 85 foot (25.9m) point.
(d) To install peak, install upper pins, then raise until lower pins can be installed. Don't lift peak off the ground or damage to boom may occur.

5-19 Boom Assembly Step 4: Boom down until pendants are slack. Disconnect pendants from assembly links. Assemble the necessary length of main pendants to connect between the headshaft links and bridle spreader bar. Install a cotter pin in each pendant pin. Refer to Chart A earlier in this section for pendant length per given boom length.

Note: <u>Headshaft link must be connected in 2'6" (76.2cm)position.</u>

5-20 Inline Pin Tubular Boom Disassembly

(a) Boom down until the boom peak is resting on ground and main pendants are slack.
(b) Install assembly links at 85' (25.9m) point. They must be used to disassemble 120 to 130 (36.58-39.6m) foot long booms.
(c) Booms 120 to 130 feet (36.58-39.6m) in length:
  (1) Remove all but 59'8" (18.1m) of main pendants. Leave the 59'8" (18.1m) lengths of main pendants connected to the bridle spreader bar.
  (2) Connect the other end of these pendants to the assembly links. (A in Fig. 5-18).
  (3) Boom up until center line of boom is straight and pendants are tight. Boom Peak Must Be Resting On Ground,
  (4) Remove the bottom pins only at or ahead of point E. Removing pins behind E, (behind point of suspension) will cause boom to fall.
  (5) Boom down until the boom sections ahead of point (E) are flat on the ground.
  (6) Disassemble the boom sections ahead of point (E).
  (7) To remove boom sections ahead of point (E) follow the procedure below.
(d) Booms 110 feet (33.5m) in length or less:
  (1) Boom down until the boom peak or end boom section is resting on the ground, and the main pendants are slack.
  (2) Disconnect the main pendants.
  3) Remove all main pendants except the 19' 8" (5.99m) basic pendant pair. This pendant pair must be connected to the bridle spreader bar.
  (4) Connect the other ends of the 19'8" (5.99m) basic pendant pair to the boom assembly links (B) at the end of boom

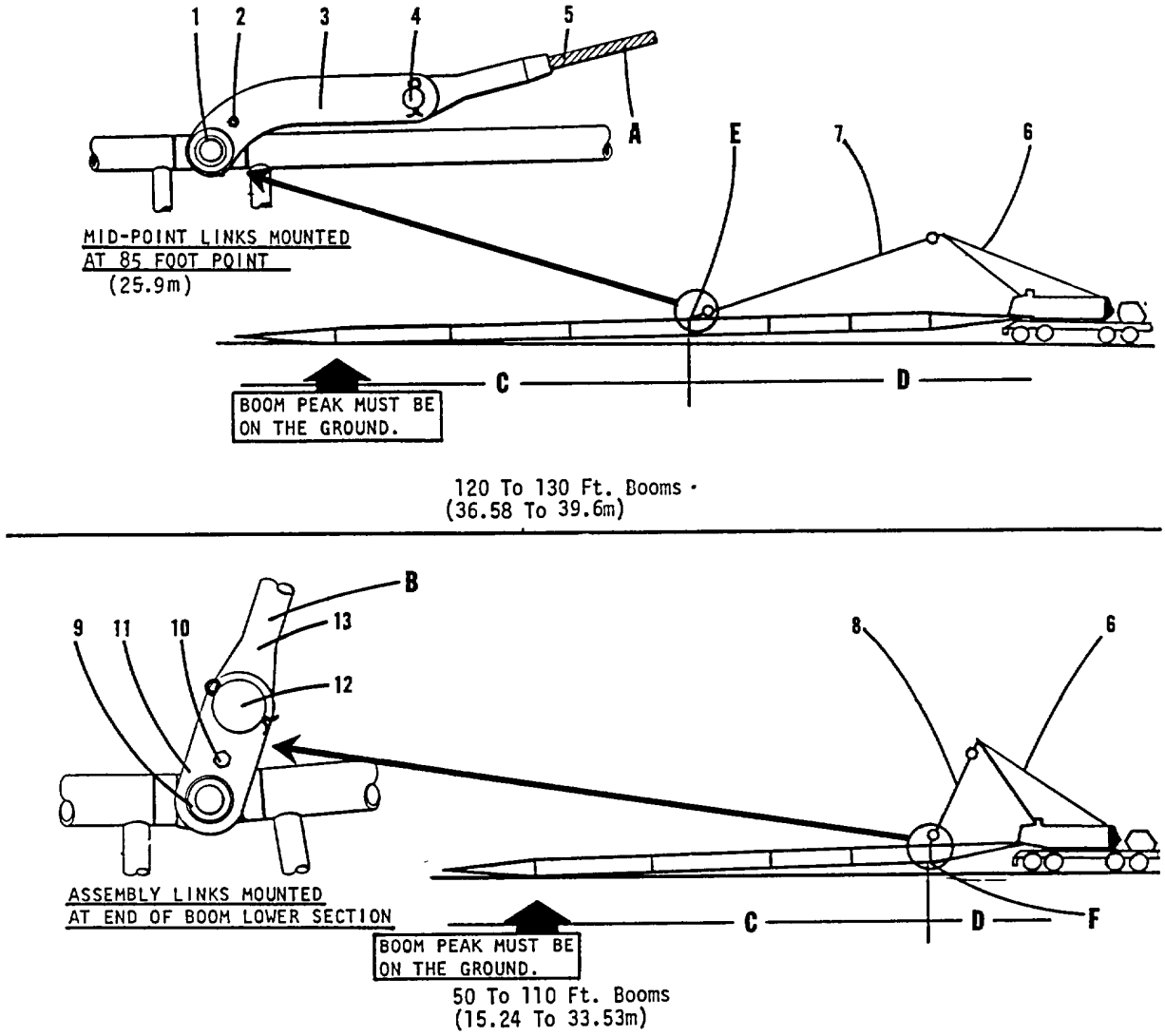


Fig. 5-18 Inline Pin Tubular Boom Disassembly NA252-D

Note: All boom disassembly must be done with upper facing directly over rear of carrier.

(A) 59'8" (18.1m) Of Main Pendants Connected To Mid-Point Links At 85 Foot (25.9m) Point
(B) 19'8" (5.99m) Basic Pendant Connected To End Of Boom Lower Section
(C) Ahead Of Suspension Point
(D) Behind Suspension Point
(E) 85 Foot (25.9m) Point
(F) End Of Boom Lower Section

(1) Pin Connection Hub
(2) Capscrew, Spacer, Nut
(3) Assembly Links
(4) Pin & Cotter Pins
(5) Main Pendants
(6) Live Mast (Fully Extended)
(7) 59'8" (18.1m) Main Pendants
(8) 19'8" (5.99m) Pendant Pair
(9) Pin Connection Hub
(10) Capscrew, Spacer, Nut
(11) Assembly Links
(12) Pin & Cotter Pins
(13) Main Pendants

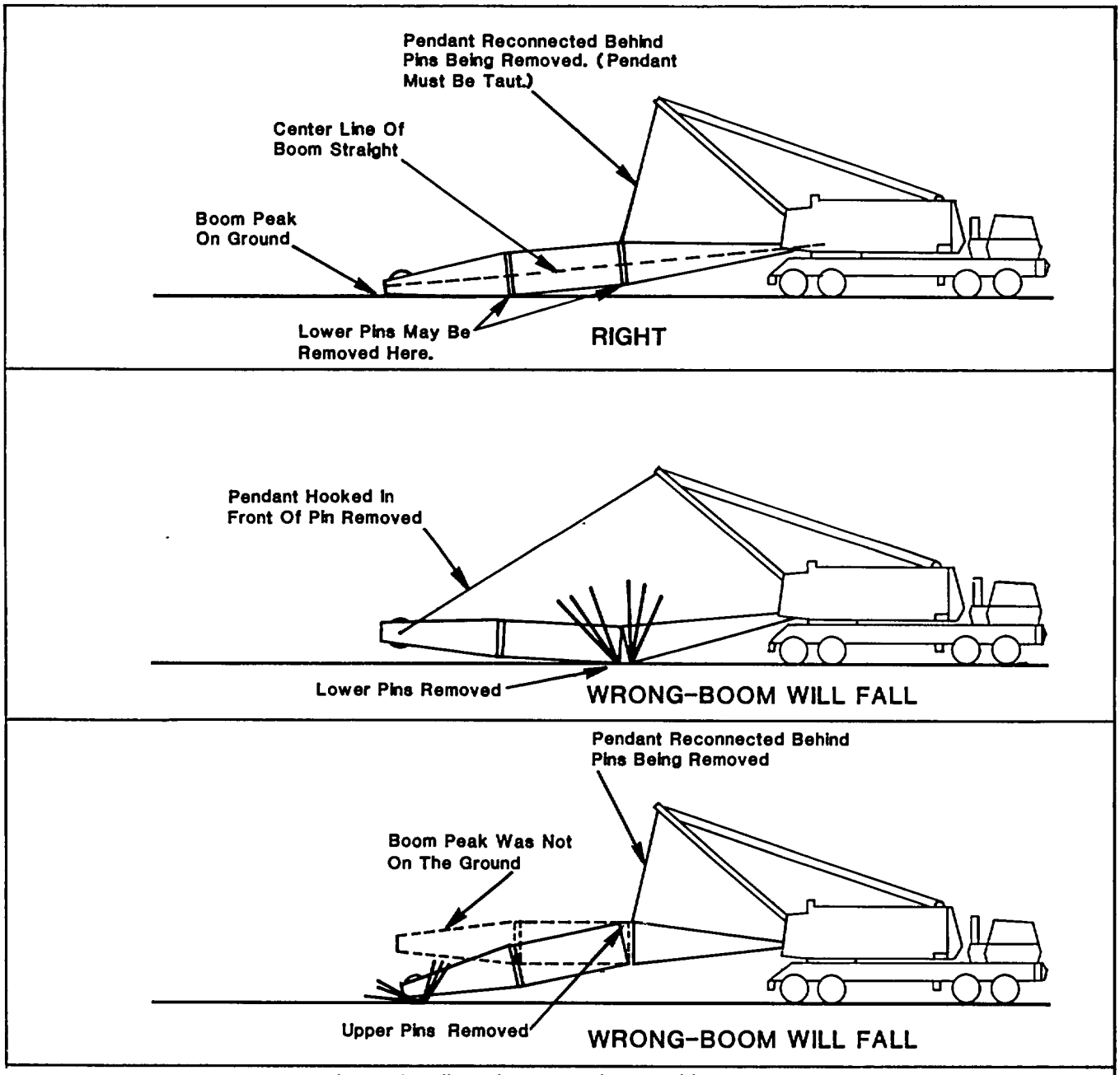


Fig. 5-19 Inline Pin Boom Disassembly NA253-A

WARNING

Incorrect Disassembly Of A Pin Connected Boom May Result In Machine Damage, Personal Injury, Or Even Death. Before Disassembling Boom, Read And Be Sure You Understand Fig. 5-19, And The Disassembly Procedure On The Preceeding Pages. As An Alternate Disassembly Procedure, Block Tightly Under The Pin Connection Before Removing Pins. Never Stand Under A Boom When Removing Pins.

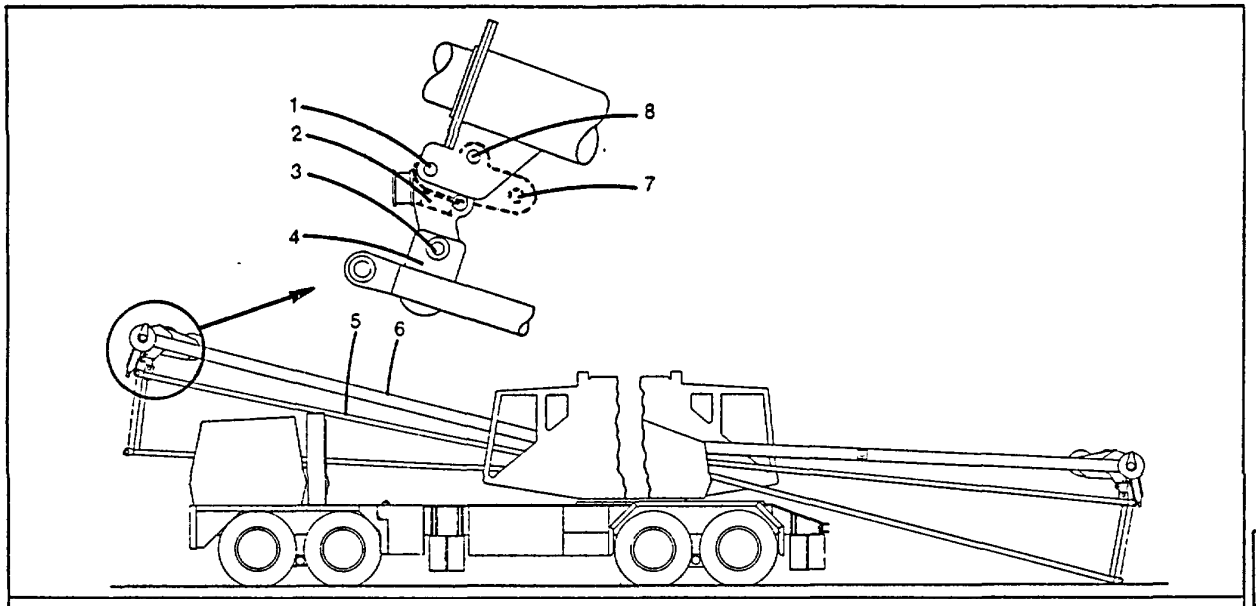


Fig. 5-20 Carrying Link Assembly NA241-D,NA242-B

(1) Pin And Cotter Pin
(2) Carrying Link
(3) Pin And Cotter Pin
(4) Lug
(5) Boom Lower Section
(6) Live Mast (25'6", 7.8m Position)
(7) Raised Position (Of Link)
(8) Pin And Cotter Pin

lower section.

(5) Boom up until center line of boom is straight and pendants are tight. Boom Peak Must Be Resting On Ground.
(6) Remove the lower pins only at end of boom lower section.
(7) Boom down until the boom sections ahead of (F) are flat on the ground.
(8) Disassemble the boom sections ahead of point (F).

(e) The boom lower section may be removed by using the live mast reeved as a short boom as explained earlier in this section.

5-21 Carrying Link Assembly

The boom lower section only may be transported at a reduced overall height by attaching it to the boom live mast with the carrying links as follows:

5-22 Chart B

Maximum Travel Speed With Base Section Over The Front Of The Carrier.	
W/"A" Upper Ctwt. W/"A" Bumper Ctwt.	5 MPH (8.04 kph)
W/"A" Upper Ctwt. W/O "A" Bumper Ctwt.	20 MPH (32.2 kph)
W/O Upper Ctwt. W/O Bumper Ctwt.	40 MPH (64.3 kph)

(a) Remove all boom but the lower section as explained under "Disassembly Of Inline Pin Connected Boom", earlier in this section.
(b) Retract mast to 25'6" (7.77m) length as explained on page 1-32. Remove the pin which holds the carrying links in the raised position, allowing them to swing free.
(c) Lower the mast until the links may be pinned to the lugs on the boom lower section.
(d) Boom up until the lower section will clear the boom cradle. Swing the boom around over the front of the machine.
(e) Engage the swing lock. Do not raise boom higher than necessary to clear cradle as damage to-the base section may result.
(f) Counterweight machine for travel per Chart B.
(g) Overall travel height is 14' 9-1/2" (4.5m).

CAUTION
Do Not Allow Boom To Rest On Cradle Or It May Be Damaged. Lower Section Only May Be Carried With These Links.

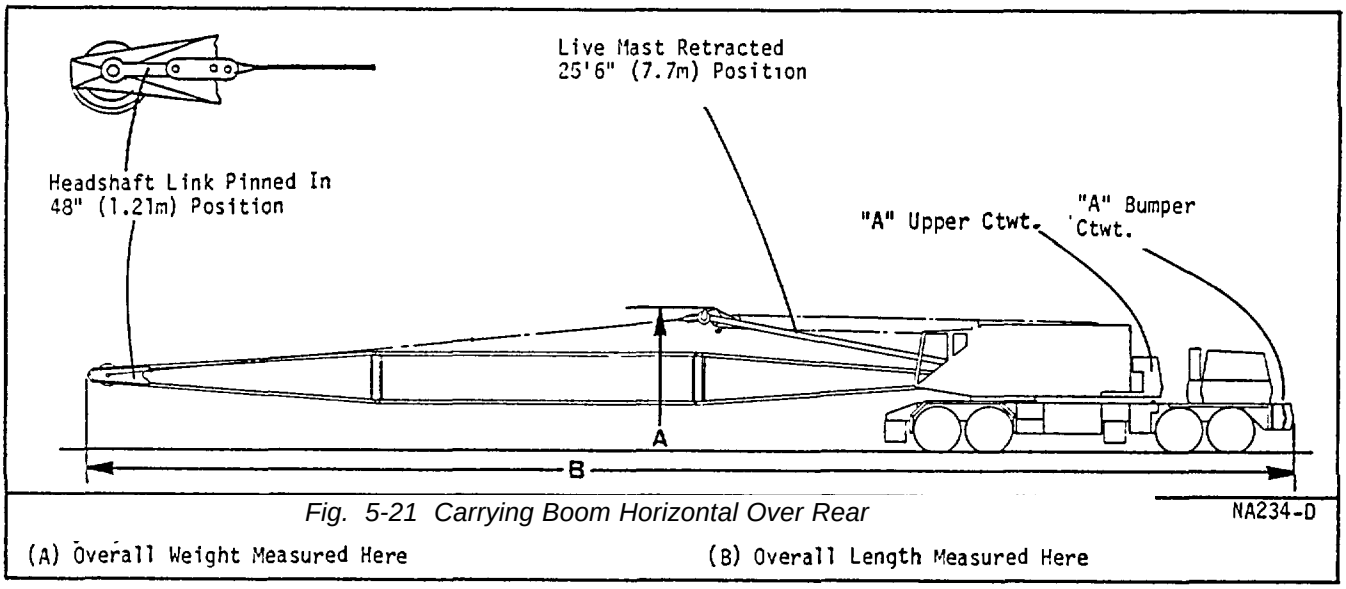


Fig. 5-21 Carrying Boom Horizontal Over Rear

Chart C

W/"A" Upper Counterweight; W/"A" or "A" Bumper Counterweight, W/140 Ton Hook Block At Headshaft

Boom Length Ft.	Overall Travel * Height (Boom Horiz)	Travel Length And Speed (Boom Horizontal) **	
		A Bumper Ctwt.	No. Ctwt.
50' (15.24m)	12' 3-1/4" (3.74m)	81' 8" (24.9m) 5 MPH (8 kph)	40 MPH 64.3 kph
60' (18.29m)	12' 8-1/2" (3.89m)	91' 8" (27.9m) 20 MPH (32.1 kph)	20 MPH 32.1 kph
70' (21.34m)	13' 0" (3.90m)	101' 8" (30.9m) 5 MPH (8 kph)	
80' (24.3m)	13' 2-3/4" (4.03m)	111' 8" (34m) 5 MPH (8 kph)	
90' ** (27.43m)	13' 4-3/4" (4.08m)	121' 8" (37m) 5 MPH (8 kph)	
100' ** (30.48m)	13' 6-1/4" (4.12m)	131' 8" (40m) 5 MPH (8 kph)	
110' ** (33.53m)	13' 7-1/2" (4.15m)	141' 8" (43.1m) 5 MPH (8 kph)	
120' ** (36.58m)	13' 8-1/2" (417m)	151' 8" (46.2m) 5 MPH (8 kph)	
130' ** (39.62m)	13' 9-1/4" (4.19m)	161' 8" (49.2m) 5 MPH (8 kph)	

* Centerline Of Boom Horizontal

** 5' (1.52m) Pendant Pair Removed For Travel Only. Must Be Installed For All Load Lifting Conditions.

CAUTION

Travel With Horizontal Boom Can Create Traffic Hazards. In Addition It May Be Necessary To Have An Operator In Crane Cab To Swing Upper And Boom For Proper Clearance When Traveling. Local Codes And Regulations Should Be Checked To See If Such Operation Is Permissible.

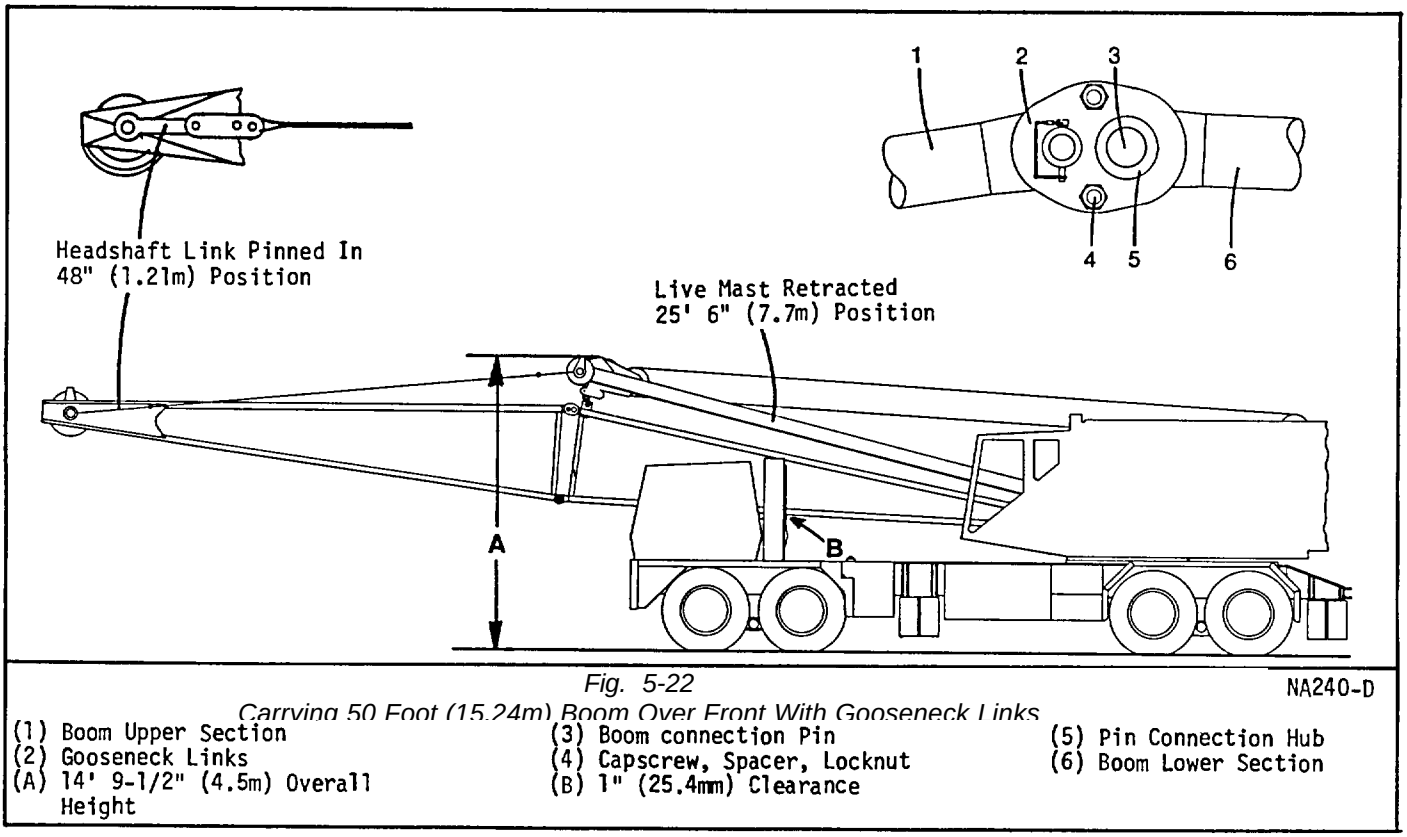


Fig. 5-22 NA240-D

Carrying 50 Foot (15.24m) Boom Over Front With Gooseneck Links

(1) Boom Upper Section
(2) Gooseneck Links
(A) 14' 9-1/2" (4.5m) Overall Height
(3) Boom connection Pin
(4) Capscrew, Spacer, Locknut
(B) 1" (25.4mm) Clearance
(5) Pin Connection Hub
(6) Boom Lower Section

5-23 Disconnecting Links:

(a) Disengage swing lock. Swing upper until boom is over rear of carrier.
(b) Boom down until boom lower section just contacts ground, with boom hoist ropes still taut.
(c) Remove pins which connect links to lower section lugs.
(d) Pin links in raised position as shown above.
(e) Lower mast to rest on boom base lugs and allow boom hoist ropes to slack.
(f) Extend mast and pin. Assemble desired boom length on machine as explained earlier in this section.

5-24 Carrying Booms Horizontally Over Rear Of Carrier

Booms of 130 feet (39.62m) and less may be suspended over the rear of the carrier for transportation purposes. The pendants are hooked to the headshaft links in the normal manner, except that the links must be pinned in the 48" (1.21m) position.

To transport the boom, proceed as follows:

(a) Lower boom to the ground.
(b) Retract the live mast to the 25' 6" (7.8m) position as explained on page 1-32.
(c) Pin the two position headshaft link in the extended 48" (1.21m) position.
(d) On 90 through 110 foot booms only, boom down until the pendants are slack, remove the 5 foot (1.52m) pendant pair, and rehook the main pendants to the headshaft link. This reduces overall travel height.

Note: The 5 foot (1.52m) basic pendant pair must be installed in the pendant system before making any lifts.

(e) Boom up until boom is horizontal.
(f) Engage swing lock before roading.

Note: Boom live mast must be fully extended, and the headshaft links pinned in the 76" (76.2cm)position before raising boom -to working position, and making lifts with the boom.

5-25 Carrying 50 Foot (15.24m) Boom Over Front With Gooseneck Links

The 50 foot (15.24m) basic boom may be carried over the front of the carrier at a reduced overall height by installing gooseneck links at the top pin connections between the upper

and lower boom sections. To install the links, proceed as follows:

(a) Break the boom down to the basic 50 foot (15.24m) boom with 30' (9.14m) mast position.
(b) Counterweight machine for travel per Chart D.
(c) Remove the pin which holds the carrying links in the raised position allowing them to swing free.
(d) Lower the mast until the links may be pinned to the lugs on the lower section.
(e) Boom up until the boom hoist ropes are taut with the boom peak still touching the ground.
(f) Remove the two upper pins only. Boom up until the pin connecting holes are 3-1/4" (82.5mm) apart, center of hole to center of hole.
(g) Install the gooseneck links over the pin connecting hub on the boom lower section. Install two bolt, spacer and locknuts between each pair of links to hold them in place.
(h) Install the boom connection pin through the links, and the pin connection hole in the boom upper section. Insert a keeper pin in each boom connection pin.
(f) Pin the headshaft links in the 48" (1.21m) position. Connect the 19'8" (5.99m) basic pendants between the headshaft links and the bridle spreader bar.
(j) Disconnect the carrying links. Pin links in storage position.
(k) Boom up and swing around until boom is over front of machine. Rest boom on boom guide bar.
(l) Retract mast to 25'6" (7.8m) position as explained on page 1-32.
(m) Position boom one inch above guide bar for travel.

Chart D

Maximum Travel Speed With 50 Foot (15.24m) Boom Over Front Of Carrier	
W/"A" Upper Ctwt. W/"A" Bumper Ctwt. W/140 Ton Hook Block	5 MPH (8.04 kph)
W/"A" Upper Ctwt. W/0 "A" Bumper Ctwt. W/140 Ton Hook Block	5 MPH (8.04 kph)
W/O Upper Ctwt. W/O Bumper Ctwt. W/140 Ton Hook Block	20 MPH (32.2 kph)

5-26 Removing Gooseneck Links:

(a) Extend mast to 30'0" (9.14m) position as explained on page 1-32.
(b) Swing boom around over rear of machine. Boom down until boom peak is on ground and pendants are slack.
(c) Unpin carrying links and allow them to drop down.
(d) Boom down until the carrying links may be attached to the boom lugs.
(e) Boom up until boom hoist ropes are taut, But With Boom Peak Resting On The Ground.
(f) Remove the boom connecting pins from the gooseneck links. Remove the gooseneck links from the boom pin connection hubs.
(g) Lower mast until boom pin connection holes line up. Insert boom pins. Insert keeper pins in boom pins.
(h) Disconnect carrying links, and pin in stored position.
(i) Pin headshaft links in 2'6" (76.2cm) position.
(j) Assemble desired length of boom on machine as explained earlier in this section.

Chart E

Tubular Boom And Boom/Jib Machine Can Travel At 1 MPH (1.6 kph) at 80° Boom Angle		
	Boom	Boom/Jib
With "A" Upper Ctwt.	50' (15.2m)	50' + 30' (15.2m + 9.14m)
With "A" Bumper Ctwt.	180' (54.86m)	180' + 60' (54.86m + 18.29m)
With "A" Upper Ctwt.	190' (57.91m)	190' + 30' (57.91m + 9.14m)
With "A" Bumper Ctwt.	230' (70.1m)	200' + 60' (60.9m + 18.29m)

5-27 Travel On Tires (Job Site Moves Only)

This machine may be moved around on the job site with the boom in the air per the chart above (Chart E). The following conditions must be met:

(a) Boom must be on centerline of machine, over the rear. Swing lock must be engaged.
(b) Boom must be at minimum radius (Approximately 800 boom angle).
(c) Tires must be inflated to values shown in inflation chart for "Maximum Static Lifts".
(d) Outrigger beams must be fully extended, jacks extended so that pontoons just clear the ground.
(e) Travel must be on smooth, level, hard surface, adequate to support the weight of the machine.
(f) Travel must be done at creep speed. (Creeper transmission in low, main transmission in first gear, deep reduction. See Section 1, "Operating Instructions".)

CAUTION

Exercise Extreme Caution To Avoid Contacts With Hazards When Moving The Machine With The Boom In The Air.

5-27 Reeving

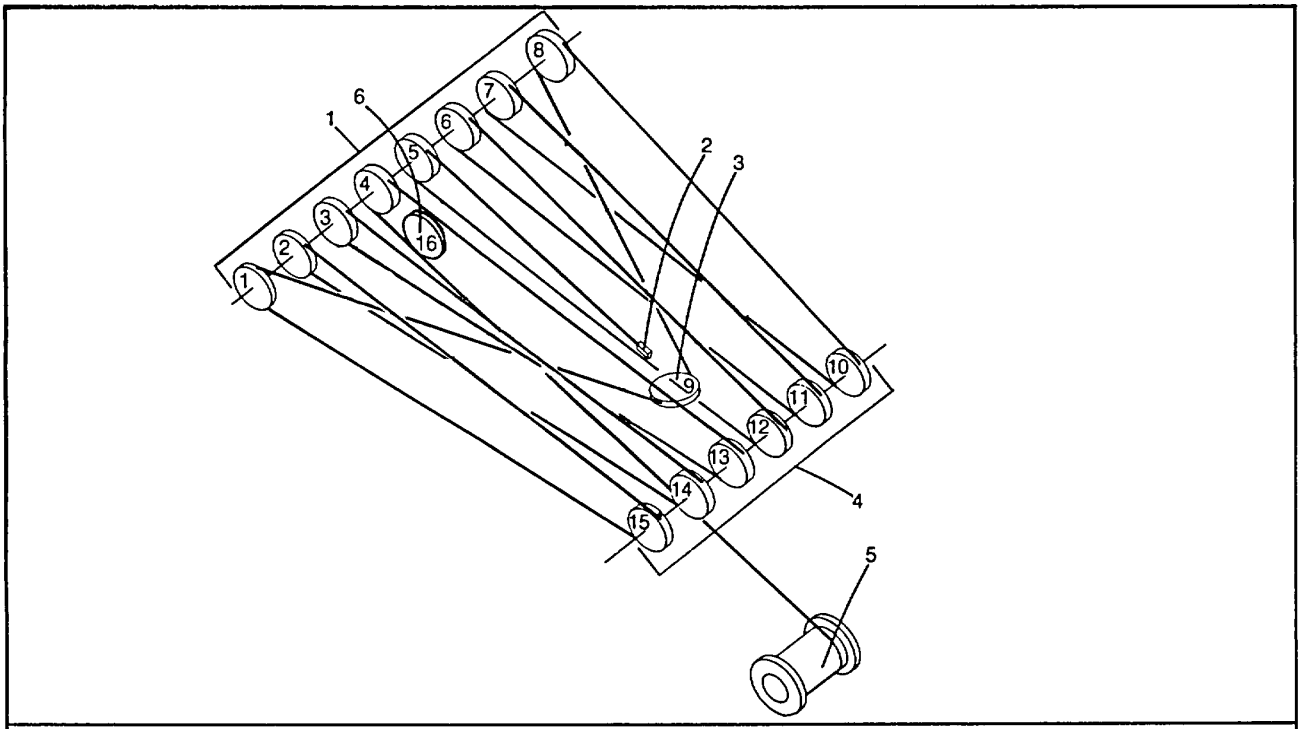


Fig. 5-23 16 Part Boom Hoist Reeving N21-B

(1) Bridle Sheaves
(2) Dead End Anchor
(3) Horizontal Bail Sheave
(4) Vertical Bail Sheave
(5) Boom Hoist Drum
(6) Deflector Sheave

5-28 Boom Hoist Reeving

The boom hoist reeving consists of 16 parts of wire rope, reeved between sheaves on the boom hoist bail, and the bridle on top of the live mast. To install the boom hoist rope, proceed as follows. Refer to Fig. 5-23.

(a) Push a pipe through the holes in the wire rope spool. Set the spool on block or horses so it can rotate. The rope must spool off over the top of the reel. Position the reel in front of the machine.

(b) Refer to the numbers on the sheaves in Fig. 5-23. Take the free end of the rope, and reeve as follows:
  (1) Over sheave, 4 over the top and around sheave 13.
  (2) Under the bottom and around sheave 3.
  (3) Over the top and around sheave 14.
  (4) Under the bottom and around sheave 2.
  (5) Over the top and around sheave 15.
  (6) Under the bottom and around sheave 1.
  (7) Around horizontal bail sheave 9.
  (8) Under the bottom and around sheave 8.
  (9) Over the top and around sheave 10.
  (10) Under the bottom and around sheave 7.
  (11) Over the top and around sheave 11.
  (12) Under the bottom and around sheave 6.
  (13) Over the top and around sheave 12.
  (14) Under the bottom and around sheave 5.
  (15) Connect to dead end wire rope socket on B.H. bail.
  (16) Pull the rest of the rope off of the reel. Run it under deflector sheave (16). Connect to the socket in the B.H. drum.

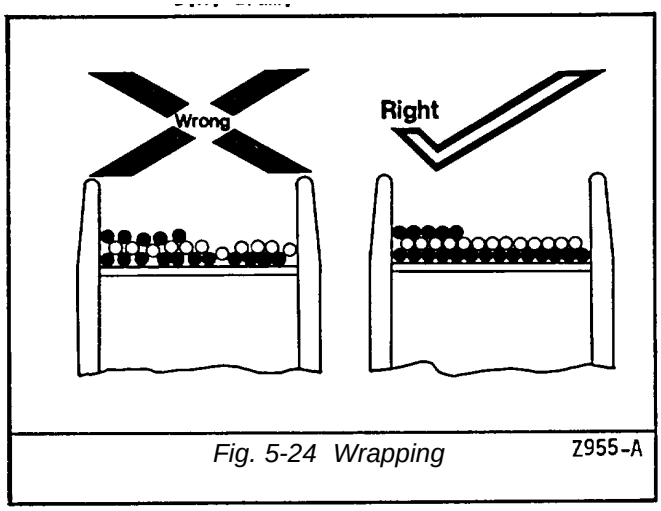


Fig. 5-24 Wrapping Z955-A

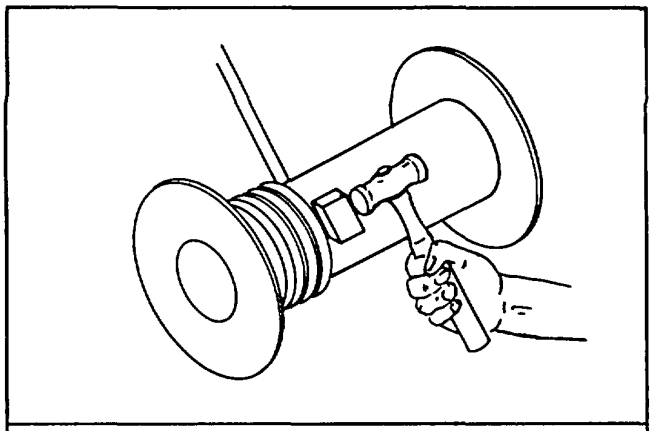


Fig. 5-25 Hammer And Block Z955-A

5-29 Spooling Wire Rope (Cable), General

Proper spooling of hoist rope is becoming increasingly important as wire rope cost and availability become pressing problems.

