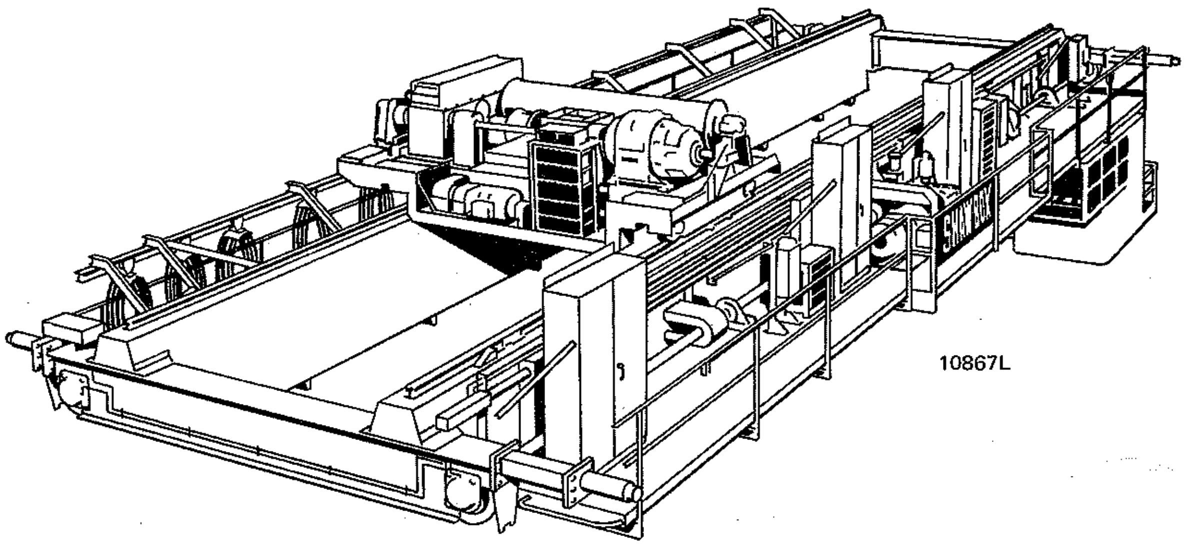
GENERAL INSTRUCTION MANUAL



SHAW-BOX®

DOUBLE GIRDER OVERHEAD CRANES

SHAW-BOX DRESSER

CRANE & HOIST DIVISION • DRESSER INDUSTRIES, INC.
MUSKEGON, MICHIGAN 49443
U.S.A.

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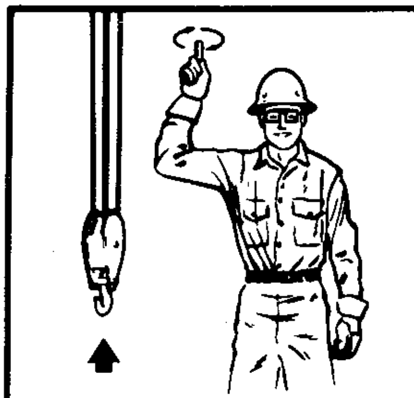
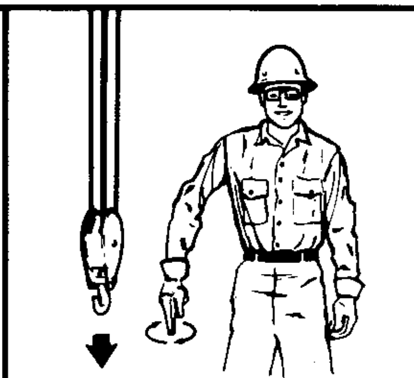
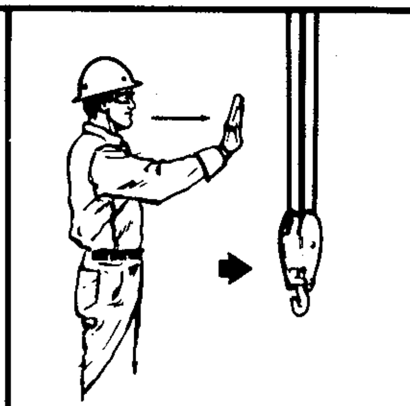


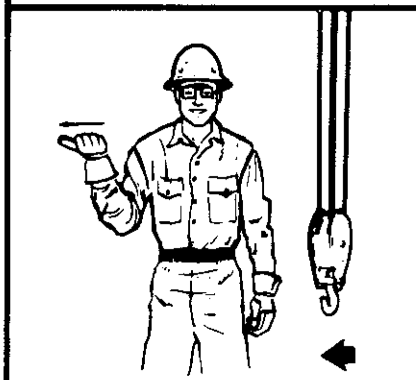
HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circles.



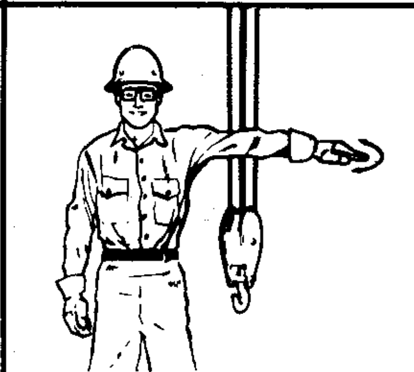
LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circles.



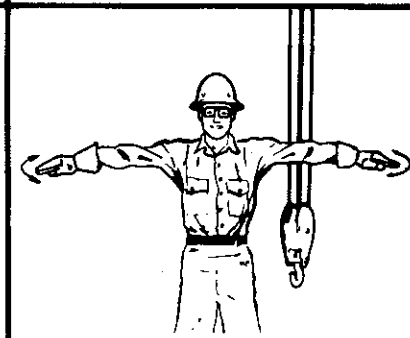
BRIDGE TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.



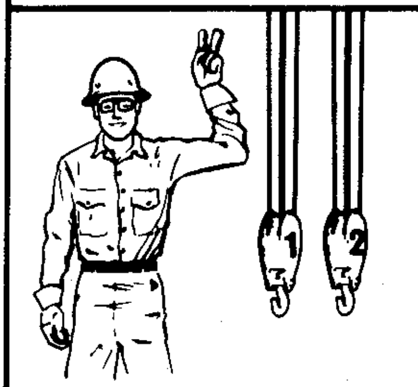
TROLLEY TRAVEL. Palm up, finger closed, thumb pointing in direction of motion, jerk hand horizontally.



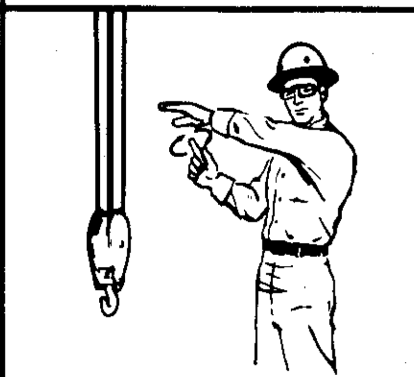
STOP. Arm extended, palm down, move arm back and forth.



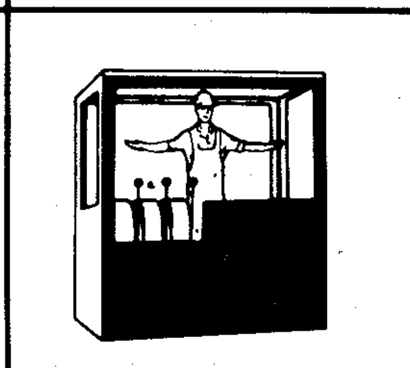
EMERGENCY STOP. Both arms extended, palms down, move arms back and forth.



MULTIPLE TROLLEYS. Hold up one finger for block marked "1" and two fingers for block marked "2". Regular signals follow.



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



MAGNET IS DISCONNECTED. Crane operator spreads both hands apart palms up.

Source: ANSI B30.2-1983

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STANDARD HAND SIGNALS FOR CONTROLLING DOUBLE GIRDER CRANES

SHAW-BOX DRESSER

CRANE & HOIST DIVISION • DRESSER INDUSTRIES, INC.
MUSKEGON, MICHIGAN 49443

FOREWORD

This manual contains important information to help you install, operate, inspect and maintain your new SHAW-BOX crane. We recommend that you study its contents thoroughly before putting your crane into service. It is also recommended that users of overhead cranes read ANSI B30.2, Safety Standards for Overhead and Gantry Cranes.

The contents of this manual are of necessity general in nature and may cover features which are not incorporated in your crane; therefore, the user must exercise care in applying instructions given in this manual to his crane. When specific information not contained in this manual is required, contact the Field Service Department of DRESSER Crane & Hoist Operations outlining your request. Please identify your crane by referring to its serial number which is shown on a plate attached to the crane.

THE INFORMATION CONTAINED IN THIS BOOK IS FOR INFORMATIONAL PURPOSES ONLY AND DRESSER INDUSTRIES DOES NOT WARRANT OR OTHERWISE GUARANTEE (IMPLIEDLY OR EXPRESSLY) ANYTHING OTHER THAN THE COMPONENTS THAT DRESSER MANUFACTURES AND ASSUMES NO LEGAL RESPONSIBILITY (INCLUDING, BUT NOT LIMITED TO, CONSEQUENTIAL DAMAGES) FOR INFORMATION CONTAINED IN THIS MANUAL.

NOTICE: Information contained in this book is subject to change without notice.

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SECTION I – GENERAL

1-1. PURPOSE OF MANUAL. This manual has been prepared for your guidance in receiving, installing, operating and maintaining your crane.

CAUTION

Failure to follow the recommendations outlined in this manual may void your Warranty.

Information contained in this manual, while of a general nature, is applicable to overhead double girder cranes with crane type trolleys built by Dresser. Every effort has been made to include a wide variety of Mechanical and Electrical components commonly used in the construction and control of these overhead cranes. The user is expected to compare his crane to these descriptions, note applicable components, and follow instructions outlined in this manual. Customized parts identification is also supplied to the user with each crane order.

You can expect many years of good reliable service, providing that the crane is properly installed, correctly operated and adequately maintained and inspected.

1-2. CRANE APPLICATIONS. Your crane was ordered and built for a defined service requirement. The components, electrical, mechanical and structural, selected for use in building your crane, reflect the service or work which the crane was intended to perform.

CAUTION

Use of the crane for service exceeding its design service requirement will result in voiding the Warranty.

The service requirements referred to are as follows:

Class A	Standby or Infrequent Service
Class B	Light Service
Class C	Moderate Service
Class D	Heavy Service
Class E	Severe Service
Class F	Continuous Severe Service

Typical applications are shown in Figure 1-1.

1-3. CRANE WARRANTY. Each crane is factory tested without load and inspected prior to shipment. A duly executed inspection certificate accompanies the shipment. Terms of the Warranty are shown on this inspection certificate. The customer should familiarize himself with the Warranty coverage. Misuse of the crane for any reason will be cause for voiding the Warranty. Implementation of Coverage under the Warranty must be authorized by the Field Service Department of Dresser Industries, Inc. Crane & Hoist Division.

1-4. GLOSSARY OF CRANE TERMS. (See Figure 1-2 for a visual identification of components.) Good communication is always important. In order to better understand the terms used in this manual, and in the crane industry, the following list is presented. Every attempt should be made to use these terms in any discussion of your crane.

CRANE: A machine for lifting and lowering a load and moving it horizontally, consisting of a Bridge, Trolley and Hoist.

BRIDGE: That part of an overhead crane consisting of girders, end trucks, platform and drive mechanism which supports the trolley and travels in a direction parallel to the crane runway.

TROLLEY: The unit which travels along the Bridge on the Bridge rails carrying the hoisting and traverse drive mechanism.

HOIST: A machinery unit that is used for raising or lowering a load.

ANCHOR, ROPE: A device for attaching wire rope to a drum or other member.

ANCHOR, END: A structural support to which the ends of bare copper conductors are attached.

AUXILIARY GIRDER: A structural member arranged parallel to the front girder, used to support a portion of the weight of the platform, control, drive mechanism, etc., so as to reduce the torsional forces on the front girder.

AXLE: The pin or bar on which a wheel revolves, or which revolves with a wheel.

AXLE–FIXED: An axle rigidly attached to its support and about which the wheel revolves.

AXLE-ROTATING: An axle free to rotate in its support and which rotates with the wheel.

AXLE–M.C.B., "MASTER CAR BUILDERS": A term designated to mean rotating axle.

BLOCK–LOWER: The assembly consisting of the hook, swivel, bearing, sheaves, pins and frame suspended by the hoisting ropes and to which the load is attached.

BLOCK–UPPER: The assembly consisting of the sheaves, pin and bearings mounted to the trolley frame, and which support the hoisting ropes.

BRAKE–HOIST HOLDING: A device that automatically prevents motion when power is off.

BRAKE–HOIST CONTROL: An electrical or mechanical braking method of controlling crane motor speed when in an overhauling condition.

BRAKE–TRAVERSE: A device for retarding or stopping motion by friction.

BRIDGE RAIL: The rail supported by the bridge girders on which the trolley travels.

BUMPER: An energy absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel; or when two moving cranes or trolleys come into contact.

CAMBER: The slight upward vertical curve built into the girders to partially compensate for deflection due to hook load, weight of the trolley and dead loads.

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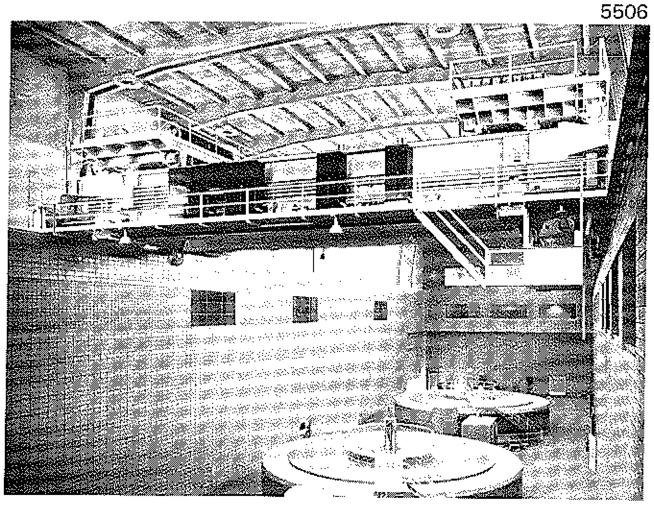
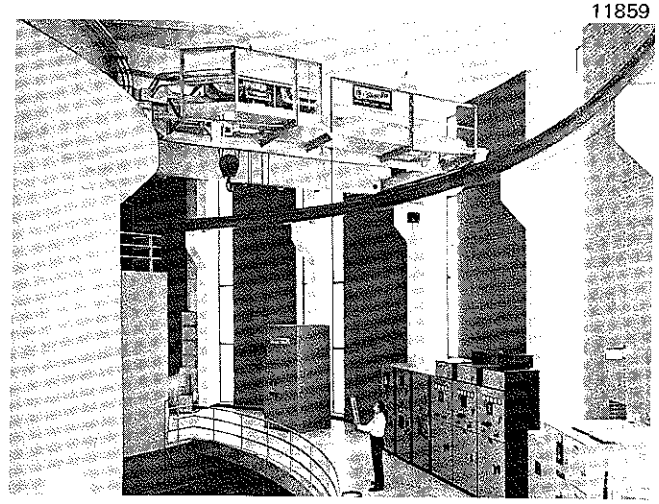


Typical of Class A

11859



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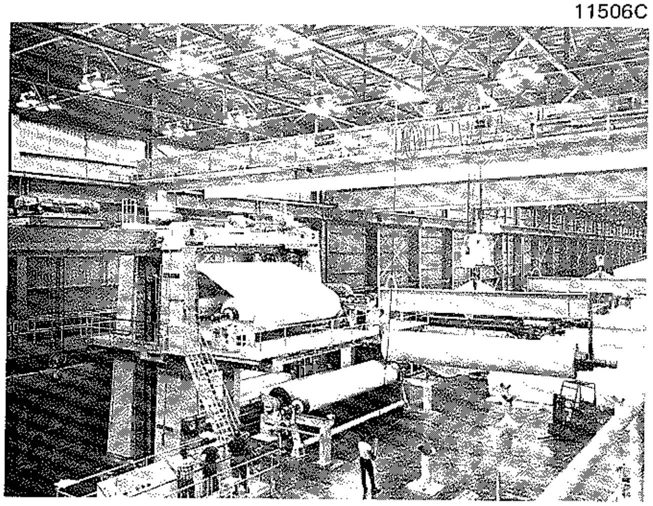

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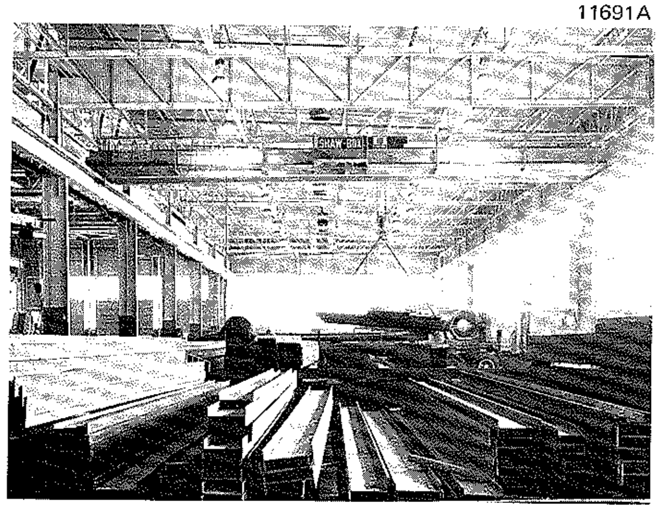

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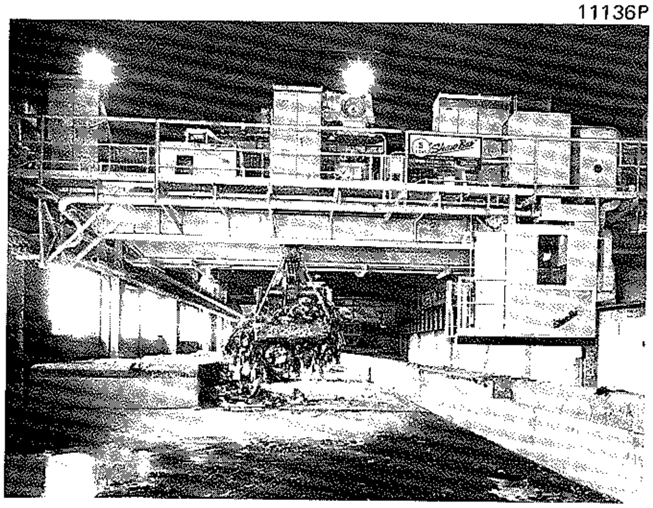

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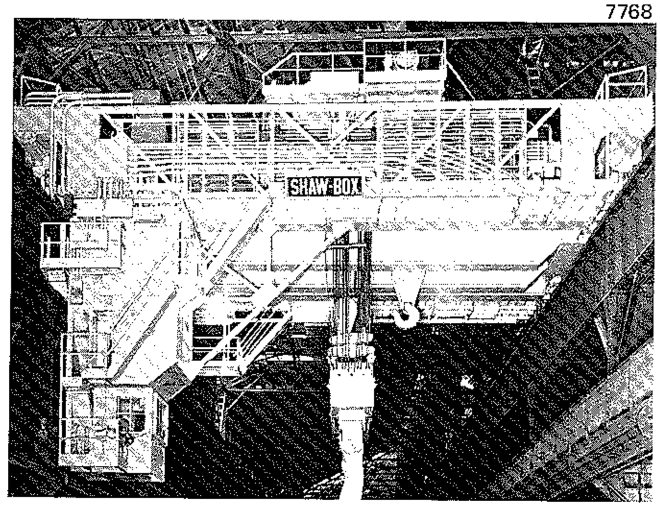

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Figure 1-1. Crane Installations Identifying Service Classifications

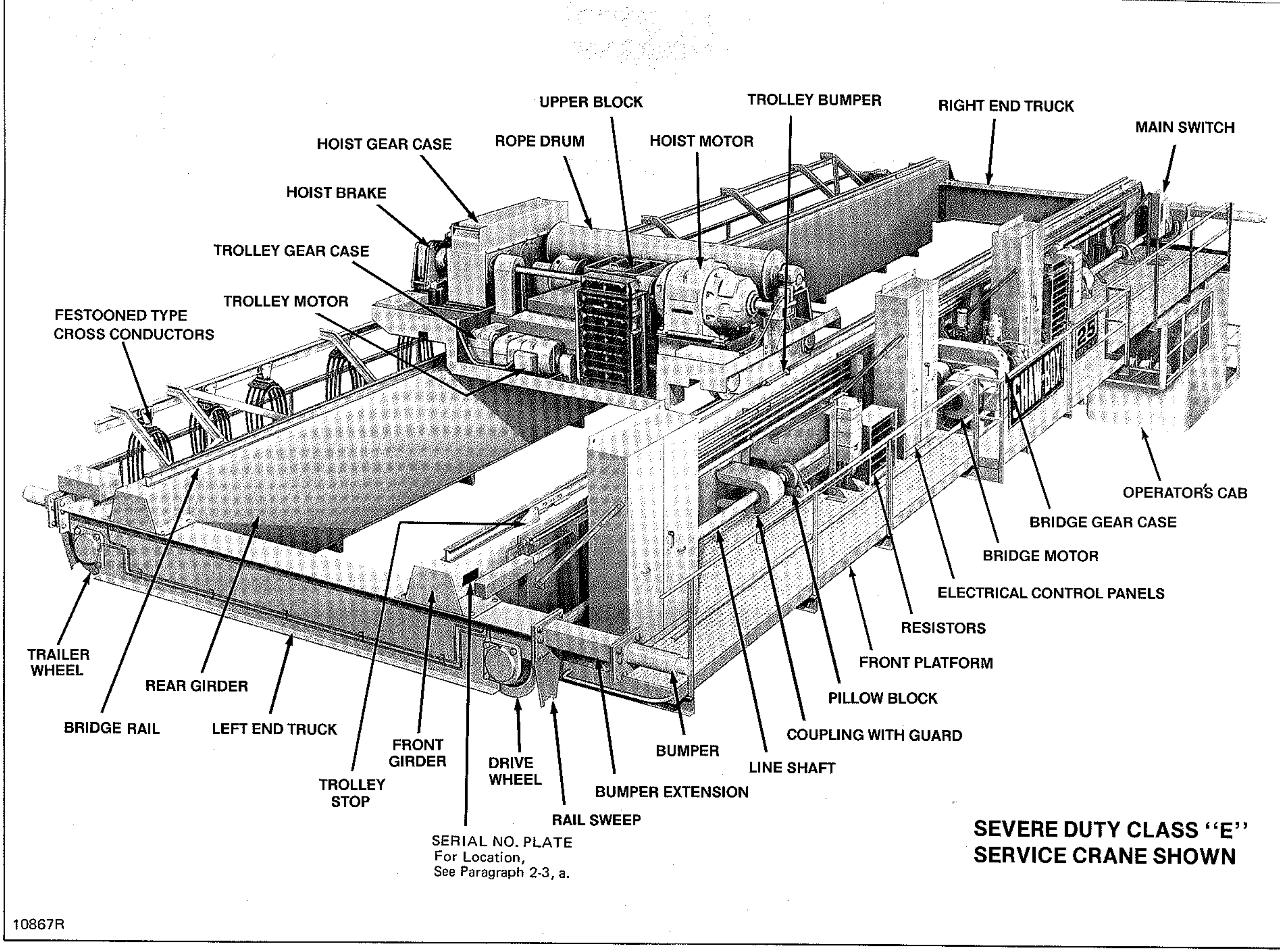

Figure 1-2. Identification of Crane Components

CAPACITY: The maximum load the crane is designed to handle and indicated on a large sign attached to each side of the bridge. Capacity of each hoist is shown on a sign attached to the lower blocks. Note that crane capacity and hoist capacity may not be the same.

CLEARANCE: Minimum distance from the extremity of a crane to the nearest obstruction in all directions.

C.M.A.A.: Crane Manufacturers Association of America, 1326 Freeport Road, Pittsburgh, Pa. 15238, U.S.A.

COLLECTORS: Contacting devices for collecting current from the runway or bridge conductors. The bridge collectors are mounted on the bridge and transmit current from the runway conductors to the bridge; the trolley collectors are mounted on the trolley and transmit current from the bridge conductors to the trolley.

COVER PLATE: The top or bottom plate of a fabricated plate box girder.

CROSS SHAFT: The shaft extending across the bridge used to transmit torque from the motor to bridge drive wheels.

DEAD LOADS: The loads on a structure which remain in a fixed position relative to the structure. On a crane bridge such loads include the girders, footwalk, cross shaft, drive machinery, etc.

DRIFT POINT: A position on the master control switch which de-energizes the motor, but holds the brake open, thus allowing coasting.

DRUM: In hoisting equipment, the grooved cylinder upon which the hoisting rope (or cable) is wound.

DYNAMIC LOWERING: A method of control by which the hoist motor is so connected in the lowering direction, that when it is overhauled by the load, it acts as a generator and forces current either through the resistors or back into the line.

EDDY-CURRENT BRAKING: A method of control by which the motor drives through an electric induction load brake.

END APPROACH: The minimum horizontal distance, parallel to the runway, between the outermost extremities of the crane and the centerline of the hook.

END TIE: A structural member other than the end truck which connects the ends of the girders to maintain the squareness of the bridge.

END TRUCK: The unit consisting of truck frame, wheels, bearings, axles, etc., which supports the bridge girders.

EQUALIZER (IDLER) SHEAVE: In a hoist reeving arrangement, that sheave which equally divides the parts of rope, and distributes equal tension to all parts of rope.

FIELD WIRING: The wiring required during erection of a crane.

FLEET ANGLE: The angle between the rope and a line in a plane perpendicular to the axis of the sheave.

FLOAT: The horizontal clearance between the wheel flanges and the rail head.

FOOT WALK (PLATFORM): The walkway, with handrail, attached to a bridge or trolley for access and maintenance purposes.

GIRDER: The principal horizontal beams of a crane bridge which supports the trolley and is supported by the end trucks. The girder which supports the bridge drive machinery is called the drive or front girder.

HOLDING BRAKE: A brake that automatically prevents motion when power is off.

HOOK APPROACH: The minimum horizontal distance between the center of the runway rail and the hook.

LIFT: The maximum safe vertical distance the hook can be raised and lowered.

LIMIT SWITCH: A device which is operated by some part or motion of a power-driven machine or equipment to alter the electric circuit associated with the machine or equipment.

LIVE LOAD: A load which moves relative to the structure under consideration.

MAGNETIC CONTROL: A device or system of devices having all basic functions operated by electro-magnets.

MASTER SWITCH: A manually operated device which serves to govern the operation of contactors and auxiliary devices of an electric control.

MATCH MARKING: Identification of noninterchangeable parts for reassembly after shipment.

MECHANICAL LOAD BRAKE: An automatic type of friction brake used for controlling loads in the lowering direction, commonly used with reversing control. The brake prevents the load from overhauling the motor.