The following information is intended to provide general and specific instructions on the selection, strength and installation of wire rope on hoist drums.

5-30 Wrapping

Improper wrapping of the hoist rope on a drum leads to:
(1) Jerky operation of hoist lines.
(2) Scuffing, fraying, and crushing of hoist ropes.

Refer to Fig. 5-24. Note that on the properly wrapped example, the first layer of rope is even and rope contact is maintained all the way across the lagging. Succeeding layers will fall in the low spots created by the layer of rope underneath.

CAUTION
The First Layer Of Rope On The Drum Must Be Tight And Without Spaces To Insure Succeeding Layers Will Go On Properly.

In the incorrect example the irregular first layer has led to improper spooling of the second and third layers.

5-31 To Obtain A Tight First Layer

Use a hammer and wooden block to tap the rope tight. Refer to Fig. 5-25. During this operation the rope must be kept under tension.

Note: Grooved drums may not require this hammer and block method, but the wire rope must be kept under tension. Examine the spooling of the first layer to make certain that the rope is seated in the drum grooves.

WARNING
The Hammer And Block Method Requires Being Near Moving Machinery. Perform This Operation Slowly And Cautiously. The Operator And Workers Must Be Fully Informed Of The Procedures To Avoid Pinching Tools Or Body Parts In The Machine. Do Not Use Your Hands To Guide The Wire Rope At The Drum, Or Sheaves, Or Entanglement May Result.

5-32 To Obtain Tight Successive Layers

To obtain tight successive layers keep the rope under tension, and take care that it is seated in the depressions between the strands of the previous layers.

Note: This must be done on all drums.

5-33 Main Hoist Reeving

The main hoist rope can be reeved with one through 12 parts, depending upon the job at hand. Figures 5-26 and 5-27 illustrate the recommended way to reeve for the various parts of line that may be used on the machine.

Consult the parts book, page 16-4-22.0, to find the proper size, type, and length of rope to use for each reeving.

Never lower the boom, or a load past the point where two full wraps of rope are left on the drum.

5-34 Wire Rope Construction.

Wire ropes are made with two types of "lay". Lay refers to the direction in which the wires and strands are twisted to form the rope.

Regular lay as opposed to lang lay denotes the direction of wire twist In the individual strands. In regular lay rope, the wires in each strand lay in the opposite direction from the strands.

In lang lay rope the wires in each strand lay in the same direction as the strands.

Right or left are used to refer to the lay of the strands.

Right regular lay rope is the most commonly used, and will be furnished on an order unless other lay is specified.

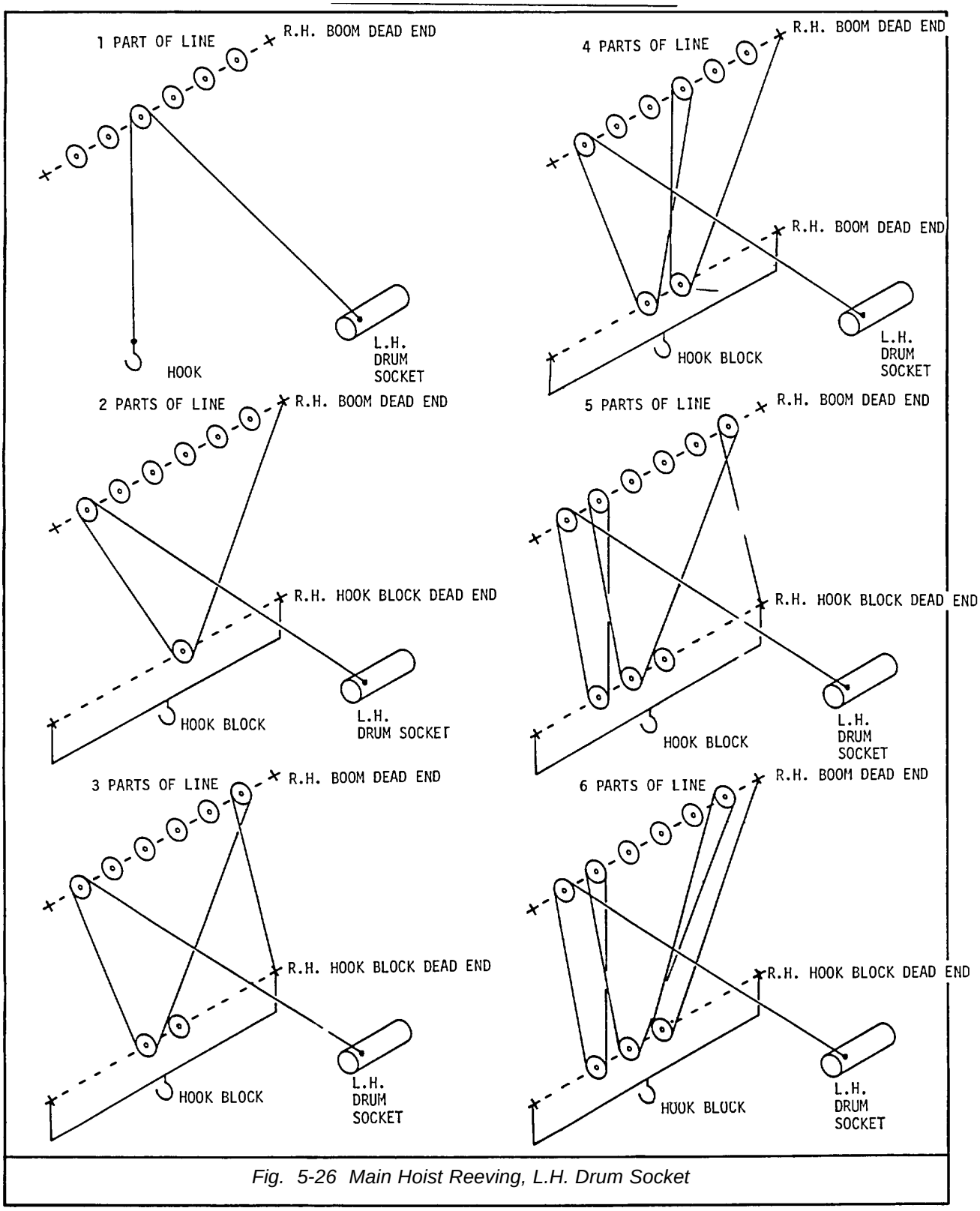


Fig. 5-26 Main Hoist Reeving, L.H. Drum Socket

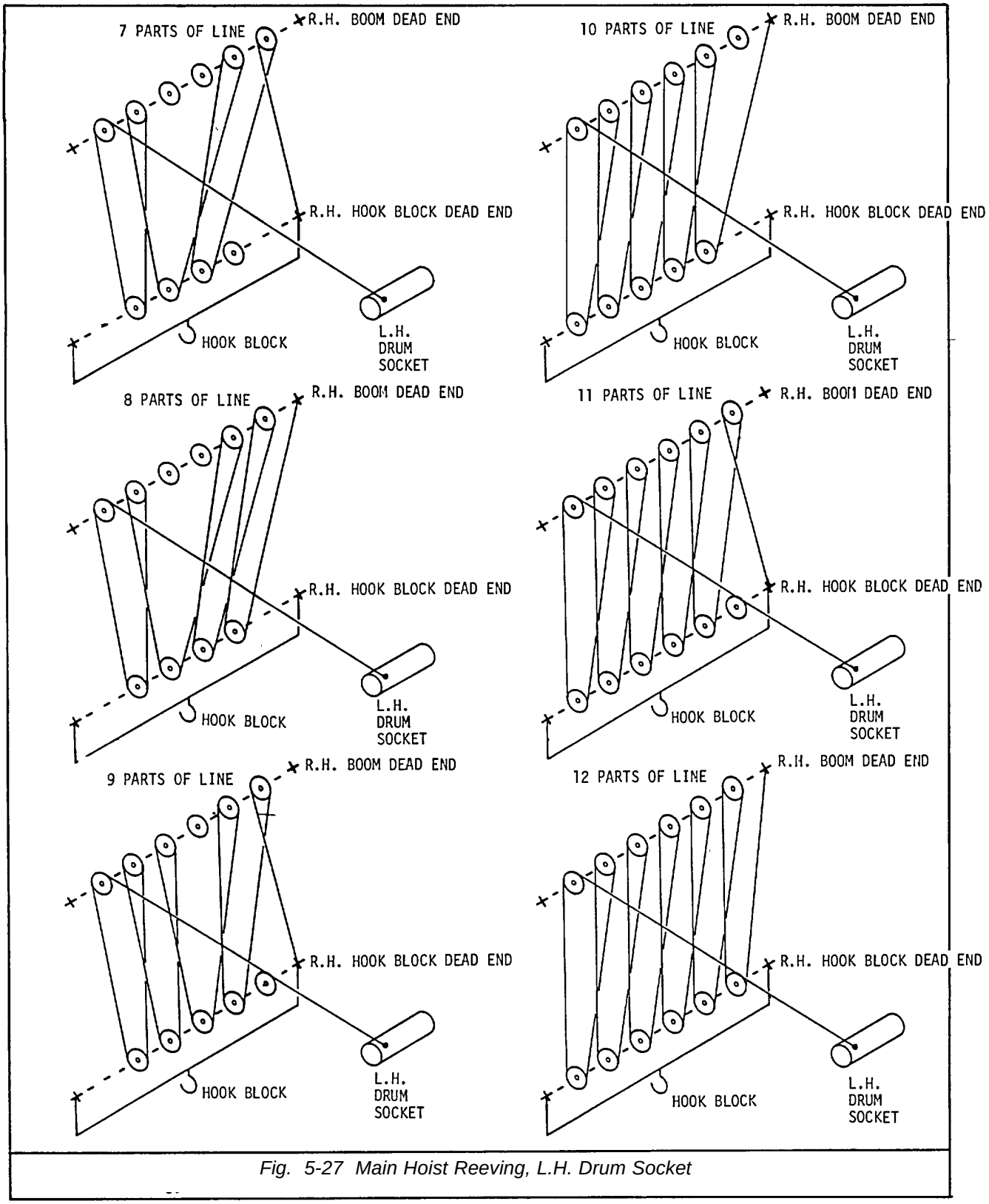


Fig. 5-27 Main Hoist Reeving, L.H. Drum Socket

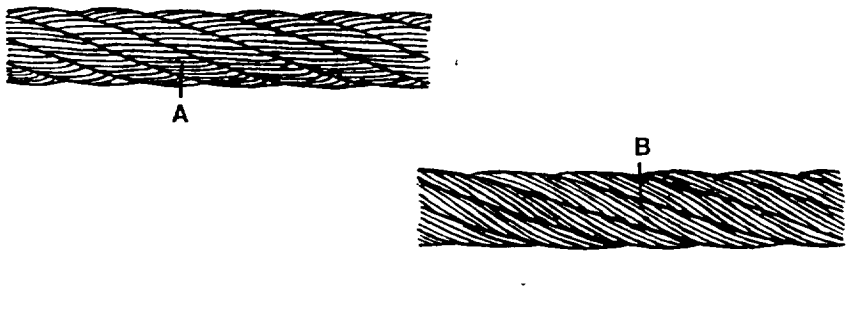


Fig. 5-28 Wire Rope

(A) Right Regular Lay
(B) Right Lang Lay

5-35 Measuring Wire Rope Diameter

As the illustration in Fig. 5-29 indicates there is a right and wrong way to measure wire rope diameter. Wire rope is always measured across the largest diameter that will fit inside a true circle.

Wire rope is always made larger, not smaller, than the nominal diameter. The allowable tolerances on wire rope diameters are:

Nominal Dia. In Inches	mm	Allowable Over Size In Inches	mm
To 3/4	19.05	1/32	.79
13/16 to 1-1/8	20.6 to 25.6	3/64	1.19
1-3/16 to 1-1/2	25.6 to 38.1	1/16	1.58
1-9/16 to 2-1/4	29.6 to 51	3/32	2.38
2-5/16 And Larger	51.1 ---	1/8	3.17

In standard practice, the nominal diameter is the minimum diameter. A rope is not considered oversized until its diameter exceeds the maximums listed above.

5-36 Ordering Wire Ropes When ordering wire ropes, the following information must be furnished, to be sure of receiving the correct wire rope. This is especially true when ordering wire rope from other sources than FMC Corporation.

(a) Length required.
(b) Diameter (c) Construction (type and number of strands, and wires per strand).
(d) Type of core (hemp or wire center).
(e) Grade of steel.
(f) Direction of lay (right or left lay).
(g) Regular lay or lang lay.
(h) Class of service wire rope is intended; that is drag wire rope on a drag line, hoist wire rope on a shovel, etc.
(i) Preformed or not preformed. When the above information is not specified, the wire rope manufacturer will generally furnish right, regular lay, ordinary fabrication, hemp center wire ropes.

5-37 Wire Rope Inspection And Replacement P1

All wire rope will eventually deteriorate to the point where it must be replaced. There are three basic reasons for this deterioration as follows:

(a) Abrasion or wear.
(b) Corrosion.
(c) Fatigue, caused by the constant pulling, bending, crushing, or kinking forces acting against the rope during normal usage.

When wire rope is replaced, use the type specified in the parts manual. Machines are designed to use a specific type and size of rope. Using anything but the recommended rope may result in short life, or even breakage.

All wire ropes in active service MUST BE inspected daily. Dated records should be kept on this inspection. A sample inspection report is shown in Fig. 5-30.

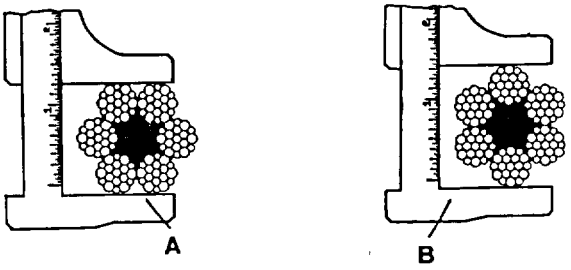
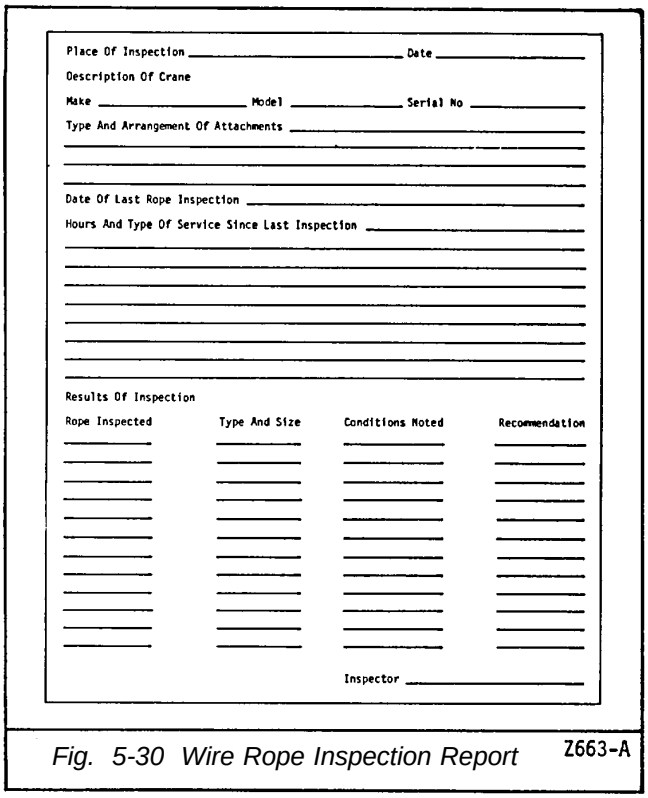


Fig. 5-29
Measuring Wire Rope Diameter
(A) Incorrect (B) Correct



Place Of Inspection _____ Date _____

Description Of Crane

Make _____ Model _____ Serial No _____

Type And Arrangement Of Attachments _____

Date Of Last Rope Inspection _____

Hours And Type Of Service Since Last Inspection _____

Results Of Inspection

Rope Inspected	Type And Size	Conditions Noted	Recommendation

Inspector _____

Fig. 5-30 Wire Rope Inspection Report Z663-A

This inspection should determine the degree of deterioration at the worst rope lay, as this will determine the suitability of the rope for continued service. By definition, a rope lay is the axial distance along the rope in which one strand makes on complete turn around the rope. Conditions such as the following would be reason to question rope safety:

(a) Evidence of rope deterioration from corrosion should be cause for replacement.

(b) More than one broken wire in any one strand should be cause for caution. Breaks that occur on the worn crown of the outside wires indicate normal deterioration. Breaks that occur in the valleys between strands indicate some abnormal condition, possibly fatigue and breakage of other wires not readily visible. One or more valley breaks should be cause for replacement.

(c) Wire breaks generally occur in those portions of a wire rope which pass over sheaves, wind onto drums, or receive mechanical abuse. Breaks that occur near attached fittings are apt to result from fatiguing stresses concentrated in these localized sections. Breaks of the latter type should be cause for replacement of the rope or renewal of the attachment to .eliminate the locally fatigued area.

(d) Heavy wear or broken wires may occur in sections under equalizer sheaves or other sheaves where rope travel is limited, or in contact with saddles. Particular care should be taken to inspect ropes at these points.

Rope stretch is generally greatest during initial stages of operation when the strands are becoming adjusted and seated. This is accompanied by some reduction in rope diameter, but not the extent that the condition of the rope can be judged on this basis.

(f) Time for rope replacement is indicated by the extent of abrasion, scrubbing, and peening on the outside wires, broken wires, evidence of pitting or severe corrosion, kink damage, or other mechanical abuse resulting in distortion of the rope structure.

(g) Sheaves, guards, guides, drums, flanges and other surfaces contacted by wire rope during operation should be examined at the time of inspections.
Any condition harmful to the rope in use at the time should be corrected. The same equipment and particularly sheave and drum grooves, should be inspected and placed in proper condition before a new rope is installed.

(h) Any of the following listed conditions should be cause for rope replacement:

(a) In running ropes, six randomly distributed broken wire in one rope lay, or three broken wires in one strand in one rope lay.

(b) In pendants or standing ropes, evidence of more than one broken wire in one rope lay.

(c) Abrasion, scrubbing or peening causing loss of more than 1/3 the original diameter of the outside wires.

(d) Evidence of rope deterioration from corrosion.

(e) Severe kinking, severe crushing, or other damage resulting in distortion of the rope structure.

(f) Evidence of any heat damage resulting from a torch or arc caused by contact with electrical wires.

(g) Reduction from nominal diameter of more than 3/64" (1.19mm) for diameters up to and including 3/4" (1.58mm); 1/16" (1.58mm) for diameters 7/8" to 1-1/8" (22.22mm to 28.6mm); 3/32" (2.38mm) for diameters 1-1/4" to 1-1/2" (25.6mm to 38.1mm). Marked reduction in diameter indicates deterioration of the core resulting in lack of proper support for the load carrying strands. Excessive rope stretch or elongation may also be an indication of internal deterioration.

(h) Evidence of "bird-caging" or other distortion resulting in some members of the rope structure carrying more load than others.

(i) Noticeable rusting or development of broken wires in the vicinity of attachments.

Note: <u>If this condition is localized in an operating rope and the section in question can be eliminated by making a new attachment, this can be done rather than replacing the entire rope.</u>

Classification	Effect	Cause
Shipping	Crushed or bruised wire rope	1. Excessive amount of rope on shipping reel causing weight of reel to be carried on wire rope. 2. Dropping reel off truck, dock, etc., onto hard surface. 3. Open drum reels.
	Doglegs or Kinks	1. Rolling reel over large stones or other objects.
	Rust	1. Poor storage facilities.
Installing	Doglegs or Kinks	1. Improper procedure for removing rope from reels. 2. Rope Jumping sheaves. 3. Pulling or dragging rope around a post, sill, or relatively sharp corner.
	Excessive Abrasion	1. Improper reeving causing rope to rub against equipment or against itself.
	High Strands	1. Improper socketing, splicing, or seizing. 2. Driving nails or other objects between strands.
In Use	Crushed or Bruised	1. Improper drum winding. 2. Pinching of rope. 3. Peening against equipment. 4. Running over rope with equipment.
	Doglegs or Kinks	1. Jumping sheaves. 2. Bad drum winding. 3. Lifting sharp cornered objects without corner protection.
	Corrosion and Rust	1. Lack of lubrication. 2. Corrosive fluids. 3. Atmosphere.
	Popped Core	1. Momentary compressive force on rope which pushes strands apart crushing on drums.
	Excessive Abrasion	1. Improper reeving. 2. Improper alignment of sheaves. 3. Presence of abrasive materials.
	Broken Wires	1. Fatigue from excessive bending over small sheaves or reverse bends. 2. Incorrect rope size. 3. Excessive rope speeds. 4. Collapse of core due to overloading. 5. Vibration set up by worn bearings. 6. Broken sheave or drum. 7. Corrugated sheaves.
	Bird Cage	1. Too sudden release of load.
	High Strands	1. Condition starts at some localized area such as dogleg, crushed section, improperly attached end fitting or splices.
	Failure at Socket	1. Wrong size wedge used or socket deformed from consistent overloading.

Fig. 5-31
Wire Rope (Cable) Failure Chart

5-38 Lubrication

Wire rope is a machine. Each time a wire rope bends over a sheave, or straightens from a slack position, many wires move against each other. Lubrication is necessary to help prevent wear caused by this movement. Lubrication also helps prevent deterioration of wire rope due to rust and corrosion.

Note: Rusty rope is dangerous since there is no way of determining its remaining strength.

Most wire ropes are lubricated during manufacture, but the lubricant doesn't last the life of the rope. The lubricant is squeezed out of the rope as it turns over sheaves under tension, washed off by rain, etc.

For the previous reasons, wire ropes MUST BE periodically re-lubricated. Crude or used oils and grease should not be used as lubricants because they may be grit or acid laden. Either of these conditions would be bad for the rope.

No set rule can be given for lubrication frequency. This will depend on the conditions the rope is operating under. A rope operating in wet conditions would need lubrication more often than one operating under dry conditions to prevent rust and corrosion.

Lubricants used for wire rope lubrication should have the following properties:

(a) They must contain no acids or alkalis.
(b) They must have enough adhesive strength to stay on the rope.
(c) They must be able to penetrate between the wires and strands.
(d) They must have high film strength.
(e) They must resist oxidation.
(f) They must remain soft and pliable.

WARNING

Warn Personnel In The Immediate Area Before Using Compressed Air For Cleaning. Wear Safety Glasses. Compressed Air, Coming Into Contact With The Human Skin Or Causing Flying Metal Chips Can Cause Injury.

5-39 Application Of Lubricant: Wire ropes that have been in service must be cleaned before lubrication. Use a wire brush, and compressed air to clean the rope. All possible foreign material and old lubricant must be removed from the rope before lubrication. Use one of the following methods to apply the lubricant:

(a) Continuous Bath: Run the rope through a container filled with lubricant. A sheave mounted in the center of the container will hold the rope submerged as it passes through the container. Use swabbing to remove excess lubricant as the rope leaves the container.
(b) Dripping: Place a container above a sheave so that a spigot may be opened to drip oil on the wire rope as it passes through the sheave groove.
(c) Swabbing and Painting: Two fast methods are swabbing the lubricant on with rags, or painting it on with a brush.
(d) Spraying: Light lubricants may be applied with a spray gun. Aerosol cans of lubricant are also available.

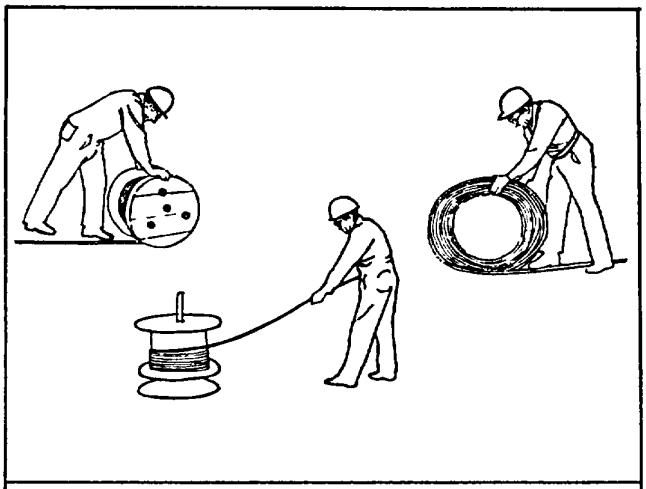


Fig. 5-32 Uncoiling Wire Rope

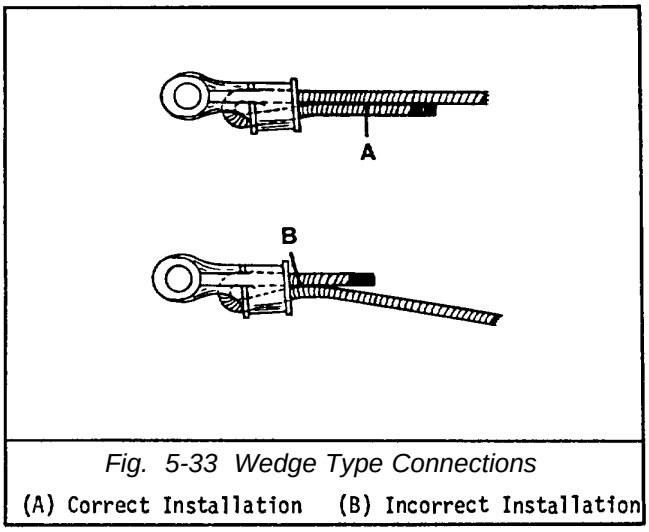


Fig. 5-33 Wedge Type Connections

(A) Correct Installation (B) Incorrect Installation

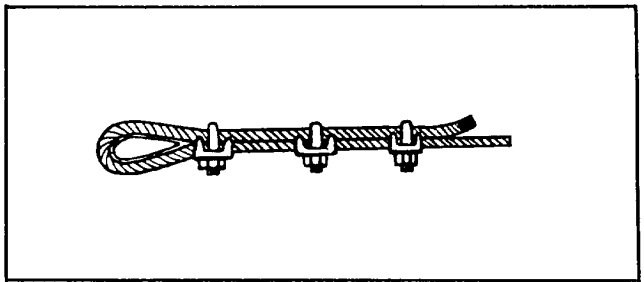


Fig. 5-34 Wire Rope Clip Installation

5-40 Unreeling Wire Rope

When unreeling wire rope, set the reel up horizontally so it can rotate as the rope is reeled off. Reel the rope off slowly, so the reel won't tend to "throw" the rope off. Avoid reverse bends. If installing rope over the top (over winding drum), of a drum, set the reel up so the rope is removed over the top of the reel. When installing rope around the bottom of a drum (under winding drum) set the reel up so rope is removed under the bottom of the reel. To obtain snug and uniform winding on the drum, brake the reel with a large timber to provide back tension.

When uncoiling wire rope, roll the coil along the ground and the rope will be as straight as it was before being coiled for shipment. Don't uncoil rope where it may be run over by trucks or other equipment.

Note: A new rope should be broken in by running it slowly through its working cycle for a short period under a light load.

Sheave Inspection

Whenever wire rope is replaced, the sheaves and grooves in drums should be checked for wear or damage and replaced if necessary. Damaged, worn, or undersized sheaves will damage the rope. On older equipment remember that new rope is always bigger in diameter than the worn rope it replaces. The sheave grooves may be worn to the smaller diameter of the old rope.

5-41 Cutting Wire Rope

When wire rope is to be cut, seizings should be placed on each side of the point where the rope is to be cut, to keep the strands in place. On preformed rope, one seizing on each side of the cut is enough. On non-preformed rope less than 7/8"(22.2mm) diameter, two seizing are recommended. On non-preformed ropes over 7/8" (22.2mm) diameter, three seizings are recommended.

Three basic methods of cutting wire rope are recommended:

(a) Abrasive cutting tools.
(b) Shearing tools. (Wire cutters on small rope, a wire rope cutter and hammer for larger ropes).
(c) Acetylene cutting torch.

5-42 Socket and Wedge Connections

The correct and incorrect methods of attaching a wedge and socket to wire rope are shown in Fig. 5-33. The dead end of the wire rope must always be on the sloped portion of the socket. The load line must be in a straight line pull with the eye of the socket. If the rope is installed backward, as shown at (B) in Fig. 5-33, a kink will develop at the point where the rope enters the socket.

Note: The use of wire rope clips with socket and wedge connections is not recommended, Addition of wire rope clips will actually weaken the connection.

CAUTION
Use The Proper Size Wedge With A Wire Rope Socket Or Lagging. The Use Of An Off Size Wedge In A Socket Or Lagging Is Dangerous As It May Not Hold. Wedges And Sockets Shipped From FMC Corporation Are Stamped With Size And Type Identification, A Lagging Or Socket May Be Stamped For Two Or More Sizes Of Rope, And A Wedge, Must Correspond To The Rope Size Used.

5-43 Wire Rope Clip Installation

The correct method of installing wire rope clips is as shown in Fig. 5-34. The "U" bolt must always be over the short end of the wire rope, and the base must always contact the long end. Clips should not be staggered; that is "U" bolt of one clip over short end, "U" bolt of next clip over long end, etc. This practice will not only distort the wire rope excessively, but will prevent maximum strength of this type fastening. Placing all clips with the "U" bolt over the long end of the wire rope will damage strands, and result in an unsafe condition.

The distance between clips should not be less than six times the wire rope diameter. In relation to size of wire rope, the minimum number of clips recommended for a safe connection is as follows:

Clip Size	Min. No. Of Clips	Amount Of Rope Turnback	Torque In Ft/Lbs.
7/8" (22.2mm)	4	19" (48cm)	225 (300N•m)
1" (25.4mm)	5	26" (66cm)	225 (300N•m)

Note: If a greater number of clips are used than shown in the table above, increase the turnback of rope.

CAUTION
Apply The Initial Load And Retighten Nut To The Recommended Torque. Rope Will Stretch And Shrink In Diameter When Loads Are Applied. Inspect Periodically And Retighten.

5-44 Use Of Wire Rope Clips With Sockets

Some codes require the use of a wire rope clip in conjunction with a wedge socket. In some cases, particularly in wrecking ball work, there is a chance that the wedge can loosen, releasing the socket from the rope. This could be caused by the banging action, and alternate loading and unloading of the rope that occurs during this type work.

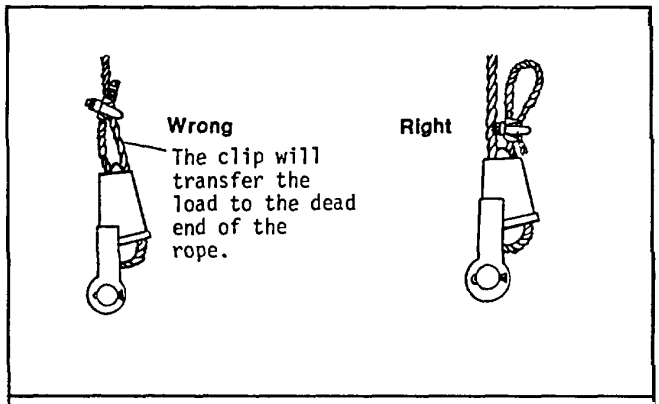


Fig. 5-35
Securing Dead End Of Rope With A Wire Clip

As noted before, use of wire rope clips with a wedge socket connection can weaken socket connection.

Do not attach the dead end of the rope to the live side with the clip as this will seriously weaken the connection. The clip will ultimately take the load as shown in Fig. 5-35 and may deform or break the rope.

Either install the clip on the dead end of the rope, or loop the dead end over (Fig. 5-35) and install a clip. The loop thus formed must not be allowed to enter the wedge, or the connection will be weakened.

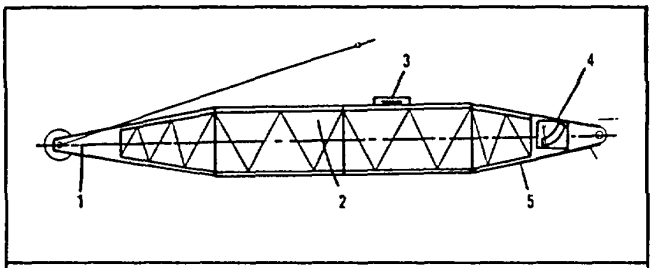


Fig. 5-36 Boom Angle Indicator

(1) Upper Section
(2) Extension
(3) Level
(4) Indicator
(5) Boom Lower Section

5-45 Boom Angle Indicator

The boom angle indicator, when properly installed and adjusted, reflects the approximate working

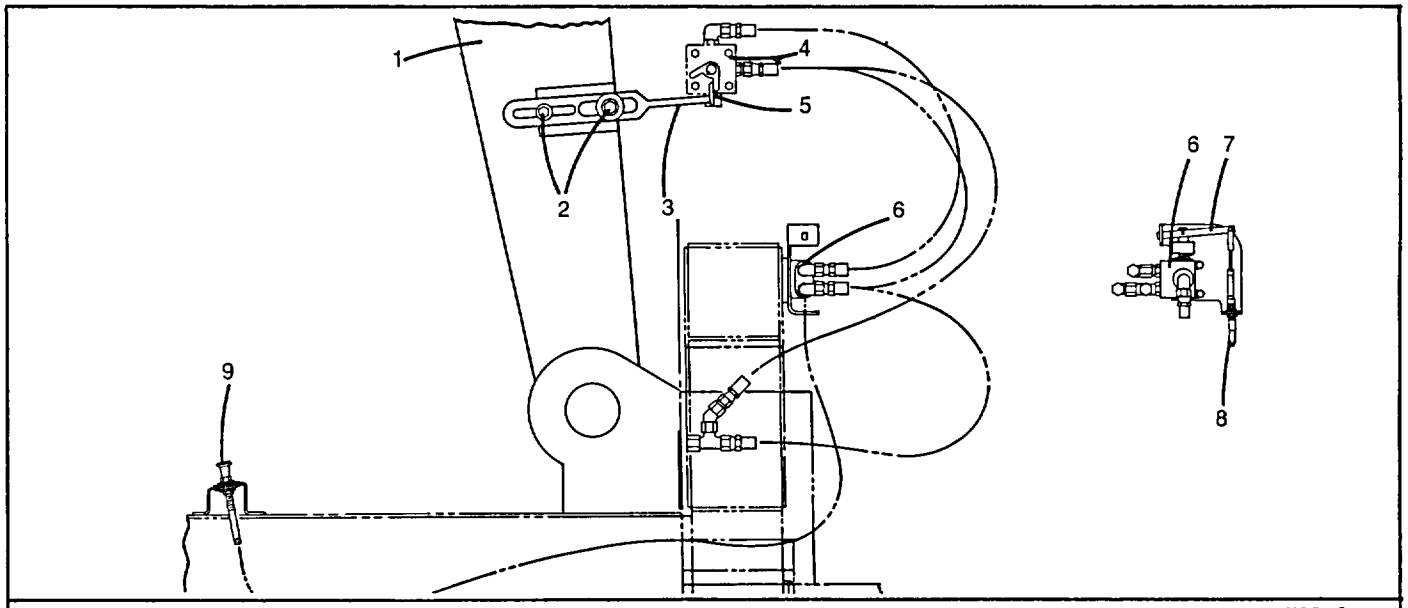


Fig. 5-37 Boom Hoist Limiter

(1) Boom Lower Section
(2) Capscrew, Lockwasher
(3) Striker
(4) Rotary Valve
(5) Bell Crank
(6) Override Valve
(7) Lever
(8) Control Cable
(9) Override Control

angle of the crane boom. The indicator is not installed on booms shipped from the factory as it could be damaged during shipment. It must be mounted in the field, after the boom is assembled on the machine.