PARTS OF ROPE: The total number of ropes supporting the lower block.

PENDANT PUSHBUTTON CONTROL: Means suspended from the crane for operating the controllers from the floor or other level beneath the crane.

RUNWAY: The assembly of rails, beams, girders, brackets and framework on which the crane travels.

SPAN: The horizontal distance center to center of runway rails.

TROLLEY GAGE: The horizontal distance center to center of bridge rails.

1-5. RECEIVING YOUR CRANE. Your crane has been factory assembled and shop tested without load. It has been disassembled only to the extent required for shipment. Figure 1-3 indicates typical dis-assembly required for shipment. Figures 1-4 and 1-5 show typical loading of both rail or truck type shipments. The bridge, girders, trolley and all components are shored, blocked, and secured with tie downs to avoid damage in transit. Loose items are separately packed and secured in boxes with identification. The carrier inspects the load for proper packing and security prior to accepting it for shipment.

Short term 'in-transit' weather protection has been incorporated in the shipping preparations undertaken at the factory. It is expected that the crane will be erected within a few days after receipt of the shipment. If erection is delayed, then provisions for storage as outlined in Paragraph 1-6 must be followed. The crane shipment should be coordinated with your installation schedule, and arrange-

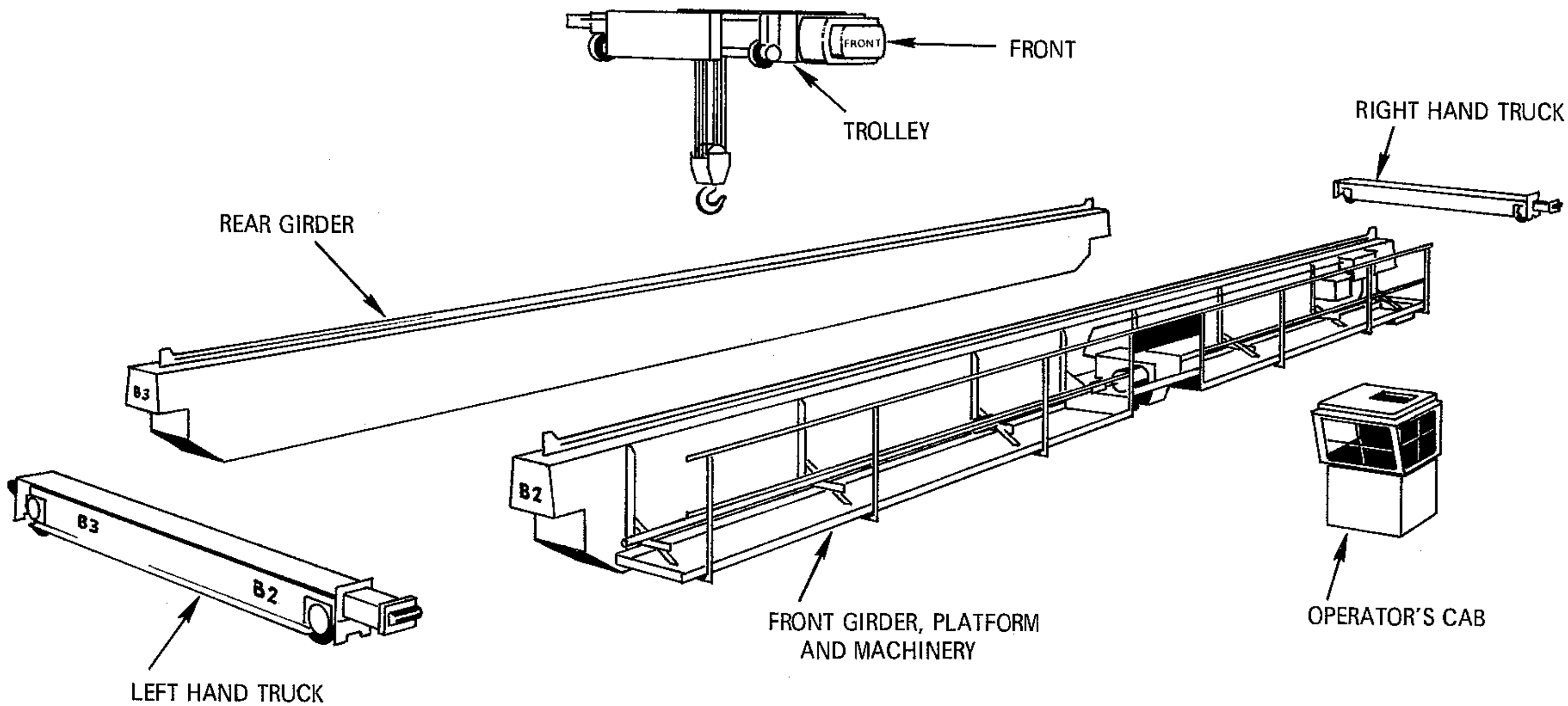

Figure 1-3. Typical Disassembly Required for Shipment.

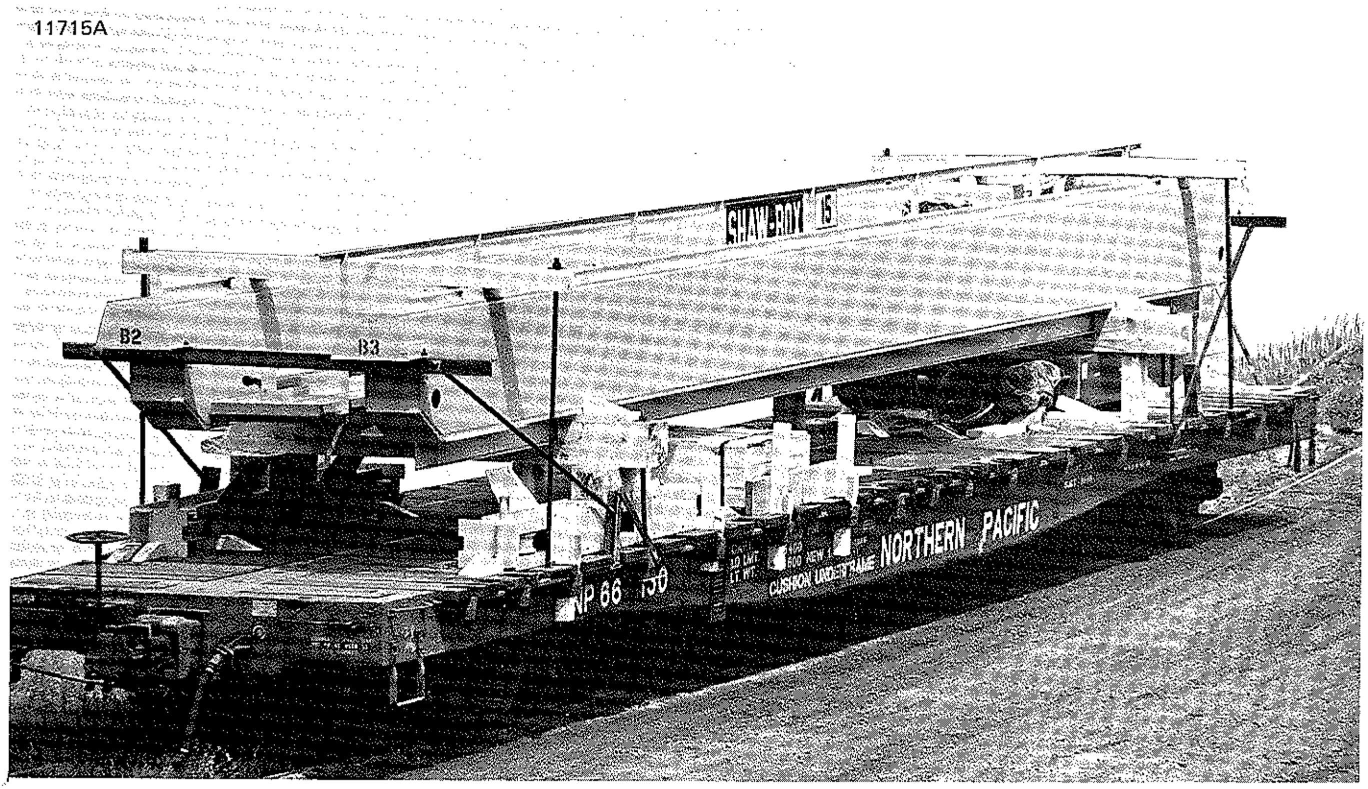

Figure 1-4. Typical Rail Shipment.

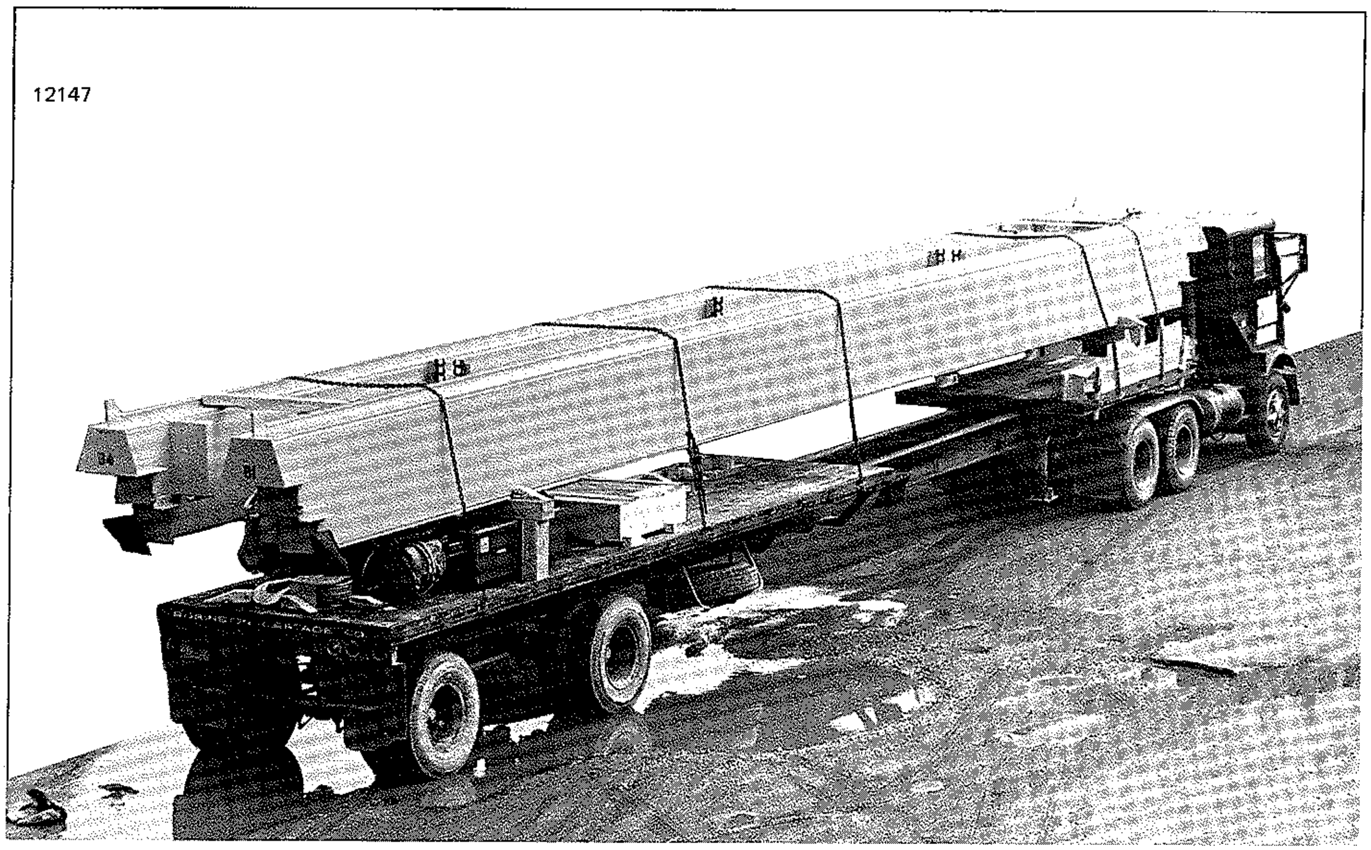

Figure 1-5. Typical Truck Shipment.

ments made for on-site delivery. Prompt installation of the crane minimizes exposure to the weather and costs of erection.

Immediately upon receipt of shipment and prior to removal of any part, a complete inspection is to be made to determine if any damage has occurred. If damage is evident, contact the carrier for a full inspection and report. Be certain that the original freight bill is marked "Damaged When Received". Itemize, list and photograph the damage. If shipment has been made FOB the factory, or FOB the factory, freight allowed, it is the responsibility of the buyer to file a claim with the carrier. If shipment is made FOB job site, then it is Dresser's responsibility to file claim. In all instances where damage has occurred, our Field Service Department must be contacted and apprised of the damages after which you will be instructed on repairs required to maintain a valid warranty. Also check shipment against the packing list to insure receipt of all parts. If shortages are identified, notify the factory immediately to avoid delay, erection and start-up.

1-6. PRE-INSTALLATION STORAGE. If the crane arrives prior to time that installation can take place, follow instructions below:

a. Cranes built for indoor service.

1. Short term on-site storage (one month or less):

(a) Select a high site with good drainage so as to eliminate the possibility of any part standing in a pool of water.

(b) All stored items should be resting on wood bunkers at least one foot off the ground. Items should be stored so that parts may be rotated freely.

(c) Provide protective tarp over entire crane girders, end trucks, trolley, etc. Arrange tarp so as to shed water.

(d) Lubricate all alemite fittings thoroughly to insure the bearing capsule is completely filled with grease.

2. Long term storage:

(a) Provide for indoor, heated storage.

(b) If indoor storage is not available, follow instructions outlined in paragraph 1-6a.1 (above) in addition to the following:

(1) On NEMA #1 electrical enclosures only, drill several 1/4" (.65 cm) drain holes in bottom plate. Provide similar drain holes in bottom of all junction boxes.

CAUTION

In drilling these holes be careful not to damage any wiring or electrical components.

(2) Apply generous applications of lubricant to hinges on electrical panels, rope on drum, exposed rope on lower block, flexible couplings, or other areas requiring oiling or greasing.

(3) Exposed fitted surfaces, such as girder to truck seat connection, all machined unpainted surfaces, items such as brake wheels, and shaft ends exposed for couplings, must be protected with cosmoline or other type protective compound, and repeated as often as necessary to protect from rusting.

(4) Fill gear boxes with lubricant, as outlined in SECTION IX. Breather openings are to be taped shut, and gearing completely revolved to insure coating gears with lubricant. In addition, where bearings are splash oil lubricated, oil spray is to be directed at these bearings through the inspection holes in the gear case cover.

(5) Smaller loose items, such as the pendant control pushbutton station, should be stored indoors. All master control switches in the cab are to be individually wrapped with heavy gage plastic, in addition to a protective tarp over the complete cab.

(6) All rotating parts, such as gear shafts, motors, wheels, line shafts, etc., should be rotated every month, and relubricated with oil or grease as described above.

b. Cranes built for outdoor service.

1. Short term on site storage (one month or less):

(a) Same instructions as 1-6a.1 except protective tarp over girders, end trucks, trolley, etc., is not required.

2. Long term storage:

(a) Same instructions as 1-6a.2 except DO NOT drill holes in electrical enclosures or junction boxes.

c. Cranes built for special conditions (such as explosion proof, etc.).

1. Refer to the factory for storage instructions on cranes built for unusual environments.

SECTION II – INSTALLATION

2-1. PREPARATION AFTER STORAGE. Certain procedures and inspections should be followed in removing your crane from storage and preparing it for installation.

a. On site storage of one month or less:

1. Remove oil from all gear cases; flush, drain and refill with fresh lubricant as instructed in SECTION IX.

2. Remove covers from all junction boxes and inspect for condensation. If moisture is present, take steps to thoroughly dry all conduit as well as junction boxes.

3. Remove covers from motor junction boxes and inspect for condensation. If moisture is present, remove, disassemble and thoroughly dry out all parts prior to reassembly.

4. On slip ring motors, remove inspection covers, check rings, brushes, and windings for condensation, corrosion, dirt, and other foreign matter. If moisture is present, dry out as above. Clean slip rings, and check for freedom of brushes in brush holders.

5. Lubricate motor bearings if they are provided with lubrication fittings.

6. Re-grease and oil entire crane as outlined in SECTION IX.

7. Inspect all electrical panels for condensation. If moisture is present, thoroughly dry the panels as well as all components in the panel.

8. Remove cosmoline from all surfaces so protected. Make certain that cosmoline or other protective compound is removed from exposed shaft ends which receive field installed couplings, as well as the inside surfaces of the couplings.

9. Remove all masking tape covering nameplates, serial number plates, brake wheel surfaces, etc.

b. On site long term storage:

1. Proceed with all recommendations as outlined in paragraph 2-1a.

2. Inspect all electrical contact surfaces, such as contactors, wire terminals, cross conductors, etc., for signs of corrosion, dirt or any foreign deposit which would interfere with good conductivity. Clean wherever required, by solvent, sand paper, wire brushing or other means to insure good clean contact surfaces.

3. Clean, inspect and re-lubricate hoisting rope.

CAUTION

Stored rope showing any signs of deterioration or damage shall be thoroughly inspected by a qualified person before operating the crane.

4. Examine complete painted surfaces of the crane. Any places where the paint shows signs of deterioration; scrape, wire-brush and apply one coat of primer and two coats of finish paint, as originally specified.

2-2. RUNWAY REQUIREMENTS. The successful operation of an overhead crane depends upon a properly installed runway. The runway should be checked by a competent structural engineer for adequacy of the following:

a. Size of crane rail (crane wheels were arranged to operate on rail size shown on the crane clearance diagram).

b. Crane rails are to be solidly fastened to the supporting beam. (Dresser cranes will not operate properly with a "floating rail" installation; that is a rail which will allow lateral movement.)

c. The rails shall be straight, parallel, level and at the same elevation. The distance (span) center to center of crane rails as well as the rail elevation shall be within a tolerance of plus or minus 1/8" (.32 cm).

d. Rail joints must be smooth and held in tight alignment by properly fitted rail joint bars so that ends are held tightly with no crack or opening.

e. The crane runway should be designed in accordance with specifications outlined by the American Institute of Steel Construction for the maximum wheel loads involved. (These maximum wheel loads are shown on the Crane clearance diagram.)

f. Size and placement of runway end stops should be checked against the clearance diagram to insure that they are of the proper height and width to fully contact the bridge bumpers and also placed so as to stop the crane with sufficient clearance between any portion of the crane and the building.

g. The crane is grounded through the wheel's contact with the runway rails. The runway rails, therefore, shall be connected to the building's grounding system. If the environment prevents the wheels from making continuous contact with the rails, a separate runway conductor for grounding purposes shall be added to the main runway conductor system.

2-3. MATCH MARKING AND CRANE IDENTIFICATION.

a. Each crane built by Dresser is assigned a specific 5 digit Serial number for identification purposes. This number appears on a special plate which is attached to the web plate of the drive (front) girder usually at the cab end of the crane or at the center near the drive machinery of a floor operated crane. It is important to always identify your crane by this Serial number when corresponding with the factory.

b. At the completion of factory assembly and final painting the cranes are match-marked, after which the components are disassembled, as required, to facilitate shipment. Figure 2-1 shows typical method of match marking. Note that one side of the trolley is marked by stencil to read "FRONT". This is to indicate that the side so marked is to be placed on the front (drive) girder of the bridge. In general, components marked with prefixes of "B", "T", and "H" belong to the bridge, trolley or hoist respectively. Loose items such as bolts for girder to end truck connections are packaged in bags and marked for identification. Like parts for repetitive connections are packaged together.

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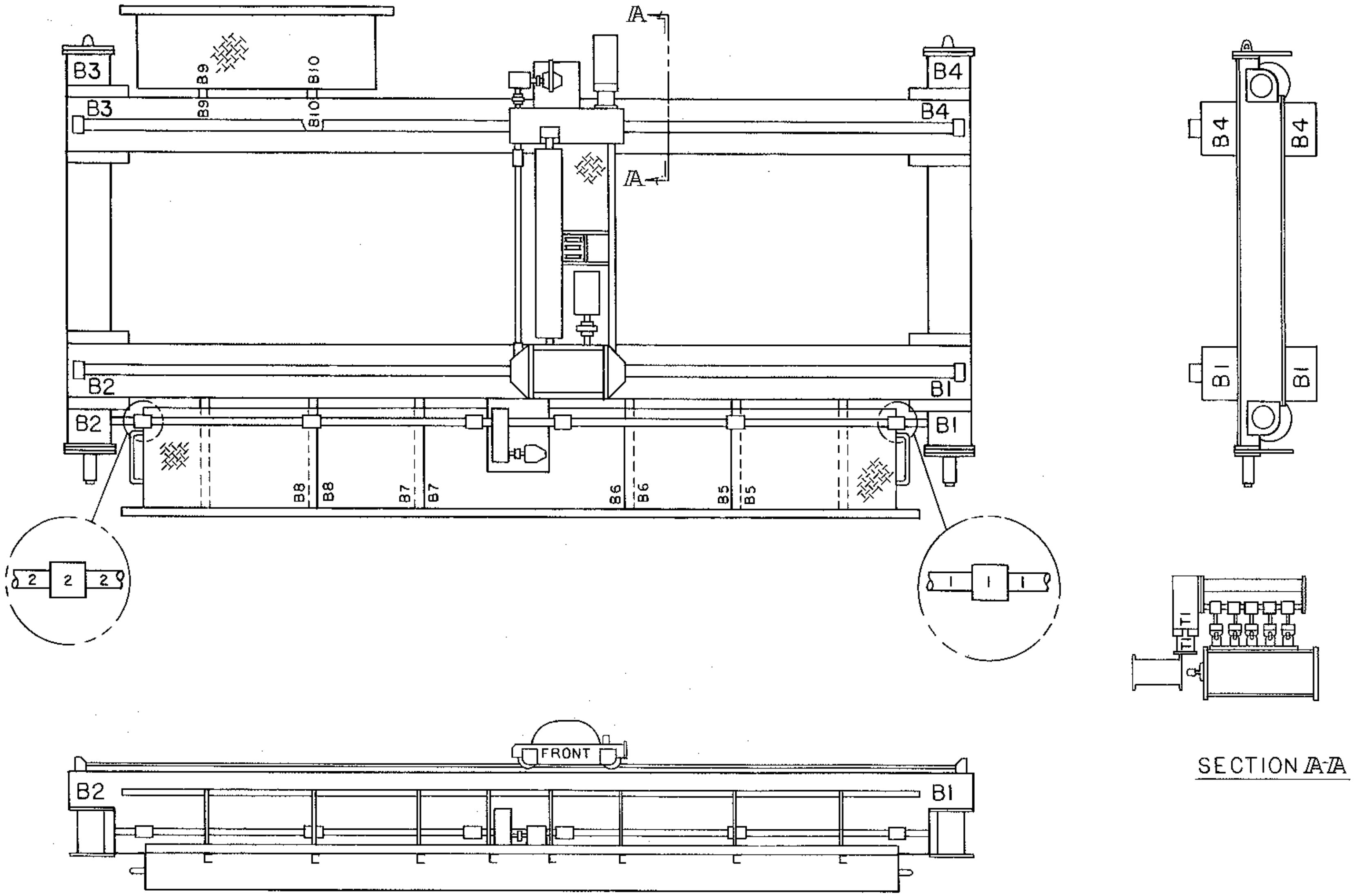

TYPICAL MATCH MARKING OF PARTS WHICH WILL BE DISASSEMBLED FOR SHIPPING.

Figure 2-1. Match Mark.

2-4. CRANE ERECTION.

a. General. Before attempting to erect the crane on the runway, a responsible person should check the building dimensions where the crane will be installed against the clearance diagram dimensions prepared for the crane. Note the crane orientation in the building and arrange sequence of erection accordingly. The weight of the main components is submitted to the user prior to delivery of the crane. This information is useful in selecting lifting equipment required. Sort out all components and identify for sequence of erection in accordance with their match marks.

b. Structural. Figures 2-2 through 2-9 show a typical installation of an overhead double girder crane. Assembly is usually accomplished on the runway starting with the end trucks, and followed by the girders, end tie, platforms, drive machinery and the trolley. The girder to end truck or end ties connection is made by the use of closely fitted bolts into reamed holes, which assures that the reassembled components are brought back to factory set dimensions. In lifting the girders, blocking must be used to prevent gouging or scuffing of the girder plates with the sling. Sling all parts so as to avoid damage to the lifted member.

CAUTION

Do not use tapered drift pins to force joint connection. This will cause distortion of the holes resulting in inability of the fitted bolts to hold the joint securely.

After the girders are secured to the trucks and/or end ties, install the other components. The order in which these components are installed is usually a field decision. Attention to the match marks will insure proper reassembly of platforms, pillow blocks, shafting, etc. As previously mentioned the trolley side which is positioned on the front (drive) girder is marked "FRONT". For further verification of proper orientation of the trolley to the bridge, the installer must examine the crane clearance diagram. Upon completion of the structural erection, all bolts should be examined for tightness.

c. Mechanical. Portions of the bridge drive machinery, such as the line shaft, pillow blocks, and supports may have been removed for shipment. Reassembly by match-marked location assures proper position of all components. In attaching the coupling connecting the bridge line shaft to the driver

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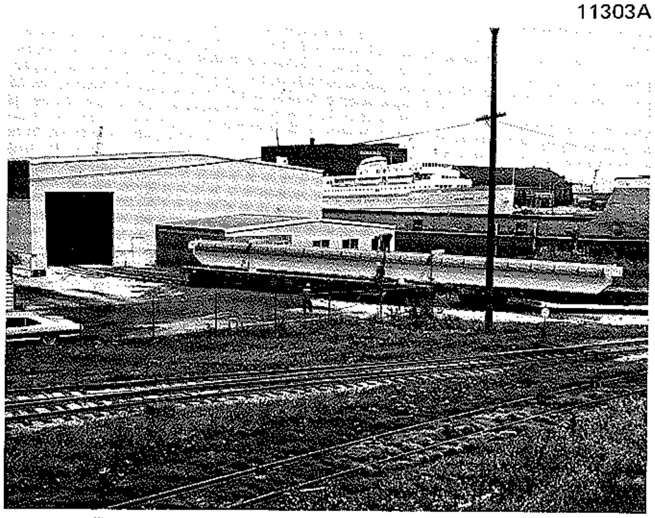

Figure 2-2. Receiving Crane at User's Plant.

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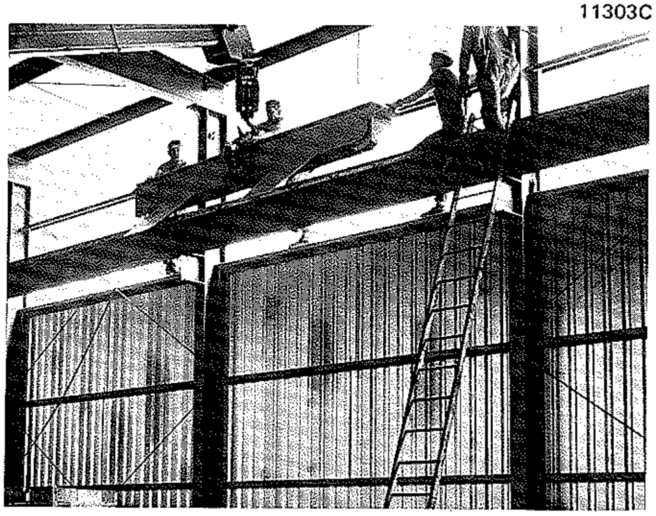

Figure 2-3. Placing End Trucks on Runway.

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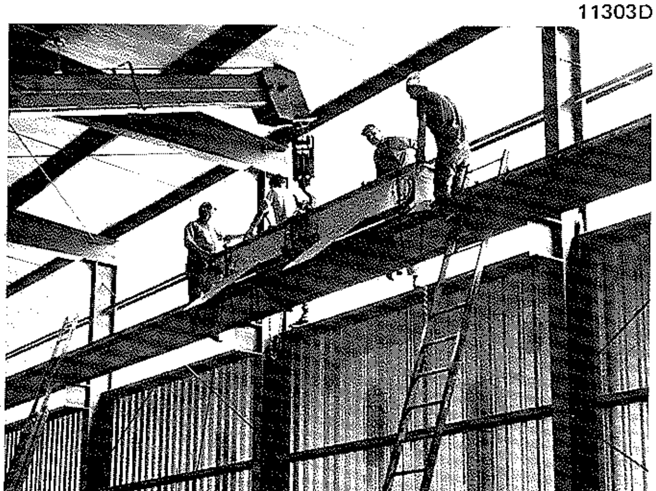

Figure 2-4. Lashing End Truck to Runway Beam.

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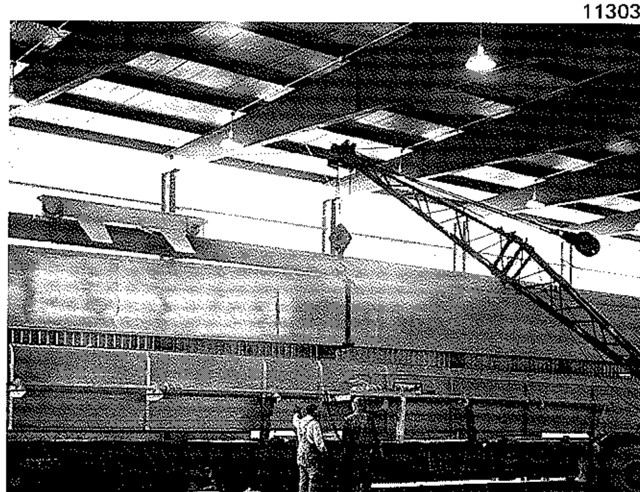

Figure 2-5. Lifting Rear Girder from Rail Car.

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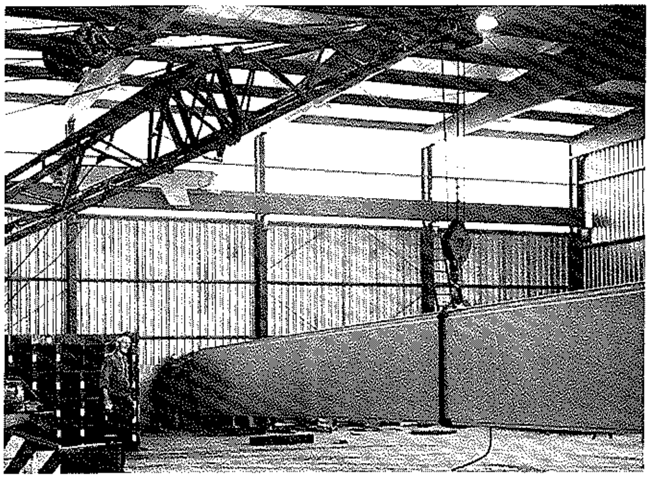

Figure 2-6. Rear Girder Rotated and Positioned for Lift.

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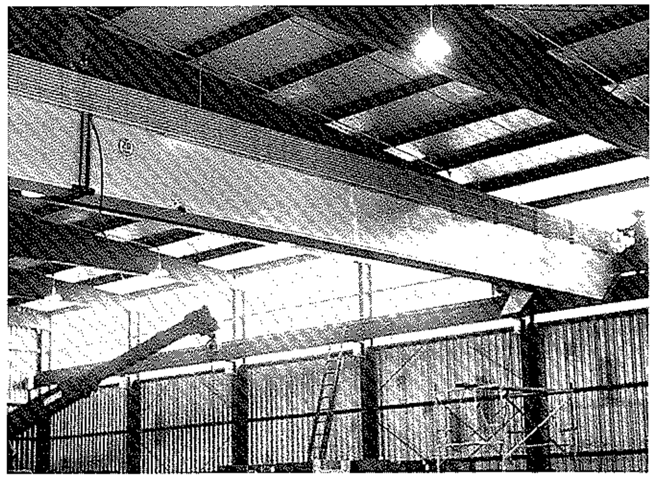

Figure 2-7. Securing Rear Girder by Fitted Bolts to End Trucks.

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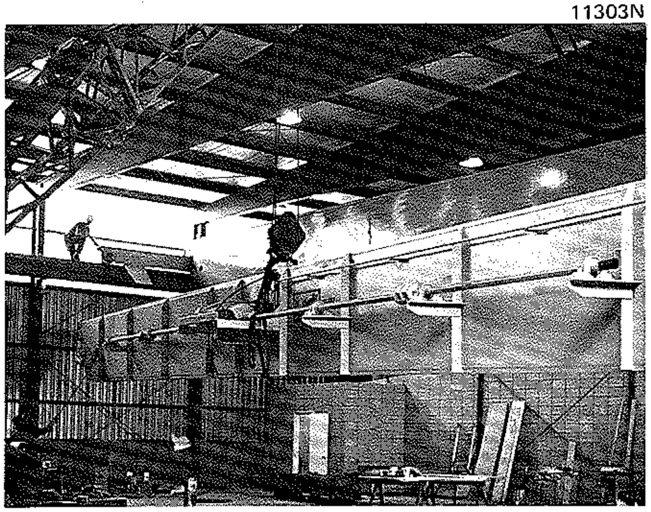

Figure 2-8. Lifting Front Girder in Position.

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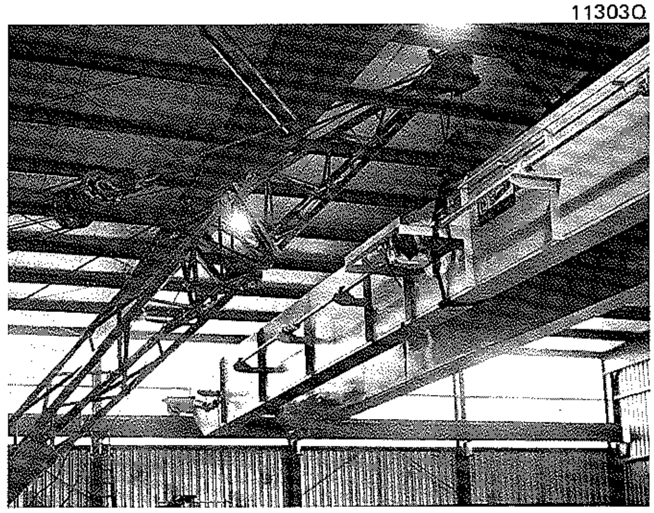


Figure 2-9. Securing Front Girder by Fitted Bolts to End Trucks.

wheel axle, the end truck must be raised to allow freedom of axle rotation in order to align keyways for coupling fit.

If the bridge is equipped with an operator's cab and a hydraulic bridge brake, then in addition to the structural fastening of the cab to the girder, reconnection of the brake hydraulic line or lines is also required. These lines are marked with metal identification tags to assure correct reconnection. If any doubt exists on line identification please refer to SECTION VI, Paragraph 6-3 and use the appropriate schematic diagram for tracing hydraulic lines.

Compression or clamp type couplings which have been removed for shipment should be reassembled using the bolts specifically identified for the couplings. Please refer to SECTION VI, Paragraph 6-4 for further identification of coupling types and bolting instructions.

All other loose parts, such as bumpers, rail sweeps, cable reels, track type limit switches, etc., should be sorted out, identified by match marks for location and reassembled.

d. Electrical.

1. Before beginning any electrical work, become acquainted with the crane wiring diagram which shows all wiring required between the various devices and the crane. This diagram is stored in the main switch enclosure.

2. Bridge conductors are assembled to the girder.

WARNING

Lock main runway disconnect switch in the open position before attempting to install or adjust the main collectors, or any other wiring on the crane.

3. Install the main collector support staff and collectors. Refer to collectors listed in SECTION VI for the type used on your crane and follow the instructions given for proper adjustment.

If collectors are not identified in SECTION VI, refer to the customized parts manual furnished with your crane. Location of the main collector staff structural support is identified by match marks located on the girder, end trucks or end platform section.

4. Install the electrical panels, resistors and any other electrical equipment on the bridge or trolley which has been removed for shipment.

5. In general, the field wiring required falls into one of the categories underlined below:

(a) Cab operated cranes, where electrical panels have been removed from the bridge platform or girders for shipment. (Cab on bridge.)

(1) Power wires from the main disconnect switch (usually in the cab) must be attached to the main collectors. Connection at the main disconnect switch is usually made at the factory. Sufficient wire to reach from the main disconnect switch to the main collector, is coiled and stored in the cab.

(2) Power wires from the main disconnect switch to the mainline contactor must be pulled through conduit or raceway provided, and attached to designated terminals. (All wires carry wire tags for correct reconnection.)

(3) Power wires from the mainline contactor must be pulled to each panel through conduit or raceways and from the trolley and hoist panel (assumed mounted on the bridge) across the end truck to the bridge cross conductors, for distribution to the trolley. Incoming power wire leads are attached to terminals on top side of reversing contactors in each panel. Outgoing power leads to motors are attached to terminals on bottom side of overload relays.

(4) Power wires from the A. C. motor rotor are attached to terminals appropriately marked on the last accelerating relay.

(5) Resistor wires must be reconnected to each accelerating relay.

(6) All control wiring must be reconnected. Reconnection is by marked terminal strips in each panel. Any hoist or trolley control circuit wiring must be brought over from each panel through conduit or raceways to the bridge cross conductors. All control circuit internal panel wiring is done at the factory.

(7) Power wires for all electric brakes must also be reconnected.

(8) Wiring of the trolley is usually complete requiring only reconnection to each collector. In attaching wires to the collectors be certain that wiring does not interfere with freedom of collector movement.

(b) Cab operated cranes where only the cab and end trucks have been removed for shipment.

(1) Power wires from the main disconnect switch (usually in the cab) must be brought over and attached to the main collectors. Connection at the disconnect switch is usually made at the factory with sufficient wire to reach the main collectors, coiled and fastened to the cab.

(2) Power wires to the mainline contactor and to the panels are installed at the factory. Sufficient wire to reach the main disconnect switch is coiled and stored on the bridge platform at the cab opening.

(3) All power wires, and control circuit wires leading to the cross conductors have been wired to the panels. These wires are coiled and stored on the platform near the end truck and must be brought across the end truck for reconnection to the cross conductors.

(4) Master switches in the cab are factory wired with sufficient wire coiled and stored in the cab to reach each panel on the bridge for reconnection.

(c) Floor operated cranes where only the end trucks have been removed for shipment.

(1) Crane is completely wired at the factory. All wires which cross the end trucks for attaching to the cross conductors are coiled and stored on the bridge platform or end of girder.

(2) Power wires from the main disconnect switch must be connected to the main collectors.

(3) The pushbutton station is completely wired; however, the pushbutton cable is usually disconnected from the bridge for shipment. Reconnection of the pushbutton cable is required. Connection is generally to a terminal strip located in one of the panels on the bridge.

(4) In general all power connections are made directly to the device served, while control connections are to terminal strip in the panels. Field wiring will involve final cutting of the wires to correct length, plus stripping ends for terminal connection. Lugs or other wire terminals if required are packaged separately. Individual wiring diagrams of each panel can be found in their respective panel. The crane wiring diagram is also shipped with the crane and is located in the panel containing the main disconnect switch.

2-5. LUBRICATION. All SHAW-BOX cranes are completely lubricated at the factory. However, gear cases are drained of oil for shipment, and other parts requiring lubrication, such as flexible couplings may be disassembled. It is important therefore that all components requiring lubrication be serviced. Complete instructions concerning initial lubrication are to be found in SECTION IX. Refer to the manufacturer's instruction manuals on purchased equipment (those components not built by Dresser). The manufacturer's lubrication instructions supercede instructions given in this manual for similar equipment.

2-6. PRE-OPERATION CHECKS.

WARNING

Before energizing the crane, and prior to running any motion, be certain that you have read this manual in its entirety and you are familiar with your crane.

a. Check the main switch serving the runway conductors and also the main disconnect switch on the bridge. Lock both switches in the open position.

b. Check bridge wheel engagement to the rail for float clearance. Make visual as well as measured checks (if required) for crane clearances to the building, and runway rail alignment.

c. Check all connections for tightness of bolts, inclusion of lock washers or other type fasteners to insure correct material has been used. This check must be made for all connections, mechanical, structural and electrical including both field and factory made connections.

d. Check to insure that all shipping supports, tie downs, brackets or other items which were used only for shipping or storage purposes are removed from the crane.

e. Check alignment of main collectors to the runway conductors.

f. Check alignment of trolley collectors to the bridge conductors.

g. Check electrical wiring for conformance to the wiring diagram.

h. Check all brakes for alignment and proper adjustment. Also check for freedom of shoes and brake arms.

i. Check all gear cases for oil level, and check all other parts for lubrication.

j. Check to be certain that the runway is clear and free of all obstructions.

2-7. PRELIMINARY TESTING. Prior to the start of these tests, make a last minute check to see that loose parts, such as tools, covers, excess hardware, nuts, bolts, etc., have been picked up and safely stored.

All personnel not required or involved in testing of the crane should vacate the area. Only qualified journeymen, electricians and millwrights should be used for this work.

CAUTION

Verify that the crane is furnished for the same voltage, frequency, and phase as the runway power supply. This information is shown on a nameplate attached to the Mainline Panel.

Place all master control switches in the OFF position. If crane is Pendant Pushbutton operated, check that all buttons are in the OFF (fully released) position. Open power circuit knife switches of each control panel. If the panels are not so equipped, then remove fuses in the motor circuit.

a. Hoist Test:

1. Test is made prior to reeving the hoist. If your hoist was reeved at the factory then lower the hook manually to a position 8 to 10 feet (2.5 to 3.5m) below the trolley. This can be done by manually releasing the motor brake. If the hoist is equipped with a mechanical load brake, some effort will be required to rotate the motor shaft.

2. Close the mainline disconnect switch serving the runway conductors.

3. Using a voltmeter, check all legs of the power leads at the mainline disconnect switch, located on the crane. Determine that power being supplied is of the correct voltage.

4. Close the crane mainline disconnect switch after checking to see that fuses are in place.

5. Energize the mainline contactor by depressing the START button. De-energize by depressing the STOP button. The action of the contactor in closing and opening the circuit is audible. After determining reset circuit is operating leave circuit with mainline contactor energized.

6. At the hoist control panel, check all legs of the power leads. Determine that power is being supplied at the correct voltage.

7. Check out reversing contactor and accelerating contactor sequencing. Operate the hoist master switch in the cab, or the hoist pushbutton on the pendant control, step by step in both directions. At each step, check contactor sequence with sequence shown on panel wiring diagram for proper operation.

8. Open crane mainline disconnect switch and replace fuses in the hoist motor circuit of the hoist panel.

9. Close crane mainline disconnect switch and reset mainline contactor by pressing the START button.

10. Jog the hoist master switch or pushbutton in the UP direction. Check to insure that the drum is rotating in a direction which would raise the hook. (Refer to Reeving Instructions, Paragraph 2-8, to determine drum direction for raising.) If direction is wrong, correct by interchanging any two leads at motor conduit box (for example, interchange HT1 and HT2). For D. C. current supply, reverse the leads to the motor armature. Be certain main disconnect switch is open when making this correction.

11. Operate the hoist several revolutions of the drum in both directions, observing that the motor brake releases properly, and that the gear train and bearings operate without binding.

12. After the hoist is reeved and before placing crane in service, a confirming load test is recommended under the direction of an appointed qualified person. See SECTION X paragraph 10-3.

b. Hoist Limit Switch Test: (no load)

After the hoist is completely reeved as outlined in Paragraph 2-8 the upper and lower (if so equipped) limit switches must be checked for proper operation and safe stopping distance.

1. Block operated upper limit type (Ref. SECTION V and VIII)

(a) With power off, check weighted arm of limit switch for freedom of movement. Also check drop cord weight for clearance to trolley frame or other structure.

(b) Slowly inch the lower block into the weight, stop hoist and check contact of lower block to weight.

(c) Continue to slowly raise the lower block. Observe the relationship of the lower block to the underside of the trolley. The hoist limit switch should stop the upward travel of the lower block within a few inches (centimeters) after lifting the weight.

WARNING

Do not contact or strike trolley frame with lower block. If hoist motion is not interrupted by limit switch, stop hoist by returning master switch to OFF position or depress the STOP button.

(d) If the limit switch does not stop the lower block, or if stopping distance exceeds several inches (centimeters) after lifting weight, check electrical circuit against wiring diagram, determine cause and correct. Also check brake torque adjustment.

(e) Repeat test increasing the speed at which the lower block contacts the limit switch, until test is performed at full speed.

WARNING

Distance required to stop the lower block after tripping the limit switch increases with speed. Be certain that the limit switch trips soon enough so that the lower block will not contact the trolley frame or other obstruction in stopping. Reset weight to provide whatever stopping distance is required.

2. Geared type limit switch (Ref. SECTION V and VIII).

(a) Set upper and lower limits of lower block travel as outlined in SECTION V.

(b) Check switch trip setting in the hoist direction as outlined in Paragraph b.1 above.

(c) If crane is equipped with a lower limit switch, check switch trip setting by lowering hook until motor stops. With hook in extreme low position, two full wraps of rope must be on the drum.

c. Trolley Test:

1. At the trolley control panel check all legs of the power leads. Determine that power is being supplied at the correct voltage.

2. Check reversing contactor and accelerating contactor sequencing by operation of the trolley master switch in the cab, or by the trolley pushbutton on the pendant control in both directions. Check sequence with panel wiring diagram to determine proper operation.

3. Open crane mainline disconnect switch and replace fuses in the trolley motor circuit of the trolley panel.

4. Close crane mainline disconnect switch and reset mainline contactor by pressing the START button.

CAUTION

When operating the trolley or bridge motion, place hook in high position and watch out for overhead or side interferences between the building and the crane.

5. Jog trolley master switch in the forward direction (be sure trolley is free to move in either direction). If direction of trolley is incorrect reverse leads as described under Hoist Test 2-7a-10 above.

6. Operate the trolley slowly across the entire bridge and slowly contact the end stops. Check contact of bumpers or wheels to end stops. Operate several times back and forth across the bridge avoiding contact with end stops, working the unit up to full speed. Observe that the trolley brake (if so equipped) releases properly, that the gear train and bearings operate without binding and that the trolley travels across the bridge without skewing.

d. Bridge Test:

1. Follow same procedure as outlined for the trolley except before operating the bridge motion, fill, bleed and adjust the hydraulic brake (if so equipped) as outlined in SECTION VI.

2. Bridge should be traversed for the full length of the runway with the trolley placed at different points across the bridge (center span, quarter span, etc.) to insure overhead clearances in the entire building.

3. Check contact of bridge bumpers with the runway stops for elevation, squareness and adequate clearance to end of building for bumper compression.

2-8. REEVING.

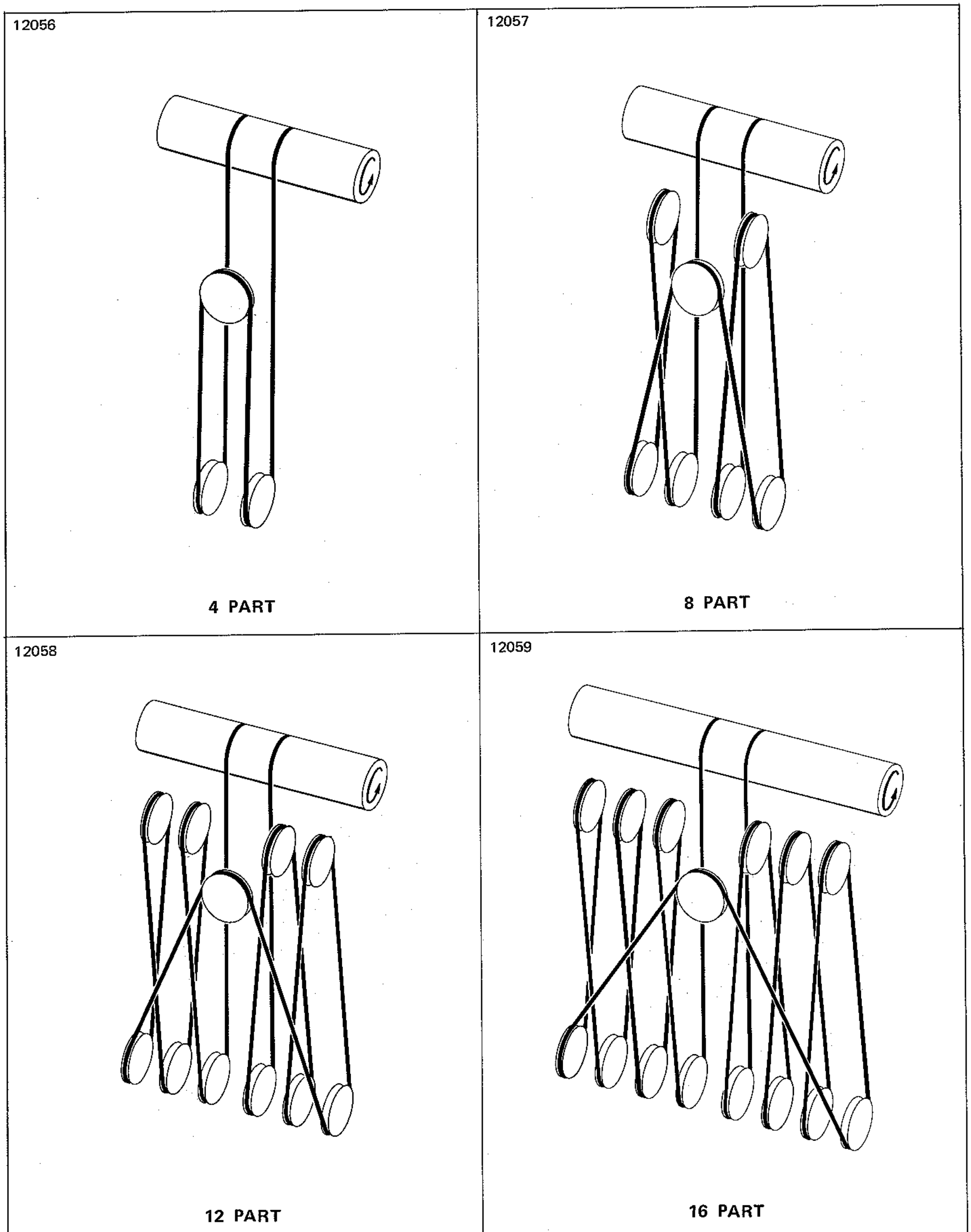
a. General. As previously indicated certain trolleys (generally 20 ton capacity or less) may be shipped with the hoist completely reeved at the factory. This should not be interpreted as a commitment for factory reeving of all hoists. It is an option which Dresser may or may not choose to exercise.

b. Standard Dresser cranes are arranged for either CONVENTIONAL or CROSS reeving arrangements. CONVENTIONAL reeving diagrams are shown in Figure 2-10 while CROSS type reeving diagrams are shown in Figure 2-11. (For cranes with nonstandard reeving a diagram is included in the manual prepared for the crane.)

c. Select the proper reeving diagram for your crane as follows:

1. Examine the upper block in the trolley. If all sheaves are in line and supported by a common sheave pin, use CROSS reeving diagram. If equalizer sheave is at right angles to the other sheaves, use CONVENTIONAL reeving diagram.

2. Examine lower block; count number of sheaves and multiply by (2). This is the total parts of ropes. Select correct diagram.



NOTE: Arrow shows direction of drum when lowering.

Figure 2-10. Diagrams Illustrating Conventional Type Reeving.

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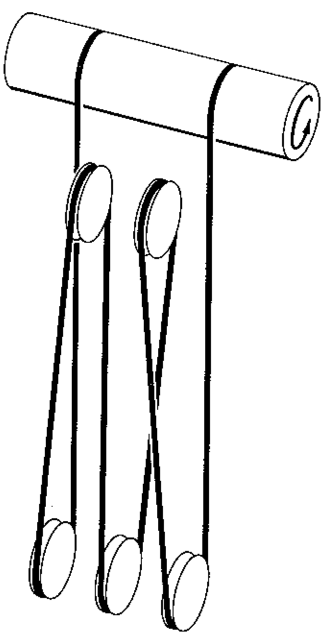

6 PART

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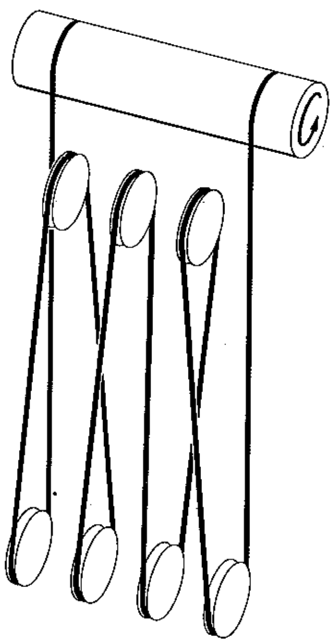

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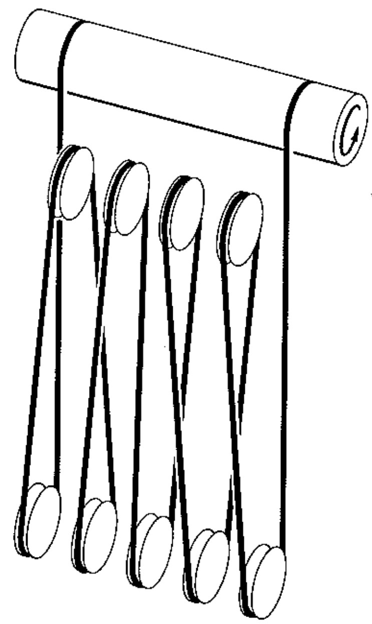

10 PART

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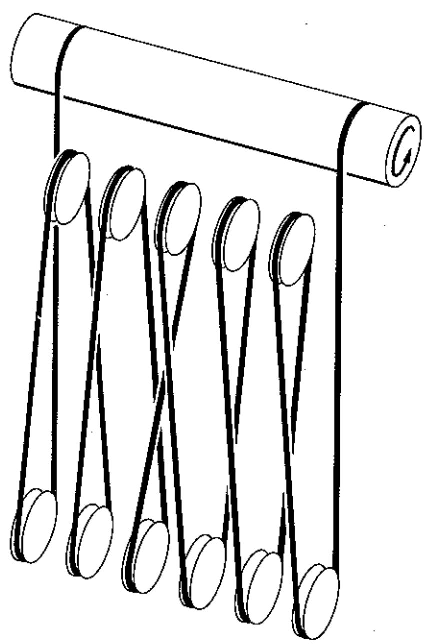

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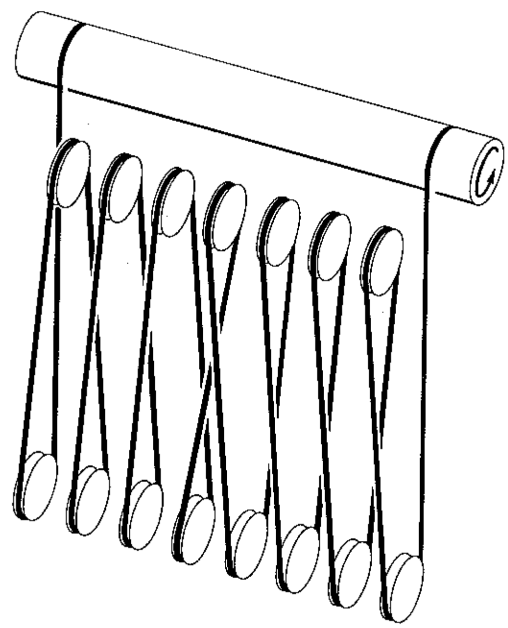


16 PART

NOTE: Arrow shows direction of drum when lowering.