5-46 Boom Angle Indicator Adjustment: When mounting the angle indicator assembly, make sure the pendulum pointer is at zero when the boom is horizontal. The boom position may be checked by placing a level on a straight boom extension near boom mid-point. Set the indicator to zero by adjusting the pendulum.

After installation, boom up slowly and observe the motion of the pendulum in various boom position. If the indicator sticks or drags, repair it before use. An inoperative or damaged boom angle indicator must never be used to determine boom angle.

Recheck the indicator once a month, any other time when freedom of pendulum action or position of zero is questioned, or when boom has been removed from machine and then reinstalled.

Note: Boom angle indicator is approximate only When making a lift that is close to rated loads, load radius should be determined by actually measuring from center line of rotation to center of gravity of the load.

5-47 Boom Hoist Limiter

A hydraulic boom hoist limiter is used on the machine. As the boom nears minimum radius, a striker (3) on the boom lower section contacts a bell crank (5) on rotary valve (4). As the boom raises further, the rotary valve (4) actuates, directing oil from the B.H. clutch and brake, back to the sumo tank. This allows the clutch to disengage, and the spring applied brake to engage, stopping upward travel of the boom.

When the boom is lowered, the striker pulls on the bell crank, shifting the rotary valve back to its original position, allowing the boom hoist system to function normally again.

5-48 Override Control: In some cases it is necessary to boom up slightly to release the B.H. ratchet pawl after the boom hoist limiter has functioned.

Pulling upon the override control on the cab floor will direct oil under pressure around the rotary valve so the boom hoist system will function.

CAUTION

Boom Up With Extreme Caution When Overriding The B.H. Limiter. The Bell Crank, Striker, Boom Lower Section Or Boom Backstops May Be Damaged By Booming Up Past Minimum Radius.

5-49 Boom Hoist Limiter Adjustment: The limiter should be adjusted upon delivery of a new machine, any time the boom is removed from or replaced on the machine, or any time the machine is to be used after sitting idle 50 hours or more.

Adjust as follows:

(a) Check limiter operation. Trip the rotary valve by hand, then actuate the boom hoist lever. The boom shouldn't raise.

(b) Rotate the valve to its original position and try the control again. The boom should raise this time.

(c) Boom up "VERY CAUTIOUSLY" to see what position the limiter functions at.

The limiter should function when the boom backstop bumpers just contact the targets on the boom lower section. If not, boom down to a position which allows room to adjust the limiter.

Loosen capscrews (2) and move striker m (3) in or out to adjust boom angle. Move out (away from boom) to increase boom angle. Move in toward boom to decrease boom angle. Tighten capscrews.

(d) Boom up "VERY CAUTIOUSLY" to see what position the limiter functions.

If necessary, repeat step (c) until proper adjustment is reached.

Operator's Manual Section 6 - Auxiliary Generator Assembly

Index Section 6

Notes

Operator's Manual Section 6 - Auxiliary Generator Assembly

6-1 General

An Onan DJA Series electric generating set consists of a one-cylinder diesel engine and a 3.0 kW (2.5kW for 50 Hertz) alternating current generator with standard or optional equipment as ordered.

6-2 Engine

The DJA engine has 30 cubic inch (491 cm^3) piston displacement, 19 to I compression ratio, and is air-cooled. Basic measurements and other details are listed under Specifications.

6-3 Generator

The generator is a revolving armature, 4-pole, single phase, self-excited model of drip-proof construction. The generator aligns to the engine through a rigid coupling and incorporates an engine cranking winding. A commutator, collector rings and associated brushes provide the electrical connections.

6-4 Controls

The standard control box has a battery charge rate ammeter, pre-heat switch, a start-stop switch and fuse.

The following is a brief description of typical controls.

6-5 Start-Stop Switch: Starts and stops the unit locally.

6-6 Battery Charge Rate DC Ammeter: Indicates the battery charging current.

6-7 Pre-Heat Switch: Provides pre-heat control for manifold heater and glow plug for cold diesel engine starting.

6-8 Oil Pressure Gauge: Indicates pressure for lubricating oil in engine (located on the engine).

6-9 Fuse: Protects the fuel solenoid, ignition and general control components including the wiring harness.

6-10 Pre-Starting

Preparations for the initial and each additional starting operation should include careful checks of the oil fuel cooling, exhaust and electrical systems. The cylinder air housing door should be closed with all air shrouds in place.

Before operating generator set, check all components for mechanical security. If an abnormal condition, defective part, or operating difficulty is detected, repair or service as required. The generator set should be kept free of dust, dirt, and spilled oil or fuel. Be sure proper operating procedure is followed.

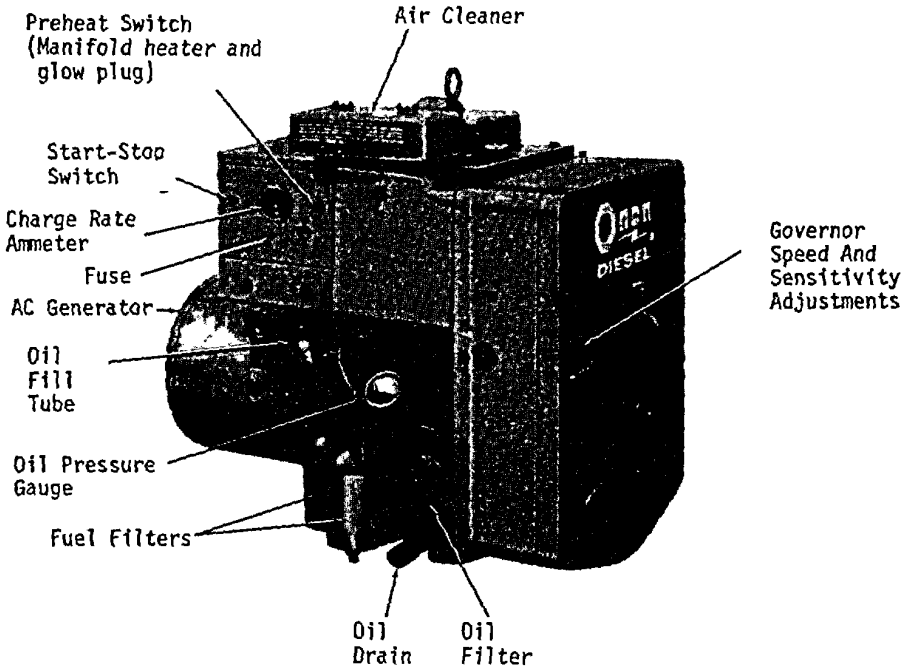


Fig. 6-1 Auxiliary Generator Assembly

6-11 Operation

WARNING

Engine Exhaust Gas (Carbon Monoxide) Is Deadly!

Carbon Monoxide Is An Odorless, Colorless Gas Formed By Incomplete Combustion Of Hydrocarbon Fuels. Carbon Monoxide Is A Dangerous Gas That Can Cause Unconsciousness And Is Potentially Lethal. Some Of The Symptoms Or Signs Of Carbon Monoxide Inhalation Are:

Dizziness	**Vomiting**
Intense Headache	**Muscular Twitching**
Weakness and Sleepiness	**Throbbing In Temples**

If You Experience Any Of The Above Symptoms, Get Out Into Fresh Air Immediately.

The Best Protection Against Carbon Monoxide Inhalation Is A Regular Inspection Of The Complete Exhaust System. If You Notice A Change In The Sound Or Appearance Of Exhaust System, Shut The Unit Down Immediately And Have It Inspected And Repaired At Once By A Competent Mechanic.

6-12 Crankcase Oil: Use an oil with the API designation CD/SD or CD/SE. However, to reduce oil consumption to a normal level in the shortest time possible on a new or rebuilt engine, use CC oil for the first fill only (50 hours). Then use the recommended oil only. Select the correct SAE grade oil by referring to the following:

Above 32° F (0° C) ..... SAE 30
0° F to 32° F
(-18° C to 0° C) ..... SAE 10W or 5W-30
Below 0° F..... SAE 5W-30

Multigrade oils are recommended for temperatures of 32° F and below, but they are not recommended for temperatures above 32° F. When adding oil between oil changes use the same brand and grade, as various brands of oil may not be compatible when mixed together.

6-13 Recommended Fuel

Using ASTM 2-D or 1-D fuel with a minimum Cetane number 45* Number 2 diesel fuel gives the best economy for most operating conditions; however, use ASTM 1-D fuel during the following conditions:
(a) When ambient temperatures are below 32° F (0° C);
(b) During long periods of light engine load; or no load.

Note:

Fuels with Cetane numbers higher than 45 may be needed in higher altitudes or when extremely low ambient temperatures are encountered to prevent misfires.

Use low sulfur content fuel having a pour point (ability to filter) of at least 10° F (6°C) below the lowest expected temperature. Keep the fuel clean and protected from adverse weather.

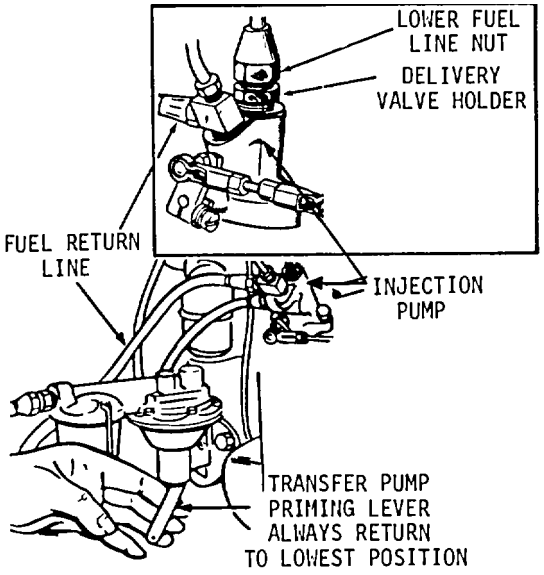


Fig. 6-2 Bleeding The Fuel System

Leave some room for expansion when filling the fuel tank.

CAUTION

Due To The Precise Tolerances Of Diesel Injection Systems, It Is Extremely Important The Fuel Be Kept Clean. Dirt In The System Can Cause Severe Damage To Both The Injector Pump And The Injection Nozzles.

6-14 Bleeding Fuel System: Disconnect fuel return line and operate hand priming lever on fuel transfer pump (Fig. 6-2) until fuel flows bubble free from fuel return line. Then reconnect the fuel return line fitting.

Note:

If the camshaft's pump lobe is up, crank engine one revolution to permit hand priming. When finished, return priming lever inward (disengaged position) to permit normal pump operation.

Batteries may be conserved by using this alternate method of bleeding the fuel system. Completely loosen the lower nut on the injection pump to nozzle fuel line. Loosen the delivery valve holder, located below the fuel line nut, until it can be turned with the fingers. Crank engine until clear fuel emerges around the loosened delivery valve holder. Retighten the delivery valve holder and fuel line. Fuel injection should occur almost immediately when engine is cranked.

6-15 Starting Sequence

The starting and stopping sequence lists the manual, mechanical, and electrical events required for satisfactory start, run, and stop cycles. Figure 6-3 illustrates controls for starting and stopping sequence.

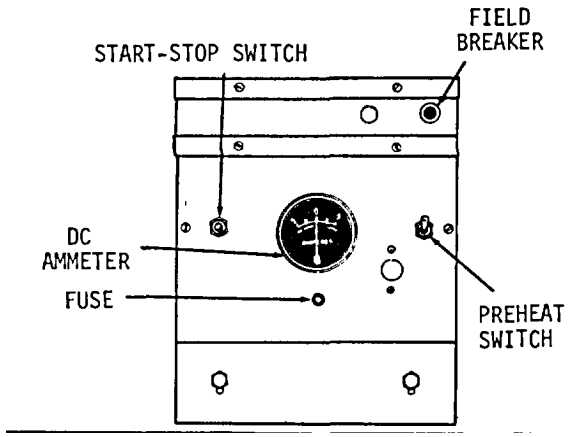


Fig. 6-3 Standard Control Panel

6-16 Pre-Heating And Starting

Extremes in starting temperatures may require additional preheating. If engine fails to start quickly, rest engine several seconds and repeat starting sequence applying preheat for a longer interval using heater switch.

See page 6-10 for comprehensive engine starting guide.

(a) For cold engine starting below 55° F (13°C), depress the manifold heater switch for one minute.
(b) Push start-stop switch to its start position.
(c) Release switch after engine starts and reaches speed.
(d) Oil pressure should read at least 20 psi (13 kPa) (pressure-relief valve is not adjustable).

CAUTION

Do Not Apply Overvoltage To The Starting Circuit At Any Time. Overvoltage Will Destroy The Glow Plugs And Air Heater In 2 Or 3 Seconds. If It Becomes Necessary To Use An Additional Source Of Power To Start The Set, Use A 12 Volt Battery Connected In Parallel.

6-17 Automatic Starting And Stopping

Separate controls may be used for automatic start and stop, but must provide engine preheating.

The automatic control has a time delay relay to preheat glow plugs and the manifold heater for about 20 seconds before cranking occurs. The time delay relay prevents immediate engagement of the starter in case the load is reapplied before the engine stops.

6-18 Stopping

(a) Push start-stop switch to stop position.
(b) Release switch when set stops. If stop circuit fails, close fuel valve.

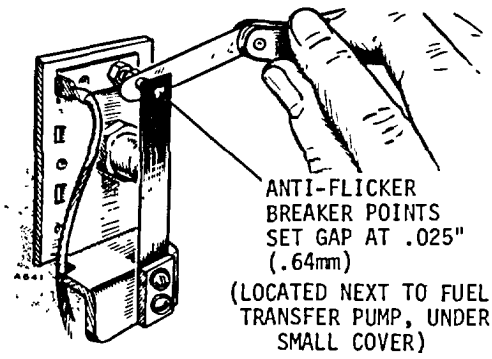


Fig. 6-4 Setting Gap

6-19 Applying Load

Allow set to warm up before connecting a heavy load. Continuous generator overload may cause high operating temperatures that can damage the windings. The generator can safely handle an overload temporarily, but for normal operation, keep the load within nameplate rating. The exhaust system may form carbon deposits during operation at light loads; apply full load occasionally before shut-down to prevent excessive carbon accumulations.

Try to connect the load in stops instead of full load at one time. Most installations use a line switch that must be closed to connect a portion of the load.

6-20 Emergency Operation If Battery Fails

The remote type revolving armature set must always have the battery connected while operating. High voltage will burn relays if battery is disconnected.

6-21 Break-In Procedure

The unit should be run in the following sequence:
(a) One half hour at 1/2 load.
(b) One half hour at 3/4 load.
(c) Full load.

Continuous running under one half load during the first few hundred hours usually result in poor piston ring seating, causing higher than normal oil consumption and blowby.

Note:

Drain and replace the crankcase oil after 50 hours of operation; drain while the engine is still hot.

6-22 Out-Of-Service Protection

The natural lubricating qualities of No. 2 diesel fuel should protect a diesel engine for at least 30 days when unit is not in service. To protect a set that will be out of service for more than 30 days, proceed as follows:
(a) Run set until thoroughly warm; generator under at least 50 percent load.

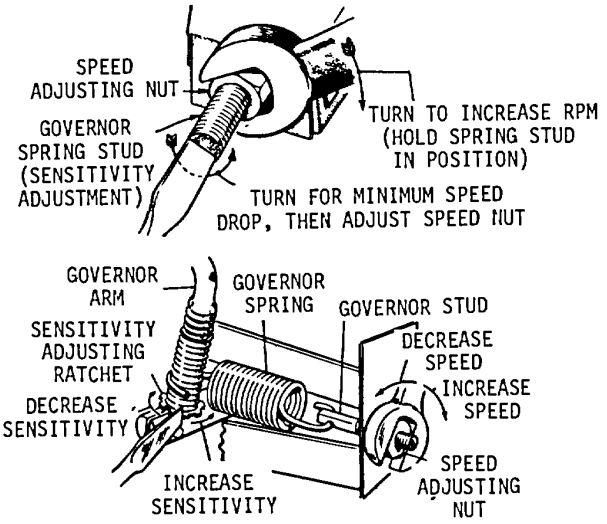


Fig. 6-5 Governor Adjustment

(b) Shut down engine and drain oil base while still warm. Refill and attach a warning tag indicating viscosity of oil used.
(c) Remove glow plug. Pour 1-ounce of rust inhibitor (or SAE#10 oil) into each cylinder. Crank engine over several times. Install glow plug.
(d) Service air cleaner.
(e) Clean throttle and governor linkage and protect by wrapping with a clean cloth.
(f) Plug exhaust outlets to prevent entrance of moisture, bugs, dirt, etc.
(g) Clean and wipe entire unit. Coat parts susceptible to rust with a light coat of grease or oil.
(h) Disconnect battery and follow standard battery storage procedure.
(i) Provide a suitable cover for the entire unit.

6-23 Returning A Unit To Service

(a) Remove cover and all protective wrapping. Remove plug from exhaust outlet.
(b) Check warning tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
(c) Clean and check battery. Measure specific gravity (1.260 at 77° F [25°C]) and verify level to be at split ring. If specific gravity is low, charge until correct value is obtained. If level is low, add distilled water and charge until specific gravity is correct. DO NOT OVERCHARGE.

WARNING
Do Not Smoke While Servicing Batteries. Explosive Gases Are Emitted From Batteries In Operation. Ignition Of These Gases Can Cause Severe Personal Injury.

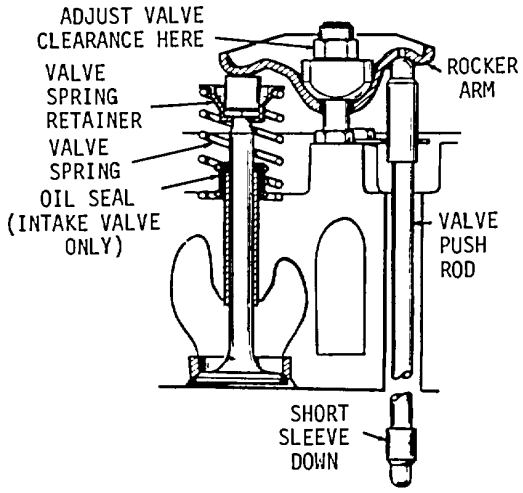


Fig. 6-6 Setting Valve Clearance

(d) Check that fuel injectors and fuel lines are secure and correctly torqued.
(e) Connect batteries.
(f) Verify that no loads are connected to generator.
(g) Start engine.

Note:
After engine has started, excessive blue smoke will be exhausted until the rust inhibitor or oil has burned away.

(h) After start, apply load to at least 50 percent of rated capacity.
(i) Check all gauges to be reading correctly. Unit is ready for service.

6-24 High Temperatures

(a) See that nothing obstructs air flow to and from the set.
(b) Keep cooling fins clean. Air housing should be properly installed and undamaged.

6-25 Low Temperatures

(a) Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm. If an unexpected temperature drop causes an emergency, move the set to a warm location or apply externally heater air until oil flows freely (never use open flame).
(b) Use fresh fuel. Protect against moisture condensation.
(c) Keep fuel system clean, and batteries in a well charged condition.
(d) Partially restrict cool air flow but use care to avoid overheating.
(e) In extreme cold temperatures it may be necessary to maintain preheating up to 2 minutes after the engine starts to obtain firing.

CAUTION
Do Not Use Preheat For More Than One Minute Before Cranking. This Will Help To Prevent Burn-Out And Conserve Battery Power.

See page 6-10 for comprehensive engine setting guide.

6-26 Dust And Dirt

(a) Keep set clean. Keep cooling fins free of dirt, etc.
(b) Service air cleaner as frequently as necessary.
(c) Change crankcase oil every 50 operating hours.
(d) Keep oil and fuel in dust-tight containers.
(e) Keep governor linkage clean.

6-27 High Altitude

Maximum power will be reduced approximately 4 percent of each 1000 feet above sea level, after the first 1000 feet.

6-28 Adjustments

6-29 Anti-Flicker Points

The anti-flicker breaker points (Fig. 6-4) are adjusted while wide open. Loosen and move stationary contact to correct gap.

Replace burned or faulty points. If only slightly burned, dress smooth with file or fine stone. Measure gap with thickness gauge.

6-30 Governor

The governor controls engine speed. Rated speed and voltage appear on the nameplate (see Specifications). Engine speed equals frequency multiplied by 30, on a 4 pole generator, thus 1800 rpm gives 60 hertz frequency. Preferred speed does not vary more than 3 hertz from no-load to full-load operation. Be sure throttle, linkage, and governor mechanism operate smoothly.

6-31 Speed Adjustment: To change the governor speed, change the spring tension by turning the governor spring nut (Fig. 6-5). Turn the nut clockwise (more spring tension) to increase rpm and counterclockwise to reduce governed speed. Hold a tachometer against flywheel capscrew.

6-32 Sensitivity Adjustment: To adjust governor sensitivity (no load to full load speed droop) turn the sensitivity adjusting ratchet accessible through a covered access hole on the side of the blower housing. Counterclockwise gives more sensitivity (less speed droop when full load is applied), clockwise gives less sensitivity (more speed droop). If the governor is too sensitive, a rapid hunting condition occurs (alternate increasing and decreasing speed). Adjust for maximum sensitivity without hunting. After sensitivity adjustment, the speed will require readjustment. After adjusting the governor, replace the knockout plug in the blower housing and secure speed stud lock nut.

Note:

Excessive droop may be caused by engine misfiring. Correct this condition before adjusting governor.

6-33 Charge Rate Adjustment

The adjustable resistor slide tap (in the charging circuit) is set to give approximately 2 ampere charging rate. For applications requiring frequent starts, check battery specific gravity periodically and, if necessary, increase the charging rate slightly (move slide tap nearer ungrounded lead) until it keeps the battery charged. Adjust only when engine is stopped. Avoid overcharging. The resistor is located in the connection box.

If a separate automatic demand control for starting and stopping is used, adjust the charge rate for its maximum 4.5 amperes. This normally keeps battery charged even if starts occur as often as 15 minutes apart.

6-34 Valve Clearance

Check valve clearance when the engine is at room temperature (about 70° F).

(a) Turn the flywheel until the cylinder is on its compression stroke. Use a socket wrench on the flywheel screw hex head.

Note:

To determine if the cylinder is in its compression stroke, observe the action of the Push rods as the engine is rotated in a clockwise direction. The exhaust valve push rod will be in its lowest position and the intake valve Push rod will be moving downward. As the piston reaches top dead center, the flywheel timing mark should be aligned with the timing pointer and the valve push rods stationary.

(b) Now turn the flywheel clockwise for an additional 10 to 45 degrees. There is no timing mark for this position, so it must be estimated. With the piston located in this position, it will be in its power stroke with both valves completely closed.
(c) Cylinder head bolt torques should be 37 to 40 ft/lbs. To change the setting of valve clearance, adjust the locknut which secures the rocker arm to the cylinder head (Fig. 6-6). Loosen the locknut to increase clearance and tighten it to reduce clearance.
(d) Check valve clearance with a feeler gauge between the rocker arm and the valve (Fig. 6-7) Increase or reduce the clearance until the proper gap is established. Correct valve

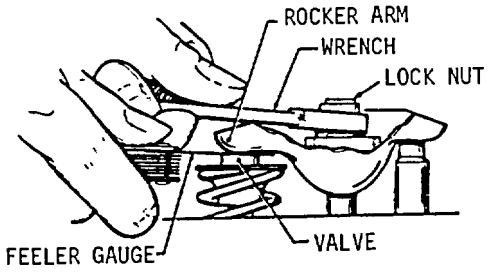


Fig. 6-7 Checking Valve Clearance

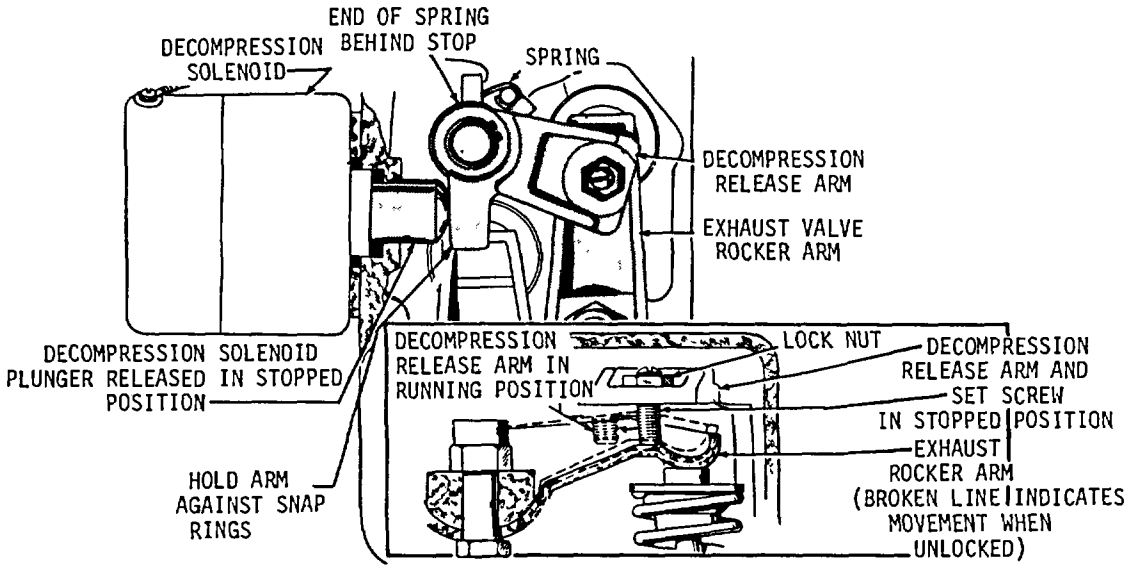


Fig. 6-8 Decompression Mechanism

clearance is 0.011-inch intake and 0.008-inch exhaust.

6-35 Decompression Release

The decompression release mechanism (Fig. 6-8) holds the exhaust valve open long enough for cranking speed (rpm's) to build up without opposition from compression. The release solenoid energizes when starting speed is attained to release the exhaust valve for operation as long as the engine runs. The solenoid deenergizes when the engine is shut down allowing the release mechanism to open the exhaust valve and stop the engine by decompression.

Note:

Before adjusting the decompression mechanism, the valves must be set for the correct clearance.

(a) With piston 10 degrees to 45 degrees past TDC on power stroke, hold arm in decompression position (tension against spring). Turn set screw so it just touches exhaust rocker arm. The release arm must be tight against snap ring during adjustment. Then turn screw exactly one revolution clockwise. Original factory setting is marked with white or yellow paint.

Note:

If screw is tightened more than one Turn piston could hit exhaust valve.

Hold the set screw and lock it into position with the attached nut. Turn the nut hand tight plus 1/4 to 1/2 turn to lock the mechanism.

(b) Release mechanism to allow compression and check the clearance between screw and rocker arm. Insert a feeler gauge between valve and rocker arm to take up valve clearance for this check. If there is no clearance, back off set screw until it just clears rocker arm.

When reassembling the rocker cover, remove the solenoid and dip the plunger "0" ring in oil. Reinstall solenoid when cover is on the engine. Align solenoid so terminal "SW" is above terminal "IGN".

6-36 General Maintenance

6-37 General

Follow a regular schedule of inspection and servicing, based on operating hours (Table 1). Keep an accurate logbook of maintenance, servicing, and operating time. Use the running time meter (optional equipment) to keep a record of operation and servicing. Regular service periods are recommended for normal service and operating conditions. For continuous duty, extreme temperature, etc., service more frequently. For infrequent use, light duty, etc., service periods can be lengthened accordingly. Refer to Figs. 6-9 and 6-10 for engine maintenance information.

WARNING

Before Commencing Any Maintenance Work On The Engine, Generator, Control Panel, Automatic Transfer Switch Or Associated Wiring, Disconnect Batteries. Failure To Do So Could Result In Damage To The Unit Or Serious Personal Injury In The Event Of Inadvertent Starting.

Operator should periodically make a complete visual inspection with set running at rated load. Some of the things to check for are as follows:

(a) Check all fuel and oil lines for possible leakage.
(b) Inspect exhaust lines and mufflers daily for possible leakage and cracks.
(c) Periodically or daily, remove moisture from sediment bowl.
(d) Inspect air shrouds for leaks and security. Be sure cooling fins are clean.
(e) Inspect electrical wires and connections for security and fray damage.

Note:

If generator requires major repair or servicing, contact an authorized Onan dealer or distributor.

6-38 AC Generator

Periodic inspections that coincide with engine oil changes will ensure good performance.

6-39 Batteries

Check the condition of the starting batteries at least every two weeks. See that connections are clean and tight. Keep the electrolyte at the proper level above the plates by adding distilled water. Check specific gravity, recharge if below 1.260.

6-40 Maintenance Schedule

Use this factory recommended maintenance schedule (based on favorable operating conditions) to serve as a guide to get long and efficient set life. Neglecting routine maintenance can result in failure or permanent damage to the set.

TABLE 1
OPERATOR AND SERVICE MAINTENANCE SCHEDULE

HOURS OF OPERATION	MAINTENANCE TASK
8	• Inspect generator set • Check fuel supply, see Note 1 • Check oil level • Check exhaust system
50 (more often in dusty conditions)	• Check air cleaner, see Figure 14
100	• Clean governor linkage, See Figure 15 • Change crankcase oil • Drain moisture from sediment bowl
200	• Clean crankcase breather, see Figure 13 • Replace oil filter • Check battery condition • Check generator slip rings and brushes, replace if worn to 5/16”
500	• Check start-disconnect circuit • Check valve clearances
600	• Change primary filter
2000	• Grind valves (it required) • Clean holes in rocker box oil line • Check nozzle spray pattern, see Note 2 • Clean generator • Replace anti-flicker points
3000	• Change secondary fuel filter
5000	• General overhaul (if required) see Note 3

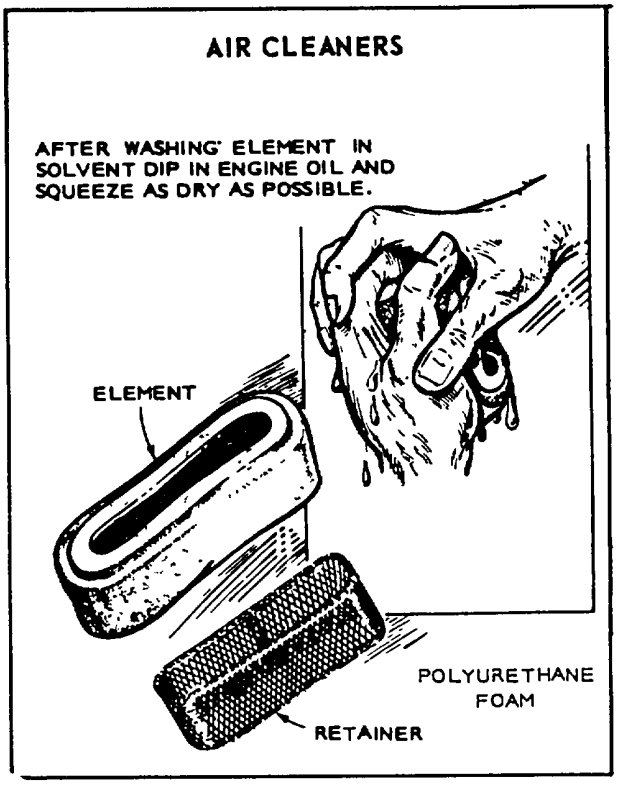
Note 1. Water or foreign material in fuel can ruin the injection system. If daily inspection shows water or excessive dirt in sediment bowl, fuel handling and storing facilities should be checked and situation corrected. Primary and secondary fuel filters must be replaced following correction of fuel contamination problem.

Note 2. This service must be conducted by trained diesel injection equipment personnel with suitable test facilities. Omit this service until these conditions can be met.

Note 3. Tighten head bolts and adjust valve clearance after first 50 hours on a new or overhauled engine.

6-41 Oil Filter Change

Place pan under oil filter and remove by turning counterclockwise. Clean filter mounting area. Install new filter, oil filter gasket and turn filter on clockwise until gasket touches mounting base, then tighten 1/4 to 1/2 turn.