Figure 2-11. Diagrams Illustrating Cross Type Reeving.

CAUTION

NOTE that in conventional reeving the rope from the drum leads to the inside sheave of the lower block while in cross reeving the rope from the drum leads to the outside sheave in the lower block.

d. Take care that the floor in the reeving area is clean. Dirt picked up by the rope can cause excessive wear of parts and shortened rope life.

e. The following reeving instructions are based upon 8 parts of rope. Figure 2-12 illustrates CONVENTIONAL reeving while Figure 2-13 illustrates CROSS reeving. As shown in these Figures, provide a support stand for the lower block, and position block directly under the trolley. Provide a support for the reel, positioned as shown, which will allow reel to turn freely. (If rope is furnished in a coil provide similar support to allow coil to rotate as rope is removed.)

CAUTION

Rotation of the reel or coil of rope is necessary to eliminate twisting and kinking. A severely kinked rope is cause for rejection, and is unsafe to use. See Figure 2-14 for correct method of handling rope.

f. As shown in Figure 2-12 thread free end of rope through lead (drum) side of the inside sheave of the lower block. (Outside sheave if CROSS reeving; see Figure 2-13.) From there pull rope up to the upper block sheave. (Outside sheave if CROSS reeving.) Pass free end of rope over upper sheave and then down and under the outside sheave in the lower block. (Inside sheave if CROSS reeving.) Continue to pull the rope back up the upper block and pass over the equalizer sheave. (Note, in CROSS reeving, rope goes from back side of sheave in lower block to front side of sheave in upper block.) Now pull rope down from the equalizer and pass under the outside lower block sheave, (inside sheave if CROSS reeving) and back up to the upper block sheave. Pass the rope over the top of upper sheave, back down and under the inside sheave of the lower block, (outside sheave if CROSS reeving) and then up to the drum. Anchor rope as shown in Figures 2-12 and 2-13, spin off remaining rope on the reel and bring free end of rope to the drum and anchor.

g. Energize hoist in UP direction. Proceed at slow speed to wind rope on the drum, making certain that rope is winding in drum grooves. Stop hoist at soon as block is lifted from the support cradle. Check rope at each sheave to make certain that rope is properly located in sheave groove. Operate hoist up and down several times through a distance of several feet (meters), checking rope for proper tracking on drum and in sheaves. Proceed to set limit switches as outlined in Paragraph 2-7b.

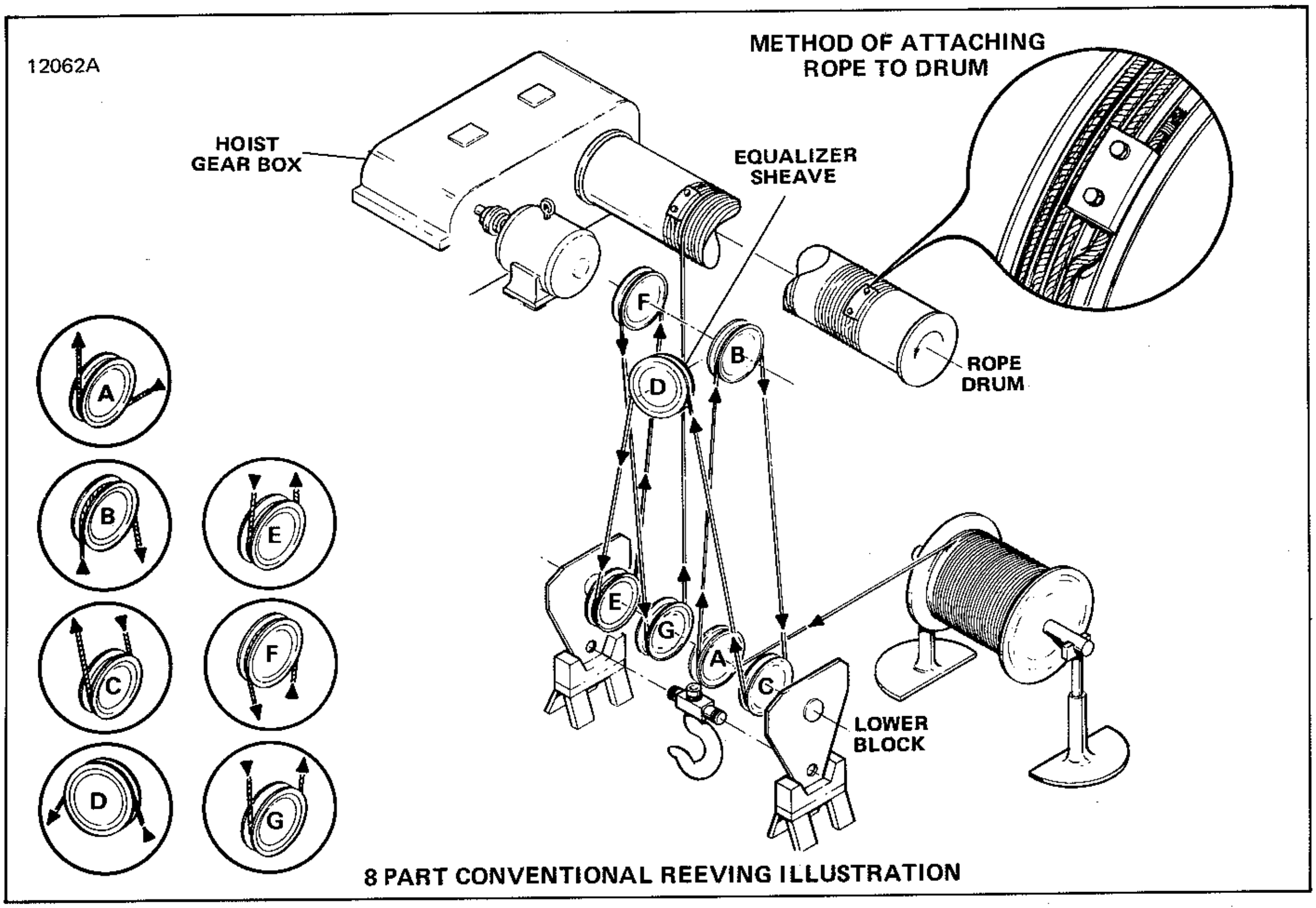


Figure 2-12. Conventional Reeving.

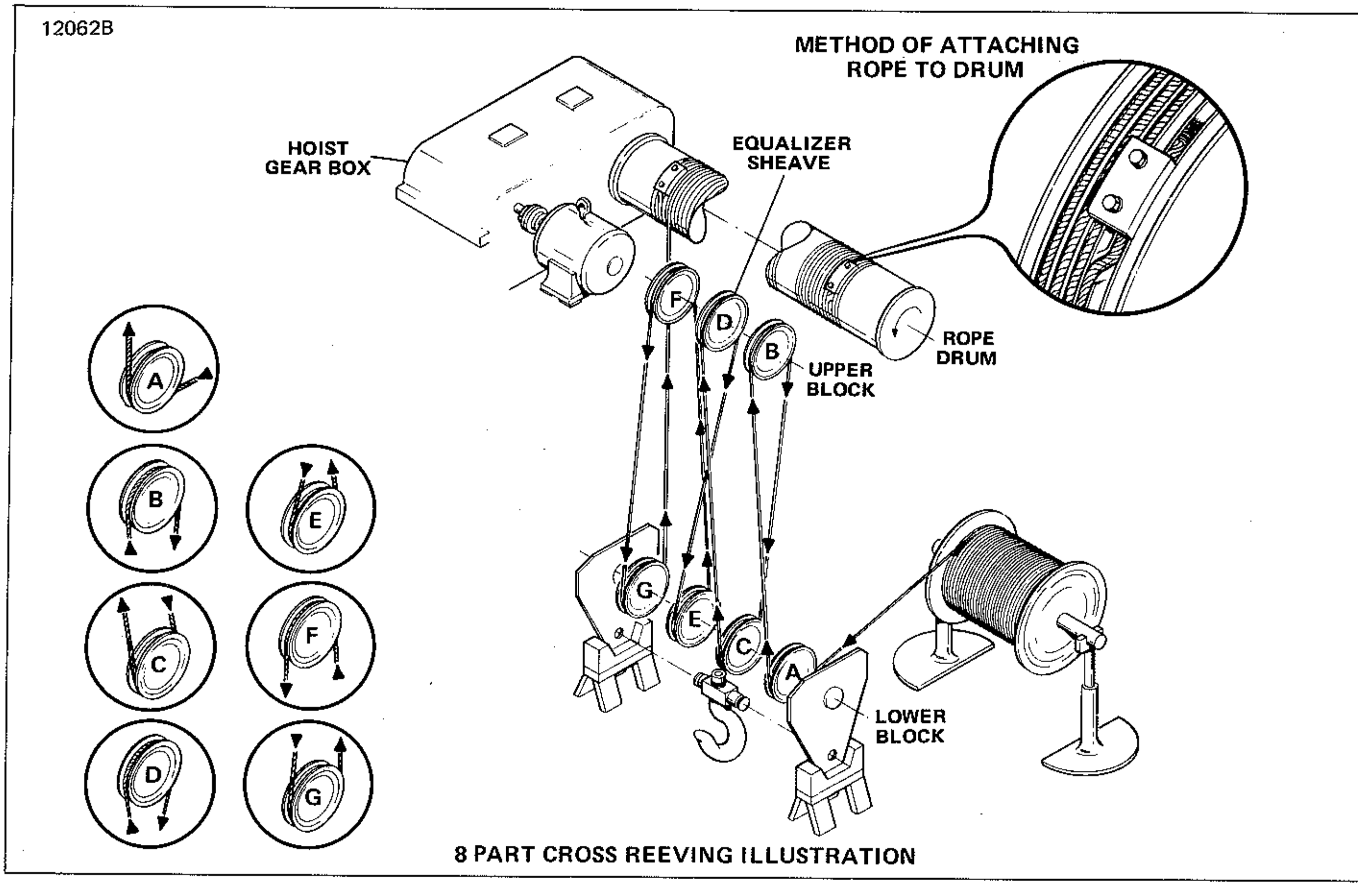


Figure 2-13. Cross Reeving.

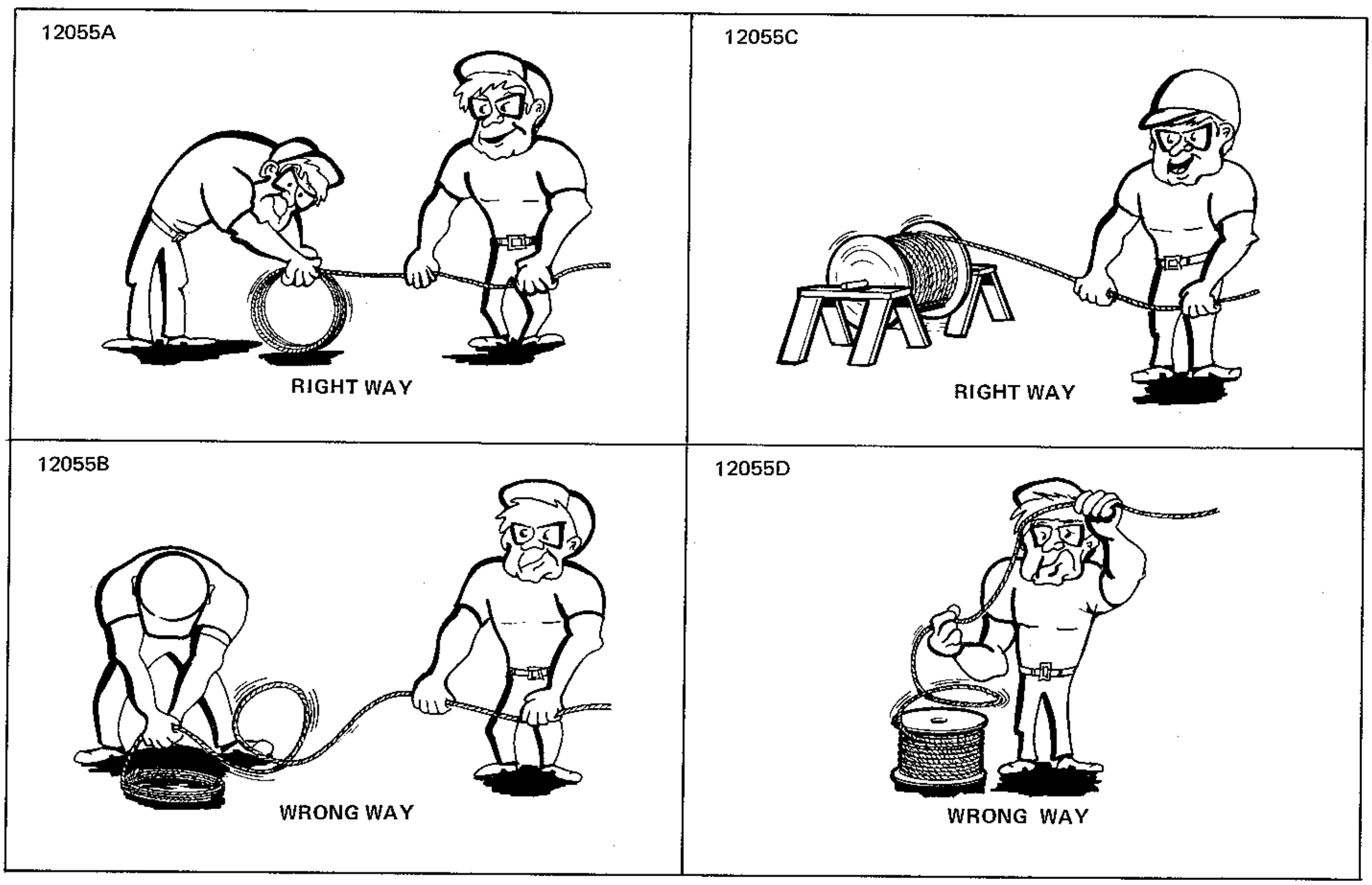


Figure 2-14. Rope Handling Instructions.

SECTION III – SAFETY

3-1. GENERAL.

a. The importance of safe handling of overhead hoisting apparatus cannot be overstated. The operator should be aware at all times that he is in control of a powerful machine, which if used carelessly, can do a great deal of damage. Crane operators contribute to the safety record of the plant. Correct usage is fundamental to reliable operation and minimum maintenance costs of the crane. One measuring stick of a good operator is his smoothness of operation. Jumpy or jerky crane movements, flying starts, quick reversals and sudden stops are the "trade marks" of the careless operator.

b. Equally important to the safe operation of the crane is frequent and systematic inspection and maintenance. Mandatory requirements on a National level are detailed in OSHA Part 1910.179. The user should become familiar with those regulations, along with any other state or local codes.

3-2. OPERATOR QUALIFICATIONS.

a. Safe and efficient crane operation requires skill, extreme care, good judgment, alertness, concentration, knowledge of and rigid adherence to proven safety rules and practices. No person should be permitted to operate a crane:

1. Who does not possess above characteristics,
2. Who is not qualified or has handicaps that could adversely affect such operation,
3. Who has not been properly instructed,
4. Who has not been informed and does not have thorough knowledge of all applicable safe operating practices, including those in this book as well as rigging equipment and practices.

b. The user is also referred to American National Standards ANSI B30.2.0 Section 2-3.1 for qualification and conduct of crane operators. Additionally, the user should become familiar with National, State or Local safety codes which may apply.

3-3. OPERATING PRECAUTIONS.

WARNING

Equipment covered herein is not designed or suitable as a power source for lifting or lowering persons.

Safe operation of an overhead crane is the operator's responsibility. Listed below are some basic rules that can make an operator aware of dangerous practices to avoid and precautions to take for his own safety and the safety of others. Observance of these rules in addition to frequent examinations and periodic inspection of the equipment may save injury to personnel and damage to equipment.

a. DO'S

(1) DO read ANSI B30.2 Safety Standard for Overhead and Gantry Cranes.

(2) DO be familiar with hoist operating controls, procedures and warnings.

(3) DO make sure hook travel is in the same direction as shown on controls.

(4) DO make sure hoist limit switches function properly.

(5) DO maintain firm footing when operating hoist.

(6) DO make sure that load slings or other approved single attachments are properly sized and seated in the hook saddle.

(7) DO make sure that the hook latch, if used, is closed and not supporting any part of the load.

(8) DO make sure that load is free to move and will clear all obstructions.

(9) DO take up slack carefully, check load balance, lift a few inches and check load holding action before continuing.

(10) DO avoid swinging of load or load hook.

(11) DO make sure that all persons stay clear of the suspended load.

(12) DO warn personnel of an approaching load.

(13) DO protect wire rope from weld spatter or other damaging contaminants.

(14) DO promptly report any malfunction, unusual performance, or damage of the hoist.

(15) DO use common sense and best judgment whenever operating a hoist.

(16) DO inspect hoist regularly, replace damaged or worn parts, and keep appropriate records of maintenance.

(17) DO use the hoist manufacturer's recommended parts when repairing a hoist.

(18) DO use hook latches wherever possible.

(19) DO apply lubricant to the wire rope as recommended by the hoist manufacturer.

(20) DO avoid striking bumpers or end stops with the bridge or trolley.

(21) DO leave all controllers in "OFF" position and open mainline switch when leaving the crane.

b. DO NOT'S

(1) DO NOT lift more than rated load.

(2) DO NOT use the hoist load limiting device to measure the load.

(3) DO NOT operate damaged hoist or hoist that is not working correctly.

(4) DO NOT operate the hoist with twisted, kinked, damaged or worn wire rope.

(5) DO NOT lift a load unless wire rope is properly seated in its grooves.

(6) DO NOT use load rope as a sling or wrap rope around the load.

(7) DO NOT lift a load if any binding prevents equal loading on all load supporting ropes.

(8) DO NOT apply the load to the tip of the hook.

(9) DO NOT operate unless load is centered under hoist.

(10) DO NOT allow your attention to be diverted from operating the hoist.

(11) DO NOT operate the hoist beyond limits of load rope travel.

(12) DO NOT use limit switches as routine operating stops unless recommended. They are emergency devices only.

(13) DO NOT use hoist to lift, support or transport people.

(14) DO NOT lift loads over people.

(15) DO NOT leave a suspended load unattended unless specific precautions have been taken.

(16) DO NOT allow sharp contact between two hoists or between hoist and obstructions.

(17) DO NOT allow personnel not physically fit or properly qualified to operate the hoist.

(18) DO NOT allow the rope or hook to be used as a ground for welding.

(19) DO NOT allow the rope or hook to be touched by a live welding electrode.

(20) DO NOT remove or obscure the warnings on the hoist.

(21) DO NOT adjust or repair a hoist unless qualified to perform hoist maintenance.

(22) DO NOT attempt to lenghten the load rope or repair damaged load rope.

(23) DO NOT operate unless direction of hook travel agrees with direction shown on control.

(24) DO NOT drag slings, chain, hooks or loads along the floor with the crane.

3-4. HAND SIGNALS. Standard hand signals are shown in front of this manual.

SECTION IV – OPERATION

WARNING

This equipment is not designed or suitable as a power source for lifting or lowering persons.

4-1. GENERAL. Operation of an electric motor driven overhead crane may be accomplished from either an operator's cab, a pendant pushbutton station, or radio control station. The cab and/or pendant station may be attached either to the bridge or trolley. Cranes operated from a pendant station are called floor controlled cranes. Cranes operated by radio signals are called remote controlled cranes. Most crane controls are of the stepped variable speed type employing (3) three or more distinct speed steps.

4-2. LEARNING THE CONTROLS. The operator should locate and be familiar with the operation of the runway mainline disconnect switch and for this exercise lock switch in the OPEN position. The operator should now manipulate the various pushbuttons (if floor operated), master switch (if cab operated) or toggle switches (if radio controlled), to get the "feel" and determine that they do not bind or stick in any position. The operator should become familiar with the location of the buttons or switches for their respective motions, as well as the "START" and "STOP" buttons which operate the crane mainline contactor. The "STOP" button should be used in any emergency since it will shut off power to all motions.

On cab controlled cranes, other switches may be employed for the operation of cab lights, heaters, crane lights, air conditioner, etc. The operator should become familiar with all of these switches. Most cab controlled cranes are equipped with a hydraulically operated bridge brake. The operator is referred to SECTION VI for a description of this type brake. In addition, the operator must acquaint himself with any vision restriction encountered either in the cab or in the building and exercise good judgment in altering operating position in order to maintain safe control.

WARNING

If a pushbutton binds or sticks in any position, or if the lever, on spring return master switches, does not return to the OFF position—do not turn power on—determine the cause of malfunction and correct before operating crane.

4-3. OPERATING THE CONTROLS (NO LOAD).

a. Close the runway mainline disconnect switch. Close crane mainline disconnect switch mounted on the bridge. Press the START button. The crane is now under power and ready to operate. (For description purposes we will assume crane is cab controlled with all motions (5) five speed stepped control.) Be certain area is clear of all obstruction and people.

b. Hoist motion. Push master switch lever away from you to the first speed point. Observe that the hook is moving down slowly.

With the hook moving downward, move lever successively to the 2nd, 3rd, 4th and finally to the 5th (full speed) point of control observing the increase in speed as the lever is advanced. Return master switch lever to the OFF position and observe distance required to stop hook. The hook may be lowered until two full wraps of cable remain on the drum. Never lower hook below this position. In the same manner pull master switch lever toward you to the first speed point, then successively through the other speed points and finally to the 5th (full speed) speed point. Return master switch lever to the OFF position and observe stopping distance. During this practice be certain to stop the hook several feet (meters) below bottom of the trolley.

At the beginning of each shift the operator must check the hoist upper limit switch with no load. Extreme care must be exercised to avoid accidental damage in the event the switch does not operate. Raise the hook by slow inching. Carefully observe the relationship of the hook block and the bottom of the trolley frame. The hoist upper limit switch, when working properly, should cause the hoist upward motion to stop.

WARNING

Do not contact or strike trolley frame, drum or upper block with hook block. If hoist motion is not interrupted by limit switch, stop hoist by returning master switch lever to the OFF position and/or depressing the STOP button. Do not attempt further operation. Report condition to proper supervisor for correction.

Repeat upper limit switch test described above several times, each time increasing the hoist speed until switch is tested at full speed. Do not use this upper limit switch as an operating control.

c. Trolley motion. The operator must develop complete familiarity with response of the trolley motion and direction relative to position of the master switch lever. As with the hoist, the operator should become familiar with each speed point working to full speed ONLY after stopping from each speed point. This practice should continue long enough so that direction, speeds, stopping distance, hook swing control, etc., become "second nature" to the operator's judgment and reflexes.

d. Bridge motion. The same procedure is to be followed as given for the trolley. One major difference in stopping the bridge is that the bridge is usually equipped with a hydraulic service brake controlled by a foot lever in the cab. The rate at which the bridge can be stopped is determined by the amount of force applied to the brake foot lever. Rapid stops are not recommended. The operator should become proficient at judging the stopping distance so that he avoids rapid sudden stops.

Certain cranes (especially cab operated) may also be equipped with a control which allows plugging. This is a feature which allows for reversing the master switch lever to a direction opposite to the direction of bridge or trolley motion. This type of control is very useful as a braking device, and is used successfully in the control of hook swing and controlling distance required to stop. It also adds to the service life of the electric or hydraulic brakes.

CAUTION

Never attempt reversing control lever direction unless the control has plugging protection.

4-4. OPERATING THE CONTROLS (WITH LOAD). The exact same procedures apply with load as given in Paragraph 4-3 for no load. Start operation using a light load of 10 to 15% full load graduating to approximately 50% load and then to full load in three load steps. This will give the operator a feel for control response throughout the load range. The most important effect of a changing load with which the operator must become familiar is the variation of stopping distance required.

SECTION V – ELECTRICAL

5-1 THE COMPLETE ELECTRICAL SYSTEM. A brief description of the complete electrical system for a typical crane will serve as a general introduction to more detailed instructions that follow on start-up, maintenance and service. It will also help to explain functions of various components described later in this section, and show how they are related.

For system description that follows, refer to Figure 5-1, which is a one-line electrical diagram for a typical 3 motion, cab-operated, A.C. crane, using wound rotor motors. (System would be similar for a D.C. crane except for use of D.C. motors and other components rated for operation on D.C.)

Electrical power is brought onto crane through Main Collectors and Runway Conductors (1), and is connected directly to Main Disconnect Switch (2). This switch is fused, manually operated, and lockable in "OFF" position, and is located either in cab or on bridge platform near point of access. Separate disconnect switches, also taking power directly from main collectors, are provided for lifting magnets and crane lights, as required.

When main switch is closed, power is connected to Main Line Contactor – MLC (3). MLC is magnetically operated and is opened and closed by means of a "START" – "STOP" Pushbutton Station (4), located in operator's cab. A Control Transformer (5) provides a 115 volt A.C. supply for operating coil of MLC, as well as for control circuits of Hoist (6), Trolley (7), and Bridge (8) Controls. (On D.C. applications, there is no transformer and control circuits operate on 230 volts, or normal line voltage.)

Controls (6), (7) and (8) provide for individual protection and control of Hoist (9), Trolley (10), and Bridge (11) Motors. As controls are generally mounted on bridge, connections from controls to hoist and trolley motors, which are mounted on trolley, must be made through Cross Conductors (12). Operation of controls is by means of Master Switches (13), (14), and (15), located in operator's cab. Resistors (16), (17) and (18), used in conjunction with controls, provide for smooth starting and speed control of motors. Several types of controls for differing applications are more fully described later in this section.

An Upper Limit Switch (19), which turns off hoist control when operated, serves to limit upward travel of hoist hook.

Each motor is protected against overheating by a Temperature Actuated Switch – TAS (20), installed within motor. If motor temperature rises to maximum allowable for type of insulation used, TAS will operate to turn off control and prevent further operation of motor until it has cooled down.

Hoist Brake (21) is used for holding or stopping any hook load up to rated capacity. Brake is set by spring when hoist motor is not running, and releases electrically whenever hoist motor is operated.

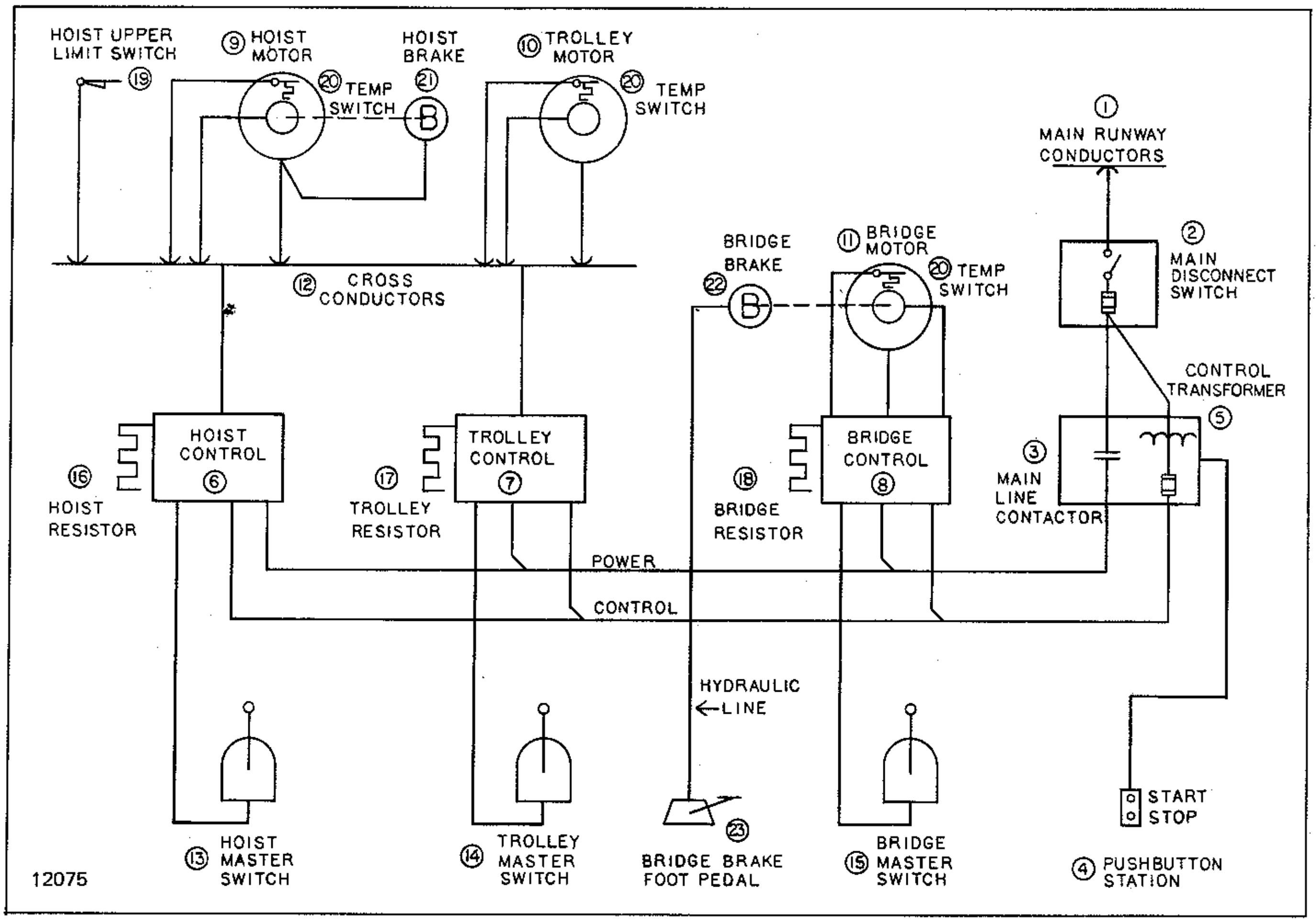


Figure 5-1. One Line Electrical Diagram.

Bridge Brake (22) is hydraulic operated and is applied when operator presses Foot Pedal (23), located in cab. As with automobile brake systems, increasing the pressure applied to foot pedal will increase brake effort.

For a typical 3 motion A.C. crane that is floor-operated instead of cab-operated, the one-line diagram and system description are the same, except that functions performed by Master Switches (13), (14), and (15) and "START" – "STOP" Pushbutton Station (4) are replaced by push-buttons in the pendent station. Also, the hydraulic bridge brake is replaced by a spring-set, electrically released brake that functions in same manner as hoist brake described above.

5-2 TYPES OF CONTROLS. The purpose of this Paragraph is to describe performance characteristics of several types of controls most widely used on cranes. This will enable user to better understand how his crane operates, and help him to obtain safe, reliable and efficient performance from his crane.

In discussion that follows, references will be made to typical speed-torque performance curves for each type of control. These curves (or graphs), representing a plot of motor torque vs. motor speed, can be used to determine motor (and load) speed for any given torque load and for any given speed point in either direction of motor rotation. Thus the speed-torque curve provides both a useful tool for understanding the performance characteristics of a given type of control and a basis for comparison with other types of controls.

Before proceeding, an important distinction should be made in regard to performance curves for hoist drives versus performance curves for bridge-trolley drives. For example, given a 25 ton capacity hoist, on which hook loads vary from 0 to 25 tons (0% to 100% capacity), torque loads on motor also vary, in direct proportion to hook load (0% to 100%). Therefore, the speed-torque curve for a hoist drive can also be correctly designated as a speed-load (hook load) curve. This is not true in the case of a bridge-trolley drive. Consider the same 25 ton hoist installed on a crane weighing 50 tons. Load to be moved by bridge motor could then vary from 50 to 75 tons, depending on hook load. Thus, load on bridge motor is not proportional to hook load, as it was in the case of hoist. For this reason, performance curves for bridge-trolley drives are more properly referred to as speed-torque curves. This distinction should be kept in mind because, in descriptions that follow, performance curve that accompanies each type of control is shown for hoist applications.

Some controls are usable for both hoist and bridge-trolley applications. When applying their performance curves to bridge-trolley drives, consideration must be given to the fact that "hook load" on horizontal axis cannot be used directly, for reason explained above.

a. Single Speed Control (used with squirrel cage motor). Speed-load curve for single speed control mechanical load brake (MLB) hoist applications, is shown on Figure 5-2, with hook speed plotted along vertical axis and hook load along horizontal axis. Dashed lines indicate performance at 100% load. Single speed controls, although less expensive than other types, are also less versatile. Their usage is

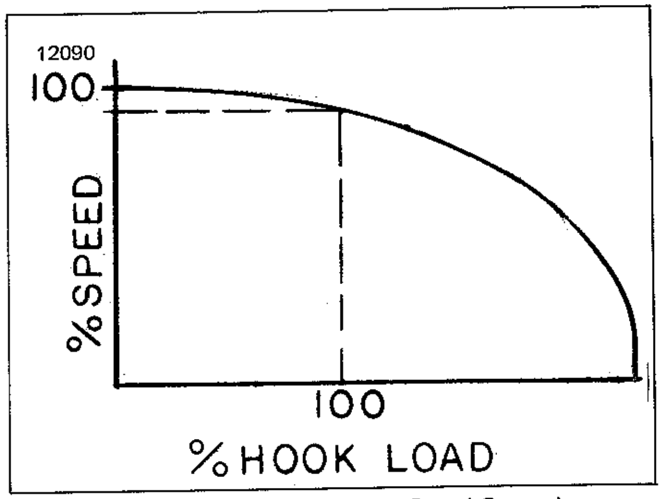


Figure 5-2. Speed-load Curve. Single Speed Control.

generally limited to hoist drives with slow hook speed and slow speed bridge or trolley drives.

b. Two Speed Control (used with dual wound squirrel cage motor). Speed-load curves for two speed control are similar to that of single speed control except for the addition of slow speed curve. See Figure 5-3. This control is widely used on MLB hoist drives, and sometimes for bridge and trolley applications. It offers the advantage of a slow speed point that is not appreciably affected by hook load.

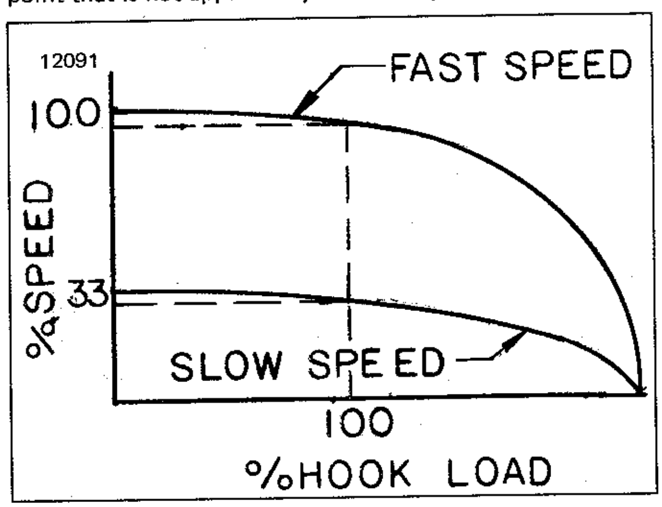


Figure 5-3. Speed-load Curve. Two Speed Control.

c. Five (or Three) Speed Point Magnetic Control – MLB, R-P (used with wound rotor motor and secondary resistor). Speed-load curves for hoist applications are shown on Figure 5-4. This type of control is very widely used for MLB hoist drives as well as for bridge and trolley applications. When used for bridge or trolley service, the control is equipped with a plugging relay. Controls with this feature will be more fully covered in Paragraph 5-4, dealing with control operating instructions. For three point controls, refer to same speed-torque curves, except omit speed points (2) and (4) for hoist applications, and omit points (3) and (4) when applied for bridge or trolley service. Note that when this type of control is used with light loads, there is little change in speed between speed points.

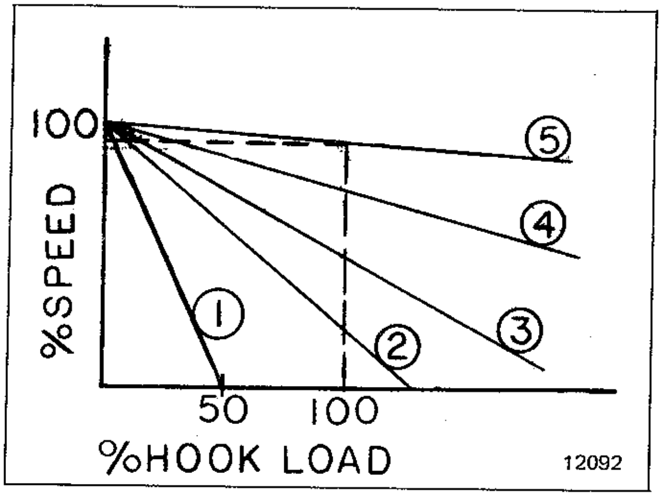


Figure 5-4. Speed-load Curve. Five Point Magnetic Control.

d. Five Speed Point Eddy-Current Braking Hoist Control (used with wound rotor motor, secondary resistor and eddy-current brake). See Figure 5-5 for speed-load curves for this control. Curves above horizontal axis represent speed points in hoisting direction while those below axis are for lowering. Eddy-current control is used where availability of a very slow hook speed is required for setting delicate loads in place. Note that, with this control, a slow speed may be obtained even with light hook loads. An additional feature of this control, which will be discussed in detail in Paragraph 5-4 on Control Operating Instructions, is electric braking, which allows operator to slow down hook (motor) speed very quickly, thus reducing wear on shoe brake lining.

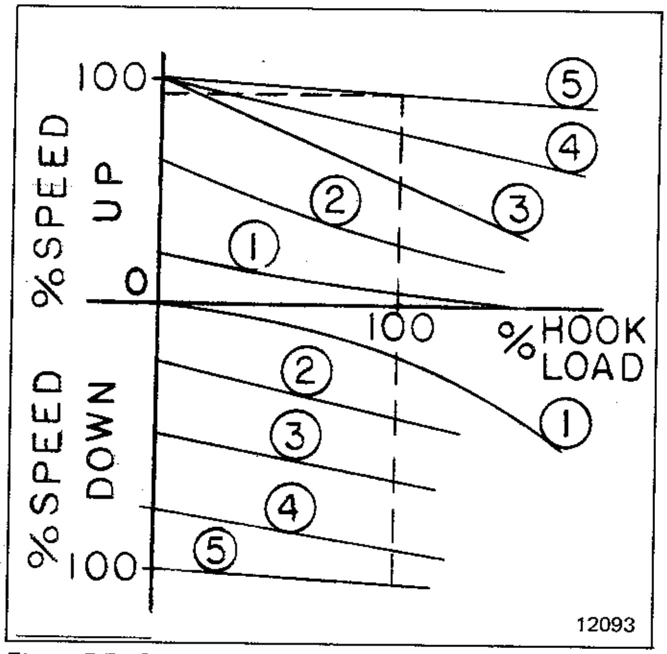


Figure 5-5. Speed-load Curve. Five Point Eddy-Current Braking Hoist Control.

e. Counter-Torque Hoist Control (used with wound rotor motor and secondary resistor). This type of control has been widely used for hoist drives on grab-bucket and magnet cranes. As shown in speed-load curves, Figure 5-6,

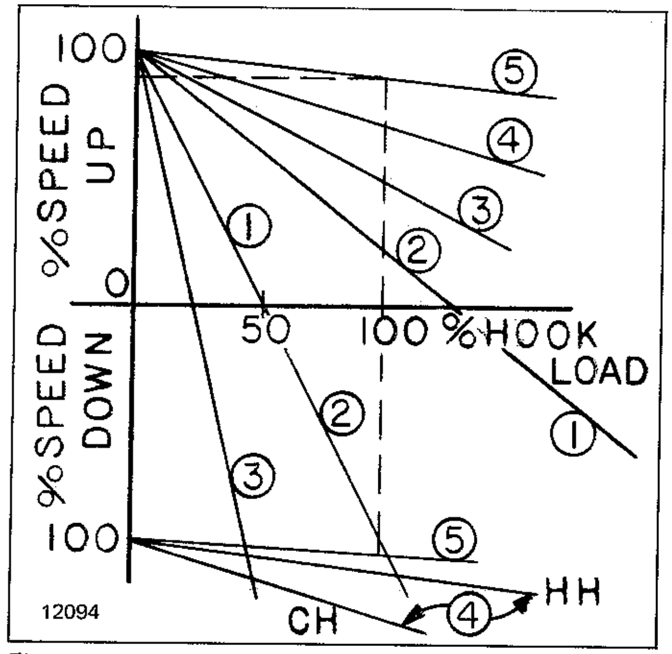


Figure 5-6. Speed-load Curve. Counter-Torque Hoist Control.

hoisting direction performance is same as standard 5-point control shown previously. In lowering direction, there is no light load slow speed performance capability. Therefore, this control is not suitable for use on loads requiring careful handling. Operation of counter-torque control will be covered in detail in Paragraph 5-4 on Control Operating Instructions.

f. A.C. Single Phase Dynamic Braking Hoist Control (used with wound rotor motor and secondary resistor). Speed-load curves for this control are shown on Figure 5-7. Curves for hoisting direction are the same as for a standard 5-point wound rotor control. In lowering direction, A.C. single phase dynamic braking provides very poor control for rated

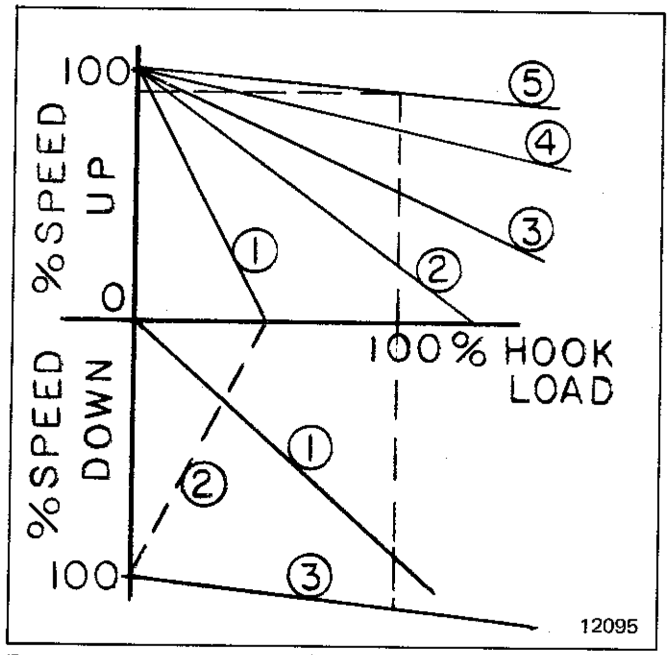


Figure 5-7. Speed-load Curve. A.C. Single Phase Dynamic Braking Hoist Control.

loads. A second lowering point, shown dashed, will provide a weak motoring torque for starting light hook loads in lowering direction. This control is used only when loads handled are less than 50% of rated capacity or where rough handling of rated loads is not a problem.

g. D.C. Dynamic Braking Hoist Control (used with A.C. wound rotor motor and secondary resistor). See Figure 5-8 for speed-load curves for this control. Hoisting performance is the same as for a standard 5-point wound rotor control. For lowering control, as with A.C. dynamic braking, motor is used for braking, except that D.C. power is applied to motor stator (primary winding) instead of A.C. power. This control provides very good lowering control for loads ranging from 50% to 100% of hoist rated capacity. From 50% toward 0% load, the difference between speed points becomes less. There is also weak "kick off" torque for starting light loads in lowering direction.

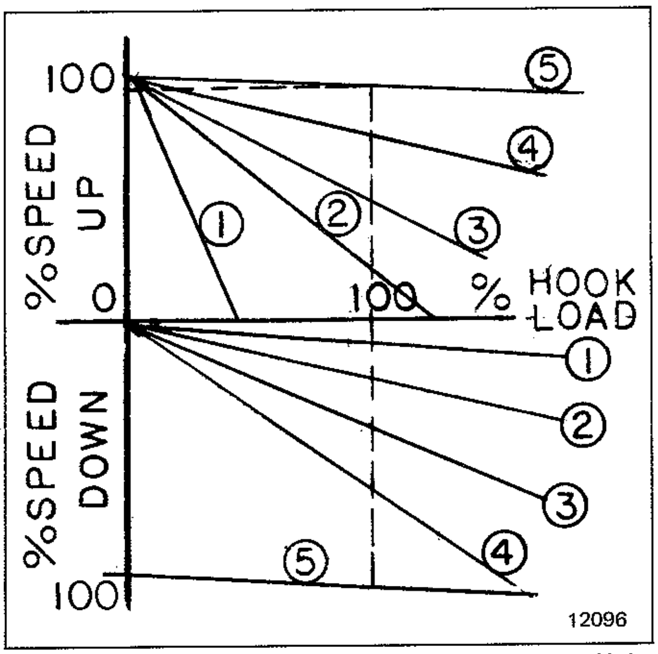


Figure 5-8. Speed-load Curve. D.C. Dynamic Braking Hoist Control.

h. D.C. Dynamic Lowering Hoist Control (used with D.C. Series wound motor and accelerating resistor). Speed-load curves for this control are shown on Figure 5-9. Performance is similar to that obtained with eddy current braking control. This control has been widely used on steel mill cranes, to the extent that it is virtually a standard for that industry.

i. D.C. Reversing-Plugging Control (used with D.C. series wound motor and accelerating resistor). Performance of this control, shown on Figure 5-10, is similar to A.C. reversing-plugging control, used with wound rotor motors. Like D.C. Dynamic lowering control, this control is widely used on steel mill bridge-trolley drives. This control is also sometimes used on hoist drives with MLB.

j. Stepless Control. This type of control is featured by continuously variable (or stepless) speed control from zero to rated speed in either direction. Controls of this type provide great versatility but at substantially more cost than controls previously discussed. There are a variety of types of stepless controls presently available, some designed for use with A.C. motors of different types, and others for use with D.C. motors of different types. Solid state components (transistors, diodes, SCR's, etc.) are used extensively in stepless control systems.

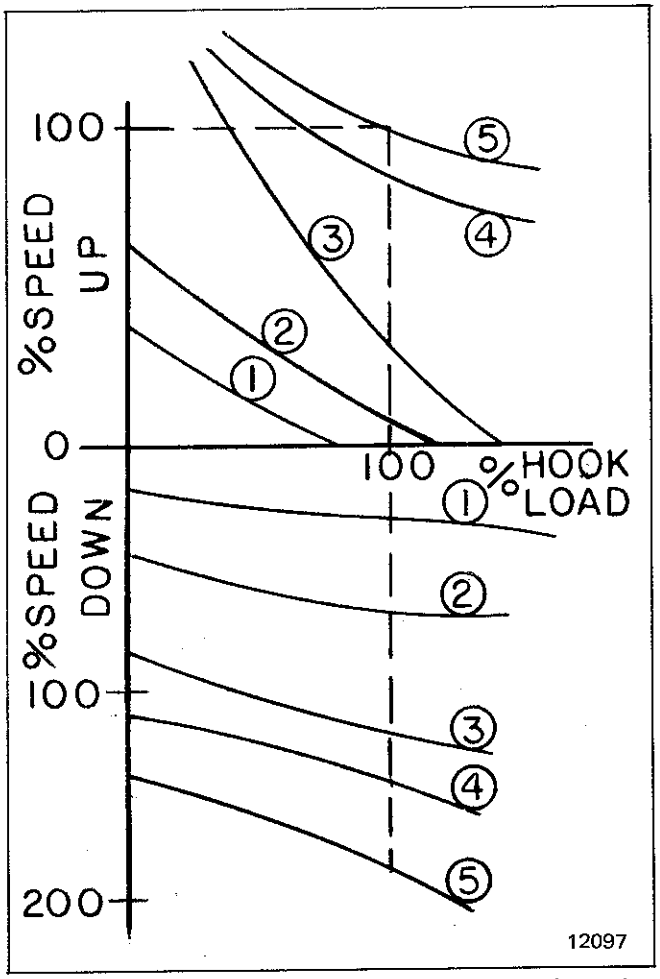


Figure 5-9. Speed-load Curves. D.C. Dynamic Lowering Hoist Control.

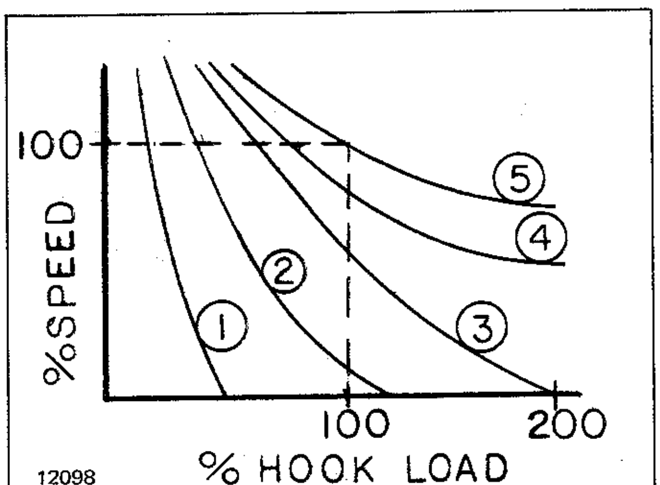


Figure 5-10. Speed-load Curve. D.C. Reversing Plugging Control.

5-3 GLOSSARY OF ELECTRICAL COMPONENTS. This paragraph contains a listing with brief definitions and/or function descriptions of all electrical equipment and control components normally used on a crane. Also included is a table which serves to explain the meaning of various resistor classifications, such as Class 152, Class 173, etc.

a. Power Disconnect & Circuit Protective Devices.

1. A Disconnect Switch is a manually operated device for making or breaking connections in an electrical circuit. It is rated in volts and amperes and is capable of interrupting rated current at rated voltage. An enclosed disconnect switch, which has no exposed "live" parts and has an external operating handle is called a Safety Switch. On crane applications, disconnect switch is used to connect or cut off electrical power to main circuit, and also to auxiliary circuits, when required.

2. A fuse is an over-current protective device for an electrical circuit, which is designed to "burn out" when current, due to a short circuit or other fault, exceeds rated amount. This opens circuit and prevents damage from occurring to other circuit components.

3. A Circuit Breaker is a device that combines functions of disconnect switch and fuses and has generally similar applications. It can be manually operated to open or close an electrical circuit and is designed to open automatically, by means of a thermal or magnetic tripping device, when rated current is exceeded.

b. Control Panels, Components and Enclosures. A Control Panel is a unit assembly consisting of all, or most, of the necessary control components, switches, contactors, relays, terminal boards, etc., for one or more crane operations. Control panels can be provided Open with components exposed and mounted on a flat base or panel board. They can also be Enclosed with components mounted inside on back wall of a cabinet type enclosure with front door(s). Control panels can also be Modular in form, in which all components are mounted on a common base, which in turn mounts as a sub-panel within a cabinet enclosure.

Enclosures for control equipment may be of differing quality and type depending mainly on environmental conditions, but also on specific requirements of the application.

Most frequently used control panel components are defined as follows:

1. A Contactor is a device for repeatedly establishing and interrupting an electrical power circuit. For crane applications, contactors are generally of electromagnetic type, actuated in a separate low voltage (115 volt) control circuit by a remote operating device, such as a pushbutton or master switch. Contactors may have the following functions for crane service:

(a) The Mainline Contactor, when coil is energized, connects main power supply to controls for all motions, making them ready for operation. The mainline contactor, because it will drop out (open) under low voltage conditions, also serves to provide undervoltage protection for crane motors.

(b) A Reversing Contactor is used to apply power directly to drive motor for each motion and provides, in addition, for changing the operation of drive from one direction to the other. Reversing contactors are provided with mechanical and electrical interlocks to prevent simultaneous closing of power contacts on both contactors.

(c) Accelerating Contactors are used in controls of A.C. wound rotor and D.C. series motor for adding or removing resistance from motor circuits to vary speed and starting torque of motor.

2. A Relay is a device which is caused to operate by a variation in the conditions of one electrical circuit, which in turn causes the operation of other devices in the same or another electrical circuit. Types of relays commonly used in crane control application are as follows:

(a) A Control Relay, unless otherwise specified, is electromagnetically operated by the opening and closing of its coil circuit. This in turn opens or closes a contact (or contacts) in coil circuit(s) of contactors or other relays, thus producing desired circuit changes.