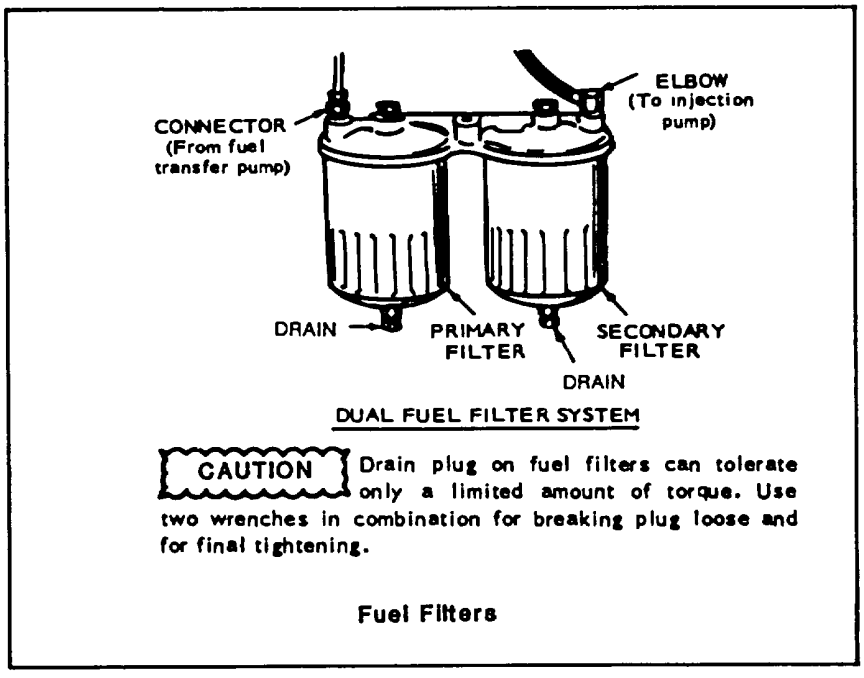


Fig. 6-9 Air Cleaner And Fuel Filter Maintenance

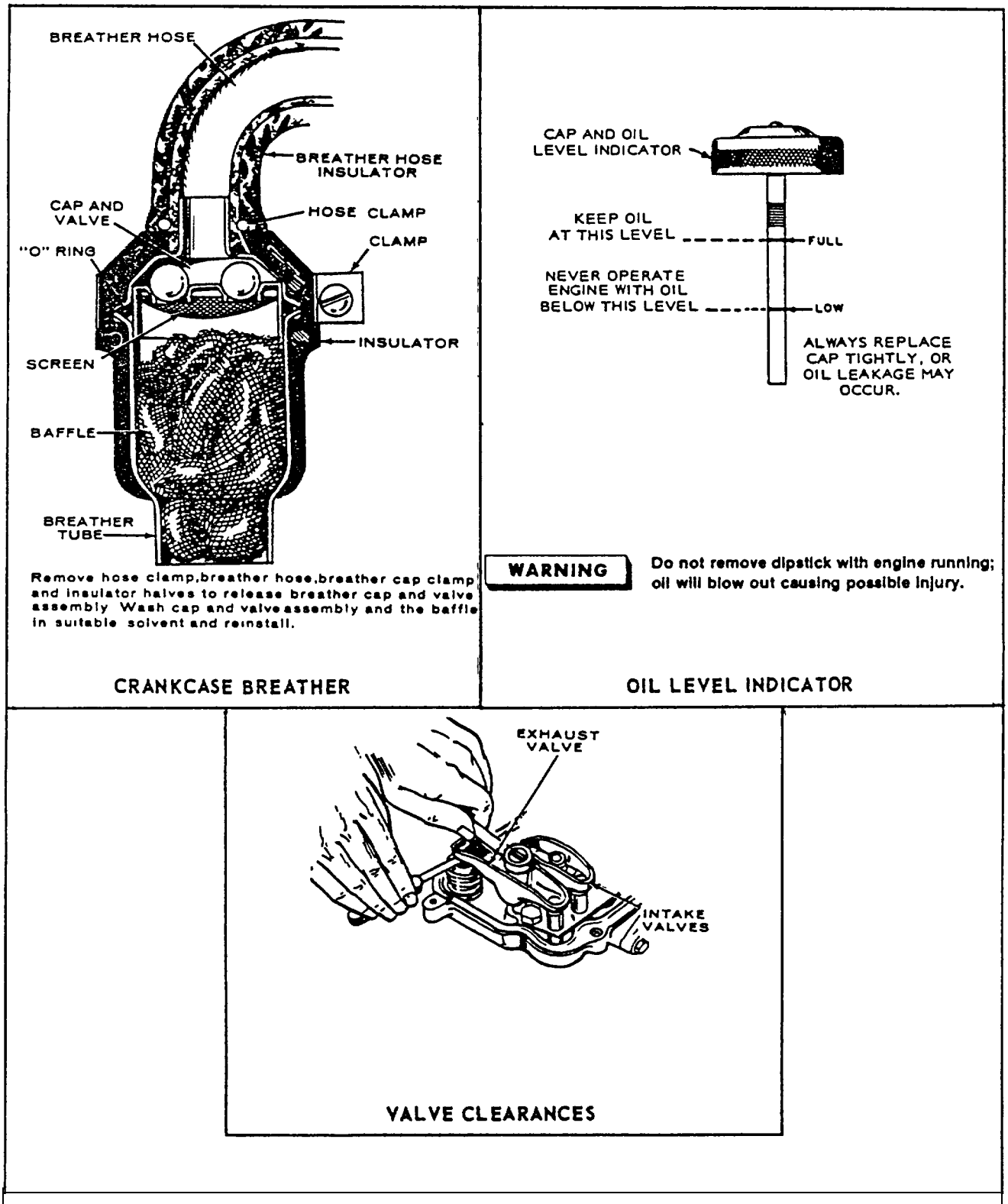


Fig. 6-10 Oil Level, Valves, And Crankcase Breather Maintenance

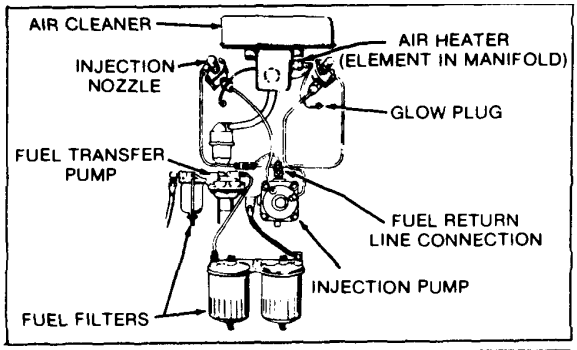
6-42 Onan Diesel Starting Guide

IMPORTANT!

KEEP ENTIRE FUEL SYSTEM CLEAN AND FREE FROM WATER
- DIESEL INJECTION PUMPS WILL FAIL IF SYSTEM CLEANLINESS IS NEGLECTED

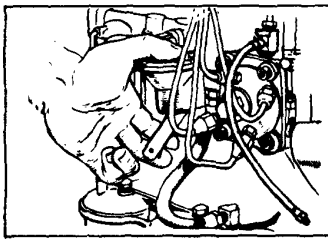
INJECTION PUMPS AND NOZZLES ARE NOT FIELD REPAIRABLE
- WHEN TROUBLESHOOTING, CHECK ALL OTHER COMPONENTS FIRST

WARNING **DO NOT USE ETHER STARTING AIDS! ETHER IS EXTREMELY EXPLOSIVE AND MAY CAUSE SERIOUS PERSONAL INJURY. ENGINE DAMAGE IS ALSO LIKELY.**



BEFORE STARTING:

CHECK FUEL SUPPLY. BE SURE SHUTOFF VALVES ARE OPEN.



PRIME FUEL SYSTEM IF: FUEL FILTERS WERE DRAINED OR CHANGED, SYSTEM WAS JUST INSTALLED, FUEL TANK RAN DRY.

TO PRIME PUMP, MOVE PRIMING LEVER UP AND DOWN UNTIL FUEL FLOWS STEADILY FROM RETURN LINE (DISCONNECTED).

PREHEAT COLD ENGINE: PUSH PREHEAT SWITCH AND HOLD —
- **30 SECONDS IF ABOVE 55°F (13°C);**
- **60 SECONDS IF BELOW 55°F (13°C).**

TO START:

RELEASE PREHEAT

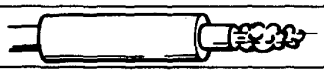
ENGAGE START SWITCH

LIMIT CRANKING TO 15 TO 20 SECONDS TO CONSERVE BATTERY. ALLOW 1 MINUTE BEFORE RE-CRANKING.

IF ENGINE DOES NOT START:

IF ENGINE FIRED, REPEAT ABOVE PROCEDURES, INCLUDING PRE-HEAT. IF IT STILL DOES NOT START, PROCEED AS FOLLOWS:

TEMPERATURES BELOW 32°F (0°C): **USE NUMBER 1 DIESEL FUEL. USE CORRECT VISCOSITY OIL. KEEP BATTERIES FULLY CHARGED. DO NOT USE ETHER STARTING AID.**



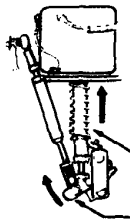
OBSERVE ENGINE EXHAUST "SIGNALS":

BLUE-WHITE EXHAUST SMOKE: ENGINE IS GETTING FUEL

1. **OBSERVE AIR HEATER THRU AIR INLET HOLE OR BY REMOVING AIR CLEANER.**
2. **ENGAGE PREHEAT.**
3. **IF HEATER ELEMENT DOES NOT GLOW RED WITHIN 30 SECONDS, CHECK AIR HEATER AND GLOW PLUG WIRING:**
   - **CONNECTIONS TIGHT?**
   - **FREE FROM CORROSION?**

LITTLE OR NO EXHAUST SMOKE: ENGINE IS NOT GETTING FUEL.
- **PRIME FUEL SYSTEM AS SHOWN ABOVE:**
  OBSERVE FUEL FLOW FROM RETURN LINE

FUEL FLOWS STEADILY

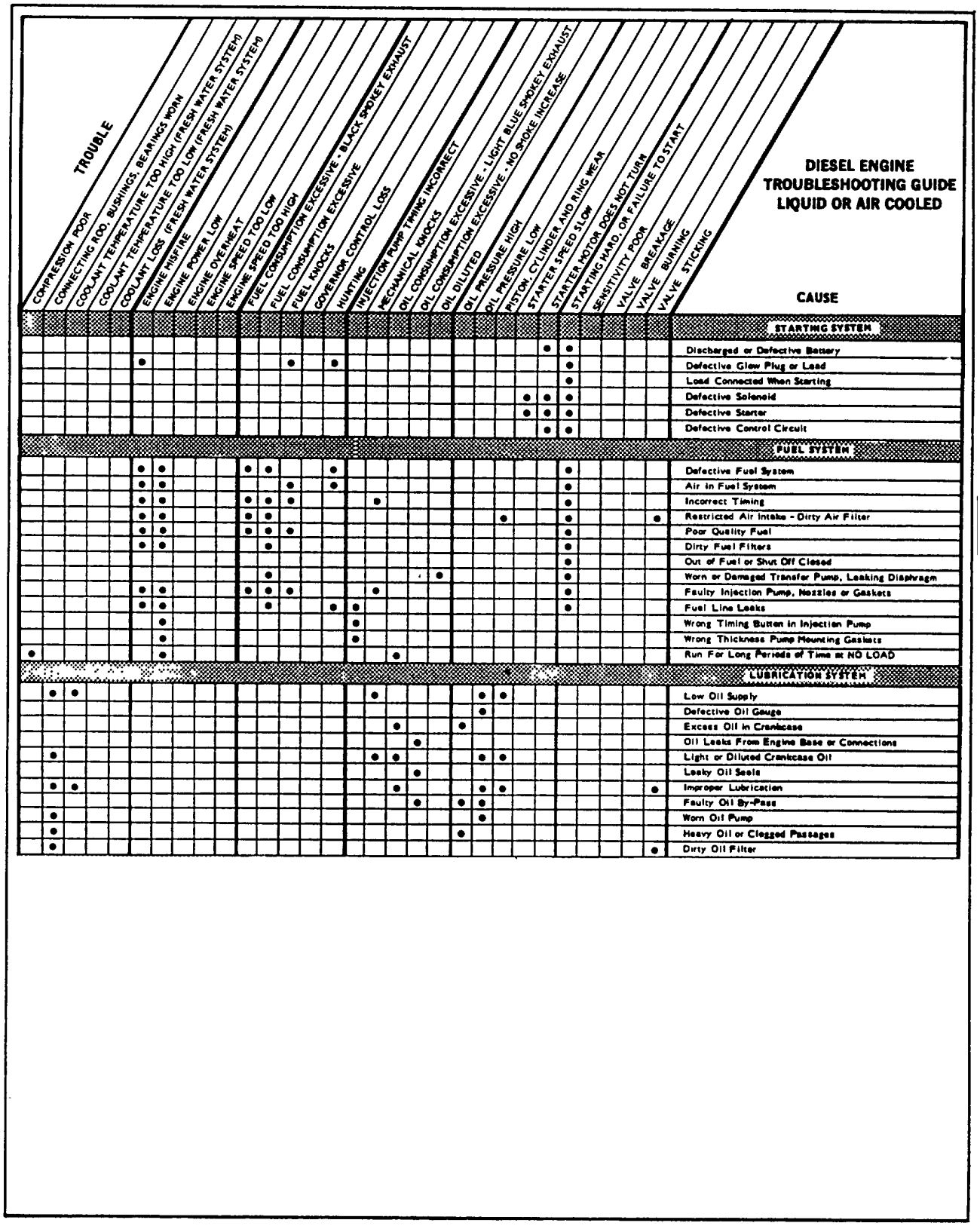


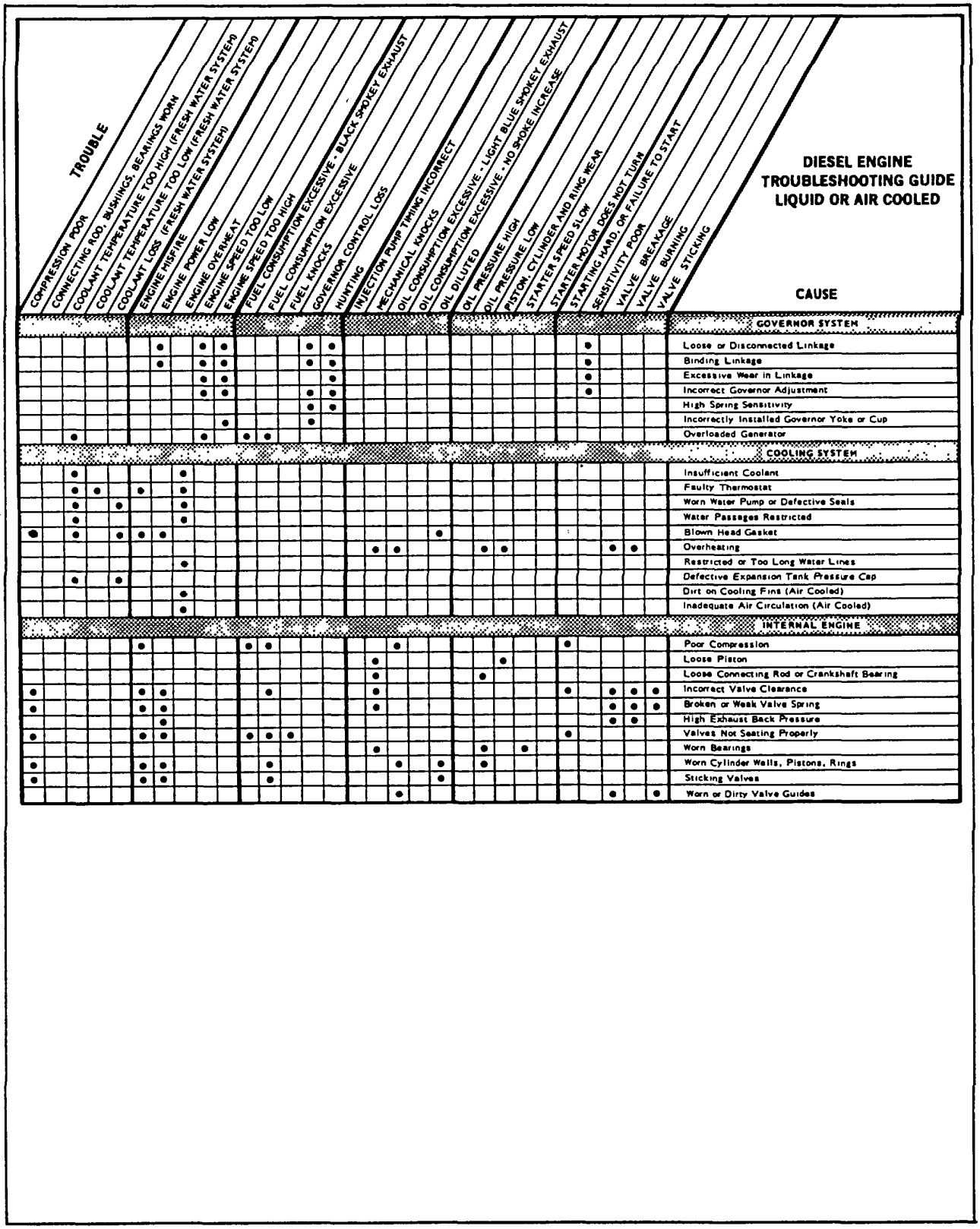
CHECK FUEL SOLENOID: SOLENOID ROD SHOULD PULL IN AND THROTTLE ARM FOLLOW (AS SHOWN) WHEN START SWITCH IS TURNED ON. IF NOT, CHECK FOR
- **BINDING LINKAGE**
- **LOOSE OR BROKEN WIRES**

LITTLE OR NO FUEL FLOW

CHECK FUEL SUPPLY SYSTEM:
- **FUEL TANK EMPTY?**
- **SHUTOFF VALVES CLOSED?**
- **FUEL LINES KINKED?**
- **LOOSE CONNECTIONS?**
- **CLOGGED FUEL FILTERS?**

IF ENGINE IS STILL NOT GETTING FUEL, CHECK TRANSFER PUMP:
1. **CRANK ENGINE AND OBSERVE FUEL FLOW FROM RETURN LINE.**
2. **IF FUEL DOES NOT SPURT OUT, PUMP MAY BE DEFECTIVE.**


DIESEL ENGINE
TROUBLESHOOTING GUIDE
LIQUID OR AIR COOLED
TROUBLE
CAUSE
COMPRESSION POOR
CONNECTING ROD, BUSHINGS, BEARINGS WORN
COOLANT TEMPERATURE TOO HIGH (FRESH WATER SYSTEM)
COOLANT TEMPERATURE TOO LOW (FRESH WATER SYSTEM)
COOLANT LOSS (FRESH WATER SYSTEM)
ENGINE MISFIRE
ENGINE POWER LOW
ENGINE OVERHEAT
ENGINE SPEED TOO LOW
ENGINE SPEED TOO HIGH
FUEL CONSUMPTION EXCESSIVE - BLACK SMOKEY EXHAUST
FUEL CONSUMPTION EXCESSIVE
FUEL KNOCKS
GOVERNOR CONTROL LOSS
HUNTING
INJECTION PUMP TIMING INCORRECT
MECHANICAL KNOCKS
OIL CONSUMPTION EXCESSIVE - LIGHT BLUE SMOKEY EXHAUST
OIL CONSUMPTION EXCESSIVE - NO SMOKE INCREASE
OIL DILUTED
OIL PRESSURE HIGH
OIL PRESSURE LOW
PISTON, CYLINDER AND RING WEAR
STARTER SPEED SLOW
STARTER MOTOR DOES NOT TURN
STARTING HARD, OR FAILURE TO START
SENSITIVITY POOR
VALVE BREAKAGE
VALVE BURNING
VALVE STICKING
STARTING SYSTEM
Discharged or Defective Battery
Defective Glow Plug or Lead
Load Connected When Starting
Defective Solenoid
Defective Starter
Defective Control Circuit
FUEL SYSTEM
Defective Fuel System
Air in Fuel System
Incorrect Timing
Restricted Air Intake - Dirty Air Filter
Poor Quality Fuel
Dirty Fuel Filters
Out of Fuel or Shut Off Closed
Worn or Damaged Transfer Pump, Leaking Diaphragm
Faulty Injection Pump, Nozzles or Gaskets
Fuel Line Leaks
Wrong Timing Button in Injection Pump
Wrong Thickness Pump Mounting Gaskets
Run For Long Periods of Time at NO LOAD
LUBRICATION SYSTEM
Low Oil Supply
Defective Oil Gauge
Excess Oil in Crankcase
Oil Leaks From Engine Base or Connections
Light or Diluted Crankcase Oil
Leaky Oil Seals
Improper Lubrication
Faulty Oil By-Pass
Worn Oil Pump
Heavy Oil or Clogged Passages
Dirty Oil Filter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VALVE STICKING
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Loose or Disconnected Linkage
Binding Linkage
Excessive Wear in Linkage
Incorrect Governor Adjustment
High Spring Sensitivity
Incorrectly Installed Governor Yoke or Cup
Overloaded Generator
COOLING SYSTEM
Insufficient Coolant
Faulty Thermostat
Worn Water Pump or Defective Seals
Water Passages Restricted
Blown Head Gasket
Overheating
Restricted or Too Long Water Lines
Defective Expansion Tank Pressure Cap
Dirt on Cooling Fins (Air Cooled)
Inadequate Air Circulation (Air Cooled)
INTERNAL ENGINE
Poor Compression
Loose Piston
Loose Connecting Rod or Crankshaft Bearing
Incorrect Valve Clearance
Broken or Weak Valve Spring
High Exhaust Back Pressure
Valves Not Seating Properly
Worn Bearings
Worn Cylinder Walls, Pistons, Rings
Sticking Valves
Worn or Dirty Valve Guides

Index Section 7

Notes

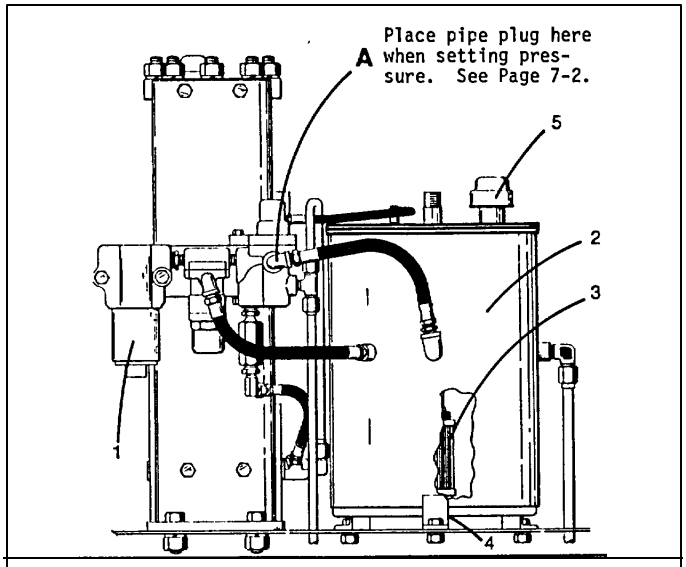

Fig. 7-1 Hydraulic Power Supply

(1) Filter
(2) Sump Tank
(3) Strainer
(4) Drain Plug
(5) Dipstick and Breather

7-1 S-o-M System Sump Tank

7-2 To check:

(a) Park machine on level ground.
(b) Disengage the master clutch, and shut down the engine.
(c) Reduce the S-o-M system to zero by working the levers back and forth. If this is not done, a false reading will be obtained due to the amount of oil stored in the accumulator.
(d) Remove and wipe off the dipstick. Insert the dipstick in the tank, remove and read. Add oil as necessary. Use only FMC hydraulic oil in the system. This oil is available in four weights, and comes in either 5 gallon cans or 55 gallon drums. The weights and stock numbers are as follows:
    (1) 5 Vis
        5 Gal Can (18.9L) 830661001
        55 Gal Drum (208L) 830661002
    (2) 5 Vis 20
        5 Gal Can (18.9L) 830662001
        55 Gal Drum (208L) 830662002
    (3) 10 Vis 20
        5 Gal Can (18.9L) 830663001
        55 Gal Drum (208L) 830663002
    (4) 20 Vis 40
        5 Gal Can (18.9L) 830664001
        55 Gal Drum (208L) 830664002

    The 5 vis oil is to be used in machines operating in temperatures of -35° F to 20° F (-37° C to 7° C). The 5 vis 20 oil is to be used in temperatures of -5° F to 65° F (-20° C to 18° C). The 10 vis 20 oil is to be used in temperatures of 10° F to 90° F (-12° C to 32° C). The 20 vis 40 oil is to be used in temperatures of 30° F to 115° F (-1° C to 46° C).

    In machines operating in temperatures of -40° F and lower it is permissible to dilute the oil with uncracked kerosene. Kerosene will evaporate, especially during warm spells, therefore, the sump tank level should be checked more often than usual. Caution should be used in diluting with kerosene in temperatures where it becomes this cold only upon occasion.

    When ordering oil, always specify the grade, stock number, and amount needed.

7-3 To change:

(a) Park the machine on level ground.
(b) Decrease the operating pressure to zero by working the control levers back and forth.
(c) Remove the oil by removing the magnetic drain plug from the bottom of the tank.

WARNING

Use Fuel Oil Or Cleaning Solvent In A Well Ventilated Area, Away From Flames.

(d) Remove and thoroughly clean the breather cap on top of the tank. Use kerosene or some similar approved solvent.
(e) Remove the top cover from the sump tank. Remove and thoroughly clean the sump tank strainer in kerosene or some similar solvent.
(f) Thoroughly clean the inside and outside of the tank and cover with kerosene or some similar approved solvent.
(g) Reassemble the sump tank strainer and cover. Clean and replace the magnetic drain plug.
(h) Replace the system filter as explained later in this section.
(i) Refill the system with oil as specified earlier in this section. When adding oil, use a clean funnel equipped with a screen filter. The importance of cleanliness cannot be stressed too highly when pouring oil into the hydraulic system. Dirt, dust lint or water must not be allowed to enter the system.
(j) Submerge the breather cap in heavy lubricating oil before installing it on the sump tank.

7-4 S-o-M System Filter (Fig. 7-2)

7-5 To change:

(a) Decrease the system pressure to zero by working the levers back and forth.
(b) Remove the filter housing and element.
(c) Remove the filter element from the housing.
(d) Remove the gasket from the filter head and the rubber washer from the filter housing.
(e) Thoroughly clean all parts in approved low toxicity non-flammable solvent. Use good ventilation.

    Kerosene or diesel fuel can be used but don't smoke while using. Never use gasoline or other highly flammable solvents.
(f) Install a new rubber washer in the housing.

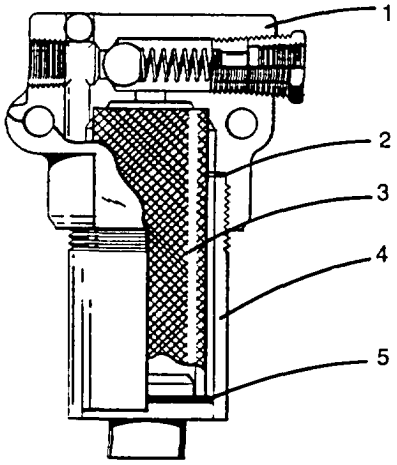

Fig. 7-2 S-o-M System Filter

(1) Head
(2) Gasket
(3) Element
(4) Body
(5) Washer

Install a new gasket in the head.

(g) Install a new filter element in the housing.
(h) Screw the housing into the head. Tighten to 150 ft/lbs. (200.4 N-m) torque.

7-6 Relief Valve Assembly

During normal machine operation the S-o-M pressure gauge will register between 900 and 1,050 (6205-7239 kPa) PSI which are the values the unloading valve is set at. If the unloading valve should malfunction, pressure could rise well above 1,050 PSI (7239 kPa). For this reason, a relief valve is included in the S-o-M system. The relief valve is set at 1250 P.S.I. (8615 kPa). The relief valve is adjusted as follows:

(a) Disengage the master clutch. Shut down engine.
(b) Reduce S-o-M system pressure to zero by working the control levers back and forth.
(c) Remove the return line from the unloading valve at (A) in Fig. 7-1. Place a pipe plug in the hole to force system pressure to build up to relief valve pressure.
(d) Start the engine and read the pressure off the gauge in the front instrument panel. If the gauge reading is 1,300 PSI (8963 kPa) or more, immediately shut off the engine. This would indicate too high a setting, or a stuck spool in the valve
(e) If the setting is not 1250 P.S.I. (8615 kPa), it may be changed as follows:
    (1) Remove valve cap
    (2) Add or subtract shims (6) to change relief valve setting. The following shims are used.
        (a) JC1690 ---------- 20 Ga. (.911mm)
        (b) JC1691 ---------- 28 Ga. (.378mm)

    Setting the pressure is a trial and error process. Add or subtract one shim at a time until correct pressure is reached.

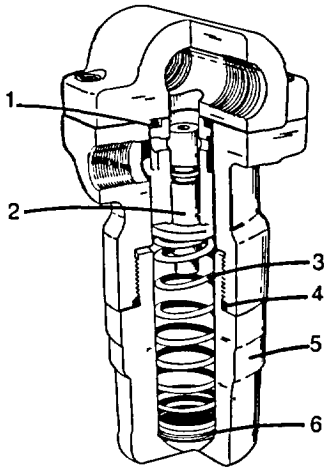

Fig. 7-3 Relief Valve Assembly

(1) "O" Ring
(2) Piston
(3) Spring
(4) "O" Ring
(5) Valve Cap
(6) Shims

WARNING

Reduce S-o-M System Pressure To Zero As Explained In Steps A And B Before Unscrewing The Relief Valve Cap, Or Before Removing The Pipe Plug From The Unloading Valve. Pieces Of The Valve May Explode Under Pressure Otherwise And Could Cause Injury.

(f) Shut off the engine. Reduce system pressure to zero by working the control levers back and forth.
(g) Remove the pipe plug from the unloading valve. Replace the return line leading to the sump tank.

Operator's Manual Section 8 -Troubleshooting Procedures

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Notes

Operator's Manual Section 8 -Troubleshooting Procedures

Troubleshooting Procedures:

Problem	Probable Cause	Solution
Carrier and Upper Engines		
Engine does not crank	(1) Battery defective or discharged. (2) Ignition switch, starter motor or solenoid defective. (3) Loose or corroded connections.	(1) Charge or replace battery. (2) Replace components as necessary (see Shop Manual). (3) Clean and tighten connections.
Engine will not start	(1) No fuel. (2) Temperature too low. (3) Emergency shutdown actuated. (4) Upper engine - engine shutdown actuated. (5) Carrier engine - defective stop-switch or solenoid.	(1) Fill fuel tank. (2) Use fluid starting aid (see p. 1-15). (3) Push in on emergency shutdown cable. Reset emergency manual reset on engine. (4) Push in on cable. Check adjustment of shutdown. (5) Replace components as necessary (see Shop Manual).
Engine runs hot	(1) Low on coolant. (2) Loose belts. (3) Defective thermostat. (4) Restricted air flow through radiator.	(1) Check coolant level. Fill as necessary (see p. 2-29). (2) Tighten belts (see p. 2-22). (3) Replace thermostat (see Shop Manual). (4) Clean radiator cooling fins.
Engine lacks power, runs irregularly or misfires	(1) Water in fuel or clogged filters (2) Loss of compression, sticking or burned valves, defective injectors.	(1) Remove water from fuel and filters. Replace filter elements (see p. 2-28). (2) Engine may need a tune up or major overhaul. Refer to Shop Manual.
Engine oil pressure drops suddenly	(1) Loss of oil in crankcase. (2) Defective gauge, sending unit, oil pump.	(1) Check for leaks. Repair and refill (see p. 2-27). (2) Replace components as necessary (see Shop Manual).
Voltmeter reading incorrectly	(1) Charging system defective.	(1) Check electrical system and repair (see p. 1-19).
Braking System		
Insufficient braking action	(1) Brakes out of adjustment. (2) Low air pressure in system. (3) Brake shoes and/or drums worn. (4) Brakes overheated because of excessive use or faulty air system.	(1) Adjust brakes (see p. 3-4, 3-5). (2) Check for leaks, and/or defective components (see Shop Manual) (3) Replace components as necessary (see Shop Manual). (4) Allow brakes to cool. Check and repair system (see Shop Manual).
Brakes engage unevenly or are noisy	(1) Brake shoes, drums, or mountings Worn or damaged.	(1) Check, repair or replace as required (see Shop Manual).
Transmission and Clutch		
Transmission shifts incorrectly	(1) Fluid level low. (2) Transmission defective. (3) Shifter slave or linkage not lubricated.	(1) Fill to correct level (see p. 2-14). (2) Repair or replace (see Shop Manual). (3) Lubricate. See lube chart.

Problem	Probable Cause	Solution
Transmission shifts incorrectly (cont.)	(4) Shifter slave or linkage defective	(4) Repair or replace (see Shop Manual).
	(5) Transmission air controls defective.	(5) Repair or replace controls (see Shop Manual).
Transmission overheats	(1) Fluid level low.	(1) Fill to correct level (see p. 2-14).
	(2) Transmission defective.	(2) Repair or replace (see Shop Manual).
Transmission grinds when shifting	(1) Clutch not properly disengaging.	(1) Adjust clutch (see p. 3-1).
Clutch slipping	(1) Clutch not properly engaging.	(1) Adjust clutch (see p. 3-1).
	(2) Clutch disc's worn.	(2) Replace clutch assembly (see Shop Manual).
	(3) Oil on clutch disc's.	(3) Disassemble and repair. Replace clutch assembly (see Shop Manual).
Steering and Driveline		
Vibration or defective steering	(1) Misalignment or ineffective power steering.	(1) Realign steering (see p. 3-3). Check and repair steering system (see Shop Manual).
	(2) Tires out of balance.	(2) Balance tires.
	(3) Damaged wheels or tires.	(3) Replace wheels or tires.
Driveline and/or rear axle noise	(1) Worn or damaged components.	(1) Repair or replace (see Shop Manual).
Hydraulic Outrigger System		
A beam or jack cylinder will not operate	(1) Defective switch or electrical connection.	(1) Check switch and electrical system. Repair or replace components.
	(2) Defective solenoid.	(2) Replace solenoid (see Shop Manual).
	(3) Mechanical interference between outrigger box and beam.	(3) Determine what is causing the interference. Correct the problem (see Shop Manual).
No beams or jacks will operate	(1) Relief valve set incorrectly.	(1) Adjust relief valve setting (see p. 3-5).
	(2) Pump failure.	(2) Repair or replace (see Shop Manual).
	(3) Power take off not engaged.	(3) Engage power take off (see p. 1-12).
	(4) Jacks only - defective blocking valve.	(4) Repair or replace valve. (see Shop Manual).
	(5) Low oil level.	(5) Refill sump tank (see p. 2-15).
Jacks will not lift machine off ground	(1) Relief valve set wrong.	(1) Adjust relief valve setting (see p. 3-5).
	(2) Pump failure.	(2) Repair or replace (see Shop Manual).
Speed-o-Matic Hydraulic Control System		
Gauge reading too high Note: Gauge should read between 900-1050 P.S.I.	(1) Unloading valve set too high.	(1) Adjust unloading valve pressure setting (see Shop Manual).
	(2) Unloading valve defective.	(2) Replace unloading valve (see Shop Manual).
	(3) Defective gauge.	(3) Replace.

Problem	Probable Cause	Solution
Gauge reading too low	(1) Relief valve set too low.	(1) Adjust relief valve (see p. 7-2).
	(2) Unloading valve set too low.	(2) Adjust unloading valve pressure setting. (see Shop Manual).
	(3) Unloading valve or relief valve defective.	(3) Replace (see Shop Manual).
	(4) Defective gauge.	(4) Replace.
	(5) Defective pump.	(5) Replace.
	(6) Low oil level.	(6) Refill with oil (see p. 7-2).
	(7) Restricted suction hose.	(7) Replace hose.
Pressure fluctuates rapidly	(1) Accumulator discharged.	(1) Repair or replace charge with dry nitrogen (see Shop Manual).
	(2) Internal leakage in system.	(2) (see Shop Manual).
No pressure	(1) Pump belt slipping or broken.	(1) Replace belt. Adjust tension.
	(2) Pump defective.	(2) pump (see Shop Manual).
	(3) Clogged inlet strainer.	(3) Clean or replace strainer. Change system oil (see p. 7-2).
Torque Convertor and Master Clutch		
Master clutch slips or jumps out of engagement	(1) Adjusted wrong.	(1) Adjust (see p. 4-1).
	(2) Clutch discs worn.	(2) Replace (see Shop Manual).
	(3) Oil on clutch discs.	(3) Repair oil leak. Replace clutch discs (see Shop Manual).
Master clutch will not engage	(1) Adjusted wrong.	(1) Adjust (see p. 4-1).
	(2) Clutch defective.	(2) Repair or replace (see Shop Manual).
Converter slipping	(1) Low oil level.	(1) Refill with oil (see p. 2-37).
	(2) Defective converter.	(2) Repair or replace (see Shop Manual).
Converter overheats	(1) Low oil level	(1) Refill with oil (see p. 2-37). m
	(2) Converter has been stalled During operation.	(2) Stop machine operations until converter cools down.
Load Hoist System		
Machine will not lift load	(1) Load too heavy for machine as Set up.	(1) Compare load weight to capacity chart. Make sure load is with-in capacity. Make sure enough parts of line are being used. See chart in operator's cab. Adjust boom length, or load radius until load is within capacity. Too many wraps of cable on the drum will decrease line pull. Reduce amount of cable on drum.
	(2) Clutches are slipping.	(2) Adjust clutches (see p. 4-6). Check clutch shoes and drum for Scoring, glazing, oil on surface. Clean or replace parts as necessary (see Shop Manual). Check S-o-M pressure at clutch Cylinder. Should be 900-1050 P.S.I. If not, adjust control Stand linkage. Set pressure in system (see p. 4-6, 7-2).