(b) An Overload Relay is a relay which functions at a pre-determined value of over-current to cause a load (such as a motor) to be disconnected from power supply. Crane controls are generally provided with overload relays, usually of Thermal or Magnetic type, in each motor circuit.

(c) A Timing Relay is one in which a definite time delay is purposely introduced into its action. In step-type magnetic crane controls, timing relays are used between speed points, making it impossible to put the motion into full speed immediately, and insuring more gradual and smoother starting.

(d) A Plugging Relay is a special purpose type used in control circuits for bridge and trolley motions. It is used in reversing operations to prevent the immediate switching of motor from full speed in one direction to full speed in the other direction, which would cause a high and potentially damaging surge of current in motor. By preventing accelerating contactors from closing until motor has decelerated to zero speed, plugging relay maintains full resistance in motor secondary circuit until motor is ready to accelerate in opposite direction and limits current surge to its normal starting value.

(e) A Field Loss Relay is a current actuated relay used in Eddy-current brake control circuits to detect the presence or absence of current through Eddy brake field. In event of loss of field current on those speed points where Eddy braking is required, field loss relay opens a contact in hoist control circuit that cuts off power to hoist motor and shuts down the motion.

3. A Transformer is a device for stepping up or down of A.C. (alternating current) voltages. On A.C. cranes, a Control Transformer is used to step down power voltage, usually 230, 460, or 575 volts, to 115 volts for operation of control devices.

4. A Rectifier is a device with electrical characteristics such that it permits flow of current through it in one direction only. Rectifiers are widely used for conversion of A.C. to D.C. power. On cranes, which most often operate on A.C. power, rectifiers are used to provide D.C. power for brakes, lifting magnets, etc.

5. A Terminal Board is an insulating base equipped with one or more terminal connectors for the purpose of making electrical connections thereto. A terminal board (or boards) thus serves as a junction point where wires from different components in a circuit (or circuits) can be brought together and connected properly.

c. Motors. A Motor is a widely used type of electrical machinery that converts electrical power, either A.C. or D.C., into mechanical power. Almost all motors consist of two basic parts. The stationary part is called the stator. The rotating part, called the rotor, is mounted on a shaft, and, on crane applications, transmits torque through suitable gearing, to the hoist drum or bridge or trolley wheel, causing motion to operate.

1. An A.C. Motor operates on A.C. power. The stator contains the primary windings, which, when energized, generate a rotating magnetic field that exerts torque on rotor, causing it to rotate. The most common types of A.C. motors used on cranes are as follows:

(a) A Squirrel-Cage Motor gets it name from the construction of the rotor, which has conductor bars embedded in slots around circumference of laminated steel core, with conductors then shorted at ends of core by end rings to give the appearance of a "squirrel cage". Because of its simple and rugged construction, the squirrel cage motor has wide usage generally. As it is essentially a one-speed motor, however, (see speed-torque curve, Figure 5-11) the squirrel cage motor has not been widely used for crane service.

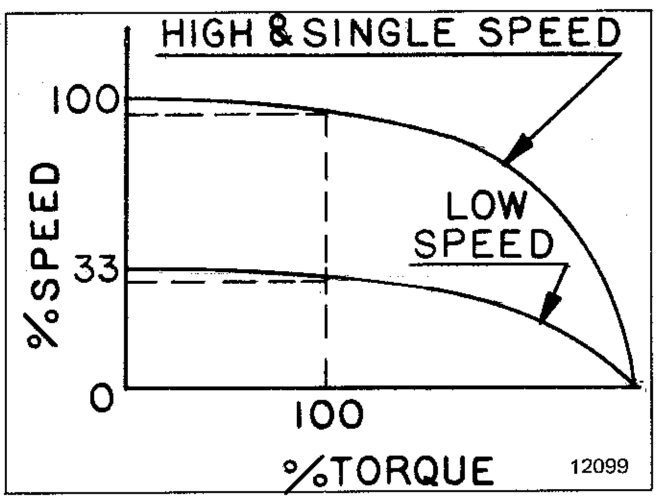


Figure 5-11. Speed-torque Curves. One and Two Speed Motors.

(b) A Dual Wound Squirrel-Cage Motor is of same construction as above except that stator has two windings, giving motor a two speed capability. For crane applications, these motors generally have a 3 to 1 speed ratio, with controls arranged to apply power to one winding or the other, providing for fast or slow speed operation. These motors are widely used for hoist drives. Speed-torque curves are as shown on Figure 5-11.

(c) A Wound Rotor Motor has a one winding primary installed in stator, and a similar winding, the secondary, is installed in rotor slots, with leads connected to slip rings mounted on shaft. Carbon brushes in contact with slip rings allow for external resistance to be added to resistance of secondary. Changing the value of this external resistance changes the speed-torque performance of motor. Thus, when used with suitable controls and resistors, the wound rotor motor provides capability of speed control for hoist or bridge-trolley drives, and is widely used for crane applications. Speed-torque curves are as shown on Figure 5-12.

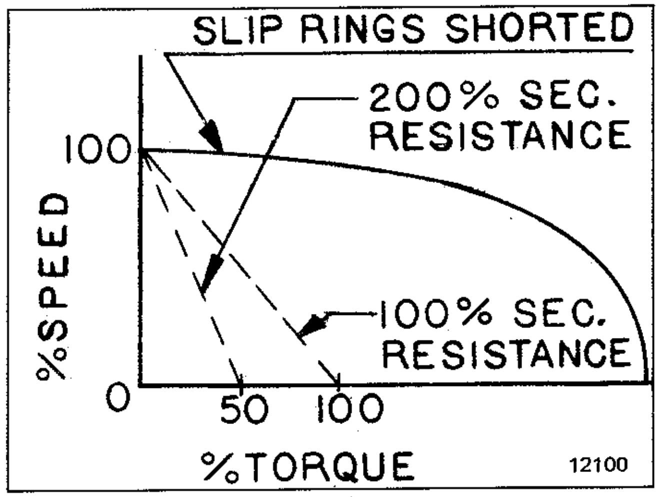


Figure 5-12. Speed-torque Curves. Wound Rotor Motors.

2. A D.C. Motor operates on D.C. power. Stator contains field windings, and rotor contains armature windings and commutator. Carbon brushes in contact with commutator bring power to armature windings. D.C. motors are of the following basic types:

(a) The Series Wound Motor is one in which armature and field windings are connected in series. A typical speed-torque curve for a series motor is shown on Figure 5-13. External resistance connected in series with motor will alter speed-torque curve. A desirable feature of the

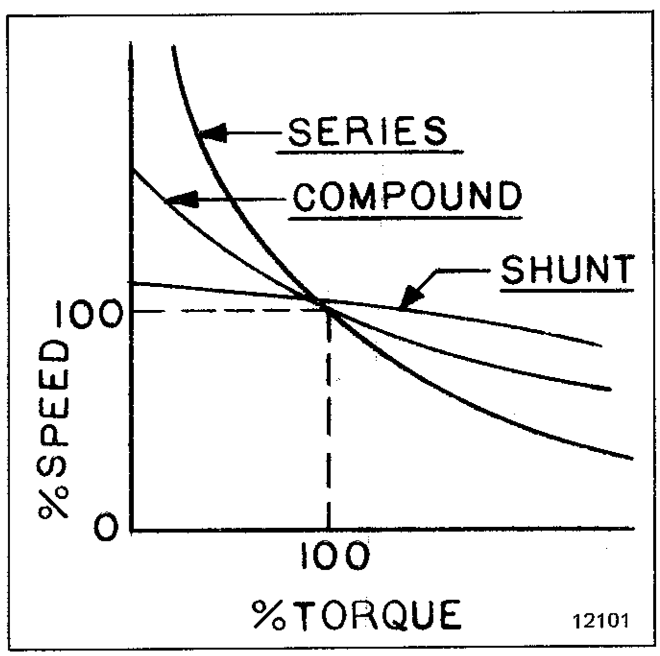


Figure 5-13. Speed-torque Curves. D.C. Motors.

series motor is that speed increases with a decreasing load. This provides for time saving in hoisting a hook without load. Also, when used for a hoist drive, the series motor is reconnected to operate as a shunt motor and to provide dynamic lowering control. Because of its versatility, the series motor is well suited for crane applications, and has been widely used for bridge, trolley, and hoist drives.

(b) The Shunt Wound Motor is one in which armature and field windings are connected in parallel. As is shown in Figure 5-13, shunt wound motor operates at near constant speed for all loads, because the shunt field is also constant in value. The shunt motor, when used for crane applications, is operated with variable voltage controls in order to obtain suitable speed control.

(c) The Compound Wound Motor has both a series and shunt field, resulting in a speed-torque curve that combines features of both series and shunt motors. See Figure 5-13. The compound motor, like the shunt motor, is generally used with variable voltage controls.

3. Motors used on cranes (both A.C. and D.C.) are generally short time rated, either 30 minute or 60 minute, for intermittent service. For some very severe duty applications, motors may be continuous rated.

4. Enclosures for most crane motors are described as TENV, or Totally enclosed non-ventilated. Other type motor enclosures sometimes used are TEFC, or Totally Enclosed Fan-Cooled, and Open Dripproof.

5. A Temperature Actuated Switch (TAS) is a temperature sensitive device, installed on motor winding. If winding temperature rises above rated limit for type of insulation used, a contact in the TAS opens. This contact is connected in control circuit of motor control, thus turning off control when motor overheats.

d. Resistors. A Resistor is a device which introduces resistance into an electrical circuit, thereby limiting current flow. For crane applications, resistors may have the following functions:

1. Secondary Resistors are used in the secondary circuit of a wound rotor motor to limit motor torque and speed. By means of a series of contactors, operating in sequence to short out successive sections of secondary resistance, a step-type speed control for motor is provided.

2. Accelerating Resistors, having a function similar to that of secondary resistors for wound rotor motors, are used with a D.C. motor for the purpose of obtaining speed control for motor.

3. Ballast Resistors may be used in the primary circuit of squirrel cage motors to limit starting current and reduce starting torque. This makes for a gradual or "cushioned" start.

For classification of secondary and accelerating resistors according to first point starting characteristics and duty cycle, see Table 5-1.

e. Electric Brakes. An Electric Brake is an electrically operated item of equipment that is designed to stop a moving load on a motor, to hold a load in place when it is at rest, or to limit the speed of a motor under load. Electric brakes most commonly used on cranes are as follows:

Approx. % of Full-Load Current on First Point Starting from Rest	Class Numbers			
	Duty Cycle			
	15 sec. on 45 sec. off	15 sec. on 30 sec. off	15 sec. on 15 sec. off	Cont. Duty
25	151	161	171	91
50	152	162	172	92
70	153	163	173	93
100	154	164	174	94
150	155	165	175	95
200 or over	156	166	176	96

Table 5—1. Resistor Classifications.

1. A Shoe Brake provides braking by means of spring loaded shoes applied to a brake wheel mounted on the shaft of the motor served by the brake. A solenoid generally operated on A.C. power, or a magnet, operated on A.C. or D.C., overcomes spring force to lift shoes clear of wheel and release brake whenever motor is operated.

A characteristic difference between solenoid and magnet operated brakes is that there is less movement with magnet operation. As a result, there is less pounding and therefore less frequent readjustment required with magnet operated brakes.

2. A Disc Brake is similar to a shoe brake, except that braking action is obtained through one or more discs, keyed to motor shaft, and spring loaded to bear against stationary brake housing. As with shoe brake, the disc brake is released through action of a magnet or solenoid whenever motor operates. For crane applications, the disc brake is generally of the motor mounted type, with brake housing mounted directly to motor to form a single unit.

3. An Eddy-Current Brake is similar to a motor in that it is made up of a stationary part or stator, and a rotating part, or rotor. Action of this brake is such that when field winding, located in stator, is excited (voltage is applied) while rotor is turning, a braking torque is exerted on rotor shaft. This braking torque increases as rotor speed increases, and also increases as field excitation current is increased. Eddy-current braking is used extensively for crane applications where precise slow speed control is required.

f. Limit Switches. A limit switch is a switch which is operated by some part or motion of a power-driven machine or equipment to alter the circuit associated with the machine or equipment. On crane applications, and though they may have other functions, limit switches are most often used to stop travel either of a hook in hoisting or lowering direction, or of a bridge-trolley motion in forward or reverse direction. The most commonly used types of limit switches for crane service are as follows:

1. A Screw Type Limit Switch is one in which a rotating cam, driven by the hoist drum, operates an electrical contact (or contacts). This contact (or contacts) is in control circuit of hoist and will turn off control to stop the hook, whenever hook reaches a preset point in either direction of travel. Additional contacts in limit switch may be connected to perform other specified functions, such as

to slow down hook speed or to operate an indicating device.

2. A Block Operated Limit Switch is used on hoists to limit upward travel only of hook. Limit switch contacts are operated whenever a weight, suspended at one end of a lever, is lifted by the upward travel of hoist lower block. A block operated limit switch may be of the Power Circuit type, in which contacts are connected directly in the power circuit to interrupt power to hoist motor. Or it may be of the Control Circuit type in which the contact is connected in control circuit of hoist control same as for a screw type limit switch.

3. A Track Type Limit Switch is normally used to accomplish limit switch functions for bridge or trolley motions. Contacts of these limit switches are of the control circuit type and are operated when a fork lever engages a tripping dog at an appropriate point along runway, or bridge rail.

g. Operator Devices.

1. A Master Switch is a cab mounted device used by crane operator for operation of a single crane motion. Normally, there is one master switch provided for each crane motion. An operating handle, extending vertically from master switch base in the off position, is pushed forward to operate motion in one direction and pulled back for motion in opposite direction. By means of a cam and contact arrangement internal to master switch, the farther the movement of handle, the higher the control speed point.

2. A Pendent Pushbutton Station is a device suspended by cable from a crane, used by crane operator standing at floor level, to operate all crane motions plus any required accessories. Two buttons are provided for each motion, one for each direction of operation. The farther a button is depressed, the higher the control speed point. All pushbuttons are of the spring-return-to-off position type.

3. A Remote Radio Control System provides a means for complete operation of a crane from any convenient remote point within a few hundred feet of crane. To accomplish this, crane operator carries a small portable transmitter containing all necessary levers and buttons for operation of crane. A receiver on crane converts radio signals from transmitter into appropriate form for operation of controls as directed by operator.

5-4 CONTROL OPERATING INSTRUCTIONS. The purpose of this Paragraph is to provide operating instructions for the most widely used types of crane control, and to explain, in some detail, how they work. It is written especially for the information of persons responsible for operation of the crane, but will be useful as well to maintenance personnel.

Each type of control is covered in a separate sub-paragraph. To determine types of controls used on your crane, consult Electrical Data Sheet (EDS). Copies of the EDS for your crane may be found either in your Custom Parts Identification Manual, or in wiring diagram pocket inside the door of control cabinet containing mainline panel. See Figure 5-62 for EDS, showing what data it includes and how it is to be interpreted.

For control system instructions that follow, consider that main "Start" button has been pressed, closing mainline contactor. Thus, control is "ready" for operation. For any controls on your crane not covered in this Paragraph, refer to Custom Parts Identification Manual.

a. Mechanical Load Brake Hoist Control (MLB). The mechanical load brake hoist control is very widely used for crane applications. Function of the mechanical load brake is to prevent hoist load from accelerating while lowering. The mechanical load brake will also hold load in suspension wherever hook is stopped.

Components of system are as shown in Figure 5-14.

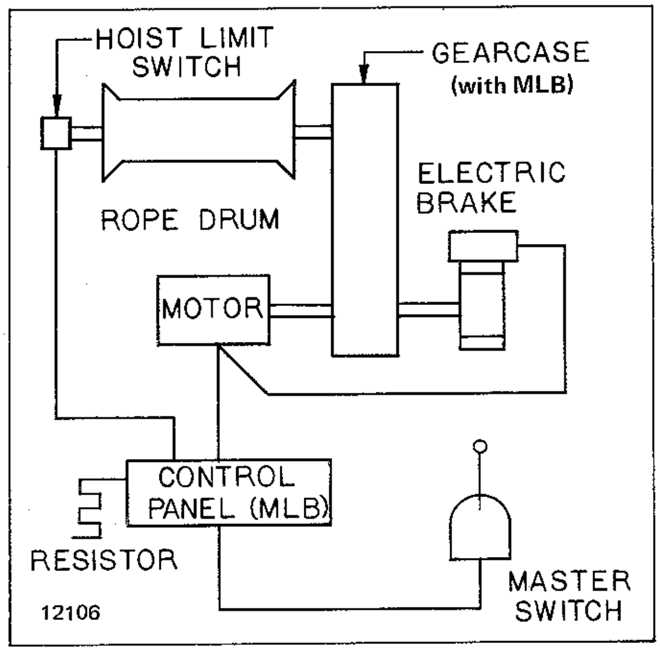


Figure 5-14. Mechanical Load Brake System.

The only device that is located in the cab is the master switch. Pushing handle forward (away from yourself) will cause the hook to go down. Pulling handle back (toward you) will cause the hook to go up. The farther the handle is moved from the vertical or off, position, the faster the hook will move. Also, the master switch handle will return to off position when released (spring-return-to-off). Control panel receives its "commands" from master switch as you move handle, causing motor to operate. Motor produces torque required to operate gearcase. Purpose of gearcase is to increase motor torque and reduce motor RPM to operate rope drum.

Rope drum on which steel rope is wound, is rotated by output of gearcase, causing hook to raise or lower, depending on direction of motor rotation. Screw type limit switch is a device which is operated by rotation of rope drum. Limit switch, when properly set, will shut off power if you raise the hook too high. Overlowering protection may also be provided.

Electric brake has the function of helping to stop load when you return master switch to neutral position. It also helps MLB hold the load. This brake is released electrically and sets by means of a spring. Brake is released when motor is energized, and sets when motor is turned off.

Refer to Figure 5-15 for performance curves for MLB hoist. Hoisting portion only is shown. Lowering performance will be similar to that shown for hoisting.

Figure 5-15 is for a 5 point MLB Control. A three point control would have the same performance curves except points 2 and 4 would be omitted. Solid state timing relays are used between the last 3 points on 5 point control and between 2nd and 3rd points on 3 point control. These timers function to limit motor torque (and input current) peaks during acceleration from zero speed to full speed by establishing fixed time intervals between speed points indicated above. This makes for smooth acceleration of motor and hook.

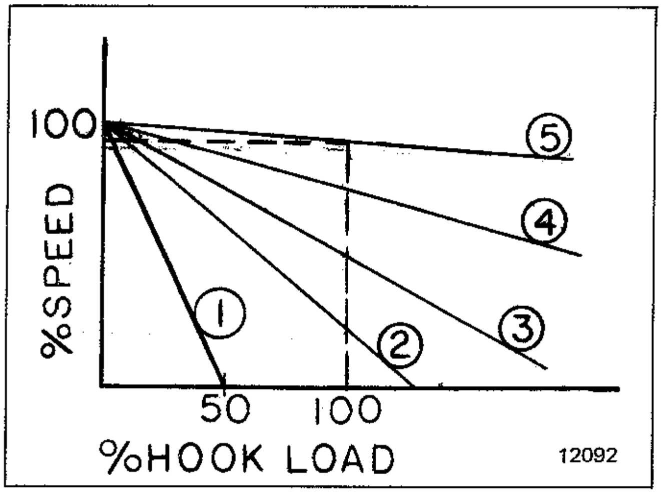


Figure 5-15. Speed-load Curve. Mechanical Load Brake Hoist Control.

b. Reversing-Plugging Control (R-P). Plugging (reversing) of a bridge or tolley drive motor is universally used as a means of electrical braking for trolley or bridge. Use of plugging will have the effect of reducing wear on friction type bridge or trolley brakes. Also, by combining the use of plugging with hydraulic braking on cab control cranes, practically any deceleration rate may be obtained.

See Figure 5-16. This shows components of a typical reversing-plugging control system for a cab operated bridge drive with hydraulic brake. Master switch and hydraulic brake foot pedal are located in cab. Pulling master switch handle toward you will cause bridge to go in one direction. Moving it in other direction will cause bridge to run in opposite direction. In vertical or off, position, bridge motor is turned off. The farther the master switch handle is moved in either direction, the greater the bridge speed. Also, master switch handle will return to off position when released (spring-return-to-off). The function of bridge control panel and resistor is to take commands which you give by moving master switch handle, and cause motor to operate accordingly. Bridge motor provides necessary torque to operate gearcase, which turns bridge drive wheels, causing crane to move on runway rails. When foot pressure is applied to hydraulic brake foot pedal, braking torque is applied by hydraulic brake. Operation of a hydraulic brake system is similar to an automobile brake system.

To further explain operation of this control, think of the bridge as being driven at full speed. If, under this condition,

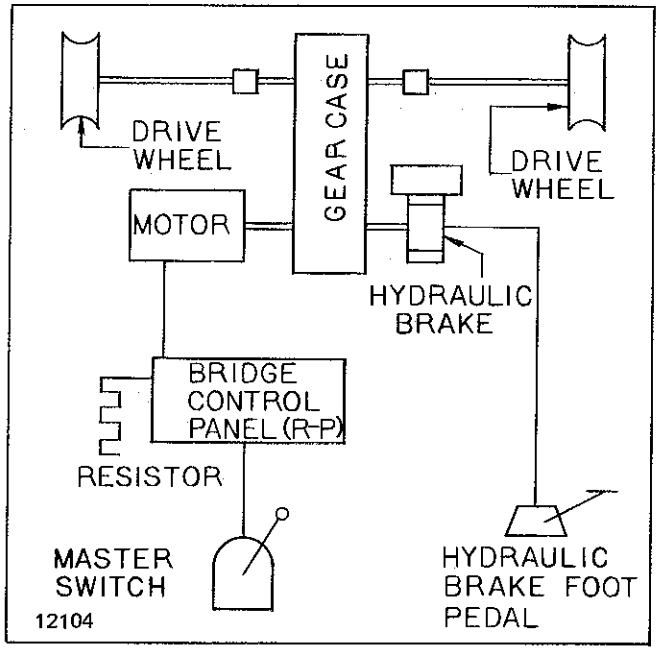


Figure 5-16. Reversing-Plugging Control System.

master switch handle is quickly moved to the opposite position, this will cause control panel to plug (reverse) motor. In doing so, however, operation of control will be such as to limit the reverse torque produced by motor. This prevents an overly abrupt stopping and reversal of bridge motion, and causes crane to come first to a more gradual stop, and then, to accelerate normally in opposite direction (if master switch is not returned to off position). Operator may also use his hydraulic brake to assist in decelerating crane during plugging operation, either for stopping crane or prior to reversing direction. For a graphic illustration of what happens during above described operation, see Figure 5-17, which shows typical performance curves for reversing-plugging controls. Consider that crane is running full speed as indicated at point "A" on graph. Then crane is plugged (reversed). With this reversal, motor is operating according to left hand side of graph at point "B". Horizontal dashed line indicates control change.

Crane decelerates to zero speed, indicated by point "C" on graph. Normal acceleration will now take place up to full speed in opposite direction. This is indicated by point "D". Note that dashed line between point "C" and "D" indicates normal acceleration pattern. Time delays between each of the last 3 speed points are provided in control by solid state timers.

Operation of a floor-operated (by pendent station) crane would be same as described above except bridge brake would be an electric-release, spring-set type rather than hydraulic. This brake will set any time pushbutton is allowed to return to off position.

It is to be emphasized that use of plugging in stopping will increase brake lining life of stopping brake, either electric or hydraulic. For this reason, you, as operator of the crane, are advised to practice starting, braking and plugging with no load on hook until you are able to bring crane to a smooth stop from full speed in either direction. This will enable you to use crane more efficiently and with less maintenance.

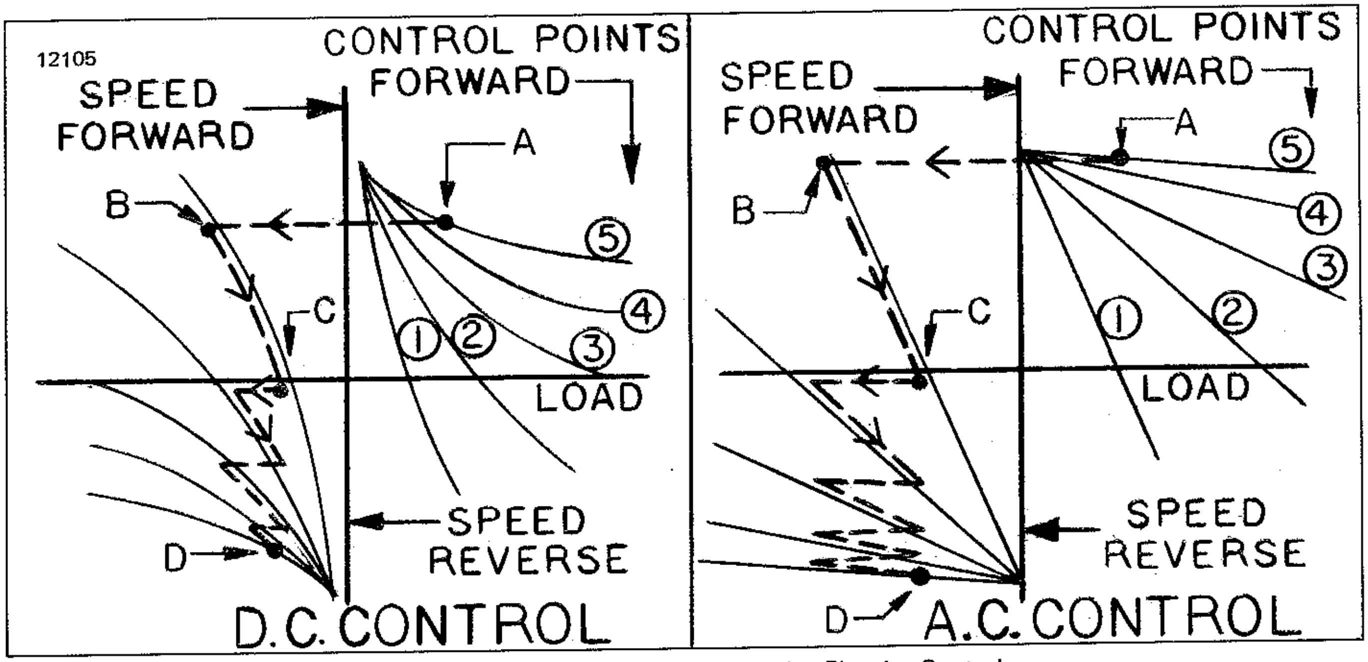


Figure 5-17. Speed-load Curve. Reversing-Plugging Control

Example given was for a 5-point bridge drive. It also applies to trolley drives. Three-point reversing-plugging is also furnished for both bridge and trolley applications. Performance curves would be same as Figure 5-17 except to omit speed points 3 and 4.

c. Drift Point – Bridge and Trolley. Drift point is a control feature which may be provided on bridge or trolley controls, employing an electric release, spring set brake. The drift point is controlled by the first point of pushbutton or master switch. In drift point (first point), brake is released but motor is not energized. This feature may be used by operator to allow bridge to coast.

d. Eddy-Current Braking Hoist Control (ECB). Eddy-current braking hoist control provides you with a type of speed control that is especially well suited to set down or pick up loads requiring very precise handling. So that you may use this control to its best advantage, it is important that you know how it operates.

Referring to Figure 5-18, basic hoist system consists of master switch in cab, control panel and resistor, hoist drive motor, eddy-current brake, shoe type holding-stopping brake and rectifier panel, gearcase, rope drum and screw type upper limit switch.

The only part of this system which you (the operator) will use during hoist operation is the master switch, which is located in cab. Pushing master switch handle forward (away from yourself) will cause hook to go down. Pulling handle back (toward yourself) will cause hook to go up. The farther the handle is moved from its vertical, or off, position, the higher the speed point and the faster the hook will travel. Also, master switch handle will return to off position when released (spring-return-to-off). Eddy-current control is provided with 5 speed points. Normally, you will use the first (slowest) speed points for initial pick up and final set down of load. Once load is "on hook" and clear of obstructions, it is best for control to be operated at full speed. Details on characteristics of each speed point will be presented later in these instructions.

Function of control panel and resistor is to take "commands" which you give, established by the position of master switch handle, and cause motor and eddy current brake to operate in the direction and speed point which you have selected. Function of the motor is to provide the necessary torque to operate gearcase and drum to lift load.

Motor is an A.C. wound rotor type. Changing the rotor circuit external resistance, which is accomplished by control in accord with master switch handle position, has the effect of changing the speed-torque characteristics of motor. The eddy-current brake, shown on Figure 5-19, is

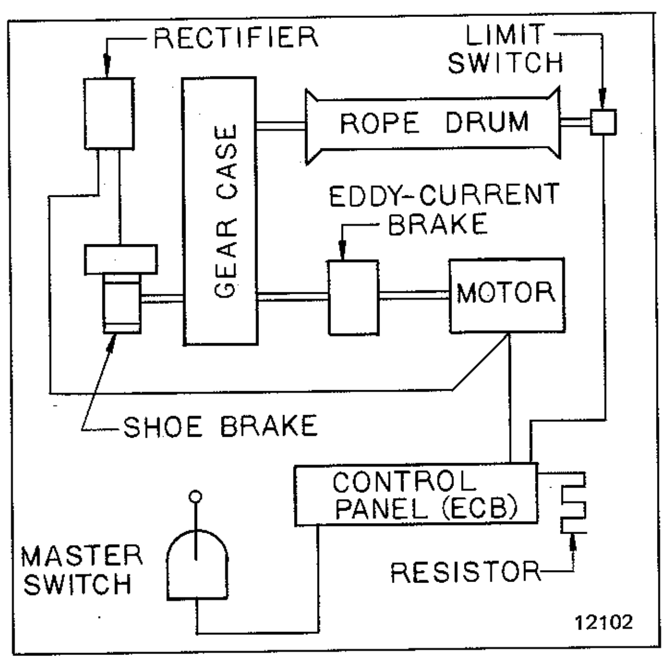


Figure 5-18. Eddy-Current Brake Control System.

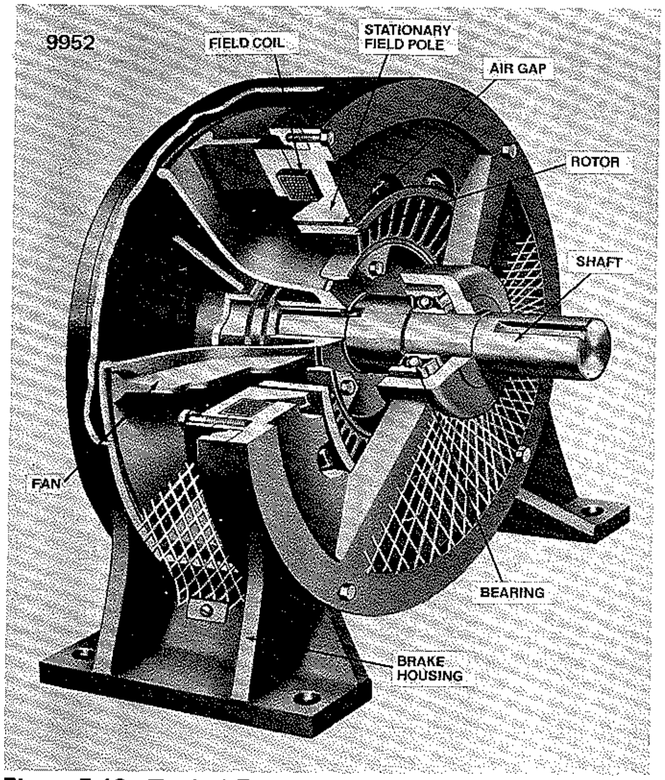


Figure 5-19. Typical Eddy-Current Brake.

usually coupled between motor and gearcase and produces a retarding torque on motor. This retarding torque is controlled electrically by control panel for each particular point of operation. The combination of motor torque and eddy-brake torque results in performance curves as shown on Figure 5-20. Use of these curves will be covered in more detail later.

The gearcase transmits torque from motor shaft to drum. Principal action of gearcase is that it increases transmitted

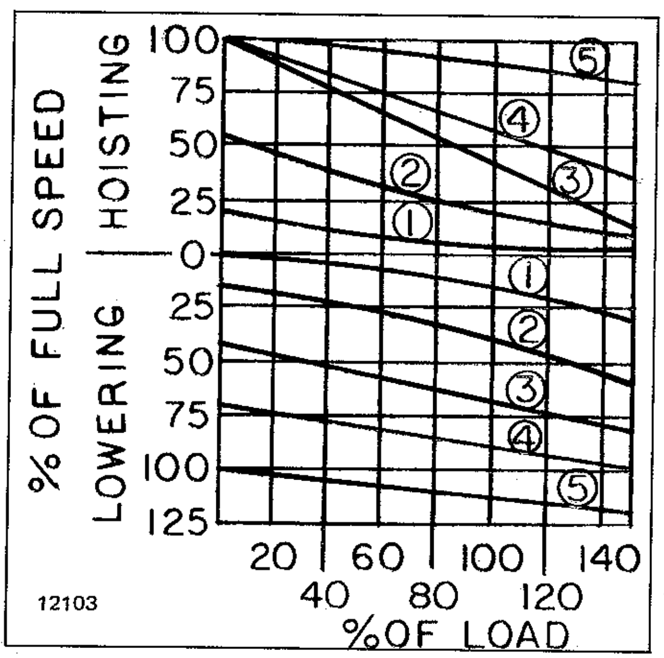


Figure 5-20. Speed-load Curve. Eddy-Current Brake Hoist Control.

torque and reduces output shaft rpm (output shaft rpm = Motor rpm ÷ gear ratio. Output shaft torque = motor torque x gear ratio.) Rope drum, on which steel rope is wound, is rotated by the output of gear box, and winds or unwinds steel rope, causing hook to raise or lower, depending on the direction of rotation of motor. Screw-type limit switch is a device which is operated by rotation of drum. Limit switch, when properly set, will always shut off power if you raise hook too high. Overlowering protection may also be provided.

Shoe brake, usually mounted on extended motor pinion shaft, has the function of helping to stop the load when you return master switch handle to off position. This brake also holds load at whatever level it is stopped when control is shut off. Shoe brake operates on a friction principal. A heavy spring pushes two shoes against brake wheel to provide friction. To release brake, a direct current electro-magnet is energized, applying a force that overcomes spring force, lifting shoes free of brake wheel. Direct current for brake coil is supplied from a brake rectifier panel, mounted near shoe brake. Rectifier panel is connected to motor supply terminals to obtain alternating current input.

As already noted, Figure 5-20, shows a set of typical speed-torque (load) curves for eddy-current control. Each curve represents, in graph form, performance of the corresponding speed point indicated. Hoisting performance curves are above zero speed line, while lowering curves are shown below same line.

For an example on usage of these curves, assume that you are to handle a load weighing 60% of hoist rated capacity. To determine how fast hook will move with this load, first find 60% load point on scale along bottom edge of graph. Extend a vertical line from that base point. At each point of intersection with speed-load curves, extend a horizontal line to scaled vertical line at left. This will enable you to determine percent hook speed for each speed point, both hoisting and lowering.

Inspection of these curves confirms that very slow speeds are available on first points of hoisting and lowering. It is for this reason that eddy-current control is to be preferred when you have a load requiring very precise handling.

The eddy-current brake is utilized on the first two points of hoisting control and on the first four points of lowering control. On the fifth point of lowering, control of load is obtained in its entirety from motor which, when driven by the downward pull of load to a speed in excess of 100% of rated speed, generates power back into line and provides its own braking effort. This is known as regenerative braking which serves to limit speed of motor and hook.

Even though the eddy-current brake produces a retarding torque without any mechanical friction, it must be realized that braking is still being provided (by electrical means). This involves absorption of kinetic energy and its conversion into heat, which must be dissipated if brake is not to overheat. Thus, for trouble free operation avoid prolonged operation in speed points using eddy-current braking. In general, eddy-current operating points should be used only for initial and final handling of load.

For long shoe brake life, eddy-current brake control should be utilized to slow down motor when bringing load to a stop. This is accomplished by moving master switch handle slowly from full speed toward the off position. This will cause eddy-current brake to slow down load before shoe brake sets (when off position is reached). This slow-down reduces braking effort required of shoe brake, and makes for less wear on shoe brake linings.

It should be emphasized that the eddy-current brake provides braking only while hoist is being operated. There is no braking effort unless brake shaft is rotating, (and field coil is energized). Eddy-current brake will not hold a load in stationary suspension as a Mechanical Load Brake will do. For this reason, an eddy-brake control system always includes a shoe brake, for stopping and holding the load.

These instructions also apply to pendent controlled cranes, except references to master switch should be considered to apply to pushbutton station, where applicable. Pushbutton station has a separate pushbutton for each direction (up or down) of motion.

e. Counter-Torque Hoist Control (C-T). Counter-torque hoist control has been most widely used for grab bucket crane applications, in which two hoist systems work in conjunction to operate bucket. Components of a single counter-torque hoist system are illustrated in Figure 5-21. See Figure 5-22 for speed-torque curves.

Explanation of this type of control should begin with master switch, which is mounted in cab. Pushing master switch handle forward (away from you) will cause hook to move down. Pulling master switch handle back (towards you) will cause hook to go up. The farther the master switch handle is moved from vertical, or off position, the greater the hook (or bucket) speed. This will be explored in detail later in this sub-paragraph.

Movements of master switch handle are converted to electrical signals, which, when received by control panel, cause motor (and hook) to operate in the direction and speed indicated by master switch handle position at any given moment. Control panel connects appropriate sections of the resistor into motor secondary circuit, thus controlling speed-torque characteristics of motor. The motor provides torque required to operate gearcase, which multiplies torque and is used to operate rope drum.

Gearcase also reduces speed from input (motor rpm) to output. (Rope drum rpm) Rope drum is used to wind and unwind steel wire rope which lifts and lowers load. The screw type limit switch shaft is rotated by rope drum. Function of the limit switch is to guard against raising hook too high. If this happens, limit switch will shut off control in hoisting direction. Limit Switch will automatically reset when load is lowered. Overlowering protection may also be provided.

Hoist shoe brake will hold load when power is off and help stop load when master switch handle is returned to vertical, or off, position. Shoe brake is released electrically, and set mechanically by a spring. Braking effort is caused by friction between brake shoes and brake drum. A rectifier converts the A.C. supply voltage to D.C. to provide brake with direct current. A.C. input to rectifier comes directly from motor terminals.

Counter-torque control is so named because of its mode of operation in the first three speed points of lowering. In

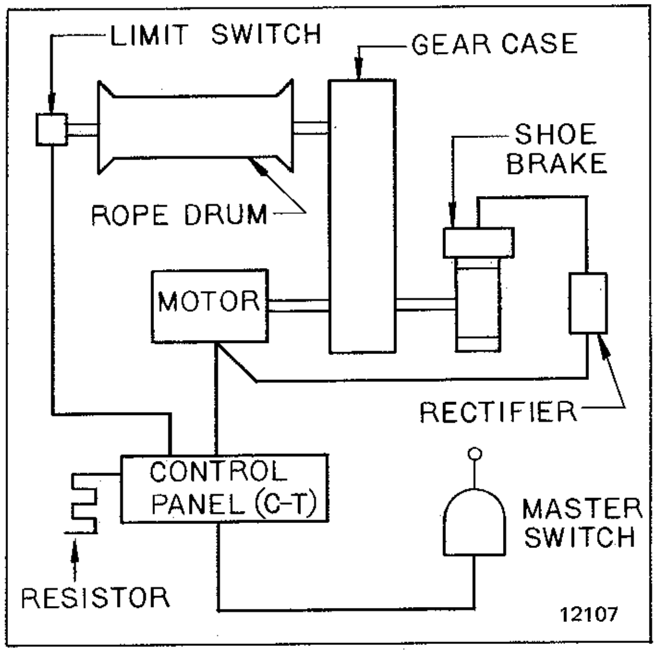


Figure 5-21. Counter-Torque Hoist Control System.

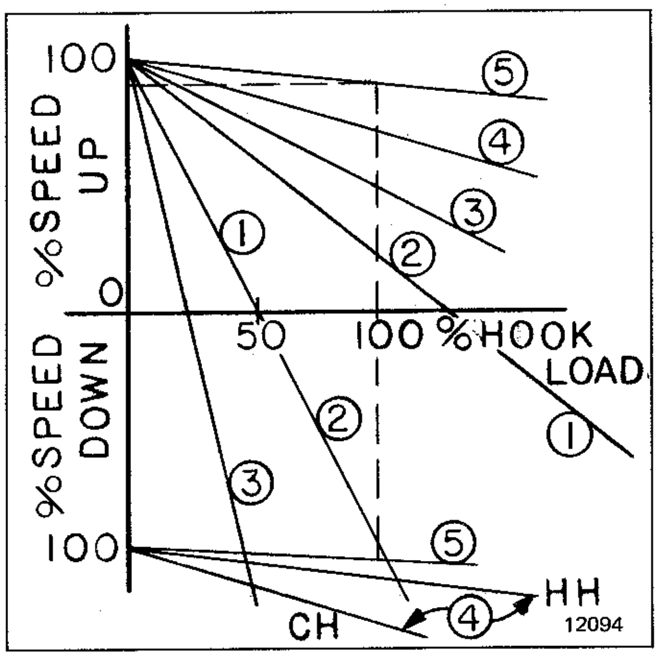


Figure 5-22. Speed-load Curves. Counter-Torque Hoist Control.

these points, control is arranged to connect motor so that it applies an upward torque, or "counter-torque", to resist downward movement (due to pull of gravity) of load. This counter-torque is strongest in the first position lowering of master switch, and weakest in the third position lowering. In the fourth and fifth points lowering, motor is connected to drive downward with regenerative braking serving to limit speed of load. (See subsection on eddy-current control for an explanation of regenerative braking.) Hoisting performance is the same as for Mechanical Load Brake (MLB) hoist. (There is no MLB on a counter-torque hoist.)

If your crane has counter-torque hoist control, load is carried either by a bucket or magnet, or other device, generally permanently attached to crane. Two complete systems, as previously noted, are required for a bucket hoist drive system. One system is called the "holding line" and the other is called the "closing line". These names are descriptive of the functions they perform in operation of bucket. Suppose bucket is open, and suspended in air. Under this condition almost the entire load (weight of bucket) is suspended on holding line. To close bucket, operate closing line control in hoisting direction. This will wind up cable on closing hoist rope drum and close bucket. To raise or lower closed bucket operate both "holding" and "closing" line master switches in desired direction of control. The same procedure would apply to raise and lower open bucket.

Procedures described in above paragraph cover basic operations you will perform doing your work. Much practice is required to become proficient in bucket operation. A word of caution applies when you have bucket in open position. Do not allow too much slack in closing line because bucket will have a tendency to rotate on holding line, twisting cables.

Using the example of a grab bucket crane application, it will be useful to examine, step by step, a complete cycle of operation, starting with open bucket in a high position over pile of material that is to be handled. Cycle consists of four steps, as outlined below:

1. Lowering open bucket. Push both masters forward to fourth point of control. Bucket will now lower, open, at maximum speed. Fourth point, rather than fifth, is used with an open bucket because control is designed to provide differing speed torque characteristics for holding and closing hoists in fourth point. Purpose of this is to compensate for the unbalanced loading of the two hoists while lowering open bucket (holding line has practically all the weight of bucket and closing line has almost no load) and to provide an arrangement whereby both hoists will run at the same speed to prevent bucket from closing. As bucket nears pile, move master switch handle back toward the off position. This shifting to a lower speed point will cause control panel to connect motors so as to apply counter-torque. This will exert a braking action, slowing downward speed of bucket. As already indicated, extent of this braking action increases from third point to second point, and is strongest in first point lowering. Practice and experience will be your best guide in determining when and how much counter-torque to apply.

As soon as bucket hits pile, return master switch handles to off position. Holding line should be allowed to run a little longer than closing line to put a little slack in closing line.

2. Closing bucket. Operate closing line in hoisting direction. This will cause bucket to begin to close, taking a bite of material. As bucket bites in, it will move downward. Thus you may find it necessary to operate holding hoist in downward direction (fourth or fifth point) momentarily to provide a little more slack.

3. Hoisting full bucket. Just before bucket closes (step 2 above), operate holding line master in hoisting direction. What you are trying to accomplish is to start holding hoist so that, when bucket closes, hoisting operation may begin without stopping and restarting closing line motor. To handle this phase of the operation smoothly will require some practice. As bucket begins to raise, both masters should be in the fifth point, hoisting. Master switches should be left in this position during hoisting operation and until desired height is approached. Returning both masters to the "off" position (at same time) will cause bucket to stop. At this point, bridge and/or trolley may be operated to place bucket over desired dumping spot.

4. Dumping load.

(a) If you wish to lower bucket before dumping load, operate both holding and closing line masters in 5th point lowering, until desired level is reached.

(b) Operate closing line master in fifth point lowering. This will cause bucket to open, allowing material to fall out. Continue to operate until bucket is completely open.

(c) As you become more experienced, (a) and (b) above may be combined into one operation. Now return crane to its original location over material being transferred, and cycle is complete.

Counter-torque controls are also used on magnet cranes, and on others where there is a fixed minimum load on hoist. Performance of the single motor C-T control would be the same as has been described, except the fourth point of regenerative lowering is eliminated, and one more counter-torque braking point is added.

There is a separate master switch for energizing and de-energizing lifting magnet. Magnet should be placed directly on material to be carried before being turned on. Depending on the type of material being handled, magnet may be de-energized when load is over or on the drop area. Magnet should always be de-energized when not in use.

An additional control feature is provided by the non-hoist relay, which shuts off motion if you select a counter-torque point of control strong enough to hoist, instead of lower the load. Control panel is also equipped with an over-speed relay, which will increase counter-torque if, while lowering a heavy load, speed should become excessive.

f. Multiple Trolley Cranes. Cranes used for roll handling in the paper industry are equipped with two trolleys, and sometimes three trolleys. This arrangement is also used in other industries where requirement is to handle long loads which cannot be handled with one hook. These cranes are generally pendent pushbutton operated from floor level, but can also be cab operated to suit a user's requirements. The pendent arrangement will be described below.

The pendent pushbutton contains one pair of buttons each for bridge, trolley, and hoist, as on a standard one trolley, 3 motion crane. In addition, there is a three position selector switch on the two trolley crane pushbutton station. Selector switch is labelled; "#1 Trolley", "Both", "#2 Trolley". When selector is in the #1 Trolley position, operating hoist and trolley pushbuttons, will operate only the "#1 Trolley". When in the "#2 Trolley" position, only the #2 Trolley is operable. In the "Both" position of selector, operating hoist and trolley pushbuttons will cause both hoists and both trolleys to operate at the same time.

On three trolley cranes, arrangement of pushbutton is similar, except there are three two position selector switches instead of a single three position selector switch.

Selectors are labelled Trolley #1, "On" – "Off", Trolley #2, "On" – "Off" and Trolley #3 "On" – "Off". With selector for Trolley#1 in "On" position, and other two selectors in "Off" position, only #1 Hoist-Trolley would be operable. With all switches in the "On" position, all three hooks and trolleys would operate at the same time. On most three trolley cranes, third hoist-trolley is of different speed and capacity than the other two hoist-trolleys. On such applications, control interlocks can be provided to shut down crane if all three switches are placed in "On" position.

Hoist and trolley overload relays are connected so that tripping of an overload relay or temperature actuated switch on any one hoist-trolley unit will shut down all units. This is to prevent load tipping or other problems caused by one unit continuing to operate when another has shut down.

Operation from master switches in cab would be similar except that selector switches would be in a separate enclosure, and mounted in cab.

g. Radio Control Operation. Radio control is similar to pendant pushbutton control in that crane operator is stationed at floor level. The essential difference between pendent pushbutton control and radio control is that radio control operator may move about on floor without any of the restrictions imposed by attachment of pushbutton to crane.

The radio control operator station, or transmitter, is attached to a carrying harness worn by operator. Transmitter contains necessary levers for operating each motion on crane, and a Stop-Start switch, which is used to turn main power "On" and "Off". There is also a switch to turn transmitter "On" and "Off". When not in use, transmitter should be turned off to save on battery use. Moving a motion lever will cause transmitter to send out a signal to radio receiver which is mounted on crane. Radio receiver converts signal to a relay operation, to operate motor control panels in the same manner as a pushbutton station or master switch. Motor control panels will operate as previously described for the types of control used.

You may operate two motions at once, such as hoist and bridge, just as can be done with pushbutton or master switch control.

Optional accessories, such as warning device, magnets, signal lights, etc., may be operated by radio.

Some cranes are equipped with radio control and a backup means of operation, usually a pushbutton station, but sometimes master switches in a cab.

Since the pushbutton, when provided, is normally used as a backup system, and radio is the primary method of control, the pushbutton cable is arranged with a plug-receptacle for removing pendent station from crane when not in use. The radio system is not operable when pushbutton is plugged in, as this completes an interlock arrangement in control system.

On "Cab-Radio" cranes, there is a 2-position selector switch in cab marked "Radio-Cab". In the "Radio" position, crane is operated by radio transmitter, and cab controls are inoperative. In the "Cab" position of selector switch, crane is operated by means of master switches in cab and radio system is inoperative. Cab-Radio cranes are generally equipped with two bridge brakes, a hydraulic type for use when operating from cab, and an electric release-spring set type for use when operating from "Radio" control. With selector switch in the "Radio" position, electric brake is connected so that it is released when bridge is operated and sets when bridge control is returned to "Off" position. In the "Cab" position of selector, electric brake is released at all times, except when main crane power is turned off.

h. Cab-Floor Operation. Some cranes are designed for operation from either cab (by master switches) or floor (by pushbutton station). A 2-position selector switch in cab provides for selection of mode of operation desired. When operating from cab, a hydraulic bridge brake is generally used. An electric bridge brake is maintained in released position at all times. For pushbutton operation, electric brake is so connected to release when bridge is operated and to set when control is in "Off" position. This is accomplished automatically by control system when selector is turned to "Pushbutton" position.

When in the "cab" mode of operation, pendent push button must be raised to clear all obstructions, or removed from crane and placed in storage until it is required. A plug-receptacle in pushbutton cable may be provided for removing pendent station from crane. Pushbutton station may be raised by torque reel, cable reel (electric or spring driven), or simply pulled up by hand for storage on bridge platform. The method selected depends on frequency of changes from "cab" to "floor" operation, and vice versa. Another method used where cab operation is desired only occasionally, and crane is usually floor operated by pendent pushbutton station, is to provide a "Dummy Cab". A dummy cab is a cab that contains no master switches or other devices normally found in cab. When cab operation is desired, operator pulls pushbutton into cab with him. He then operates crane, using pendent pushbutton station.

Sometimes a hydraulic brake is provided for cab operation. In that case a switch is provided in the bottom of the tray which holds pushbutton station. When pushbutton is in the tray, switch is depressed and electric brake circuit is changed so that electric brake is relased as long as pushbutton remains in tray. When pushbutton is removed from tray and lowered for floor operation, tray switch is released, returning brake circuit to its normal arrangement for floor operation.

5-5 ELECTRICAL COMPONENTS, THEIR MAINTENANCE, AND ADJUSTMENT. Descriptions and instructions included in this Paragraph are for standard components only. For any non-standard equipment used on crane, refer to your Custom Parts Identification Manual.

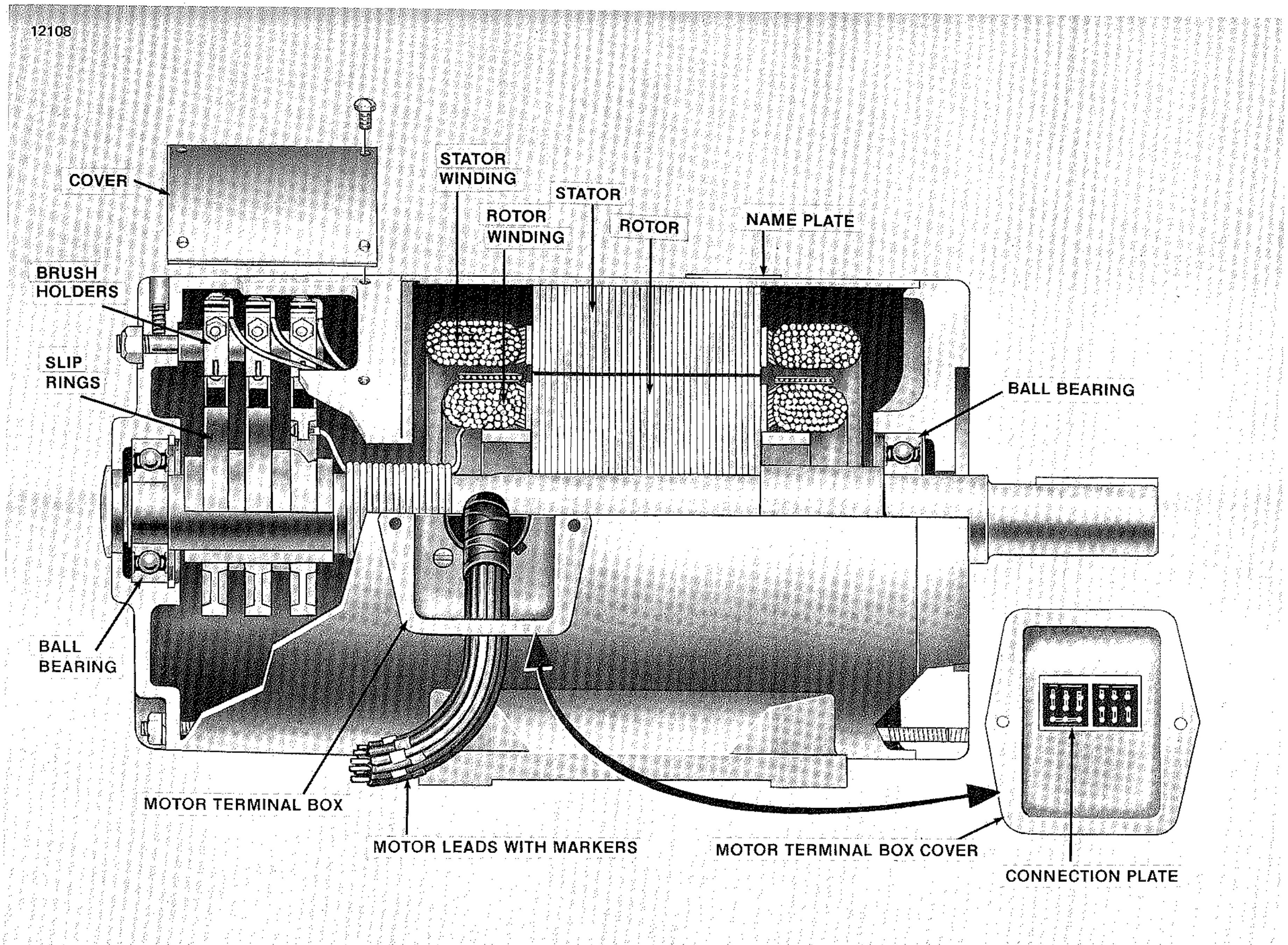


Figure 5-24. Cutaway View of Typical WOUND Rotor Motor.