Problem	Probable Cause	Solution
Machine will not lift load (cont.)		Make sure clutches are assembled in energized position (see Shop Manual 5-9-2-0).
	(3) Torque converter slipping.	(3) Load to heavy for machine as equipped (see Cause 1 previously) Torque converter defective. Repair or replace (see Shop Manual) Converter low on oil. Refill will oil (see p. 2-37).
	(4) Master clutch slipping.	(4) Adjust (see p. 4-1). Replace clutch linings (see Shop Manual)
Load will not lower (Free fall)	(1) Brake out of adjustment. (2) Load too light to overhaul cable (too many parts of line).	(1) Adjust brake (see p. 4-4). (2) Power load down with lowering clutch. Reeve with fewer parts of line.
	(3) Cable jammed on drum or sheave.	(3) Remove load with auxiliary crane. Lower boom to the ground. Unjam cable. Inspect cable for damage - replace if necessary.
	(4) Bearing failure in side frame.	(4) Remove load with auxiliary crane. Remove and replace bearing (see Shop Manual).
Cannot hold load with brake	(1) Brake out of adjustment. (2) Brake linings glazed or contaminated.	(1) Adjust brake (see p. 4-4). (2) Replace brake linings (see Shop Manual).
Boom Hoist System		
Boom will not raise	(1) Boom too long.	(1) Reduce boom length below max-aximum listed in operator's manual.
	(2) Clutch slipping.	(2) Adjust clutch (see p. 4-6). Check clutch shoes and drum for scoring, glazing, oil on surface. Clean or replace parts as necessary (see Shop Manual). Check S-o-M pressure at clutch cylinder. Should be 900-1050 P.S.I. If not, adjust control stand linage - set pressure in system (see p. 4-6, 7-2). Make sure clutch is assembled in energized position (see Shop Manual 5-9-2-0).
	(3) Brake not releasing.	(3) Adjust brake (see p. 4-5). Inspect ball check valve in hydraulic line leading to B.H. brake cylinder. Ball may be stuck.
	(4) Torque converter slipping.	(4) Converter low on oil. Refill with oil (see p. 2-37). Torque converter defective. Repair or replace (see Shop Manual).
	(5) Cable jammed on drum or sheave.	(5) Support boom with auxiliary Crane. Unjam cable. Lower boom to the ground. Inspect cable for damage. Replace if necessary.

Problem	Probable Cause	Solution
Boom will not lower	(1) Pawl not releasing.	(1) Release pawl with operator's control (see p. 1-24). Check to see if pawl is stuck. If so, remove, clean up, and lubricate. Replace and adjust pawl (see Shop Manual).
	(2) Brake not releasing.	(2) See #3 under Cause: Boom will not raise.
	(3) Planetary brake malfunctioning.	(3) Adjust planetary brake (see p. 4-3). Check S-o-M pressure at planetary brake cylinder. Should be 900-1050 P.S.I. If not, adjust control stand linkage. Set pressure in system (see p. 4-6, 7-2).
	(4) Cable jammed on sheave.	(4) See #1 under Cause: Boom will not raise.
	(5) Defective lowering planetary.	(5) Engage B.H. pawl. Disassemble and repair or replace planetary (see Shop Manual).
Boom creeps down	(1) B.H. brake slipping.	(1) Adjust (see p. 4-5). Lower boom to the ground. Disassemble brake and inspect for contaminated or glazed linings. Replace as necessary (see Shop Manual).
Boom lowers when trying to raise	(1) Engine running too slow.	(1) Increase engine throttle setting.
	(2) Boom hoist clutch slipping.	(2) Adjust clutch (see p. 4-6). Check clutch shoes and drum for scoring, glazing, oil on surface. Clean or replace parts as necessary (see Shop Manual). Check S-o-M pressure at clutch cylinder. Should be 900-1050 P.S.I. If not, adjust control stand linkage. Set pressure in system (see p. 4-6, 7-2).
Will not boom up with load	(1) Engine running too slowly.	(1) Increase engine throttle setting.
	(2) Boom hoist clutch slipping.	(2) See #2 under Cause: Boom lowers when trying to raise.
	(3) Overload	(3) Check capacity chart. Make sure load is within capacity of machine.
Swing System		
Machine will not swing either left or right.	(1) Swing lock engaged	(1) Disengage (see p. 1-21).
	(2) Swing brake engaged.	(2) Disengage (see p. 1-21)
	(3) Master clutch not engaged.	(3) Engage (see p. 1-21).
		Check operating controls and adjustment (see p. 4-1).
	(4) Mechanical failure.	(4) Inspect shafting, pinion, bevel gears, drive chain, turntable bearing. Repair or replace components as necessary (see Shop Manual).

Problem	Cause	Solution
Machine swings one way and not the other	(1) Defective swing clutch.	(1) Adjust clutch (see p. 4-6) Check clutch shoes and drum for scoring, glazing, oil on surface. Clean or replace parts as necessary (see Shop Manual). Check S-o-M pressure at clutch cylinder. Should be 900-1050 P.S.I. If not, adjust control stand linkage. Set pressure in system (see p. 4-6, 7-2). Make sure clutch is assembled in energized position (see Shop Manual 5-9-2-0). Check clutch shoes and arms for binding on pins. Free up and lubricate.
Jerky or rough swing	(1) Turntable bearing binding up. (2) Worn bevel gears. (3) Swing brake dragging.	(1) Refer to lubrication chart. Thoroughly lubricate the bearing. If this doesn't help, contact factory service department (2) Repair or replace (see Shop Manual). (3) Disengage. Adjust if required (see p. 4-2). Check linings for scoring or foreign objects. Repair or replace as necessary (see Shop Manual).
Swing brake will not hold	(1) Adjusted wrong, control adjusted wrong. (2) Oil or grease on linings. Worn linings.	(1) Adjust (see p. 4-2). (2) Clean or replace linings (see Shop Manual).
Swing brake will not release	(1) Swing brake control adjusted wrong. (2) Swing brake adjusted wrong. (3) Rusty or bound up pins and linkage.	(1) Adjust (see p. 4-6). (2) Adjust (see p. 4-2). (3) Disassemble and repair. Lubricate (see Shop Manual).
Gear Train		
Gear train will not turn	(1) Master clutch not engaged. (2) Mechanical failure of drive chain or reduction shafts.	(1) Engage master clutch (see p. 1-21). Check adjustment of clutch and controls (see p. 4-1). Repair or replace master clutch. (2) Determine where failure is. Repair or replace parts as required (see Shop Manual).
Gear train is noisy	(1) No lubricant on gears. (2) Worn gear teeth. (3) Bad bearing on one or more shafts.	(1) Refer to lubrication chart. Lubricate gear train. (2) Check backlash between gear teeth. Replace worn gears (see Shop Manual). (3) Isolate the bad bearing. Replace (see Shop Manual).

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9-1 Upper Engine

Type	GM 6-71N with single stage torque converter
Bore and stroke	4-1/4" x 5"
Number of cylinders	6
Displacement	425.6 cubic inches
High idle speed	2040 RPM
RMP at full load speed	1900 RPM
H.P. at F.L.S.	171
Peak torque	1400 ft/lbs
Electrical system	12 volt
Crankcase capacity	7.25 gal.
Cool system capacity	8.75 gal.

9-2 Carrier Engine

Type	GM 6V-92TA
Bore and stroke	4.84" x 5"
Displacement	552 cubic inches
Governed load speed	2100 RPM
Brake H.P. at governed load speed	318
Peak torque	900 ft/lbs at 1400 RPM
Electric system	12 volt
Crankcase capacity	6.25 gal.
Cool system capacity	

9-3 Fuel Tanks

Upper (one)	75 gal. cap.
Carrier (two)	45 gal. cap. each

9-4 Transmission - Upper

Make	FMC
Type	Quadruple roller chain
Torque Converter	
Make	Allison
Model	TCD0A 475
Type	Single stage

9-5 Transmission & Clutch - Carrier

Main Transmission	
Make	Eaton
Model	RT0 915
Type	13 speed road ranger
Auxiliary	
Make	Eaton
Model	AT 1202
Type	Two speed
Clutch	
Make	Lipe Rollway
Type	14", Two plate, dry disc

9-6 Outriggers

Make	FMC
Type	Electric/hydraulic
Pump	
Make	Vickers.
Model	V20P series
type	Vane w/flow divider and relief valve
Power takeoff	
Make	Tulsa
Model	28HG6
Type	Onespeed - disengage system
Sump tank	
Make	FMC
Capacity	35 gal.
Control valves	
Make	Racine hydraulics
Model	3/4" valve stack (jacks) 3/8" valve stack (beams)
Type	Electric solenoid operated
Mechanical	
Make	FMC
Type	Full width, double box, pin connected to carrier frame
Cylinders	
Make	FMC
Type	Double acting hydraulic

9-7 Power Steering

Type	Power assist
Power	Hydraulic
Steering gear	
Make	Ross
Model	HSP 70
Turning circle diameter. Over outside of front bumper	120 ft.

9-8 Brakes

Type	8 wheel air brakes
Actuators	Single diaphragm on front, double diaphragm on rear.
Size and area	Rear wheels - total braking area 574 sq. inches per axle Front wheels - total braking area 248 sq. inches per axles.
Parking	Brakes on 4 rear wheels apply and air chamber push rods mechanically lock. Controlled by air from dash.
Emergency	Brakes on 4 rear wheels apply and mechanically lock if air pressure drops below 40 P.S.I.

9-9 Electrical System (Carrier)

Upper	12 volt, with 2, 225 amp. hour batteries
	12 volt, with one 225 amp. hour battery.

9-10 Bumper Counterweight — Mounts on front bumper hooks. 11,400 lbs.

9-11 Carrier Speeds/ Transmission Gear Ratios

Based on GM 6V-92TA engine at 2,100 r p m. governed full load speed

Gear		Main-Eaton RTO-915	Auxiliary - Eaton AT-1202 1.00:1.00 M.p.h.	1.00:1.00 km/hr	2.036:1.00 M.p.h.	2.036:1.00 km/hr
High	10th	.81	42.0	67.58	20.6	33.15
	9th	1.00	34.0	54.71	16.7	26.87
	8th	1.26	27.0	43.44	13.3	21.40
	7th	1.59	21.4	34.43	10.5	16.89
	6th	2.04	16.7	26.87	8.1	13.03
	Rev.	2.21	15.4	24.78	7.6	12.23
Low	5th	2.59	13.1	21.08	6.5	10.46
	4th	3.20	10.6	17.06	5.2	8.37
	3rd	4.04	8.4	13.52	4.1	6.60
	2nd	5.10	6.7	10.78	3.3	5.31
	1st	6.51	5.2	8.37	2.6	4.18
	Rev.	7.06	4.8	7.72	2.4	3.86
Deep Reduction	5th	3.87	8.8	14.16	4.3	6.92
	4th	4.78	7.1	11.42	3.5	5.63
	3rd	6.03	5.6	9.01	2.8	4.51
	2nd	7.62	4.5	7.24	2.2	3.54
	1st	9.73	3.5	5.63	1.7	2.74
	Rev.	10.55	3.2	5.15	1.6	2.57

Creep speed in deep reduction low (1st) based on peak engine torque of 1,400 r.p.m. for GM. Creep speed Is 1.1 m.p.h. (1.77 km/hr)
Rear axle ratio 9.00 to 1.00

9-12 Cab (Carrier) — One man, offset, fully enclosed, steel construction. Shatterproof windows. Headliner. Floor mats. One man bucket seat.

Cab (Upper) — One man, modular type. Isolated from machinery house. Tempered glass windows. Cushioned seat with head rest.

Cab (Machinery) — All steel. Hinged doors on two sides. Removable panels for machinery access. Skid resistant finish on roof.

9-13 Upper Machinery Gear Train — Full function design. Two directional power available to all operating shafts. Operating shafts mounted in line bores on anti-friction bearings. All operating functions independent of one another.

9-14 Clutches — Speed-o-Matic power hydraulic actuated for all clutch-controlled functions (except engine master clutch). Internal expanding, 2-shoe type, aluminum alloy shoes; clutch drums bolted to spur gears - units mounted on shafts on anti-friction bearings; clutch spiders involute splined to shafts.

9-15 Swing System — Spur gear driven; single bevel gears (enclosed and running in oil) on horizontal and vertical swing shafts. Swing pinion, involute splined to ver-vertical swing shaft, meshes with external teeth of swing gear integral with outer race of turntable bearing.

Swing clutches - 23" diameter x 6" face width; aluminum alloy shoes.

Swing brake - External contracting band; spring applied, hydraulically released by operator controlled lever. Brake drum involute splined to horizontal swing shaft; brake 20" diameter, 3-1/4" face width.

Swing lock - Mechanically controlled pawl engages external teeth of turntable bearing swing (ring) gear.

Maximum swing speed - 2.8 RPM

9-16 Load Hoist/ Lowering System — Wire rope drum gear train (front and rear main, operating drums) powered by chain transmission from engine. Tandem design drums.

Front and rear drums - One-piece, 17-1/4" (.44m) root diameter smooth drums; involute splined on shafts.

Drum clutches - Control load hoist and power load lowering. Clutches for front and rear main, and optional third, operating drums - 23" diameter, 6" face width.

Power load lowering clutches - Standard on rear main operating drum; optional on front drum.

Brakes - Two-piece, external contracting band; mechanically foot pedal operated. Foot pedals equipped with latch to permit locking

brakes in applied position. Front and rear brakes 34" diameter, 5" face width; optional third drum brake 28" diameter, 5" face width.

Drum rotation indicators - Standard for front and rear main operating drums. Solenoid operated indicator buttons, recessed in drum clutch control lever handles, pulsate whenever rope drums rotate in either direction. Three to five pulsations represent approximately 1' rope travel on or off drum.

9-17 Boom Hoist/ Lowering System

Independent, spur gear driven, Precision control - Hoisting through power hydraulic 2-shoe clutch, lowering through low speed planetary drive unit.

Wire rope drum - 12-1/4" root diameter, smooth; involute splined to shaft.

Drum locking pawl Operator controlled; spring applied, hydraulically released.

Boom hoist clutch- 23" diameter, 6" face width.

Planetary (lowering) - Mounts on outer end of shaft; planetary external contracting band brake hydraulically controlled by boom hoist/lowering control lever.

Boom hoist/lowering brake External contracting band; spring applied, hydraulically released as hoist clutch or lowering planetary are engaged. Brake drum involute splined to shaft; brake 28" diameter, 5" face width.

Boomhoist limiting device Provided to restrict hoisting boom above recommended minimum radius; located on exterior right hand side of operator's cab. When hydraulic device is contacted by boom in near vertical position, control oil is bled from clutch and brake to sump tank, disengaging clutch and applying B.H. brake.

Gantry - Mounted to upper frame; supports boom suspension system.

Bail Integral part of machinery side housings with cross-over sheave frame pinned to bail; supports boom suspension system. Contains 7 sheaves mounted on anti-friction bearings for 16-part boom hoist rope reeving.

9-18 Control System (Speed-o-Matic)

Speed-o-Matic power hydraulics; a variable pressure control system. Variable pressure is transmitted through oil to all operating cylinders. The system includes a pump to provide a constant flow of oil, an accumulator to maintain operating pressure, oil filter, relief valve, unloading valve, and variable pressure operator controlled valves to regulate the pressure to each hydraulic cylinder. Oil sump tank - FMC, 12 gal. capacity with filter and strainer assembly.

9-19 Counter weight Total “AB”

Counterweight - 57,000# "A" counterweight - 27,000 # held in place on two hydraulically controlled frustums; frustum control valves located at rear of upper machinery cab. "B" counterweight 30,000# bolted in position on top of "A" counterweight for ease in mounting or dismounting. Total "A" or "AB" counterweight power hydraulically raised from, or lowered to, carrier deck in seconds.

9-20 Attachment

Boom - Tubular; two section basic boom; main chords, alloy steel; round tubular steel lattice, fully copes.

Base section 25' long; 60" wide by 54" deep, with main chords 3-5/8" outside diameter. Section equipped with basic pendants.

Boomfeet - 2-3/4" wide on 60" centers.

Boomfoot pin removal - Standard; pins manually installed/removed with threaded rod. Optional: double-acting hydraulic

cylinder mounted between boomfoot lugs for pin installation/removal.

Extensions - Available in 10', 20', 30', and 40' lengths with appropriate length pendants, and one hoist line deflector roller per extension.

Top section 25' long; six 21" root diameter head sheaves, 2 hoist line deflector rollers, and back stay lines for jib (if ordered). Permissible boom lengths without jib minimum 50'; maximum 230'. Maximum boom length when using jib 200'.

Boom stops Dual, lever type, with spring-loaded bumper ends.

Boomhoist bridle and spreader bar - Serves as connection for boom suspension system. Bridle contains eight 15" root diameter sheaves (for 16 - part boomhoist reeving) mounted on anti-friction bearings, and two 15" root diameter auxiliary load hoist sheaves, mounted on bronze bushings, which enable boom live mast to be used for machine assembly or disassembly.

Boom live mast - Supports boomhoist bridle. Required for all boom lengths Hydraulically extends from 25' 6" to 30' 0" working position, mechanically retracts to 25'6" position.

Boom live mast stops - Incorporated with boom stops; manually positioned when using live mast as short boom.

Boom angle indicator - Pendulum type; mounted on boom base section.

Load hoist line deflector rollers - To minimize line chafing on top side of boom. Rollers mounted on anti-friction bearings. One roller furnished with each extension, 2 boom pendants - standard. Furnished in pairs for basic boom lengths plus appropriate lengths with each boom extension.

9-21 Components Weights

Crane upper w/27,000 lb. "A" ctwt., boom lowering planetary, rear drum lowering clutch, GMC 6-71 engine w/single stage torque convertor.	67,810	lbs.
8 x 4, 11'10" wide FMC carrier with GMC 6V92TA engine, 14: 00 x 24L custom high miler tires front and rear, 11,400 lb. bumper ctwt.	76,600	lbs.
Total combined weight of upper and carrier described above.	144,410	lbs.
Boom lowering planetary	790	lbs.
B.H. rope (675', 7/8")	970	lbs.
Front drum rope (1050', 1")	1,940	lbs.
Rear drum rope (1050', 1")	1,940	lbs.
Upper ctwt. "A"	27,000	lbs.
Upper ctwt. "B"	30,000	lbs.
Upper ctwt. "AB"	57,000	lbs.
30' basic boom w/ accessories	6,720	lbs.
25' top section	4,610	lbs.
Boom stops	660	lbs.
Boom live mast, bridle, spreader bar	7,000	lbs.
10' extension (w/pendants)	785	lbs.
20' extension (w/pendants)	1,320	lbs.
30' extension (w/pendants)		
Carrier "A" bumper ctwt.	11,400	lbs.
Front or rear outrigger box, beams, jacks	7,500	lbs.
Outrigger floats (each, side)	170	lbs.
Outrigger float (front bumper)	130	lbs.

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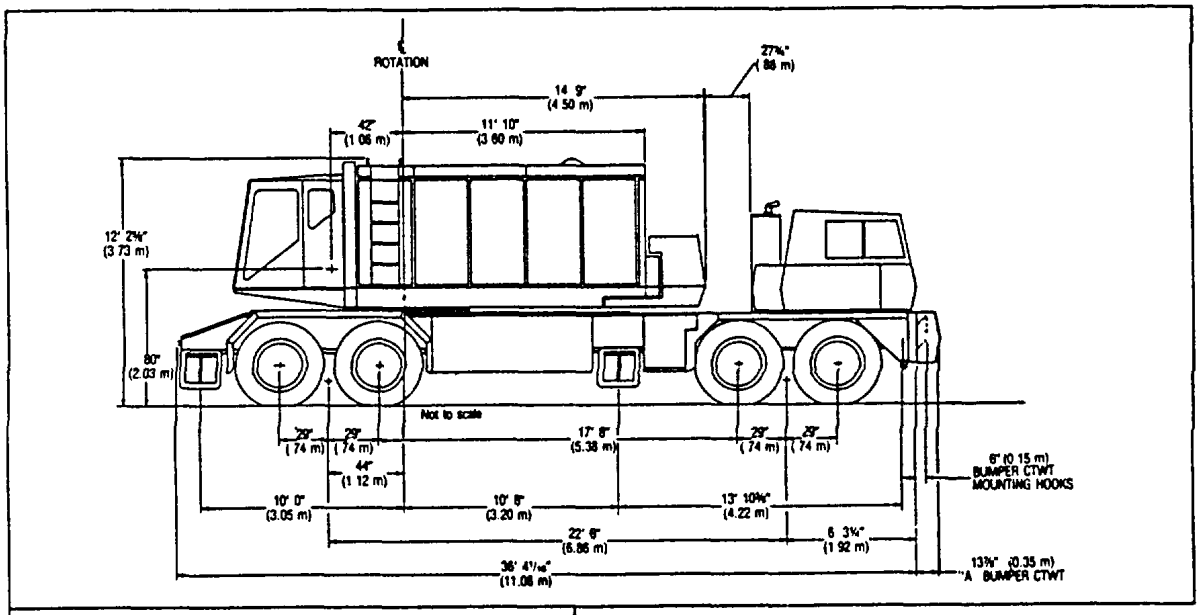
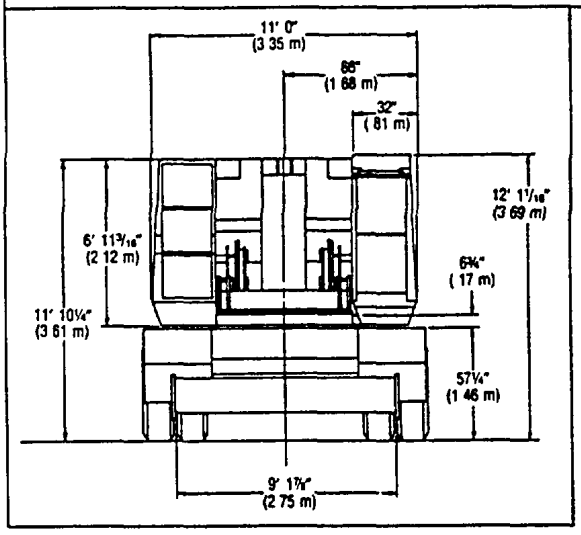
9-22 Dimensions





General Dimensions	
Overall length with basic boom in travel position over rear of carrier with bumper counterweight open throat boom	81' 8-1/8"
Overall length with basic boom in travel position over front of carrier open throat boom	70' 0"
Height over boom live mast with basic boom in travel position over rear of carrier open throat boom	12' 3-1/4"
Height over boom live mast with basic boom in travel position over front of carrier open throat boom	14' 9-1/2"
Radius of boom hinge pin	3' 6"
Height of boom hinge pin	6' 8"

General Dimensions	Feet
Overall width, outriggers extended (over floats)	24' 6"
Overall width, outriggers extended (center line of jacks)	22' 0"
Overall width, outriggers retracted (floats removed)	11' 10"
Minimum ground clearance	9-9/16"
Ground clearance under upper counterweight with machine on tires	4' 11-1/16"
Counterweight tailswing, across corners	15' 8-7/8"
Overall upper cab width	11' 0"
Basic boom length - open throat	50' 0"

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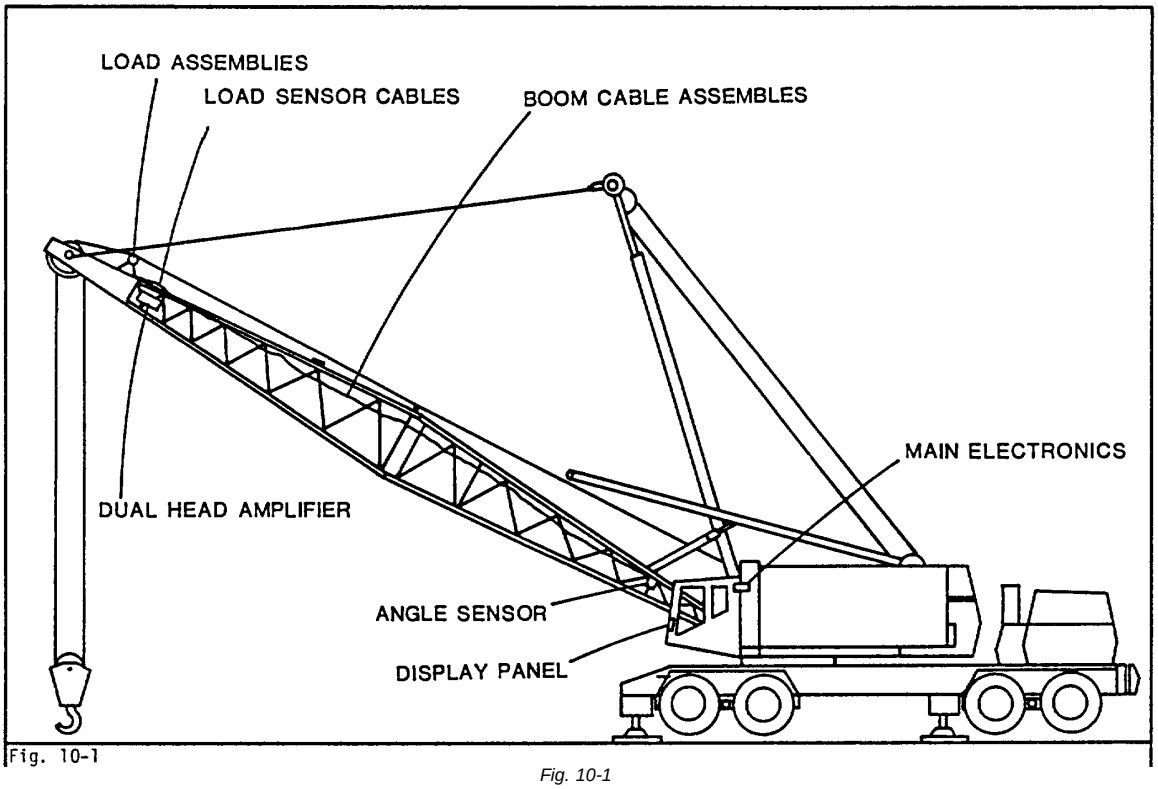

Fig. 10-1
Overload Warning System Nomenclature

10-1 Overload Warning System

CAUTION

This System Is Designed To Function With Crane Power From 10 Volts DC to 14 Volts DC. Voltages Outside Of These Limits Will Cause Erroneous Readings Or Damage To The System.

The System Must Be Connected With Black Wire To Positive And White Wire To Negative Crane Power Supply.

This crane is equipped with an overload warning system. When used properly, this system will provide the operator with a precise moment-by-moment updating of the hook block radius in feet, reports on the weight of the load, and alert the operator with audible and visual warning signals when the load is at or above the rated capacity.

Note: The system works for 50 through 130 ft. (15.24 through 39.62m) of main boom and a single hook block reeved from 1 to 12 parts of line or two hook blocks reeved from 1 to 6 parts of line (when using two hook blocks, they must be reeved with the same number of parts of line. The maximum allowable loads are based on the machine's capacity chart for 50-130 ft. (15.24 39.62m) of main boom, using "AB" upper and "A" bumper counterweights, lifting on outriggers only and over the rear, and 1" (26mm) diameter, type "N" wire rope.

10-2 Components and Location

The crane overload warning system is made up of the following six different assemblies:
(a) Display
(b) Main Electronics
(c) Angle Sensor
(d) Dual Head Amplifier
(e) Load Sensors
(f) Cables

The location of each assembly is shown in Fig. 10-1. Fig. 10-2 shows the connections between each assembly.

10-3 Component Description and Operation

(a) Display: The display assembly includes three digital LCD meters, a horn, three red lights, three amber lights, a power switch, a test button, and a hook select switch.

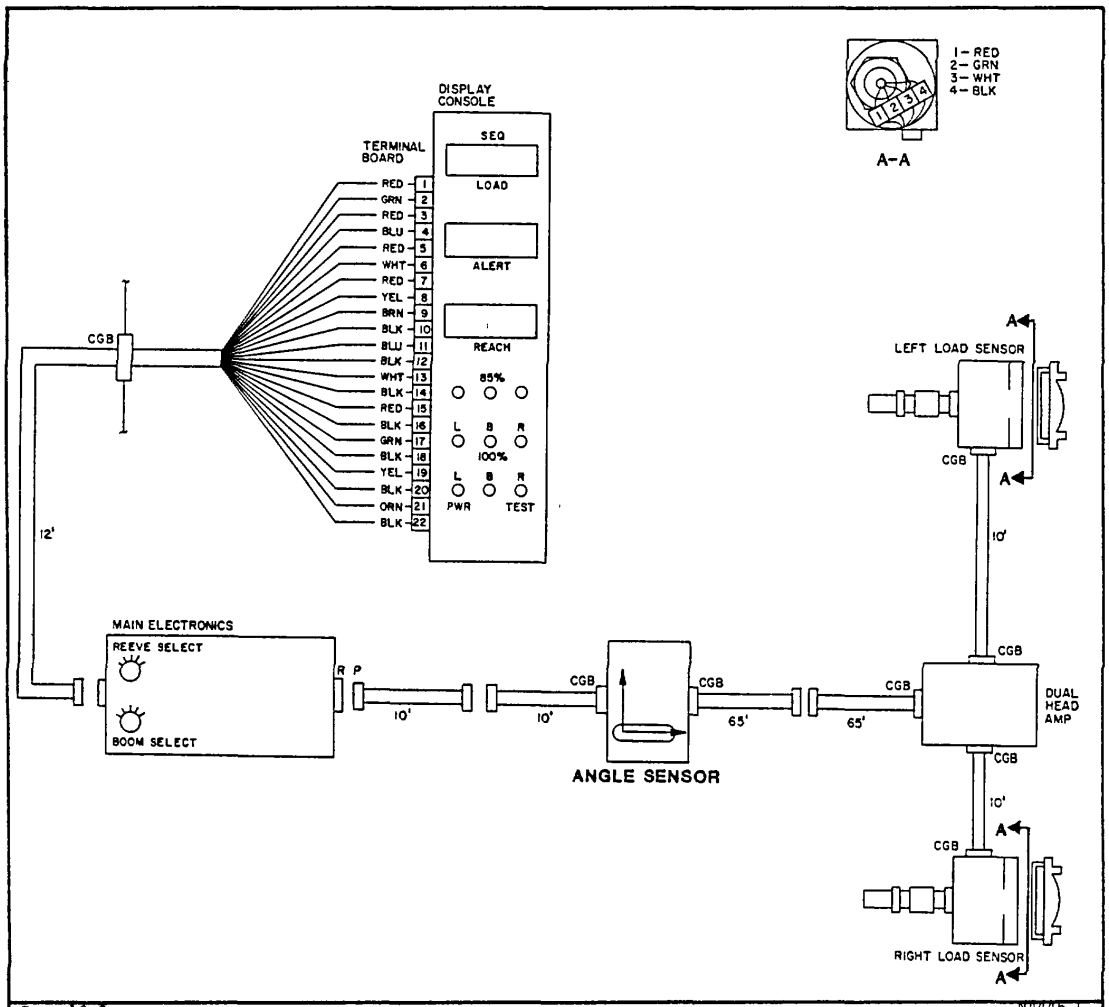

Fig. 10-2
System Cabling and Interconnect
NA446-C

The top meter is the load meter. It indicates the total weight of the hook block(s), all the wire rope between the hook block(s) and boom point, chains, slings, and the load on the hook block(s).

The middle meter is the Alert meter. It indicates the crane capacity as shown on the capacity chart in the upper cab for the parts of line reeved on the main hoist hook block(s) at the radius shown on the Reach meter.

The Load and Alert meters scale read 0 to 1,999. To compute the weight, multiply the meter reading by 1,000 lbs. For example, if the meter reading is 100, then 100 multiplied by 1,000 lbs equals 100,000 lbs.

The bottom meter is the Reach meter. It indicates horizontal distance in feet from the upper centerline of rotation to the main hoist hook block(s). The meter scale reads from 0 to 199.9.

The Amber lights are warning devices. It will come on when 85% of the maximum allowable load, shown on the Alert meter has been reached. For example, if the Alert meter reads 100 (100,000 lbs), the Amber light will then come on when the Load meter

equals or exceeds 85 (85,000 lbs).

The Red lights and Horn are also warning devices. They will come on when 100% of the maximum allowable load, shown on the Alert meter, has been reached.

Note: There are separate sets of warning lights for each hook arrangement: L - Left, R - Right, And B - Both.

The Hook Selector switch must be set to the hook arrangement that is being used for the system to function properly.

The Power (PWR) switch turns the system "On" and "Off." The Test button is a system test switch.

When pushed, the Amber lights, Red.

lights, and Horn will come on, and each meter will indicate predetermined numbers (refer to Table 1O-1).

Note: The Alert reading is from the crane's capacity chart for 100 ft. of main boom with 4 parts of line at 40 ft. radius.

(b) Main Electronics: The main electronics assembly has two rotary switches. They are Boom Select and Reeve Select. The Boom Select switch must be set to the length of main boom on the crane. The Reeve Select switch must be set to the parts of line reeved on the hook block(s). These switches match the system's electronics to the boom length and reeving of the crane.

Note: The operator must make sure these switches are in the positions which match the actual boom length and reeving of the crane, or the system will not function properly.

(c) Angle Sensor: The angle sensor assembly serves a dual purpose: It is a junction box for the electrical cable coming down the boom. It also contains a device which senses the angle of the boom, and outputs an electrical signal from which the radius can be calculated.

(d) Head Amplifier: The dual head amplifier assembly takes the electrical signal from the load sensor(s) and boosts it down the boom cable.

(e) Load Sensors: The load sensor assemblies are the shafts of the idler sheaves located directly behind the boom point sheaves. The load sensors sense the line pull through the idler sheaves when a load is put on the main hoist hook block(s). The electrical signal goes from the load sensor(s) directly to the dual head amplifier.

(f) Cables: The cable assemblies are used to connect all the electrical assemblies together to make a complete assembly.

10-4 General System Operation

The crane supplies the electricity to power the overload warning system. The system receives the electricity through a cable assembly leading to the main electronics; the main electronics' black wire connects to the positive lead, and the main electronics' white wire connects to the negative lead of the crane's electrical supply. The electricity goes to the main electronics. From the main electronics the electricity is sent to the Power (PWP) switch on the display, then back to the main electronics where it is fused to supply power to the system sensors and relays. These sensors and relays provide the raw data to the main electronics. The main electronics processes this data and displays the information on the meters and signals the operator with warning devices.

Note: Where electricity is fused to the system at the main electronics there is a fuse on the bottom. If it needs replaced use a type 3AG fuse with 4 Amp capacity (slow blow).

10-5 Operating Instructions

WARNING

The Overload Warning System Is Not Fail Safe, It Can Malfunction. Do Not Depend Upon This System To Do The Operator's Job. The Operator MUST Use The Information On The Metal Capacity Plate Located In The Upper Cab, And Operate The Crane Within The Guidelines Spelled Out In Paragraph 1-81 "Crane Operation" In The Operator's Manual.

(a) Visually check that the components and cables are connected.

(b) Position PWR (power) switch to "On".

(c) Set the Reeve Select on the main electronics to the parts of line reeved on the hook block.

(d) Set the Boom Select switch on the main electronics to the length of boom on the m machine.

(e) Set the Hook Selector switch on the display panel to the hook block arrangement being used.

(f) Press the Test button on the display assembly. Note the meter readings and if the warning devices come on. Compare the meter readings to those in Table 10-1. If the meter readings and Table 10-1 do not match, trouble shoot the system.

10-6 Adjustments

The system is calibrated for specific reeving (parts of line) at the hook block. If the reeving at the hook block(s) is changed, the system must be calibrated for that parts of line. The system's calibration for the parts of line being used should be verified at least every six months or whenever a parts of line-which was calibrated once before is reused.

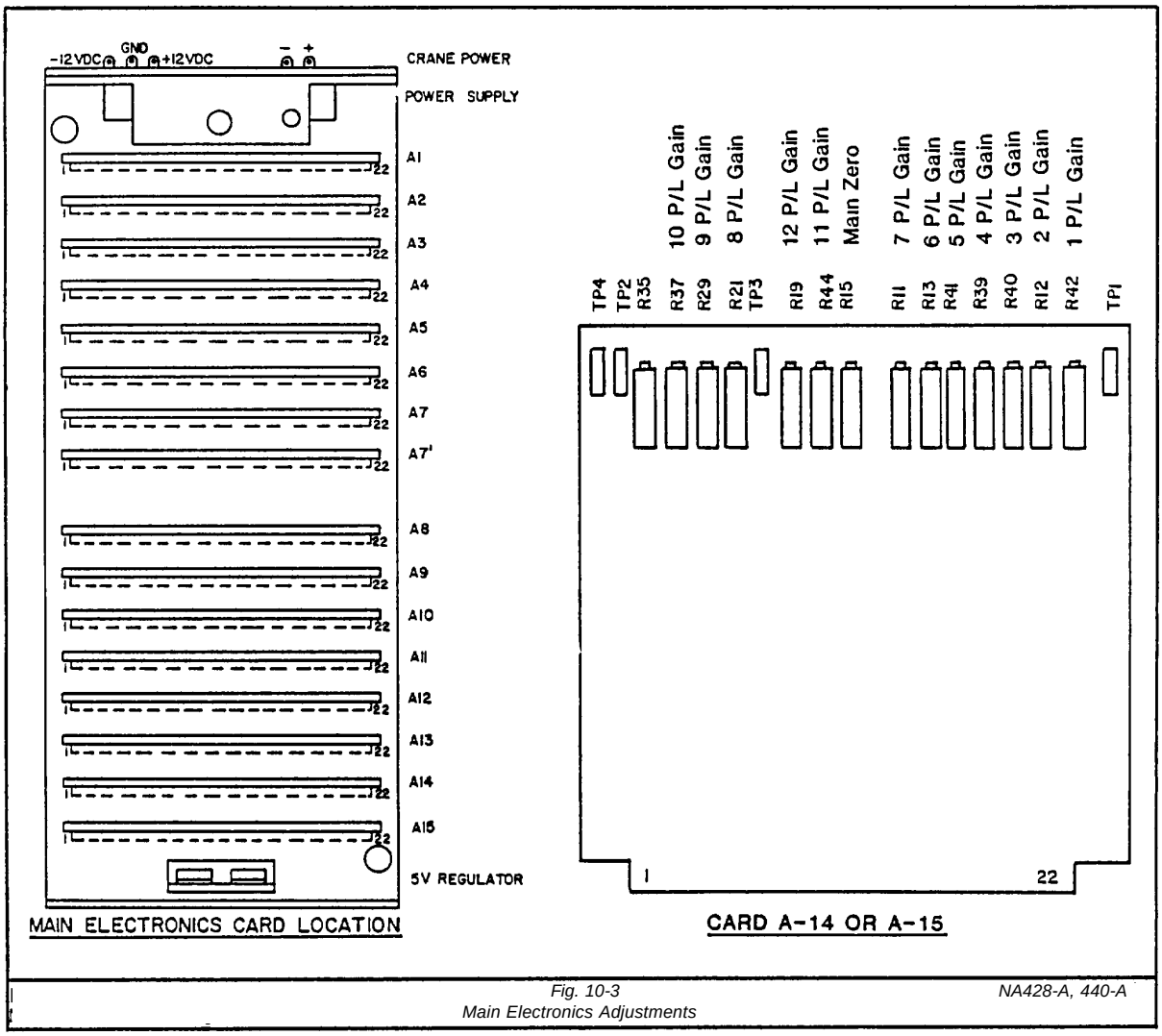

Fig. 10-3 *NA428-A, 440-A*
Main Electronics Adjustments

(a) Calibrate the system as follows:

(1) Visually verify the components and cables are connected.

(2) Position the Power switch to "On." (3) Set the Reeve Select switch to the parts of line reeved on the main hoist hook block.

(4) Set the Boom Select switch to length of boom on the machine.

(5) Set the Hook Selector switch to either L (left) or R (right).

(6) Loosen the cover retaining screws on the main electronics assembly, and remove the cover.

(7) Lower the hook block and boom onto the ground. Allow the main hoist wire rope to become slack. With the engine on, zero the Load meter as follows:

(aa) Refer to Fig. 10-3. Find load amplifier card A-14 (for left hook) or A-15 (for right hook). Locate main zero potentiometer R15 on the load amplifier Card A-14 or A-15. Using a small jewelers screwdriver, slowly adjust screw at potentiometer R15 until Load meter reads 0.

(8) Hoist boom to angle that the radius can easily and accurately be measured. Lift a "known weight." If the Load meter does not indicate the "known weight," adjust the gain potentiometer for the parts of line as follows:

(aa) Refer to Fig. 10-3. Find Load Amplifier card A-14 or A-15. Locate the gain potentiometer that corresponds to the parts of line reeved on the hook block. Using a jewelers screwdriver, slowly

adjust screw at parts of line gain potentiometer until the load meter reads the "known weight." For example, if 12 parts of line is reeved on the hook block, the 12 P/L gain potentiometer R19 on Load Amplifier card A-14 or A-15 would be adjusted.

The weight of the "known weight" is the total of the following:

(i) The weight of the certified scale or load cell used to determine the weight of the load.
(ii) The weight of the hook block(s).
(iii) The weight of the slings, chains, rigging, etc. used to support the load or scale on the hook block(s).
(iv) The total weight of all the main hoist wire rope between the boom point and hook block(s). Type N, 1" (25.4mm) diameter wire rope weighs 1.76 lbs (.798336 kg) per foot.

(9) Measure the horizontal distance between the upper center of rotation to the hook block. If the Reach meter does not read this distance, adjust the Load Sensor as follows:
(aa) Loosen Load Sensor mounting capscrews.
(bb) Adjust the position of the Load Sensor assembly on the mounting bracket of the boom until the correct distance is indicated on the Reach meter.
(cc) Retighten mounting capscrews. Recheck Reach meter reading.

(10) Install cover on main electronics, and secure with the retaining screws.

(b) Verify the system as follows:
(1) Visually verify the components and the cables are connected.
(2) Position the power switch to "On." (3) Set the Reeve Select switch on the main electronics assembly to the parts of line reeved on the main hoist hook block. For example, 3 for 3 parts of line.
(4) Set the Boom Select switch on the main electronics assembly to the length of boom on the machine. For example, 100 for 100 feet of boom.
(5) Set Hook Selector switch to either L (left) or R (right).
(6) Hoist the boom to where the radius can easily and accurately be measured. Also hoist the hook block off the ground.
(7) Accurately measure the horizontal distance from the upper center of rotation to the hook block with a tape measure. This distance must match the Reach meter reading within ± 1 foot.
(8) Lift a "known weight" of at least 50% of the maximum crane capacity for the reeving of the main hoist as shown on the capacity chart. This "known weight" must match the Load meter reading.
(9) The Alert meter must read the same as the maximum allowable lifting weight on the capacity chart for the radius indicated on the Reach meter.

Note: When in the both position mode, the Alert Limit will be twice that of the single block reeving. Unless the total allowable load as indicated on the crane capacity chart for the radius indicated on the Reach Meter is less than the sum of the individual allowable loads.
Example:
Allowable load for left hook is 25,000 pounds.
Allowable load for right hook is 25,000 pounds.
Total allowable for both hooks is 35,000 pounds.
When in the both position mode, the Alert Meter will show 35,000 pounds.

10-7 Trouble Shooting

(a) Self Test Procedure
(1) Select Both position on the Hook Select switch.
(2) 100 ft. (30.4m) main boom length on the main electronics assembly Boom Select switch, regardless of actual boom length on machine.
(3) Select 4 parts of line on the main electronics assembly Reeve Select switch, regardless of the hook block reeving.
(4) Push the Test button on the display and hold it. Record the meter readings, and note if the warning lights glow and the horn sounds. Compare the meter readings to those in Table 10-1. Record the crane's capacity for 100 ft. (30.4m) of boom, using "AB" upper and "A" bumper counterweight, lifting on outriggers only, and over the rear at a radius of 40 ft. (12.1m) off the metal capacity plate.

METER	READING
Load	194-206
Alert	166-182
Reach	39-41

Table 10-1
Self Test Reading

If the meter readings and the Table 10-1 do not agree, use the information in step (4) to help trouble shoot the system.

CAUTION

Always Turn The Power Switch On The Display Assembly "OFF" Before Connecting Or Disconnecting A Cable Assembly Or Component. Otherwise A Power Surge Or Damage To The System Can Occur.

(b) If problems with the overload warning system are encountered, perform the self test procedure. Record the results of the test procedure and use this information to trouble shoot the system. Refer to trouble shooting chart (see Table 10-2).

PROBLEM	REMEDY
Load meter, Alert meter, and Reach meter do not exactly repeat their values when PWR switch is flicked "ON" and "OFF."	Replace the defective meter. (To replace a defective meter: Remove display panel, unplug meter, loosen the two screws on side of meter, and remove meter.)
Load meter and Alert meter read correctly, but Reach meter does not.	(1) If the Reach meter does not indicate the horizontal distance from the upper center of rotation to the hook block, adjust the angle sensor until Reach meter is correct. (2) If the Reach meter does not move when the boom is raised or lowered: (a) See if the cable assembly between the main electronics and angle sensor is securely connected. (b) Check for a faulty cable assembly or angle sensor: (i) Set the reeve select switch on the main electronics box to 4 P/L regardless of main hoist reeving. (ii) Select "Both" position on the hook select switch located on the display assembly. (iii) Disconnect angle sensor-main electronics cable assembly at the main electronics connection. (iv) Press test button and hold. Record the readings on the meters. (v) Reconnect angle sensor-main electronics cable assembly at main electronics connection, then disconnect cable at angle sensor connection. (vi) Press test button and hold. Record the readings on the meters. (vii) Compare readings to those in Table 10-1. (aa) If the meters values are the same as Table 10-1, replace the angle sensor and recalibrate the system. (bb) If the meters values are different than Table 10-1, replace the cable assembly and recalibrate the system.
Reach meter and Alert meter read correctly, but Load meter does not read correct weight of "known weight."	Recalibrate the system.
Reach meter and Alert meter read correctly, but Load meter value decreases as more weight is hoisted.	(1) Refer to Fig. 10-2. Rewire the load pin terminal strip. Remove the round screw on cover. Remove cover from load sensor assembly. Reverse wires at terminal 2 and 3. Replace cover and tighten round screw. (2) Contact the FMC Service Department.
Reach meter and Alert meter read correctly, but Load meter reads zero or full scale.	(1) Check out the system: (a) Set 4 P/L and 100 ft. on select switches on main electronics box regardless of parts of line reeved on main hoist or of boom length now on crane. (b) Select "Both" position on hook select switch on display panel. (c) Disconnect the angle sensor-main electronics cable assembly at the main electronics connection. (d) Perform self test procedure. (i) If meters values match those in Table 10-1, there is a problem in either a cable assembly or component between the main electronics assembly and the load sensor assemblies. (ii) Reconnect the cable assembly at main electronics connection. Disconnect each cable assembly connection between the load sensor assemblies and main electronics assembly one at a time. Start at a load sensor-head amplifier cable at dual head amplifier, and work on down the boom until reach the main electronics, each time performing the self test procedure. When the values on the meters match those in Table 10-1, the last cable assembly or component is faulty. Replace that cable or component, and recalibrate the system.

Table 10-2
Trouble Shooting Chart

PROBLEM	REMEDY
Reach meter and Alert meter read correctly, but the Load meter does not read correctly after the reeving on the block has been changed.	(1) Is Reeve Select switch set to the correct parts of line reeved on hook block. (2) Hoist a "known weight." If Load meter value is incorrect, recalibrate the system. (3) Contact FMC Service Department.

Table 10-2 - Continued
Trouble Shooting Chart

Operator's Manual Section 11 - Alphabetical Index **R783**

Major subject areas in the Operator's and Maintenance Manual are listed here alphabetically. In some cases, subjects are listed under more than one name for instance, both cable and wire rope are listed as both names are used in field situations.

APPENDIXES

APPENDIX A

EQUIPMENT PUBLICATIONS

DA Equipment Publications		
Nomenclature	Equipment Publication Number	Date
Safety Inspection and Testing of Lifting Devices	TB 43-0142	13 Apr 79
Safe Use of Cranes Near Electric Power Lines	TB 385-101 w/Chg 1	15 Jun 79
Storage, Handling, and Shipment of Truck-Mounted Cranes	TB 740-358	11 Oct 72

APPENDIX B

WARRANTY INFORMATION

1. FMC Corporation has directed that their dealers or service representatives involved in the initial set up of the Crane establish Warranty reporting procedures with the unit. Field units must recognize that not all maintenance repairs/services are covered under Warranty. For example, minor adjustments/repairs, lubricants, filters, lights, etc., are not covered. If there is any question or doubt as to whether a repair/service is covered under Warranty, please contact the FMC Corporation Government Service Representative listed below. This representative must be contacted before any major Warranty repair is initiated. Recommend the local EIR/QDR/Warranty Claim Coordinator be the point of contact for Warranty claims.

Mr. John Claflin
2800 Lakeside Dr.
Bannockburn, IL 60015
Telephone: (312) 295-5500, Ext. 342

2. All warranties, settled or unsettled, will be reported to the National Maintenance Point (NMP) at TACOM on a DA Form 2407. The instructions for submitting the DA Form 2407 are outlined in paragraph 12-2 of TM 38-750, The Army Maintenance Management System. For warranties settled locally, the DA Form 2407 will contain a statement "For Information Only" in block 16A. This information is required by the NMP for determining warranty utilization, warranty cost avoidance to the Government, and analyzing failure trends on newly fielded equipment. Be certain to include the vehicle serial on the DA Form 2407.

3. During the Warranty Period: Quality Deficiency Report (EIR/QDR) SF 368, will be limited to the reporting of "equipment failure in design" which pose a threat to operator safety or which detract from the operational capability and for the reporting of "delays exceeding 20 days" (from contractor notification) in completing requested warranty services, or "unsatisfactory workmanship resulting in user dissatisfaction with such services."

APPENDIX C

MAINTENANCE ALLOCATION CHART FOR
CRANE, MOBILE, CONTAINER HANDLING, 140-TON CAPACITY
TRUCK, MOUNTED, DED, FMC MODEL HC-238A, NSN 3950-01-110-9224

Section I. INTRODUCTION

1. General: This Maintenance Allocation Chart designates responsibility for performance of Maintenance functions to specific Maintenance categories.

2. Maintenance functions:

a. Inspect: To determine the serviceability of an item by comparing its physical, mechanical and/or electrical characteristics with established standards through examination.

b. Test: To verify serviceability and detect incipient failures by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service: Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust: To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. Align: To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate: To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install: The act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace: The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair: The application of maintenance services or other maintenance actions to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly) end item, or system.

j. Overhaul: That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e, DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

2. Maintenance functions (cont'd)

k. Rebuild: Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipments/components.

3. Column entries: Columns used in the Maintenance Allocation Chart as explained below:

a. Column 1, Group Number: Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly: Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions: Column 3 lists the functions to be performed on the item listed in Column 2.

d. Column 4, Maintenance Category: Column 4 specifies, by the listing of a "work time" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "work time" figures will be shown for each category. The number of manhours specified by the "work time" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the Maintenance Allocation Chart.

The symbol designations for the various maintenance categories are as follows:

C - Operator/Crew
O - Organizational Maintenance
F - Direct Support Maintenance
H - General Support Maintenance
D - Depot Maintenance

e. Column 5, Tools and Equipment: Column 5 specifies by code those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks: Column 6 contains an alphabetic code which leads to the remark in Section IV, Remarks, which is pertinent to the item opposite the particular code.

MAINTENANCE ALLOCATION CHART FOR
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TRUCK MOUNTED, DED, FMC MODEL HC-238A, NSN 3950-01-110-9224

SECTION II - ASSIGNMENT OF MAINTENANCE FUNCTIONS

1	2	3	4					5	6
GROUP NUMBER	COMPONENT/ASSEMBLY	MAINTENANCE FUNCTION	MAINTENANCE CATEGORY					TOOLS EQUIPMENT	REMARKS
			C	O	F	H	D		
01	ENGINE								
0100	Engine Assembly	Inspect	0.1						
		Service	0.5	1.5				2,5	
		Adjust			2.0			1,7-9	
		Replace			8.0			1,7-9	
		Repair				2.0		1,7-9,12	
		Overhaul				80.0		1,7-9,12	
	Engine Mounting	Inspect			0.1			7,9	
		Replace			2.0			7,9	
0101	Crankcase, Cylinder Block	Service	0.5	1.0				2,5	
		Replace			12.0			1,7,9	
		Repair			1.5			1,7,9,12	
	Cylinder Head Assy	Replace			8.0			1,7,9	
		Overhaul				12.0		1,7,9,12	
	Cylinder Sleeves	Replace	1.0					1,7,9	
		Repair	1.0					1,7,9,12	
	Air Box Drain Tube	Service		0.2				1,3,5	
		Replace		1.0				1,3,5	
0102	Crankshaft	Replace				16.0		1,7,9	
		Repair				6.0		1,7,9,12	
	Bearings, Main	Replace				4.0		1,7,9	
	Pulley, Damper	Replace				1.0		1,7,9	
0103	Flywheel Assembly	Replace			4.0			1,7,9	
		Repair			1.5			1,7,9,12	
	Ring Gear	Replace			2.0			1,7,9	
	Flywheel Housing	Replace			4.0			1,7,9	
		Repair			2.0			1,7,9,12	
0104	Pistons	Replace			12.0			1,7,9	
		Repair			1.0			1,7,9,12	
	Connecting Rod	Replace			14.0			1,7,9	

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SECTION II - ASSIGNMENT OF MAINTENANCE FUNCTIONS

1	2	3	4					5	6
GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
0104	Bearings and Rings	Replace			2.0			1,7,9	
0105	Rocker Arm Assembly	Adjust			1.0			1,7,9	
		Replace			3.0			1,7,9	
		Repair				1.0		1,7,9, 12	
	Valve Rocker Cover	Replace		0.5				1,2,5	
	Valves	Replace				4.0		1,7,9	
		Repair				5.0		1,7,9, 12	
	Camshaft Assy	Replace				3.0		1,7,9	
	Balance Shaft	Replace				3.0		1,7,9	
	Timing Gear Train	Replace				4.0		1,7,9	
0106	Oil Pan	Replace			1.0			1,7,9	
		Repair			0.5			1,7,9	
	Oil Pump	Replace				0.5		1,7,9	
		Repair				1.0		1,7,9	
	Oil Filters (Spin-on)	Replace		0.2				2,5	
	Oil Filter (Cartridge)	Replace		0.2				2,5	
		Service		0.3				2,5	
	Oil Cooler	Replace			2.0			1,7,9	
	Oil Pressure Regulator	Replace			1.0			1,7,9	
		Repair			0.5			1,7,9	
0108	Manifold, Exhaust	Inspect		0.1				1,2,5	
		Replace		3.0				1-5	
0109	Accessory Driving Mechanism	Replace			2.0			1,7,9	
		Repair			4.0			1,7,9, 12	
	Hub Accessory Drive	Replace			1.5			1,7,9	
		Repair			3.0			1,7,9, 12	
	Gear Shafts and Bearings	Replace			1.0			1,7,9	

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SECTION II - ASSIGNMENT OF MAINTENANCE FUNCTIONS

1	2	3	4					5	6
GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
02	CLUTCH								
0200	Clutch Assembly	Inspect	0.3						
		Service	0.3	0.3				1,2,5	
		Replace			16.0			1,7,9	
		Repair				5.0		1,7 ,9, 12	
0202	Yoke, Pedal, Linkage	Service		0.3				1,2,5	
		Replace		0.5				1,2,5	
03	FUEL SYSTEM								
0301	Fuel Injector	Test				1.0		8	
		Replace			2.0			1,8,9	
		Repair				1.0		1,8,9	
	Fuel Injector Lines	Replace			2.0			1,8,9	
	Fuel Injector Control Tube	Replace			1.0			1,8,9	
0302	Fuel Pump	Test			1.0			8	
		Replace			1.5			1,8,9	
		Repair				2.0		1,8,9	
0304	Air Cleaner	Inspect	0.1						
		Service		0.5				2,5	
		Replace		0.5				2,5	
0305	Turbocharger	Inspect	0.2						
		Replace			2.0			1,7-9	
		Repair			3.0			1,7-9	
	Turbocharger After-cooler	Replace			1.0			1,7-9	
		Repair			0.5			1,7-9	
	Blower Assembly	Inspect	0.3					2,5	
		Service	0.5					2,5	
		Replace		3.0				1,7-9	
		Repair			6.0			1,7-9	
	Blower Drive Gear	Replace			2.0			1,7-9	

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SECTION II - ASSIGNMENT OF MAINTENANCE FUNCTIONS

1	2	3	4					5	6
GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
0306	Fuel Lines and Fittings	Inspect	0.2						
		Replace			2.0			1,7-9	
		Repair			0.3			1,7-9,12	
	Fuel Tank	Inspect	0.2						
		Service	0.5						
		Replace			3.0			1,7-9	
		Repair			2.0			1,7-9	
	Fuel Manifold	Replace			1.0			1,7-9	
	Air Intake System	Service		0.5				2,5	
		Replace			2.0			1,7-9	
		Repair			0.5			1,7-9	
	Air Inlet Adapter	Replace			1.0			1,7-9	
0308	Engine Speed Governor Controls	Adjust			0.5			1,7-9	
		Replace			0.7			1,7-9	
	Governor	Service			0.5			1,8	
		Replace			1.0			1,7-9	
		Repair			1.0			1,7-9	
0309	Fuel Strainer	Replace		0.3				2,5	
	Fuel Filter	Replace		0.3				2,5	
0311	Ether Starting Aid	Replace		0.5				1-5	
	Brackets and Tubes	Replace		0.3				1-5	
0312	Throttle Assemblies	Adjust		0.5				1-5	
		Replace		2.0				1-5	
04	EXHAUST SYSTEM								
0401	Muffler and Pipes	Inspect	0.2						
		Replace		3.0				1-5	
		Repair		1.0				1-5	

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SECTION II - ASSIGNMENT OF MAINTENANCE FUNCTIONS

1	2	3	4					5	6
GROUP NUMBER	COMPONENT/ASSEMBLY	MAINTENANCE FUNCTION	MAINTENANCE CATEGORY					TOOLS EQUIPMENT	REMARKS
			C	O	F	H	D		
05	COOLING SYSTEM								
0501	Radiator Assembly	Inspect		0.1				2,5	
		Service		1.0				2,5	
		Replace		3.0				1-5	
		Repair			3.0			1,7,9,12	
	Radiator Cap Pressure Type	Replace		0.1				2,5	
	Radiator Housing	Replace		2.0				1-5	
		Repair		0.5				1-5	
	Cables, Control	Replace		1.0				1-5	
		Repair		0.5				1-5	
0502	Shroud, Radiator	Replace		1.5				1-5	
0503	Water Manifold	Replace		1.0				1-5	
	Thermostats	Test		0.1				2,5	
		Replace		0.5				2,5	
	Hose, Lines and Fittings	Inspect		.2				2,5	
		Replace		.5				1-5	
0504	Water Pump	Replace		1.5				1-5	
		Repair			1.5			1,7,9	
0505	Fan Assembly	Replace		1.0				1-5	
		Repair			1.0			1,7,9	
	Belt Drive	Inspect	0.1						
		Adjust		0.2				2,5	
		Replace		1.0				1-5	
06	ELECTRICAL								
0601	Alternator	Replace		0.9				1-5	
		Repair			1.5			1,7-9	
	Belt Drive	Inspect	0.1						
		Adjust		0.2				2,5	
		Replace		0.5				1-5	

MAINTENANCE ALLOCATION CHART FOR
CRANE, MOBILE, CONTAINER HANDLING, 140-TON CAPACITY
TRUCK MOUNTED, DED, FMC MODEL HC-238A, NSN 3950-01-110-9224

SECTION II - ASSIGNMENT OF MAINTENANCE FUNCTIONS

1	2	3	4					5	6
GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
0603	Starting Motor	Replace		1.0				1-5	
		Repair			1.5			1,7-9	
	Solenoid	Replace		0.5				1-5	
		Repair			0.5			1,7-9	
0606	Engine Safety Control and Interlocks	Replace		0.5				1-5	
0607	Instrument/Control Panels	Inspect	0.1						
		Repair		1.0				1-5	
	Instruments	Inspect	0.1						
		Replace		0.5				2,5	
0608	Switches, Fuses	Inspect	0.1						
		Replace		0.3				1-5	
	Junction Boxes	Replace			1.0			1-5	
0609	Headlights	Inspect	0.1						
		Test		0.1					
		Replace		0.3				2,5	
	Taillights	Inspect	0.1						
		Test		0.1					
		Replace		0.3				2,5	
	Clearance Lights	Inspect	0.1						
		Test		0.1					
		Replace		0.3				2,5	
	Rotary Light	Inspect	0.1						
		Test		0.1					
		Replace		0.3				2,5	
	Floodlights	Inspect	0.1						
		Test		0.1					
		Replace		0.3				2,5	
0610	Sending Unit and Warning Switches	Inspect	0.1						
		Test		0.1				2,5	
		Replace		0.8				1-5	

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GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
0611	Horn	Test		0.1					
		Replace		0.5				2,5	
	Horn Switch	Test		0.1					
		Replace		0.3				2,5	
0612	Batteries	Inspect	0.1						
		Service	0.3						
		Test		0.3				4,5	
		Replace		0.5				2,5	
	Battery Box	Replace		1.5				1-5	
		Repair		1.0				1-5	
	Battery Cables	Inspect	0.1						
		Replace		0.5				1-5	
		Repair		0.3				1-5	
0613	Wiring Harness	Test			0.2			8	
		Replace			1.5			1,7-9	
		Repair			0.5			1,7-9	
07	TRANSMISSION								
0700	Transmission Assembly Main	Inspect		0.2				2,5	
		Service		0.3				2,5	
		Replace			8.0			1,7,9	
		Repair				10.0		1,7,9,12	
		Overhaul				25.0		1,7,9,12	
	Transmission Assembly Creeper	Inspect		0.1				2,5	
		Service		0.2				2,5	
		Replace			5.0			1,7,9	
		Repair				10.0		1,7,9,12	
		Overhaul				15.0		1,7,9,12	
0701	Transmission Shafts	Replace				8.0		1,7,9	
	Bearings, Gears, Seals, Gaskets	Replace				8.0		1,7,9,12	
0704	Transmission Top Cover Assembly	Replace			1.0			1,7,9	
		Repair			0.5			1,7,9	

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GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
0705	Transmission Range shift Air System	Replace			3.0			1,7,9	
		Repair			1.2			1,7,9	
09	PROPELLER SHAFT								
0900	Drive Shafts	Replace		3.0				1-5	
		Repair		1.5				1-5	
	Universal Joints	Service		0.2				2,5	
		Replace		1.5				1-5	
10	FRONT AXLES								
1000	Front Axle Assembly	Replace			20.0			1,7,9	
		Repair			12.0			1,7,9, 11,12	
11	REAR AXLES								
1100	Rear Axle Assembly	Service		0.3				2,5	
		Replace			30.0			1,7,9	
		Repair			14.0			1,7,9,12	
1101	Housing Assembly	Replace			15.0			1,7,9	
		Repair			2.0			1,7,9,12	
1102	Differential Assembly	Inspect		0.2				2	
		Service		0.2				2,5	
		Replace			8.0			1,7,9	
		Repair			2.0			1,7,9	
1103	Planetary Gears, Shafts, Bearings	Replace			4.5			1,7,9,12	
1108	Walking Beam, Stub Axles	Replace			8.0			1,7,9, 11,12	
12	BRAKES								
1202	Service Brakes	Inspect	0.2	0.3				2	
		Service	0.4	0.5				1,2,5	
		Replace		40.0				1,7,9	
		Repair		4.0				1,7,9,12	

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GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
1202	Brake Shoe Assembly	Replace		1.0				1-5	
	Cam	Replace		0.5				1-5	
1208	Air Brake Actuator Assembly	Replace		1.0				1-5	
		Repair			1.5			7,9	
	Air Reservoir	Service	0.2						
		Replace		3.5				1-5	
		Repair			1.0			1,7,9	
	Valve	Replace		1.0				1-5	
	Hoses, Lines and Fittings	Inspect	0.1						
		Replace		0.8				1-5	
1209	Air Compressor Assembly	Service		0.5				2,5	
		Replace		2.0				1,2,5	
		Repair			4.0			1,7,9	
	Governor	Replace		0.5				1,2,5	
13	WHEELS								
1301	Front/Rear Suspension	Replace			15.0			1,7,9	
		Repair			5.0			1,7,9,12	
	Torque Rod Assembly	Replace			4.0			1,7,9	
	Equalizer Beam	Replace			4.0			1,7,9	
	Bushing	Replace			1.0			1,7,9	
1311	Wheel Assembly	Inspect		0.2				2	
		Replace		2.0				1-5	
		Repair		0.8				1-5	
	Drums	Replace		0.5				1-5	
		Repair			0.5			1,7,9	
	Bearings	Inspect		0.8				1,2	
		Service		1.0				1,2	
		Replace		1.5				1-5	

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GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
1313	Tires	Inspect	0.1						
		Service	0.2						
		Replace		2.0				1-5	
		Repair			2.0			1,7	
14	STEERING								
1401	Steering Wheel	Replace		2.0				1-5	
	Steering Gear	Inspect		0.5				2	
		Service		0.5				2	
		Replace			6.0			1,7,9	
		Repair			4.5			1,7,9	
	Column	Replace			2.0			1,7,9	
		Repair			0.5			1,7,9	
	Tie Rod & Drag Link	Replace			1.5			1,7,12	
1410	Power Steering Pump	Service		0.1				2	
		Replace		1.5				1-5	
		Repair			1.5			1,7,9	
1411	Hoses, Lines and Fittings	Inspect	0.2						
		Replace		0.8				1-5	
1412	Power Steering Cylinder	Replace		3.0				1-5	
		Repair			1.5			1,7,9	
1413	Reservoir	Service	0.3	0.5				2,5	
		Replace		1.0				1-5	
Filter	Replace			0.3				2	
1414	Steering System Valves	Replace			3.0			1,7,9	
		Repair			1.5			1,7,9	
15	FRAME								
1501	Frame Assembly	Repair			8.0			1,7,9, 11,12	

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GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
1501	Bumper, Front	Replace		4.0				1-5	
		Repair		2.0				1-5	
1502	Counterweights	Replace			2.0			1,7	
	Counterweight Remover Cylinder	Replace			1.5			1,7,9	
		Repair			2.0			1,7,9	
1507	Outrigger Beam/Box/ Pontoon Assembly	Replace		8.0				1-5	
		Repair			2.5			1,7,9,12	
	Outrigger Hydraulic Tank	Service	0.5	1.0				2,5	
		Replace		2.0				1-5	
		Repair		3.0				1-5	
	Outrigger Hydraulic Filter	Replace		0.5				2	
	Outrigger System Values	Replace		1.2				1-5	
		Repair			0.5			1,7,9	
	Outrigger Cylinders	Replace		2.0				1-5	
		Repair			3.5			1,7,9	
	Outrigger Hydraulic Pump	Replace		1.2				1-5	
		Repair			1.0			1,7,9	
	Outrigger Hydraulic Power Take-off	Inspect		0.1				2	
		Service		0.2				2	
		Replace		2.0				1-5	
		Repair			3.0			1,7,9	
	Outrigger Hoses, Lines, Fittings	Replace		0.8				1-5	
	Outrigger Controls, Switches	Replace		1.0				1-5	
		Repair			1.0				

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GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
18	BODY, CAB AND HOOD								
1801	Cab Assembly	Repair			4.5			1,7,9,13	
	Hood/Panel Assemblies	Replace		1.5				1-5	
		Repair			2.0			1,7,9, 11-13	
	Door Assembly, Cab	Replace		1.5				1,2,5	
		Repair			4.0			1,7,9, 11-13	
1802	Windshield/Windows	Replace			2.5			1,7,9	
1805	Floorboards	Replace		1.0				1,7,9	
		Repair			0.5			1,7,9, 11,12	
1806	Seat and Back Assembly	Replace		2.0				1,2,5	
		Repair			3.0			1,7,9,11	
22	BODY ACCESSORY ITEMS								
2202	Mirrors, Reflectors	Replace		0.5				2,5	
	Windshield Wipers	Replace		0.3				2,5	
		Repair		0.3				2,5	
	Wiper Motor	Replace		1.5				2,5	
	Air Horn	Replace		1.0				2,5	
		Repair		0.5				2,5	
	Personnel Heater	Replace		2.5				1,2,5	
		Repair		1.0				1,2,5	
	Heater Hoses	Replace		1.0				1,2,5	
2210	Data and Inspection Plates	Replace		0.3				2,5	

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GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
24	HYDRAULIC SYSTEM								
2401	Speed-O-Matic Pump	Replace			2.0			1,7,9	
		Repair			2.0			1,7,9, 12	
2402	Hydraulic Valves	Inspect		0.2				2	
		Service		0.5				2	
		Replace		2.0				1-5	
		Repair			1.5			1,7,9	
2403	Accumulator	Replace		3.5				1-5	
		Repair			5.0			1,7,9	
2406	Hoses and Fittings	Replace		1.5				1,2,5	
		Repair		1.0				1,2,5	
	Strainer	Replace		0.8				2,5	
	Filter	Replace		0.5				2,5	
2407	Hydraulic Cylinders	Replace			4.0			1,7,9	
		Repair			4.0			1,7,9	
2408	Hydraulic Reservoir	Service	0.3	0.5				2,5	
		Replace			3.0			1,7,9	
		Repair			3.5			1,7,9	
29	AUXILIARY GENERATOR, ENGINE AND CONTROL								
2901	Generator and Engine Assembly	Inspect		1.0				2,5	
		Service		0.5				1,2,5	
		Replace			4.0			1,7,9	
		Overhaul				25.0		1,7,9, 12	
2911	Crankcase, Cylinder Block	Service		0.2				2,5	
		Replace				10.0		1,7,9	
		Repair				3.0		1,7,9, 12	
	Cylinder Head Assembly	Replace				5.0		1,7,9	
		Repair				3.0		1.7,9, 12	
2912	Crankshaft	Replace				2.0		1,7,9	
		Repair				1.0		1,7,9, 12	

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GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
2912	Bearings	Replace				1.0		1,7,9	
2913	Flywheel Assembly	Replace				1.0		1,7,9	
2914	Piston and Connecting Rod	Replace				2.0		1,7,9	
		Repair				3.0		1,7,9, 12	
	Piston Pin, Bearings and Rod	Replace				3.0		1,7,9	
2915	Valves	Inspect		0.2				2,5	
		Adjust			1.0			1,7,9	
		Replace				2.0		1,7,9	
		Repair				1.5		1,7,9, 12	
	Camshaft Assembly	Replace				3.5		1,7,9	
	Timing Gear	Replace				0.6		1,7,9	
	Rocker Arm Assembly	Replace				0.5		1,7,9	
		Repair				1.5		1,7,9, 12	
	Rocker Cover	Replace			1.5			1,7,9	
	Gear Cover	Replace				1.5		1,7,9	
2916	Oil Pump	Replace				0.6		1,7,9	
		Repair				1.0		1,7,9	
	By-Pass Valve (Pressure Relief)	Replace				0.7		1,7,9	
	Oil Filter	Replace		0.3				2,5	
	Crankcase Breather/ Breather Valve	Service		0.2				2,5	
		Replace		0.2				2,5	
	Oil Pan	Replace			0.8			1,7,9	
	Lines and Fittings	Replace			1.0			1,7,9	
	Oil Gage/Switches	Replace			0.3			1,7	

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GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
2918	Intake/Exhaust Manifold	Replace			1.3			1,7,9	
2930	Fuel Pump	Service		0.2				2,5	
		Replace			1.0			1,7-9	
		Repair				1.5		1,7-9	
	Fuel Injection Pump	Replace			2.8			1,7-9	
	Fuel Injection Nozzle	Adjust			0.5			1,7-9	
					0.8			1,7-9	
2933	Air Cleaner	Service		0.5				2,5	
		Replace		0.3				2,5	
2936	Engine Speed Governor	Adjust			0.3			1,8	
		Replace			1.0			1,7-9	
		Repair			1.0			1,7-9	
2937	Fuel Filters	Replace		0.3				2,5	
2938	Engine Priming System Lines	Replace			1.3			1,7-9	
2941	Muffler and Pipes	Inspect		0.1				2,5	
		Replace		1.5				1,2,5	
		Repair		1.0				1,2,5	
2952	Engine Cowling/ Blower Housing	Replace		1.5				1,2,5	
		Repair			0.7			1,7	
2961	Generator	Test			1.0			1,8	
		Adjust			0.8			1,7-9	
		Replace			2.5			1,7-9	
		Repair			3.0			1,7-9	
2963	Starting Solenoid/ Solenoid Relay	Test			0.2			1,8	
		Replace			1.0			1,7-9	
2968	Switches, Fuses	Replace		0.5				1,7-9	

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			C	**O**	**F**	**H**	**D**		
47	GAGES								
4701	Instruments (Speed and Distance)	Replace		0.5				1,2,5	
4702	Gages (Pressure, Quantity, etc.)	Replace		0.8				1,2,5	
	Lines and Fittings	Replace		1.0				1,2,3	
67	PRECISION INSTRUMENTS AND SYSTEMS								
6700	Overload Warning System	Inspect	0.3						A
		Test	0.3						
		Adjust			0.6			1,7,9	
		Replace			2.5			1,7,9	
6713	Electrical Cables	Replace			1.5			1,7,9	
		Repair				2.0		1,7,9	
74	CRANE COMPONENTS								
7411	Boom	Inspect	1.0						B
		Service	0.5						
		Replace			25.0			1,7,9, 12	
	Mast	Service	0.5						
		Replace			15.0			1,7,9, 12	
	Boom Backstops	Replace			8.5			1,7,9, 12	
	Bridle Assembly	Replace			8.0			1,7,9, 12	
	Hook Block	Replace		4.0				1,2,5	
	Crane (End Item) Lifting Assembly	Inspect	0.5						
		Service	0.5						
7414	Revolving Frame (Undecking)	Replace			85.0			1,7,10	
		Repair			20.0			1,7,10, 12	

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			C	**O**	**F**	**H**	**D**		
7411	Turntable Bearing	Service	1.5						
		Replace			16.0			1,7,10	
	Catwalk	Replace			16.0			1,7	
		Repair			8.0			1,7,12	
7415	Clutch Assemblies	Inspect		0.5				2,5	
		Service		0.8				2,5	
		Adjust		1.0				1,2,5	
		Replace			10.0			1,7,9	
		Repair			6.0			1,7,9, 12	
	Clutch Rotating Joint	Replace			6.0			1,7,9	
		Repair			2.0			1,7,9, 12	
7416	Boom Hoist Shaft Assembly	Service		0.5				2,5	
		Replace			20.0			1,7,9	
		Repair			8.0			1,7,9, 12	
	Rear Drum Shaft Assembly	Service		0.5				2,5	
		Replace			20.0			1,7,9	
		Repair			8.0			1,7,9, 12	
	Reverse (Swing) Shaft Assembly	Service		0.5				2,5	
		Replace			18.0			1,7,9	
		Repair			6.0			1,7,9, 12	
	Front Drum Shaft Assembly	Service		0.5				2,5	
		Replace			20.0			1,7,9	
		Repair			8.0			1,7,9, 12	
	Reduction Shaft Assemblies	Service		0.5				2,5	
		Replace			18.0			1,7,9	
		Repair			6.0			1,7,9, 12	
	Vertical Swing Shaft Assembly	Service		0.5				2,5	
		Replace			18.0			1,7,9	
		Repair			6.0			1,7,9, 12	

MAINTENANCE ALLOCATION CHART FOR
CRANE, MOBILE, CONTAINER HANDLING, 140-TON CAPACITY
TRUCK MOUNTED, DED, FMC MODEL HC-238A, NSN 3950-01-110-9224

SECTION II - ASSIGNMENT OF MAINTENANCE FUNCTIONS

1	2	3	4					5	6
GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
7416	Low Speed Planetary Assembly	Service		0.5				2,5	
		Replace			16.0			1,7,9	
		Repair			8.0			1,7,9, 12	
	Shaft Brake Assemblies	Inspect		0.5				2,5	
		Service		0.5				2,5	
		Adjust		0.5				2,5	
		Replace			16.0			1,7,9	
		Repair			4.0			1,7,9, 12	
7417	Boom Hoist Assembly	Replace			25.0			1,7,9	
		Repair			8.0			1,7,9, 12	
	Boom Hoist Pawl	Replace			4.0			1,7,9	
	Boom Hoist Wire Rope (Cable)	Inspect	1.0						
		Replace		16.0				1-6	
	Main Hoist Assembly	Replace			20.0			1,7,9	
		Repair			8.0			1,7,9, 12	
	Main Hoist Wire Rope (Cable)	Inspect	1.0						
		Replace		20.0				1-6	
7418	Torque Converter	Inspect	0.2						
		Service	0.2	0.5				2,5	
		Replace			20.0			1,7,9	
		Repair			8.0			1,7,9, 12	
	Pinion	Replace			16.0			1,7,9	
	Drive Chains	Adjust		0.6				2,5	
		Replace			12.0			1,7,9	
		Repair			2.0			1,7,9, 12	
	Chain Case	Service		0.5				2,5	
		Replace			20.0			1,7,9	
		Repair			3.0			1,7,9, 12	
7419	Swing Lock Assembly	Service		0.5				2,5	
		Replace			6.0			1,7,9	
		Repair			1.0			1,7,9, 12,	

MAINTENANCE ALLOCATION CHART FOR
CRANE, MOBILE, CONTAINER HANDLING, 140-TON CAPACITY
TRUCK MOUNTED, DED, FMC MODEL HC-238A, NSN 3950-01-110-9224

SECTION II - ASSIGNMENT OF MAINTENANCE FUNCTIONS

1	2	3	4					5	6
GROUP NUMBER	**COMPONENT/ASSEMBLY**	**MAINTENANCE FUNCTION**	**MAINTENANCE CATEGORY**					**TOOLS EQUIPMENT**	**REMARKS**
			C	**O**	**F**	**H**	**D**		
7420	Gearcases	Inspect		0.3				2,5	
		Service		0.5				2,5	
		Replace			12.0			1,7,9	
		Repair			5.0			1,7,9, 12	
	Housing Assembly	Replace			12.0			1,7,9	
		Repair			4.0			1,7,9, 12	
7422	Control Levers, Pedals, Linkage	Service		0.5				2,5	
		Replace			4.0			1,7,9	
		Repair			1.0			1,7,9, 12	

MAINTENANCE ALLOCATION CHART FOR
CRANE, MOBILE, CONTAINER HANDLING, 140-TON CAPACITY
TRUCK MOUNTED, DED, FMC MODEL HC-238A, NSN 3950-01-110-9224

SECTION III - TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL OR TEST EQUIPMENT REFERENCE CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	O, F, H	Shop Equip Contact Maint, Truck Mounted (SC 4940-95-CL-B04)	4940-00-294-9518	T10138
2	O, F, H	Shop Equip, Auto Maint: Org Maint, Common No. 1 (SC 4910-95-CL-A74)	4910-00-754-0654	W32593
3	O, F, H	Shop Equip, Auto Maint: Org Maint, Common No. 2 (SC 4910-95-CL-A72)	4910-00-754-0650	W32730
4	O, F, H	Shop Equip, Auto Maint: Org Maint, Supp No. 1 (SC 4910-95-CL-A73)	4910-00-754-0653	W32867
5	O, F, H	Tool Kit, General Mechanics: Auto (SC 5180-90-CL-N26)	5180-00-177-7033	W33004
6	O, F, H	Tool Kit, Rigging, Wire Rope (SC 5180-90-CL-N17)	5180-00-596-1513	W50266
7	F, H	Shop Equip,.Auto Maint: Field Maint, Basic (SC 4910-95-CL-A31)	4910-00-754-0705	T24660
8	F, H	Shop Equip, Fuel and Elec Sys Engine: Field Maint, Basic (SC 4910-95-CL-AO1)	4910-00-754-0714	T30414
9	F, H	Tool Kit, Master Mechanics (SC 5180-90-CL-N05)	5180-00-699-5273	W45060
10	F, H	Multiplier, Torque Wrench, 2500 ft lbs, PN PD2501	5120-00-482-2543	Y81747
11	F, H	Shop Equip, Welding: Field Maint (SC 3470-95-CL-A08)	3470-00-357-7268	T16714
12	F, H	Shop Equip Machine Shop: Field Maint Basic (SC 3470-95-CL-A02)	3470-00-754-0708	T15644

MAINTENANCE ALLOCATION CHART FOR
CRANE, MOBILE, CONTAINER HANDLING, 140-TON CAPACITY
TRUCK MOUNTED, DED, FMC MODEL HC-238A, NSN 3950-01-110-9224

SECTION III - TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL OR TEST EQUIPMENT REFERENCE CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
13	F, H	Tool Kit, Body and Fender Repair (SC 5180-90-CL-N34)	5180-00-754-0643	W33689

MAINTENANCE ALLOCATION CHART FOR
CRANE, MOBILE, CONTAINER HANDLING, 140-TON CAPACITY
TRUCK MOUNTED, DED, FMC MODEL HC-238A, NSN 3950-01-110-9224

SECTION IV- REMARKS

REFERENCE CODES	REMARKS
A	Repair on the Crane Overload Warning System is limited. Refer to Section 10 of this commercial operator's manual for Maintenance Instructions/Limitations and Repair Procedures on the Overload Warning System.
B	Repair of the Crane Boom Assembly is very limited. Refer to Appendix D for Maintenance Instructions/Limitations and Repair Procedures on the Boom Assembly.

APPENDIX D

ADDITIONAL MAINTENANCE INSTRUCTIONS

1. Oil Analysis Sampling Valves

Oil sampling valves have been installed on all 140-ton Mobile Cranes, as a provision of Contract No. DAAE07-80-C-6058, as follows:

a. Two valves, one each on both engines (upper, lower).

b. One valve on the upper engine torque converter.

Reference TB 43-0210 (5 Oct 81), for specific instructions, including responsibilities of user, sampling techniques, special precautions and INITIAL ENTRY INTO AOAP.

2. Prolonged Diesel Engine Idling

It is recommended that, rather than idling the engine for periods longer than 5 minutes, it be stopped and restarted when power is again required. If prolonged idling is absolutely necessary, it should be for as short a time as possible and at speeds of 1,000 RPMs or more. In addition, the engine should be periodically cleaned by operating under load at high speeds until normal lube oil and coolant temperatures are reached.

Prolonged idling has several ill effects which can eventually result in engine failure. This is especially true if the ambient temperatures are low. Ignition in diesel engines (especially 2-cycle types) takes place as a result of a sufficiently high temperature being generated by the compression of the intake air and proper injection of fuel. The loss of compression pressure, heat loss from the engine and loss of heat generation from cylinder combustion all reduce the possibility of reaching a sufficiently high compression temperature for combustion to take place. The lower engine speed (IDLE) allows more time for gas leakage past compression rings and heat transfer away from the cylinder.

3. Boom Repair

The Service Manual, Volume 2, contains repair procedures and instructions for boom and extension sections. This information has been provided as a guide to aid users of this equipment in the event that the prime contractor/subcontractor welders are not available, such as a contingency event or condition. Boom repair procedures in the commercial Technical Manuals were provided as "Information only". Field requirements for boom repair may be exercised in the form of a Contractor Support Service Contract or a commercial repair, or as an "in-house repair" when approved by the National Maintenance Point (NMP), DRSTA-MVM. This authorization will be granted upon written request to the NMP stating that all criteria listed in the Commercial Technical Manual (boom repair section) can be met or exceeded by the requesting unit. Crane serial number and US Army registration number are to accompany any such request. This action is required to insure that the structural integrity designed into the cranes is preserved at all times. Additional information is contained in TB 43-0142.

APPENDIX E

SHIPMENT AND STORAGE

Transportability Review, TR 81-4f-Q, for the 140-ton Crane is available from the Military Traffic Management Command (MTMC), Transportation Engineering Agency, 12388 Warwick Blvd., P.O. Box 6276, Newport News, VA 23606 (Phone: AUTOVON 927-4646). The manufacturer's loading recommendations are listed below:

Loading Recommendation	
Rail - Domestic	112,720 lb
1 - 60' flat car	
1 - HC-238A crane with gentry, base, and outriggers	
1 - 60' flat car	
1 - "A" upper counterweight	31,000 lb
1 - "B" upper counterweight	31,000 lb
1 - "A" bumper counterweight	13,500 lb
1 - "B" bumper counterweight	15,000 lb
1 - 60' flat car	
1 - 10' extension	577 lb
2 - 20' extension	1,984 lb
1 - 30' extension	1,392 lb
1 - 60' flat car	
1- peak	4,950 lb
1 - parts box	2,500 lb
3 - hookblocks	5,650 lb
3 - reel of cable	3,900 lb
1 - spare tire	150 lb
Rail - Export	
1 - 60' flat car	
1 - HC-238A with front outrigger	99,320 lb
1 - 60' flat car	
1 - "A" upper counterweight	31,000 lb
1 - "B" upper counterweight	31,000 lb
1 - "A" bumper counterweight	13,500 lb
1 - "B" bumper counterweight	15,000 lb
1 - 60' flat car	
1 - 10' extension	1,378 lb
2 - 20' extension	4,600 lb
1 - 30' extension	3,350 lb
1 - outrigger	7,600 lb

Rail - Export (continued)

1 - 60' flat car		
1- base		9,600 lb
1- peak		
1 - gantry		3,600 lb
1 - parts box		2,500 lb
3 - hookblocks		6,850 lb
3 - reel of cable		5,100 lb
1 - spare tire		300 lb

Domestic & Export Truck	Domestic	Export
1 - flat bed	4,950 lb	
1- peak	2,200 lb	9,800 lb
1- base	15,200 lb	15,200 lb
2 - outriggers		
	31,000 lb	31,000 lb
1 - drop frame	5,650 lb	6,850 lb
1 - "B" upper ctwt	3,900 lb	5,100 lb
3 - hookblocks		
3 - reel of cable	1,392 lb	3,350 lb
	992 lb	2,300 lb
1 - drop frame (30')	577 lb	1,378 lb
1 - 30' extension	2,500 lb (est.)	2,500 lb (est.)
1 - 20' extension		
1 - 10' extension	15,000 lb	15,000 lb
1 - parts box	3,600 lb	3,600 lb
1 - drop frame	31,000 lb	31,000 lb
1 - "B" bumper ctwt	992 lb	2,300 lb
1 - gantry		
	13,500 lb	13,500 lb
1 - drop frame (30')	150 lb	300 lb
1 - "A" upper ctwt		
1 - 20' extension		91,720 lb
	91,720 lb	
1 - drop frame		
1 - "B" bumper ctwt		
1 - spare tire		
1 - removable gooseneck		
1 - HC-238A		

APPENDIX F

TROOP AUTHORIZED OR INSTALLED ITEM LIST

- NOTE -

The following items are authorized but not issued with the end item.

National Stock No.	Description	Part Number (FSCM)	Unit of Measure	Quantity Authorized
7350-01-065-0166	Equipment Record Folder	H3986-1 (72094)	EA	1
4210-00-889-2221	Extinguisher, Fire, Dry Chemical	CS4210-0009CEFN (16236)	EA	1

APPENDIX G

MAINTENANCE OPERATING AND SUPPLY LIST FOR

CRANE, MOBILE, CONTAINER HANDLING, 140-TON CAPACITY
TRUCK MOUNTED, DED, FMC MODEL HC-238A, NSN 3950-01-110-9224

CARRIER

COMPONENT	DESCRIPTION	CAPACITY	UNIT OF MEASURE	NSN/(FSCM) PN
Cooling System	Coolant, 50/50 Ethylene Glycol/Water	8-3/4 Gal	1 Gal 5 Gal	6850-00-181-7929 6850-00-181-7933
Fuel Tank	Fuel Oil, Diesel, DF2, W-F-800	2 Tanks 45 Gal ea	Bulk	9140-00-286-5294
Engine Crankcase	Lubricating Oil, Engine, OE-30, MIL-L-2104C	6-1/4 Gal	1 Qt 5 Gal 55 Gal	9150-00-186-6681 9150-00-188-9858 9150-00-189-6729
	Lubricating Oil, Sub-Zero, MIL-L-46167	6-1/4 Gal	1 Qt 5 Gal 55 Gal	9150-00-402-4478 9150-00-402-2372 9150-00-491-7197
Rear Axle Differential	lubricating Oil, Gear GO-85/140, MIL-L-2105C	35 Pts ea	5 Gal 55 Gal	9150-01-035-5395 9150-01-035-5396
Rear Axle Planetary Hub	Lubricating Oil, Gear, GO-85/140, MIL-L-2105C	8 Pts ea	5 Gal 55 Gal	9150-01-035-5395 9150-01-035-5396
Main Transmission	Lubricating Oil, Gear, GO-80/90, MIL-L-2105C	28 Pts	1 Qt 5 Gal 55 Gal	9150-01-035-5392 9150-01-035-5393 9150-01-035-5394
Creeper Transmission	Lubrication Oil, Gear GO-80/90, MIL-L-2105C	12 Pts	1 Qt 5 Gal 55 Gal	9150-01-035-5392 9150-01-035-5393 9150-01-035-5394
Steering Gear	Lubricating Oil, Gear GO-SS/140, MIL-L-2105C	2-1/2 Pts	5 Gal 55 Gal	9150-01-035-5395 9150-01-035-5396
Power Steering System	Automatic Transmission Fluid, Type A, Dexron	3 Gal	1 Qt 1 Gal 5 Gal	9150-00-698-2382 9150-00-627-1503 9150-00-657-4959
Wheel Bearings and Grease Fittings	Bearing Grease, Automotive, MIL-G-10924	As Req'd.	1 Lb 5 Lb 35 Ib 120 Lb	9150-00-190-0904 9150-00-190-0905 9150-00-190-0907 9150-00-530-7369
Battery	Sulfuric Acid, Electrolyte	As Req'd.	1 Gal	6810-00-249-9354

CARRIER				
COMPONENT	DESCRIPTION	CAPACITY	UNIT OF MEASURE	NSN/(FSCM) PN
Various Components	Dry Cleaning Solvent, SD-2, P-D-680	As Req'd.	1 Gal	6850-00-281-1985
Outrigger System	Speed-o-Matic Oil	35 Gal	5 Gal 55 Gal 1 Qt 1 Qt	(36422) 830664001 (36422) 830664002 (34252) Gulf AW100 (80738)Exxon NutoH100
	Speed-o-Matic Oil, Sub-Zero	35 Gal	5 Gal 55 Gal 1 Qt	(36422) 830661001 (36422) 830661002 (15445) ConocoDN-600

UPPER				
COMPONENT	DESCRIPTION	CAPACITY	UNIT OF MEASURE	NSN/(FSCM) PN
Cooling System	Coolant, 50/50 Ethylene Glycol/Water	8-3/4 Gal	1 Gal 5 Gal	6850-00-181-7929 6850-00-181-7933
Fuel Tank	Fuel Oil, Diesel, DF2, W-F-800	75 Gal	Bulk	9140-00-286-5294
Engine Crankcase	Lubricating Oil, Engine, OE-30, MIL-L-2104C	7-1/4 Gal	1 Qt 5 Gal 55 Gal	9150-00-186-6681 9150-00-188-9858 9150-00-189-6729
	Lubricating Oil, Sub-Zero, MIL-L-46167	7-1/4 Gal	1 Qt 5 Gal 55 Gal	9150-00-402-4478 9150-00-402-2372 9150-00-491-7197
Torque Converter	Lubricating Oil, OE/HDO-10 MIL-L-2104C	9 Gal	1 Qt 5 Gal 55 Gal	9150-00-189-6727 9150-00-186-6668 9150-00-191-2772
	Lubricating Oil, Sub-Zero, MIL-L-46167	9 Gal	1 Qt 5 Gal 55 Gal	9150-00-402-4478 9150-00-402-2372 9150-00-491-7197
Chain Case	Lubricating Oil, SAE 10W30, MIL-L-46152	1-1/2 Gal	1 Qt 5 Gal 55 Gal Bulk	9150-00-186-6699 9150-00-256-6411 9150-00-186-6703 9150-00-451-6947

UPPER				
COMPONENT	DESCRIPTION	CAPACITY	UNIT OF MEASURE	NSN/(FSCM) PN
Reverse Bevel Gear Compart-ments	Lubricating Oil, Gear, GO-85/140, MIL-L-2105C	40 Pts	5 Gal 55 Gal	9150-01-035-5395 9150-01-035-5396
Planetary Gear Case	lubricating Oil, Gear, GO-85/140, MIL-L-2105C	2-1/2 Qts	5 Gal 55 Gal	9150-01-035-5395 9150-01-035-5396
Reduction Shaft Bear-ing Housing	Lubricating Oil, OE-50, MIL-L-2104C	1.5 Qts	1 Qt 5 Gal 55 Gal Bulk	9150-00-188-9864 9150-00-188-9865 9150-00-188-9867 9150-00-433-5968
Turntable Gear Teeth	Grease, Exposed Gear, MIL-L-18458	As Req'd.	35 Lb 120 Lb	9150-00-530-6814 9150-00-530-6813
Grease Fittings	Grease, Automotive, MIL-G-10924	As Req'd.	1 Lb 5 Lb 35 Lb 120 Lb	9150-00-190-0904 9150-00-190-0905 9150-00-190-0907 9150-00-530-7369
Linkages and Pivot Points	Lubricating Oil, OE-50, MIL-L-2104C	As Req'd.	1 Qt 5 Gal 55 Gal Bulk	9150-00-188-9864 9150-00-188-9865 9150-00-188-9867 9150-00-433-5968
Battery	Sulfuric Acid, Electrolyte	As Req'd.	1 Gal	6810-00-249-9354
Various Components	Dry Cleaning Solvent, SD-2, P-D-680	As Req'd.	1 Gal	6850-00-281-1985
Auxiliary Generator	Lubricating Oil, Engine, OE-30, MIL-L-2104C	3 Qts	1 Qt 5 Gal 55 Gal	9150-00-186-6681 9150-00-188-9858 9150-00-189-6729
	Lubricating Oil, Sub-Zero, MIL-L-46167	3 Qts	1 Qt 5 Gal 55 Gal	9150-00-402-4478 9150-00-402-2372 9150-00-491-7197
Hydraulic (S-o-M) System	Speed-o-Matic Oil	11.9 Qts	5 Gal 55 Gal 1 Qt 1 Qt	(36422) 830664001 (36422) 830664002 (34252) Gulf AW100 (80738) Exxon Nuto H100
	Speed-o-Matic Oil, Sub-Zero	11.9 Qts	5 Gal	(36422) 830661001 (36422) 830661002 (15445) Conoco DN-600

APPENDIX H

PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Section I. Operator/Crew Preventive Maintenance Checks and Services

MAINTENANCE FORMS AND RECORDS

Every mission begins and ends with the paperwork. There isn't much of it, but you have to keep it up. The forms and records you fill out have several uses. They are a permanent record of the services, repairs, and modifications made on your vehicle. They are reports to Organizational Maintenance and to your commander. And they are a checklist for you when you want to know what is wrong with the vehicle after its last use, and whether those faults have been fixed. For the information you need on forms and records, see TM 38-750.

PREVENTIVE MAINTENANCE CHECKS AND SERVICES

1. Do your before (B) PREVENTIVE MAINTENANCE just before you operate the vehicle. Pay attention to the CAUTIONS and WARNING.

2. During (D) checks and services of PREVENTIVE MAINTENANCE will be performed while the equipment and/or its component systems are in operation. Pay attention to the CAUTIONS and WARNINGS.

3. Do your after (A) PREVENTIVE MAINTENANCE right after operating the vehicle. Pay attention to the CAUTIONS and WARNINGS.

4. Do your weekly (W) PREVENTIVE MAINTENANCE weekly.

5. Do your monthly (M) PREVENTIVE MAINTENANCE once a month.

6. If something doesn't work, troubleshoot it with the instructions in the Operator's Manual or notify your supervisor.

7. Always do your PREVENTIVE MAINTENANCE in the same order so it gets to be a habit. Once you've had some practice, you'll spot anything wrong in a hurry.

8. If anything looks wrong and you can't fix it, write it on your DA form 2404. The Item Number column is the source for the numbers used on the TM Item Number column on DA Form 2404. If you find something seriously wrong, report it to Organizational Maintenance RIGHT NOW.

9. While performing PMCS, observe caution notes and warning paragraphs preceeding those operations which could endanger your safety or result in damage to the equipment.

10. When you do your PREVENTIVE MAINTENANCE, take along a rag or two.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well ventilated area. Avoid contact with skin, eyes and clothes and don't breathe vapors. Do not use near open flame or excessive heat. If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with skin or clothing is made, flush with water. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

a. Keep it clean: Dirt, grease, oil, and debris only get in the way and may cover up a serious problem. Clean as you work and as needed. Use dry cleaning solvent (SD 2) on all metal surfaces. Use soap and water when you clean rubber or plastic material.

b. Bolts, nuts, and screws: Check them all for obvious looseness, missing, bent or broken condition. You can't try them all with a tool, of course, but look for chipped paint, bare metal, or rust around bolt heads. If you find one you think is loose, tighten it. Report it to Organizational Maintenance if you can't tighten it.

c. Welds: Look for loose or chipped paint, rust, or gaps where parts are welded together. If you find a bad weld, report it to Organizational Maintenance.

d. Electric wires and connectors: Look for cracked or broken insulation, bare wires, and loose or broken connectors. Tighten loose connectors and make sure the wires are in good shape.

e. Hoses and fluid lines: Look for wear, damage, and leaks, and make sure clamps and fittings are tight. Wet spots show leaks, of course. But a stain around a fitting or connector can mean a leak. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn out, report it to Organizational Maintenance.

11. It is necessary for you to know how fluid leakage affects the status of your vehicle. The following are definitions of the types/classes of leakage you need to know to be able to determine the status of your vehicle. Learn, then be familiar with them and REMEMBER - WHEN IN DOUBT, NOTIFY YOUR SUPERVISOR.

Leakage Definitions For Crew/Operator PMCS

Class I Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.

Class II Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked/inspected.

Class III Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

CAUTION

Equipment operation is allowable with minor leakages (Class I or II). Of course, consideration must be given to the fluid capacity in the item/system being checked/inspected. When operating with Class I or II leaks, continue to check fluid levels as required in your PMCS. Class III leaks should be reported to your supervisor or Organizational Maintenance.

12. This PMCS is divided into a Carrier PMCS, an Upper PMCS and a Lifting Spreader Assembly PMCS.

Operator/Crew Preventive Maintenance Checks and Services - Carrier

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
						NOTE **PERFORM WEEKLY AS WELL AS BEFORE PMCSs IF:** **a. You are the assigned driver but have not operated crane carrier since the last weekly.** **b. You are operating the carrier for the first time.**	
1						MAKE THE FOLLOWING WALK AROUND CHECKS (EXTERIOR OF VEHICLE):	
	•					a. Check for evidence of leakage (oil, fuel, hydraulic fluid, or coolant) on or under vehicle.	Class III leakage exists.
	•					b. Visually check tires for cuts or abrasions.	Tires have cuts or abrasions which would result in tire failure during operation. One or more tires missing or unserviceable.
	•					c. Check tire pressure (correct pressure is approximately 100 PSI).	Low or flat tire.
	•					d. Check for loose, missing or damaged parts.	
2						ENGINE CRANKCASE	
	•					Check dipstick for proper oil level. Add oil as necessary to the "FULL" mark (ref. pg 2-21, para 2-47 Operator's Manual).	
3						BELTS	
	•					Check all drive belts for frays, cracks or deterioration.	Belts are frayed, cracked, unserviceable or missing.

Operator/Crew Preventive Maintenance Checks and Services - Carrier

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
4						RADIATOR	
	•					Check coolant level, add coolant as required. (Level should be approximately one inch from the bottom of the filler neck.)	
5						AIR CLEANER	
	•					a. Check air restriction indicator. If indicator has tripped, clean or replace air cleaner element and reset indicator.	Air restriction indicator has tripped.
	•					b. Empty dust cups.	
					•	c. Inspect air cleaner element. Clean or replace as necessary.	Air cleaner element or gaskets are damaged.
6						FUEL TANK	
	•					Inspect fuel tank and all visible lines and fittings for looseness, damage or leaks.	Loose or damaged parts, or Class III leakage are evident.
7						TURBOCHARGER	
	•					a. Visually inspect mountings, intake and exhaust ducting and connections for leaks.	Class III oil leakage exists.
						CAUTION **Idle engine for three (3) minutes before shutting down to avoid damaging the turbocharger.**	
		•				b. Check for unusual noise or vibration.	Unusual noise or vibration is detected.
8						POWER STEERING SYSTEM	
	•					a. Check for loose fittings, worn or chafed hoses, leaks.	Loose fittings, unserviceable hoses, or Class III oil leaks exist.

Operator/Crew Preventive Maintenance Checks and Services - Carrier

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
						CAUTION **Do not overfill Power Steering Reservoir.**	
		•				b. Check oil level. It should be one inch from top of reservoir when oil is at operating temperature. Add Type A Automatic Transmission Fluid as necessary.	
		•				c. Turn steering wheel to left and right. Check for binding, difficulty in steering or unusual noise.	Steering is binding or unresponsive, or unusual noise exists.
9						OUTRIGGER SUMP TANK	
		•				Fully retract all beams and jacks. Check hydraulic (S-O-M) fluid level. Add fluid as necessary to bring level to "FULL" mark on dipstick.	
10						BRAKE SYSTEM	
		•				a. Check low air pressure warning system for proper operation. System is activated at 60 P.S.I. or lower.	
		•				b. Check foot and emergency brake for proper operation, unusual noise, chatter, or side pull.	Brakes do not operate properly.
11						EXHAUST SYSTEM	
		•				a. Listen for exhaust leaks.	Any leaks detected inside cab.
				•		b. Visually inspect the muffler, shield, and pipes for damage and security of hardware.	
12						CAB INSTRUMENTS (GAUGES)	
	•					a. Inspect for obvious damage.	

Operator/Crew Preventive Maintenance Checks and Services - Carrier

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
						b. Check normal operating readings for the Instruments are not instruments as follows:within normal operating range.	
		•				(1) Engine water temperature 1600-1850F.	
		•				(2) Service brakes air pressure (front and rear) 115-125 PSI.	
		•				(3) Parking/emergency brakes air pressure 115-125 PSI.	
		•				(4) Supply air pressure 140-150 PSI.	
		•				(5) Battery voltmeter 11.8-15.2 volts.	
						CAUTION **Never operate engine with oil pressures below 18 P.S.I.**	
		•				(6) Engine oil pressure 30-60 PSI normal (18 PSI min).	
13						LIGHTS	
		•				Inspect all lights for proper operation.	
14						WINDSHIELD WIPERS	
		•				Check for proper operation, condition of arms and blades.	
15						AIR RESERVOIRS	
			•			Open drain cocks on the bottom of each tank to allow moisture and accumulated sediment to drain. Close drain cocks.	
16						LUBRICATION REQUIREMENTS	
						The following assemblies require lubrication IAW Lubrication Chart, Pg 2-5, Operator's Manual:	

Operator/Crew Preventive Maintenance Checks and Services - Carrier

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
				•		(1) Brake cam shafts	
				•		(2) Clutch release bearing	
				•		(3) Clutch shaft support	
				•		(4) Clutch cross shaft	
17						BATTERIES **WARNING** **Do not get battery electrolyte on your skin, clothing, or in your eyes. It is an acid which can cause injury. Keep all sparks and flames from batteries, because battery gas is explosive.** **CAUTION** **In cold weather operations, charge batteries immediately after adding water. Water must combine with the electrolyte by means of charging. Delay in charging can result in freezing water. Be careful not to overfill when servicing batteries.**	
				•		a. Check level of electrolyte. If level of electrolyte is below top of battery plates, add distilled water to cover the plates.	
				•		b. Inspect batteries and battery box for damage.	Batteries are missing or damaged, or if engine will not crank.

Operator/Crew Preventive Maintenance Checks and Services - Carrier

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
						NOTE **PERFORM WEEKLY AS WELL AS BEFORE PMCSs IF:** a. You are the assigned operator but have not operated crane upper since the last weekly. b. You are operating the upper for the first time.	
1						MAKE THE FOLLOWING WALK AROUND CHECKS (EXTERIOR OF CRANE UPPER):	
	•					a. Check for evidence of leakage (oil, fuel, or coolant) on or under the upper.	Class III leakage exists.
	•					b. Check for loose, missing or damaged parts.	
2						ENGINE CRANKCASE	
	•					Check dipstick for proper oil level. Add oil as necessary to the "FULL" mark (ref. pg 2-21, para 2-47, Operator's Manual).	
3						BELTS	
	•					Check all drive belts for cracks, frays or deterioration.	Belts are frayed, cracked or missing.
4						RADIATOR	
	•					Check coolant level, add coolant as required. (Level should be approximately one inch from the bottom of the filler neck.)	

Operator/Crew Preventive Maintenance Checks and Services - Upper

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
5						AIR CLEANER	
	•					a. Check air restriction indicator. If indicator has tripped, clean or replace air cleaner element and reset indicator.	Air restriction indicator has tripped.
	•					b. Empty dust caps.	
	•				•	c. Inspect air cleaner element. Clean or replace as necessary.	Air cleaner element or gasket is damaged.
6						FUEL TANK	
	•					Inspect fuel tank and visible lines and fittings for looseness, damage or leaks.	Loose or damaged parts or Class III leakage are evident.
7						HYDRAULIC SYSTEM (SPEED-O-MATIC)	
	•					Check hydraulic (S-O-M) fluid level. Add fluid as required to bring level to "FULL" on dipstick.	
8						BOOM CHORDS AND LATTICE	
	•					a. Check for obvious cracks, bends or damage.	The boom chords or lattice are cracked, bent or damaged.
	•					b. Check that LOAD TEST is current (refer to TB 43-0142).	LOAD TEST not current.
9						REQUIRED LUBRICATION	
						The following assemblies require lubrication:	
						IAW Lubrication Chart, Pg 2-13, Operator's Manual	
	•					(1) Boom foot pins	
	•					(2) Mast foot pins	

Operator/Crew Preventive Maintenance Checks and Services - Upper

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
						IAW Lubrication Chart, pg 2-11, Operator's Manual	
	•					(1) Throwout collar.	
					•	(2) Clutch cross shaft	
10						CHAIN CASE	
	•					Check oil level. It should be to the bottom of the check plug opening. Add SAE 10W30 detergent engine oil if necessary.	
11						OPEN GEARS	
						WARNING **Upper engine must be shut down and swing lock engaged while applying grease. This will help avoid injury to personnel.**	
	•					Maintain a thin film of grease on open gears at all times, to include swing pinion and turntable bearing.	
12						AUXILIARY GENERATOR ENGINE	
	•					a. Check dipstick for proper engine oil level. Add oil as necessary to "FULL" mark (ref. pg 6-9 Operator's Manual).	
					•	b. Inspect and clean air cleaner (ref. pg 6-8 Operator's Manual).	

Operator/Crew Preventive Maintenance Checks and Services - Upper

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
13						WIRE ROPE AND FITTINGS	
	•					Inspect the wire rope, rope sockets and fittings for damage, wear, corrosion, fatigue and rope lubrication.	a. In running ropes, there are six randomly distributed broken wires in one rope lay or three broken wires in one strand in one rope lay. b. In pendants or standing ropes, there is more than one broken wire in one rope lay. c. A loss of 1/3 the original diameter of outside wires by abrasion, scrubbing or peening is found. d. There is rope deterioration from rust or corrosion. e. There is severe kinking or crushing or evidence of "birdcaging." f. Obvious reduction in wire rope diameter exists. g. There is evidence of heat damage from any cause.

Operator/Crew Preventive Maintenance Checks and Services - Upper

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
14						CRANE OVERLOAD WARNING SYSTEM Test the Overload Warning System. Refer to Paragraph 10-4 of the Commercial Operator's Manual.	

Operator/Crew Preventive Maintenance Checks and Services - Upper

NOTE: Within designated interval these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
15						CAB INSTRUMENTS (GAUGES)	
	•					a. Inspect for damage or loose mountings.	
						b. Check normal operating readings for the instruments as follows:	Readings are outside indicated range.
		•				(1) Engine water temperature 150-185°F.	
		•				(2) Battery voltmeter 11.8-15.2 volts.	
		•				(3) Engine oil pressure - 25 PSI @1200 RPM 30 PSI @2100 RPM **WARNING** **Never operate machine when torque converter temperature is 2500F or over. Fire or explosion may result.** **NOTE** **At maximum machine load, temperature may exceed 220°F.**	
		•				(4) Torque converter oil temperature 180°-220°F (normal). (Maximum machine load temperature 220°-250°F.) **NOTE** **1250 P.S.I. indicates the system is working over relief pressure and should be shut down.**	Temperature exceeds 250°F.
		•				(5) Hydraulic system pressure (Speed-O-Matic) 900-1050 PSI.	Pressure is 1250 P.S.I. or above.

Operator/Crew Preventive Maintenance Checks and Services - Upper

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
16						TORQUE CONVERTER	
		•				Check the torque converter and the supply tank fluid level. Fluid must be checked at operating temperature and engine must be running. Add oil as necessary to bring the level to the "FULL" mark (ref. pg 2-27, para 2-81 Operator's Manual).	
17						LIGHTS	
		•				Inspect all lights for proper operation.	
18						WINDSHIELD WIPERS	
		•				Check for proper operation, condition of arms and blades.	
19						DRUM TURN INDICATOR	
		•				Check operation of the audio-visual drum turn indicator.	
20						CONTROL LEVERS AND PEDALS	
			•			Check for proper operation.	Controls perform improperly.
21						BRAKES, PAWLS AND CLUTCHES **WARNING** **Correct adjustment is required for safe load handling and to avoid injury to personnel.**	
			•			Apply every brake, pawl and clutch and check for proper engagement. Adjust or have repaired any faults.	Brakes, pawls and clutches do not engage properly.

Operator/Crew Preventive Maintenance Checks and Services - Upper

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
22						EXHAUST SYSTEM	
		•				a. Listen for exhaust leaks. Any leaks detected inside the cab.	
				•		b. Visually inspect the muffler, shield and pipes for damage and security of hardware.	
23						AIR BOX DRAINS	
			•			Drain accumulated oil and water from the air box.	
24						BATTERIES (UPPER AND GENERATOR)	
						WARNING **Do not get battery electrolyte on your skin, clothing, or in your eyes. It is an acid which can cause injury. Keep all sparks and flames from batteries because battery gas is explosive.**	
						CAUTION **In cold weather operations, charge batteries immediately after adding water. Water must combine with electrolyte by means of charging. Delay in charging can result in freezing water. Be careful not to overfill when servicing batteries.**	
				•		a. Check level of electrolyte. If level of electrolyte is below top of battery plates, add distilled water to cover the plates.	
				•		b. Visually inspect batteries and battery box for damage.	Batteries are missing, damaged, or if engine will not crank.

Operator/Crew Preventive Maintenance Checks and Services - Lifting Sling (for End Item)

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
						WARNING **Trying to lift the machine with damaged components in the Lifting Sling can cause an accident since a very heavy load is being lifted. If it falls, the machine will be damaged and personnel nearby may be injured or killed.**	
1						BEAMS	
	•					Inspect for cracked welds or cracks in the H-Beams, Lugs or Corner Braces.	Any cracks are found.
2						FITTINGS	
	•					Inspect Links and Pins for damage such as cracks, scoring or evidence of stretching or bending.	Any damage is found.
3						SLINGS AND PENDANTS	
	•					Inspect wire rope for damage, wear, corrosion, fatigue and rope lubrication.	a. There is more than one broken wire in one rope lay. b. A loss of 1/3 the original diameter of outside wires by abrasion, scrubbing or peening. c. Rope deterioration from rust or corrosion. d. Severe kinking or crushing or evidence of "birdcaging." e. Obvious reduction in wire rope diameter.

Operator/Crew Preventive Maintenance Checks and Services - Lifting Sling (for End Item)

NOTE: Within designated interval, these checks are to be performed in the order listed.

B - Before D - During A - After W - Weekly M - Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
4						PINS	
			•			Coat pins and pin holes with preservative.	
						WIRE ROPE	
			•			Coat with grease to preserve the wire rope.	

Section II. Organizational Preventive Maintenance Checks and Services (PMCS)

GENERAL

To make sure that your vehicle is ready for operation at all times, inspect it systematically so you can discover any defects and have them corrected before they result in serious damage or failure. The charts on the next few pages contain your organizational PMCS. This PMCS is divided into a Carrier PMCS and an Upper PMCS. The item numbers indicate the sequence of minimum inspection requirements. If you're operating the vehicle and notice something wrong which could damage the equipment if you continue operation, stop operation immediately.

Record all deficiencies and shortcomings, along with the corrective action taken on DA Form 2404. The Item Number column is the source for the numbers used on the TM Item Number column on DA Form 2404.

ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

1. The item numbers of the table indicate the sequence of the PMCS. Perform at the intervals shown below:
   a. Do your (M) PREVENTIVE MAINTENANCE once every month.
   b. Do your (5) PREVENTIVE MAINTENANCE semiannually (every six months).
   c. Do your (H) PREVENTIVE MAINTENANCE at the hour interval listed.
2. If something doesn't work, troubleshoot it with the instructions in the Commercial Technical Manuals or notify your supervisor.
3. Always do your preventive maintenance in the same order, so it gets to be a habit. Once you've had some practice, you'll spot anything wrong in a hurry.
4. If anything looks wrong and you can't fix it, write it down on your DA Form 2404. If you find something seriously wrong, report it to direct support as soon as possible.
5. While performing PMCS observe caution notes and warning paragraphs preceding those operations which could endanger your safety or result in damage to the equipment.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well ventilated area. Avoid contact with skin, eyes and clothes and don't breathe vapors. Do not use near open flame or excessive heat. If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with skin or clothing is made, flush with water. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

Air-Compressed air, used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personnel protective equipment (goggles/shield/gloves, etc.).

a. Keep it clean: Dirt, grease, oil and debris only get in the way and may cover up a serious problem. Clean as you work and as needed. Use dry cleaning solvent (P-D-680) to clean metal surfaces. Use soap and water when you clean rubber or plastic material.

b. Bolts, nuts and screws: Check that they are not loose, missing, bent or broken. You can't try them all with a tool, of course, but look for chipped paint, bare metal or rust around bolt heads. Tighten any that you find loose.

c. Welds: Look for loose or chipped paint, rust or gaps where parts are welded together. If you find a bad weld, report it to direct support.

d. Electric wires and connectors: Look for cracked or broken insulation, bare wires and loose or broken connectors. Tighten loose connectors and make sure the wires are in good condition.

e. Hoses and fluid lines: Look for wear, damage and leaks. Make sure clamps and fittings are tight. Wet spots show leaks, of course, but a stain around a fitting or connector can mean a leak. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn out, either correct it or report it to direct support (refer to MAC Chart).

6. It is necessary for you to know how fluid leaks affect the status of your equipment. The following are definitions of the types/classes of leakage you need to know to be able to determine the status of your equipment. Learn and be familiar with them and REMEMBER - WHEN IN DOUBT, NOTIFY YOUR SUPERVISOR.

Leakage Definitions For Crew/Operator PMCS

Class I	Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.
Class II	Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked/inspected.
Class III	Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

Organizational Preventive Maintenance Check and Services - Carrier

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
				NOTE **Perform Operator/Crew PMCS prior to or in conjunction with Organizational PMCS if:** **a. There is a delay between the daily operation of equipment and the Organizational PMCS.** **b. Regular operator is not assisting/participating.**
1				TRANSMISSION (MAIN and CREEPER) and REAR DIFFERENTIALS
	•			a. Check oil level with machine on level ground, by removing the check plug. Add lubricant until level reaches bottom of opening.
		•		b. Change oil when warm. Drain oil, fill with light oil (DE 5), run a few minutes, drain and refill with proper lubricant (ref. page 2-5 and page 2-14 Operator's Manual).
	•			c. Inspect for missing components, loose bolts, leakage or damage. Repair before roading the machine.
2				CONTROL LINKAGE
	•			a. Lubricate master shifter control. Pump in grease until it extrudes around the boot on the shift lever.
	•			b. Lubricate all pivot points on transmission, creeper transmission and throttle control linkages with engine oil.
3				CHASSIS
	•			Provide complete chassis lubrication. Force grease into fittings until old lubricant, dirt, and water are expelled.
4				WHEELS
	•			Inspect wheels, rims, and nuts for damage. Check lug nuts for proper torque (ref. page SMl-69-2.O Shop Manual).
5				REAR AXLE VENTS
	•			Clean the vents.

Organizational Preventive Maintenance Check and Services - Carrier

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
6				STEERING GEAR
	•			a. Check the lubricant level; fill as necessary with SAE 90 Extreme Pressure Gear Lubricant.
	•			b. Inspect for leakage or damage.
7				PLANETARY WHEEL HUB
	•			a. Check the oil level (ref. page 2-14, para 2-25, Operator's Manual).
		•		b. Change oil (ref. page 2-14, para 2-26, Operator's Manual).
8				TRANSMISSION AIR FILTER
		•		Replace air filter.
9				POWER STEERING RESERVOIR
		•		Change oil (ref. page 2-5 Operator's Manual).
10				FRONT WHEEL BEARINGS
		•		Inspect, replace any unserviceable parts and repack with grease.
11				BRAKES
		•		a. Check adjustment (ref. page 3-4, para 3-6 and page 3-5, para 3-9, Operator's Manual).
		•		b. Inspect linings, drums, and cylinders for excessive wear, scoring, or leaking.
12				OUTRIGGER HYDRAULIC SYSTEM
				NOTE **Change filter after the first 50 hours of machine operation. Thereafter, change at specified intervals.**
			200	a. Change filter (ref. page 2-15, para 2-29, Operator's Manual).
		•		b. Change oil (ref. page 2-15, para 2-30, Operator's Manual). Clean strainer when sump tank is drained.

Organizational Preventive Maintenance Check and Services - Carrier

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
13				COOLING SYSTEM
			500	a. Inspect all hoses for cracks, bulges, or signs of deterioration
			1000	b. Check coolant condition IAW TB 750-651. Clean, flush, refill with coolant and rust inhibitors if necessary.
14				CLUTCH LINKAGE
			50	Lubricate pivot points on the clutch pedal and linkage with engine oil.
15				ENGINE
			150	Change oil, replace filter and clean crankcase breather cap (ref. page 2-27, para 2-82 Operator's Manual).
				NOTE **For Army Oil Analysis Program Procedure, refer to TB 43-0210.**
16				DRIVE BELTS
			200	Check tension of belts and adjust as necessary (ref. page 2-22, para 2-56, Operator's Manual).
17				AIR COMPRESSOR
				WARNING **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well ventilated area. Avoid contact with skin, eyes and clothes and don't breathe vapors. Do not use near open flame or excessive heat. If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with skin or clothing is made, wash your eyes with water and get medical aid immediately.**
			200	Clean air strainer element using dry cleaning solvent (ref. page 2-23, para 2-57, Operator's Manual).

Organizational Preventive Maintenance Check and Services - Carrier

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
18				FUEL STRAINER AND FILTER
			300	Replace both elements at indicated time or when plugged (ref. page 2-24, para 2-60, Operator's Manual).
19				EMERGENCY SHUTDOWN
			300	Check emergency shutdown system to be sure it will operate when needed.
20				FUEL TANK
			500	Open drain at bottom of tank to remove any water or sediment.
21				POWER TAKEOFF
			500	a. Lubricate clutch levers and links with engine oil (ref. page 2-26, para 2-80, Operator's Manual).
			500	b. Check the clutch facing for wear (ref. page 3-1, para 3-3, Operator's Manual).
22				AIR SYSTEM
			700	Check all connections and hoses for damage or leaks.
23				AIR BOX DRAIN TUBES
			1000	With engine running, check for flow of air from the air box drain tubes. If tubes are clogged, remove, clean and reinstall.
24				GOVERNOR
			1000	Replace governor oil filter.

Organizational Preventive Maintenance Check and Services - Carrier

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
				WARNING - **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well ventilated area. Avoid contact with skin, eyes and clothes and don't breathe vapors. Do not use near open flame or excessive heat. If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with skin or clothing is made, flush with water. If contact with eyes is made, wash your eyes with water and get medical aid immediately.** - **Air - Compressed air, used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personnel protective equipment (goggles/shield/gloves, etc.).**
25				BLOWER SCREEN
			1000	a. Inspect screen and gasket (ref. page 2-26, para 2-77, Operator's Manual).
			1000	b. Clean screen in solvent and dry with compressed air. Reinstall and check for signs of blower seal leakage.
26				CRANKCASE BREATHER
			1000	Remove crankcase breather assembly and wash in clean solvent.
27				ENGINE AND TRANSMISSION MOUNTS
			2000	Check condition of mounting bolts and mounting pads. Repair or replace as necessary.
28				AIR BOX CHECK VALVES
			3000	Remove valves, clean in solvent and blow out lines with compressed air. Inspect for leaks after servicing.
29				LUBRICATION REQUIREMENTS
				Perform all other lubrication as specified in lubrication charts on pages 2-5 and 2-20 in the Operator's Manual.

Organizational Preventive Maintenance Check and Services - Upper

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
				NOTE **Perform Operator/Crew PMCS prior to or in conjunction with Organizational PMCS if:** a. There is a delay between the daily operation of equipment and the Organizational PMCS. b. Regular operator is not assisting/participating.
1				CRANE OVERLOAD WARNING SYSTEM Verify load and radius calibration with actual measurements. If recalibration is necessary, follow procedures given in Section 18 of the commercial Shop Technical Manual.
		•		a. Check load by lifting a known load that is at least 50% of the rated capacity for the given part of line.
		•		b. Check radius by booming to a radius that can be conveniently measured with a tape measure.
				WARNING **Do not service, maintain or lubricate the gear cases unless engine is shut down and swing lock is engaged.**
2				GEAR CASES (REDUCTION PINION GEAR CASE, REVERSE BEVEL GEAR CASE, PLANETARY GEAR CASE)
			50	a. Check oil levels (ref. pg 2-14, para 2-20, Operator's Manual).
			50	b. Check for damage or leakage.
			1000	c. Drain, clean, and refill with specified oil.
3				MASTER CLUTCH
			50	a. Check clutch for wear or damage, especially the throwout collar and the grease hose and fittings leading to it.
			250	b. Check adjustment (ref. page 4-1, para 4-2, Operator's Manual).
4				TORQUE CONVERTER
			50	a. Inspect and clean exterior, including oil breather.
			50	b. Lubricate the input clutch release bearing, ball bearing and front disconnect clutch drive shaft bearing.

Organizational Preventive Maintenance Check and Services - Upper

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
			1000	c. Change oil and filters (ref. pg 2-27, para 2-81, Operator's Manual.
				NOTE **For Army Oil Analysis Program Procedures, refer to TB 43-0212.**
5				CONTROL VALVES (SPEED-O-MATIC)
			50	Inspect valves and linkage for rust or corrosion, clean any that is found. Lubricate valve spools with clean hydraulic oil.
6				CLUTCHES AND BRAKES
			50	a. Check all clutches and brakes for proper adjustments and adjust as necessary (ref. SEC 4, Operator's Manual).
			50	b. Check condition of linings; greasy, worn, deteriorated linings should be replaced.
			50	c. Check for foreign material which may score drums; remove as necessary.
7				SIDE HOUSING BEARINGS (ALL HORIZONTAL SHAFTS)
			50	Pump 8 to 10 shots of grease at each lubrication point. Wipe off excess grease to keep clutch linings clean.
8				REDUCTION SHAFT BEARING HOUSING
			50	a. Check oil level. Fill to level of check plug hole if oil is low.
			50	b. Drain, clean and refill with the proper lubricant.
9				CLUTCH HEEL BLOCKS, CONTROL LEVER LINKAGE, SWING LOCK LINKAGE, SWING BRAKE LINKAGE AND PINS, S-O-M VALVE SPOOLS
			50	a. Lubricate all pivot points with engine oil.
			50	b. Check valve caps for rust and corrosion; clean if any is present. Lubricate with engine oil.

Organizational Preventive Maintenance Check and Services - Upper

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
10				AUXILIARY GENERATOR Perform the following checks and services on the auxiliary generator. For additional information, refer to the indicated areas of the Operator's Manual.
			100	a. Change crackcase oil (pg 6-1, Fig 6-1).
			100	b. Drain moisture from sediment bowl.
			200	c. Clean crankcase breather (pg 6-9).
			200	d. Replace oil filter (pg 6-1, Fig 6-1).
			500	e. Check generator slip rings and brushes; replace if worn to 5/8" (ref. Sec SM 18-10-11.0 Shop Manual).
			500	f. Check valve clearances. Adjust as necessary (pg 6-5, para 6-34, Fig 6-6 and Fig 6-7).
			600	g. Change primary fuel filter (pg 6-1, Fig 6-1).
			3000	h. Change secondary fuel filter (pg 6-1, Fig 6-1).

Organizational Preventive Maintenance Check and Services - Upper

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
11				ENGINE
			150	Change oil, replace filter and clean crankcase breather cap (ref. pg 2-27, para 2-82, Operator's Manual).
				NOTE **For Army Oil Analysis Program Procedures, refer to TB 43-0210.**
12				DRIVE BELTS
			200	Check tension of belts and adjust as necessary (ref. page 2-22, para 2-56, Operator's Manual).
13				HYDRAULIC SYSTEM (SPEED-O-MATIC)
				NOTE **The first filter change should be at 50 hours.**
			250	a. Change filter.
			1000	b. Drain, clean and refill the system (ref. page 7-1, para 7-3, Operator's Manual).
14				BRAKES (BOOM HOIST, FRONT AND REAR DRUMS)
			250	a. Check band connecting lugs, actuating linkage, related pins and the mounting bracket pin hole for signs of wear or damage. Repair or replace as necessary.
			250	b. Check band for any indications of bending, interference or unusual lining wear which would indicate excessive wear of brake parts. Repair or replace as necessary.
			250	c. Check condition of the band adjusting bolt and nut to make sure the locking nut will hold against rotation during operations.
			250	d. Remove the band and all related parts for a detailed inspection. If any parts show excessive wear, cracks or other damage, replace them. Reassemble and adjust the mechanism (ref. page 4-4, page 4-5, Operator's Manual).

Organizational Preventive Maintenance Check and Services - Upper

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
15				FUEL STRAINER AND FILTER
			300	Replace both elements at indicated time or when plugged (ref. page 2-24, para 2-60, Operator's Manual).
16				EMERGENCY SHUTDOWN
			300	Check emergency shutdown system to be sure it will operate when needed.
17				FUEL TANKS
			500	Open drain at bottom of tank to remove any water or sediment.
18				COOLING SYSTEM
			500	a. Inspect all hoses for cracks, bulges, or signs of deterioration. Replace hoses if necessary.
			1000	b. Check coolant condition IAW TB 750-651. Clean, flush, refill with coolant and rust inhibitors if necessary.
19				WIRE ROPE
			500	Inspect wire rope to insure that reductions of nominal diameter do not exceed: (1) 3/64 inch for diameters 9/16 to 3/4 inch. (2) 1/16 inch for diameters 7/8 to 1-1/8 inches. (3) 3/32 inch for diameters 1-1/4 to 1-1/2 inches. Replace if necessary (ref. page 5-21, para 5-35, Operator's Manual).
20				AIR BOX DRAIN TANK
			500	Remove cylinder block hand hole covers and check for an accumulation of liquid or sludge on air box floor. Clean air box, hoses, fittings and cover and reassemble.
21				AIR BOX DRAIN TUBES
			1000	With engine running, check for flow of air from the air box drain tubes. If tubes are clogged, remove, clean and reinstall.

Organizational Preventive Maintenance Check and Services - Upper

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
				WARNING **Do not service, maintain or lubricate gears, drive chains or chain case unless engine is shut down and swing lock is engaged.**
22			1000	BEVEL GEARS, ENGINE DRIVE CHAINS a. Inspect for excessive wear or damage and repair or replace as necessary (ref. page 2-8, para 2-14, Operator's Manual). b. Adjust bevel gear backlash and chain tension as necessary (ref. page 4-7, para 4-20, Operator's Manual).
23			1000	OPEN GEARS Inspect for excessive wear or damage and repair or replace as necessary.
24			1000	CHAIN CASE Drain, clean and refill (ref. page 2-16, para 2-33, Operator's Manual).
25			1000	GOVERNOR Replace governor oil filter.
26			1000	BLOWER SCREEN a. Inspect screen and gasket (ref. page 2-26, para 2-77, Operator's Manual). **WARNING** - **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well ventilated area. Avoid contact with skin, eyes and clothes and don't breathe vapors. Do not use near open flame or excessive heat. If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with skin or clothing is made, flush with water. If contact with eyes is made, wash your eyes with water and get medical aid immediately.** - **Air - Compressed air, used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personnel protective equipment (goggles/shield/gloves, etc.).**
			1000	b. Clean screen in solvent and dry with compressed air. Reinstall and check for signs of blower seal leakage.

Organizational Preventive Maintenance Check and Services - Upper

M - Monthly **S - Semiannually** **H - Hours**

ITEM NO.	Interval			ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND REPAIR, FILL OR ADJUST AS NECESSARY
	M	S	H	
				WARNING - **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well ventilated area. Avoid contact with skin, eyes and clothes and don't breathe vapors. Do not use near open flame or excessive heat. If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with skin or clothing is made, flush with water. If contact with eyes is made, wash your eyes with water and get medical aid immediately.** - **Air - Compressed air, used for cleaning purposes will. not exceed 30 psi. Use only with effective chip guarding and personnel protective equipment (goggles/shield/gloves, etc.).**
27				CRANKCASE BREATHER
			1000	Remove crankcase breather assembly and wash in clean solvent.
28				ENGINE AND TRANSMISSION MOUNTS
			2000	Check condition of mounting bolts and mounting pads. Repair or replace if necessary.
29				AIR BOX CHECK VALVES
			3000	Remove valves, clean in solvent and blow out lines with compressed air. Inspect for leaks after servicing.
30				LUBRICATION REQUIREMENTS
				Perform all lubrication as specified in lubrication charts on pages 2-11, 2-13, and 2-20, Operator's Manual.

APPENDIX I
PRESCRIBED LOAD LIST (PLL) AND AUTHORIZED STOCKAGE LIST (ASL)

END ITEM: Crane, Mobile, 140-Ton Capacity, Container Handler	MAKE: FMC	MODEL: HC-238A
NSN: 3950-01-110-9224		DATE: 16 Apr 82

SMR CODE	NSN	PRIME P/N	FSCM	PART DESCRIPTION	UNIT PRICE	U/M	QTY OF PARTS REQ'D FOR NO. OF FND ITEMS			
							PLL	ASL		
							1-5	1-5	6-20	21-50
PAOZZ	2540-00-477-9630	BD721011-18	01843	Blade, Wiper (Upper, Lower Window)	4.00	EA	1	2		
PAOZZ	6240-00-924-7526	1156	08108	Lamp (Back-up Lights)	1.00	EA	4	8		
PAOZZ	6240-00-889-1799	1157	08806	Lamp (Tail Light)	1.00	EA	4	8		
PAOZZ	6240-00-763-3450	1893	08806	Lamp (RH/LH Outer Headlights)	1.00	EA	4	8		
PAOZZ	6240-00-944-1264	194	08108	Lamp (I.D. Lights)	1.00	EA	4	8		
PAOZZ	6240-00-691-0369	4478	08806	Lamp (Battery Lighting Sys.)	10.00	EA	2	4		
PAOZZ	6240-00-214-9073	4000	08806	Lamp (RH Headlight)	10.00	EA	2	4		
PAOZZ	5330-01-043-5565	1P3703	11083	Packing, Preformed (Lock Valve)	6.00	EA	1	2		
PAOZZ	4130-01-098-7901	P12-9396	18265	Filter, Element (Carrier Eng, Air)	105.00	EA	1	2		
PAOZZ	6685-01-099-6261	RAX00-2351	18265	Indicator, Pressure (Carrier Eng, Air)	16.00	EA	1	1		
PAOZZ	5330-00-556-8630	3-6	30780	Packing, Preformed (Bleed Plug Gasket, Hydr. Res)	.50	EA	2	4		
PAOZZ	3810-01-100-4952	PX316	36422	Filter Element (Hydr.Reservior)	28.00	EA	1	2		
PAOZZ	4720-01-116-7813	18A4308	36422	Hose (Carrier Eng. Rad. Top)	25.00	EA	1	2		
PAOZZ	4720-01-116-7815	18A4309	36422	Hose (Carrier Eng. Rad. Lower)	15.00	EA	1	2		
PAOZZ	2910-00-125-5600	122-0325	44940	Filter, Prim. Fuel (Gen. Aux.)	5.00	EA	4	6		

PRESCRIBED LOAD LIST (PLL) AND AUTHORIZED STOCKAGE LIST (ASL)

END ITEM: Crane, Mobile, 140-Ton Capacity, Container Handler		MAKE: FMC			MODEL: HC-238A					
NSN: 3950-01-110-9224						DATE: 16 Apr 82				
SMR CODE	NSN	PRIME P/N	FSCM	PART DESCRIPTION	UNIT PRICE	U/M	QTY OF PARTS REQ'D FOR NO. OF FND ITEMS			
							PLL	ASL		
							1-5	1-5	6-20	21-50
PAOZZ	6240-01-115-3069	7400	08806	Lamp (Rotary Light)	2.00	EA	2	4		
PAOZZ	990704-463	36422		Wire Rope, 1 x 980 (Boom Load)	1285.00	EA	1	2		
PAOZZ	5330-00-255-4669	2-329N674-7	02697	Packing, Preformed (Clutch Cyl.)	3.00	EA	4	8		
PAOZZ	5330-00-821-7-317	1626545PC53	10001	Packing, Preformed (Strainer Hydr. Res.)	1.00	EA	2	4		
PAOZZ	5330-01-119-9372	5810-584003-329	02697	Packing, Preformed (Clutch Cyl.)	.50	EA	4	6		
PAOZZ	5920-00-424-8873	AGC-15	71400	Fuse 15 Amp	.75	EA	5	10		
PAOZZ	2910-01-100-3302	25010776	72582	Filter, Pri. Fuel (Carrier Eng)	11.50	EA	4	8		
PAOZZ	2910-01-097-6496	25010778	72582	Filter, Sec, Fuel (Carrier Eng)	11.50	EA	4	8		
PAOZZ	3030-00-934-8090	5133519	72582	Belt, Alternator (Upper Eng)	8.00	EA	2	4		
PAOZZ	3030-00-411-3741	5133762	72582	Belt, V, Eng Fan (Carrier Eng)	24.00	SET	1	2		
PAOZZ	3030-00-689-6099	17425	73842	Belt, Eng Fan (Upper Eng)	7.00	EA	2	4		
PAOZZ	3030-00-298-6831	5148276	72582	Belts, V, Alt. (Carrier Eng)	14.00	SET	1	2		
PAOZZ	4720-00-785-8231	5187231	72582	Hose, Rad, Inlet (Upper Eng)	3.00	EA	1	2		
PAOZZ	4720-01-037-1711	5199776	72582	Hose, Rad, Outlet (Upper Eng)	12.00	EA	1	2		
PAOZZ	2940-00-580-6283	MS35802-3	76110	Filter, Oil (Trq Conv. and Eng)	6.50	EA	8	12		

PRESCRIBED LOAD LIST (PLL) AND AUTHORIZED STOCKAGE LIST (ASL)

END ITEM: Crane, Mobile, 140-Ton Capacity, Container Handler	MAKE: FMC	MODEL: HC-238A
NSN: 3950-01-110-9224		DATE: 16 Apr 82

SMR CODE	NSN	PRIME P/N	FSCM	PART DESCRIPTION	UNIT PRICE	U/M	QTY OF PARTS REQ'D FOR NO. OF FND ITEMS			
							PLL	ASL		
							1-5	1-5	6-20	21-50
PAOZZ	2910-00-125-5601	122-0326	44940	Filter, Sec. Fuel (Gen. Aux.)	5.00	EA	4	6		
PAOZZ	2940-00-829-5676	140-0636	44940	Filter, Element Air (Gen. Aux.)	10.00	EA	2	4		
PAOZZ	2530-00-986-7596	213984	62983	Element, Pump (Power Steering)	7.00	EA	2	4		
PAOZZ	5330r01-118-9147	23J83	36422	Gasket (Hydr. Res. Fil. Access Cover)	1.00	EA	4	6		
PAOZZ	5365-01-113-3847	8J579	36422	Packing, Preformed (Hydr. Res. Oil Fil.)	.50	EA	4	6		
PAOZZ	5330-01-113-1322	8J615	36422	Gasket (Hydr. Res. Oil Fil. - Teflon)	1.25	EA	4	6		
PAOZZ	2520-01-124-8890	K-1486	52304	Air Valve, Filter (Carrier Air Sys.)	12.00	EA	1	2		
PAOZZ	2540-01-125-9697	HF-21	60703	Blade, Wiper (Upper, Upper Window Cab)	7.50	EA	1	2		
PAOZZ		91380-26TM	60703	Blade, Wiper (Carrier Cab)	20.00	EA	1	2		
PAOZZ	2940-01-131-5928	25010971	70040	Filter, Eng Oil (Carrier Eng)	6.50	EA	4	6		
PAOZZ		P16-3456	18265	Element, Filter(Hydr. Reservoir,	18.13	EA	2	4		
PAOZZ	6240-00-817-9803	MS25231-316	96906	Lamp (Warning Light)	1.00	EA	4	8		
PAOZZ	5920-00-879-6285	F02A125V10AS	81349	Fuse, 10 Amp.	.50	EA	5	10		
PAOZZ	6240-00-155-8717	67	08108	Lamp (Parking and Clearance Lights)	1.00	EA	4	8		

PRESCRIBED LOAD LIST (PLL) AND AUTHORIZED STOCKAGE LIST (ASL)

END ITEM: Crane, Mobile, 140-Ton Capacity, Container Handler		MAKE: FMC			MODEL: HC-238A					
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							PLL	ASL		
							1-5	1-5	6-20	21-50
PAOZZ	5330-01-118-4972	22A2535	36422	Gasket (Hydr.Res.Access Cover)	4.00	EA	2	4		
PAOZZ		990717-404	36422	Wire Rope, 7/8 x 675 (Boom Hoist)	1011.00	EA	1	2		
PAOZZ	4730-01-124-6535	1X5165	36422	Plug, Magnetic (Hydr.Reservoir)	5.00	EA	2	4		
PAOFF		19J1180	36422	Lock, Valve, Outriggers	800.00	EA	1	1		
PAOZZ	5310-01-119-7198	22A2580	36422	Packing, Preformed (Mag. Plug Gasket)	1.00	EA	4	6		
PAOZZ	2910-01-072-1783	820-0327	06991	Fuel, Eng Primer (Bottle Ether)	10.00	EA	2	4		
PAOZZ	6240-00-014-2454	MS35478-93	96906	Lamp (Light Dome)	1.00	EA	4	8		
PAOZZ	6240-00-577-8175	4001	08108	Lamp (LH Headlight)	10.00	EA	2	4		
PAOZZ	2940-00-926-4117	B298	12658	Filter, Element (Gen. Aux.)	8.00	EA	2	4		
PAOZZ	6240-00-270-4693	500R3FL120V	08108	Lamp (Cab and Boom Floodlights)	20.00	EA	1	2		
PAOZZ	1730-01-095-0126	AB-1010-6	55524	Breather, Assy.(Hydr.Reservoir)	22.00	EA	1	2		
PAOFH	2920-01-124-9312	1117641	16764	Alternator, Eng (Upper Eng)	520.00	EA	1	1		
PAOZZ	2940-00-832-8728	P11-7331	18265	Element, Filter Air (Upper Eng)	40.00	EA	2	4		
PAOZZ	6240-00-012-5588	MS15572-1	96906	Lamp (Cab Gauges)	1.00	EA	4	8		
PAFZZ	5930-00-111-8619	1996097	16764	Switch, Push (Outrigger, Eng. Throttle)	10.50	EA	2			
PAFZZ	5950-00-551-0574	493419	77521	Coil, Electrical (Valve Stack)	46.35	EA	2			

PRESCRIBED LOAD LIST (PLL) AND AUTHORIZED STOCKAGE LIST (ASL)

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							PLL	ASL		
							1-5	1-5	6-20	21-50
PAFZZ	5950-00-551-0573	493482	77521	Coil, Electrical (Valve Stack)	39.00	EA		2		
PAFZZ	5930-00-683-1633	MS24523-27	96906	Switch, Toggle(Outrigger, Beam)	15.00	EA		2		
PAFZZ	5930-00p-660-3947	MS24524-27	96906	Switch,Toggle(Outrigger, Jacks)	36.00	EA		1		
PAFZZ	5930-00-061-4926	MS24659-27E	96906	Switch,Toggle(Outrigger, Jacks Final)	54.00	EA		1		
PAFZZ	3020-00-252-7352	RC-60-4	36422	Chain, Link (Upper Eng. Drive)	3.00	EA		4		
PAFZZ	3020-01-126-1751	1H609	36422	Chain, Link Connecting	4.00	EA		4		
PAFZZ	3020-01-125-6120	1H610	36422	Link, Offset	13.00	EA		4		
PAFZZ	3020-01-126-1551	1H624	36422	Section, 3 Pitch	9.00	EA		4		
PAOFF	4730-01-111-4694	1J673	36422	Rotating Joint Assembly	52.00	EA	1	1		

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

DONALD J. DELANDRO
Brigadier General, United States Army
The Adjutant General

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PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO
2-26	2-79		

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

This paragraph states that as long as engine performance is satisfactory, no tune-up should be needed.

SAMPLE

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TEAR ALONG PERFORATED LINE

THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

SQUARE MEASURE

1 Sq Centimeter = 100 Sq. Millimeters = 0.155 Sq Inches
1 Sq. Meter = 10,000 Sq Centimeters = 10.76 Sq Feet
1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

WEIGHTS

1 Gram = 0 001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Lb
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

CUBIC MEASURE

1 Cu Centimeter = 1000 Cu Millimeters = 0 06 Cu Inches
1 Cu Meter= 1,000,000 Cu Centimeters = 35 31 Cu. Feet

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

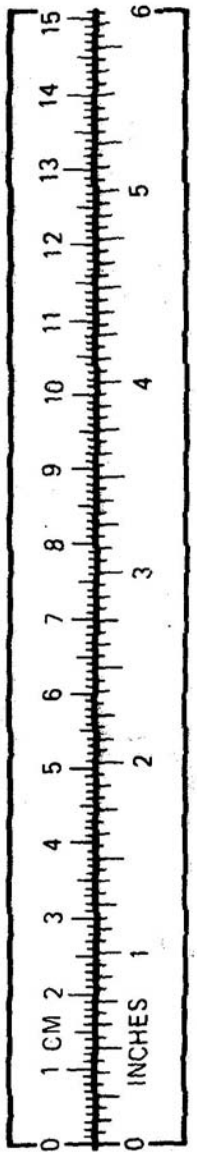
TEMPERATURE

5/9 (°F - 32) = °C
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32 2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5 °C + 32 = °F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid	Ounces Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Quarts.	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.45
Short Tons	Metric Tons	0.0907
Pound-Feet	Newton-Meters	1.356
Pounds per Square	Inch Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0 155
Square Meters	Square Feet .	10.764
Square Meters	Square Yards	1.195
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters Fluid	Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2 205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



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