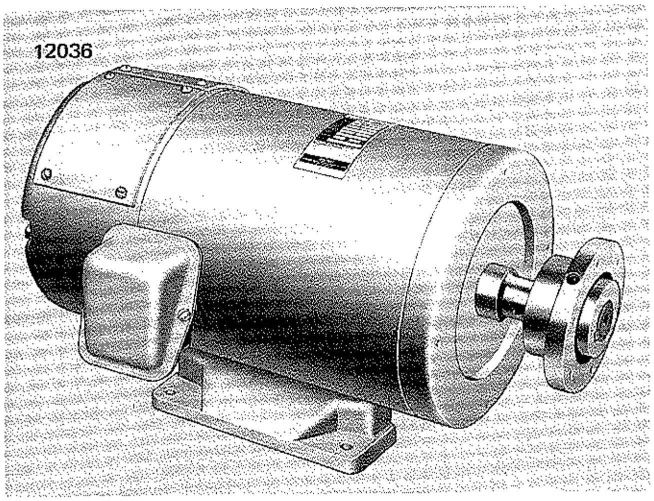


Figure 5-23. Typical Wound Rotor Motor.

a. Motors.

1. General: All motors (see Figure 5-23 for a typical motor) furnished on crane are suitable for crane and hoist duty and will perform satisfactorily if operated per ratings shown on motor nameplate. Exceeding or deviating from ratings could result in poor performance of motor and shorten expected life. For example, sustained operation of motor in an ambient 10° C over rated ambient temperature of 40° C could shorten expected life of motor insulation to one half.

2. Maintenance: General maintenance procedures for A.C. and D.C. motors are similar and should include the following steps:

WARNING

Lock open main disconnect switch on crane before starting any work on motor.

(a) Inspection. It is recommended that a periodic inspection schedule should be set up. Inspect motors for excessive dirt, moisture, loose mounting bolts, loose coupling, and bearing problems. Also, for wound rotor and D.C. motors, check brushes for wear and adjustment. Insulation and mechanical parts of motor should be kept clean. Dust that is free from oil and grease may be removed by wiping with a cloth or preferably by suction. Dust may be blown from inaccessible parts with clean, dry air using not more than 30 to 50 pounds (.20 to .34 N/mm^2) of pressure.

When grease or oil is present, wipe with a petroleum solvent of a safety type, such as Stoddard Solvent or similar material.

Wear suitable gloves to prevent skin irritation. Tighten loose bolts and coupling, if necessary.

(b) Coils. Revarnishing windings when machines are overhauled will lengthen their life.

(c) Brushes. Figure 5-24 is a cut-away view of a typical wound rotor motor showing brushes, brush holder, slip ring, etc. Figure 5-25 shows a typical brush holder with brush.*

*Details may be different for motors by other manufacturers. In such cases, refer to your Custom Parts Identification Manual for specific instructions.

To inspect brushes or to do any work on brushes or slip rings, remove two covers (see Figure 5-23) at slip ring end of motor. In the case of a D.C. motor, remove covers at commutator end of motor.

Check all brushes to make sure that they make good contact with slip rings in the case of a wound rotor motor, or with commutator in the case of a D.C. motor.

To adjust brush pressure on slip ring, if required, loosen or tighten nut A (see Figure 5-25) until concave surface of brush makes good contact with slip ring.

To replace brushes, use following steps (see Figure 5-25):

(1) Loosen nut C.

(2) Loosen nut A.

(3) Take brush holder assembly out from stud.

(4) Tilt brush lever arm upwards.

(5) Loosen screw B.

(6) Remove brush (worn out) from brush holder.

(7) Insert new brush.

(8) Tighten screw B.

(9) Tighten Nut C.

(10) Put brush holder assembly on stud and tighten nut A. Make sure brush makes proper contact with slip ring.

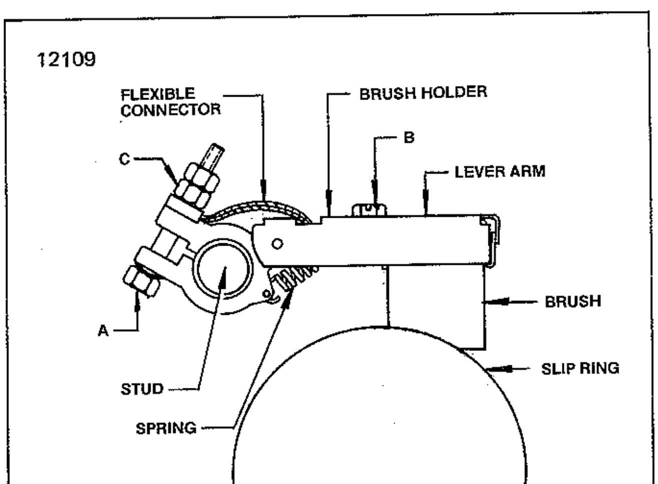


Figure 5-25. Brush Holder with Brushes.

(d) A.C. Motor Slip Rings: Slip rings of a wound rotor motor (see Figure 5-26) must be kept clean, smooth and concentric. They can be cleaned by a fine sandpaper or any commercial electrical cleaning solvent.

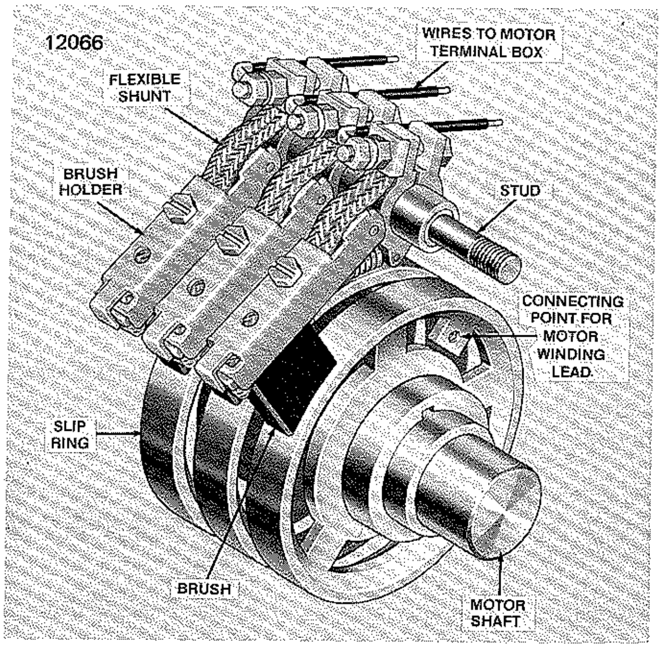


Figure 5-26. Typical Slip Ring-Brush Detail.

(e) D.C. Motor Commutator: Keep commutator clean, wiping it at frequent intervals with a clean canvas cloth free from all lint. Brushes should fit commutator, making contact over entire surface.

A commutator that is taking on a polish and shows no signs of wear requires no other attention, but a rough, raw, copper colored commutator should be smoothed with a piece of sandpaper or sandstone ground to fit, and then polished with No. 00 sandpaper. Always lift brushes when polishing commutator. Do not use solvent or lubricant on commutator.

(f) Temperature Actuated Switch. This is a thermal protective device to protect motor winding against an excessive rise of temperature. It is usually embedded in stator winding (in end turn) of motor to be protected. Two leads from the normally closed contact of switch are brought to motor terminal box and connected in control circuit of motor to be protected. If temperature of motor winding in vicinity of switch exceeds limit, normally closed contact of switch opens, thereby shutting motor off. Switch resets itself as motor cools down.

See Figure 5-27 for connection scheme for temperature actuated switch in a typical hoist control circuit.

(1) Replacement. To replace switch, disassemble motor. After installing the new switch, revarnish as required.

3. Reconnection of A.C. Motors: Reconnectible dual voltage A.C. motors show connections required both for low voltage and high voltage on a plate attached either to conduit box cover or motor frame. A typical connection diagram for a 230/460V reconnectible motor is shown on Figure 5-28.

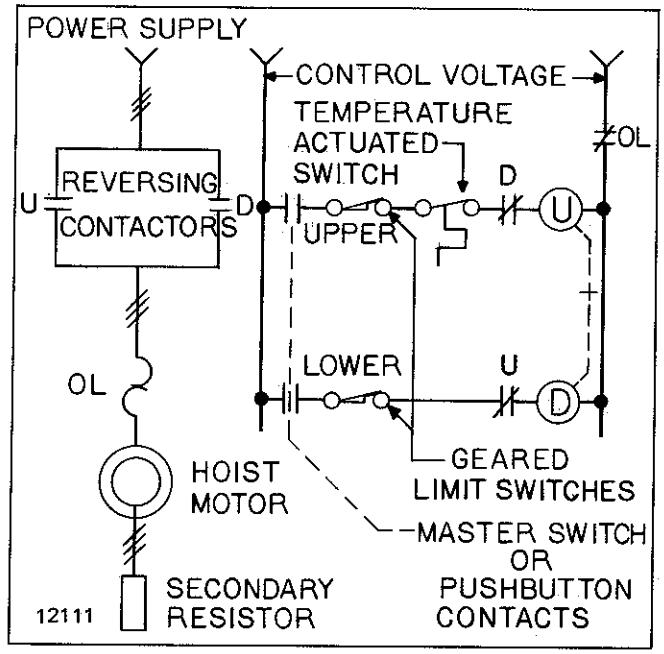


Figure 5-27. Elementary Wiring Diagram for Temperature Actuated Switch.

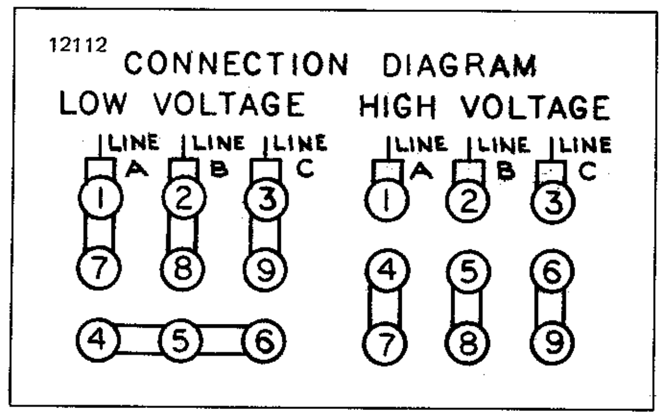


Figure 5-28. Motor Connection Diagram.

Motor as shipped on crane is connected for customer specified supply voltage. If it is necessary to reconnect motor from low voltage to high voltage:

WARNING

Lock open main disconnect switch on crane and reconnect stator terminals for high voltage in accordance with connection diagram shown on motor.

b. Electric Holding Brakes. Electric brakes are used for stopping and holding motions. Trolley or bridge brakes could be electric or hydraulic. This sub-paragraph will deal only with several types of electric brakes. Hydraulic brakes are covered elsewhere in this manual.

Electric brakes are normally shoe or disc type, solenoid or magnet operated, spring set, and normally adjustable for braking torque. Disc brakes are motor mounted, or contained in hoist gearcase housing. Shoe brakes are separately mounted. Brake coil may be for operation on D.C. or A.C. Coil is so connected in electrical circuit that brake is released when motion controller is in run position, and brake is set when motion controller is in off position.

The importance of the holding and stopping brake in the safe operation of a crane cannot be overstressed. Thus it is strongly recommended that an efficient preventive maintenance program should be set up for regular check up, cleaning, maintenance and adjustment of all brakes on crane.

1. Type WM Shoe Brake.

(a) General: Type WM brakes, are D.C. magnet operated, spring set, shoe type, with adjustable torque. Figure 5-29 shows a typical brake. The D.C. magnet uses a shunt coil on A.C. Cranes. D.C. for the coil is obtained from a brake rectifier panel. On D.C. cranes, a series brake coil is usually used.

(b) Maintenance and Adjustment:

WARNING

Lock open main disconnect switch on crane before starting any work on brake.

The brake, as shipped with crane, has been factory adjusted for proper torque, magnet air gap and shoe clearance. As linings wear through usage of brake, magnet stroke increases and braking action becomes sluggish. At this point, refer to Figure 5-29 in making the following adjustments:

(1) Magnet Air Gap Adjustment. Set magnet air gap adjustment nuts so that top of armature will move 1/8"

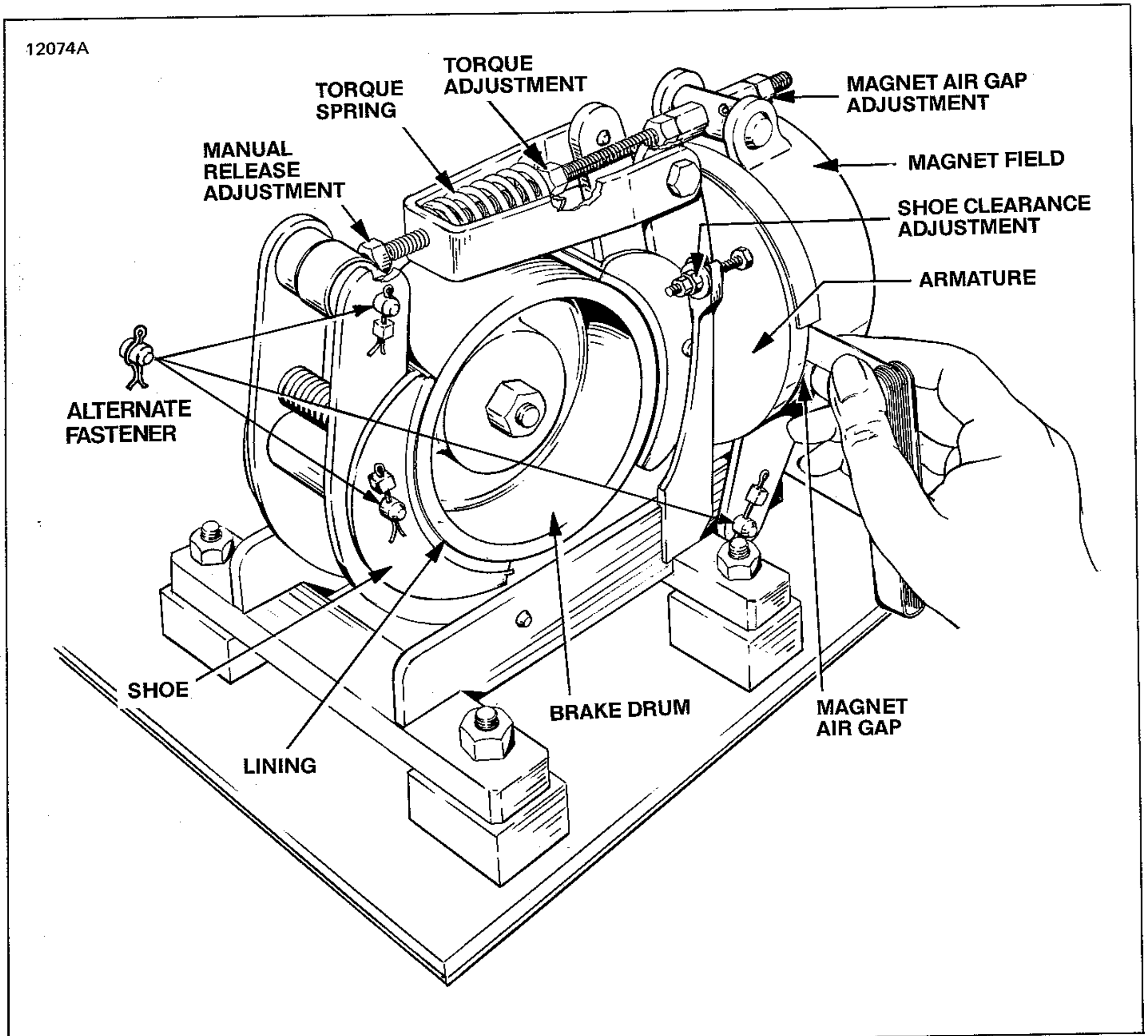


Figure 5-29. Typical Type WM Brake.

(3.175 mm) toward magnet when brake operates. As shown in Figure 5-29, clearance with feeler gauge at midpoint of armature should be approximately 1/16" (1.58 mm).

(2) Shoe Clearance Adjustment: Clearance between brake shoes and wheel is equalized at time of installation and checked whenever brake shoe travel is adjusted. Readjustment, if necessary, is accomplished by setting stop screw so that shoes clear the wheel equally on each side, approximately 1/32" (0.79 mm).

(3) Torque Adjustment: Braking torque can be adjusted by varying the compression of the torque spring by self locking nut. To obtain a desired torque, see curve on Figure 5-30 and adjust spring length accordingly.

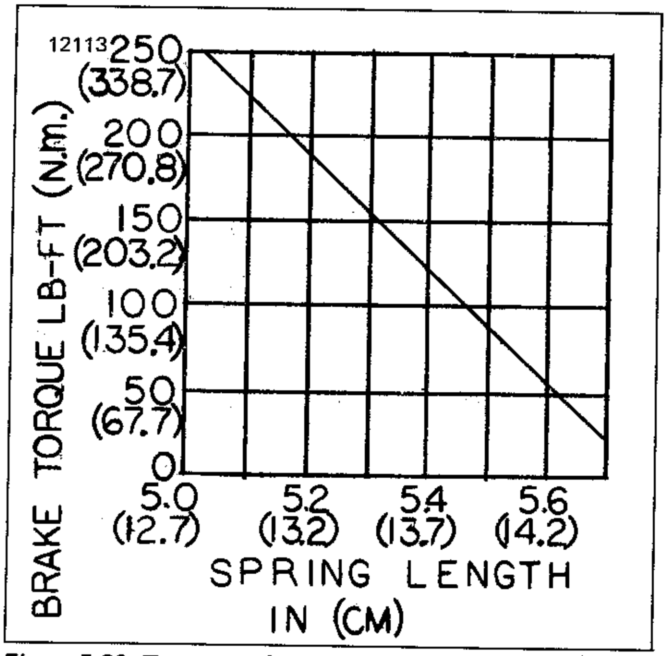


Figure 5-30. Torque vs. Spring Length for Type 10" WM Brake.

(4) Manual Release: Brake can be released manually by adjustment of manual release nut. Keep locked when not in use.

2. Type IC9516 Shoe Brakes.

(a) General: IC9516 solenoid operated shoe brakes are normally used for trolley or bridge motions. Solenoids on A.C. Brakes are shunt wound. On D.C. brakes they can be either series or shunt wound.

Figure 5-31 shows a typical IC9516 brake. When solenoid coil is energized, core is pulled down and left yoke with left shoe moves to left against adjustable stop after which right yoke with right shoe moves to right, releasing brake wheel.

(b) Maintenance and Adjustment:

WARNING

Lock open main disconnect switch on crane before starting any work on brake.

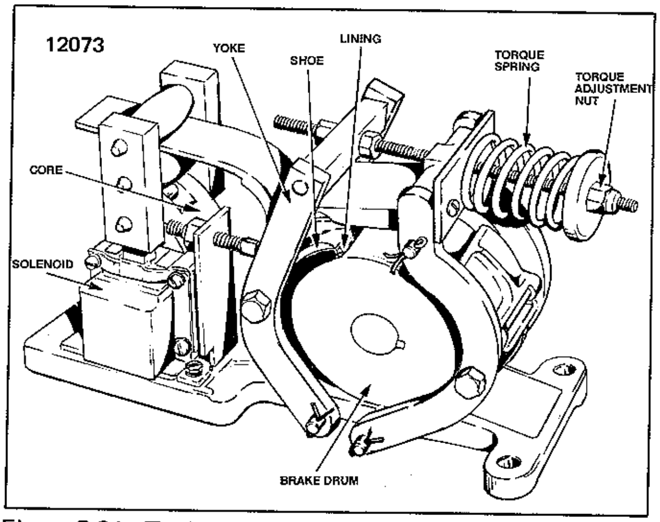


Figure 5-31. Typical Type IC9516 Brake.

(1) Spring and Torque Adjustment. Brake as shipped with crane has been set for proper torque.

If any torque adjustment is needed, this can be done by changing length of spring by turning torque adjustment nut (see Figure 5-31). If lower torque is needed, spring has to be lengthened by turning nut counterclockwise. Tables 5-2 and 5-3 show proper spring lengths for different values of torque.

Brake IC9516	Solenoid Gap		Torque		Spring Length	
	In.	Cm.	Lb. Ft.	Newt-Met.	In.	Cm.
−460	1/2	1.27	15	22.33	1-29/32	4.84
−461	1	2.54	35	47.45	2-17/32	6.42
−462	1	2.54	75	101.68	2-15/32	6.27

Table 5-2. A.C. Brakes.

Brake IC9516	Solenoid Gap		Torque		Spring Length	
	In.	Cm.	Lb.-Ft.	Newt-Met.	In.	Cm.
−160	3/8	.95	20	27.1	2-1/8	5.39
−161	3/8	.95	65	88.1	2-13/16	7.14

Table 5-3. D.C. Shunt Brakes.

(2) Solenoid Gap Setting. The solenoid gap is the total travel of solenoid core, which is a measure of the clearance between core and solenoid frame with solenoid de-energized. Gap has been properly adjusted when brake was shipped with crane. If adjustment of gap is necessary, see Tables 5-2 and 5-3, which show proper air gaps for various values of torque.

(3) Lubrication. Oil should be put on bearing pins occasionally to prevent wear.

(4) Care of A.C. Solenoid. Noise level on A.C. solenoids can, in many cases, be improved by periodic cleaning of seating surfaces (surface at end of plunger and surface of seat against which end of plunger comes into contact).

3. Type AK Shoe Brake.

(a) General: Type AK brakes, normally used on bridge and trolley, are spring set, magnet operated A.C. brakes. A short-stroke clapper type magnet releases brake when power is applied.

(b) Maintenance and Adjustment: Refer to Figure 5-32 for instructions that follow:

(1) Adjustment for lining wear, armature travel and shoe clearance. Only one simple adjustment is necessary to restore armature travel and to compensate for lining wear. Shoe clearance is automatically equalized. Turn spindle A until chisel mark or pointer is in line with "normal" travel mark. When lining wears to the point where chisel mark or pointer indicates "readjust", repeat operation mentioned in above paragraph. NOTE: Brake life may be extended appreciably by holding magnet travel to a minimum value required for free wheel. Where practical, it is best to readjust brakes frequently even though pointer has not yet reached "readjust" indicator.

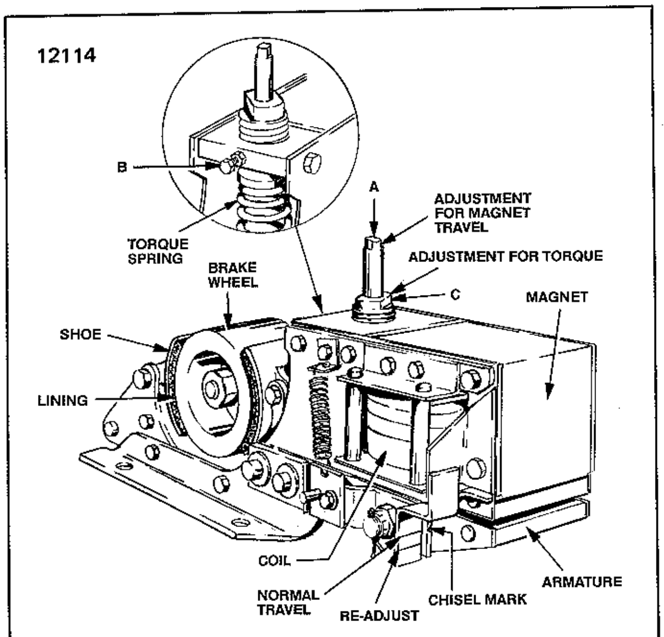


Figure 5-32. Typical Type AK Brake.

(2) Torque Adjustment. Brake has been adjusted at factory for proper torque. If decreased torque is required, loosen set screw "B" and back off plug "C". Retighten set screw "B". Normal compressed lengths of spring (which will give maximum brake torque) with brake de-energized for various brakes are as follows:

Brake Model No.	Torque (Intermittent) lb.-ft.	Newton Meters	Compressed Lg. of Spring in inches	Cm
AK-41	15	20.33	1-1/8	2.85
AK-43	35	47.45	2-3/8	6.03
AK-73	75	101.68	2-3/8	6.03

(3) Lubrication. A few drops of oil applied occasionally at bearing points will help keep bearings free to turn. Needle bearings in armature levers are packed with grease and need no additional lubricant unless levers are dismantled for maintenance.

(4) Coil. Extreme loud chattering noise may indicate improper mating of magnet and armature faces, or a broken shading coil. Inspect and replace shading coil if necessary. To obtain access to shading coil for replacement, follow same procedure as for replacement of operating coil. To replace operating coil, proceed as follows:

WARNING

Lock open main disconnect switch before doing any work on brake coil.

Disconnect leads to coil and remove conduit-bracket. Remove lock nut and hold down plate at torque adjustment bushing and two bolts at top extreme outside end of brake magnet. Lift out magnet and coil. Coil is held in place with spring clips. Reassemble in reverse order and reconnect leads to coil.

4. Series 55,000 Disc Brake (Solenoid type).

(a) General: This brake uses a single A.C. solenoid and lever type mechanism, and is for motor mounting. It is simple in design for fast installation, ease of maintenance and long service life. Brake housing provides a visual wear indicator and manual release.

(b) Maintenance and Adjustments: Brake has been factory adjusted for maximum torque, correct plunger travel and correct solenoid frame position. For proper functioning, brake has to be inspected periodically, and adjusted if required. Refer to Figure 5-33 for instructions that follow:

(1) Friction Disc Wear Adjustment. With no electric power to brake solenoid, (brake in set condition)

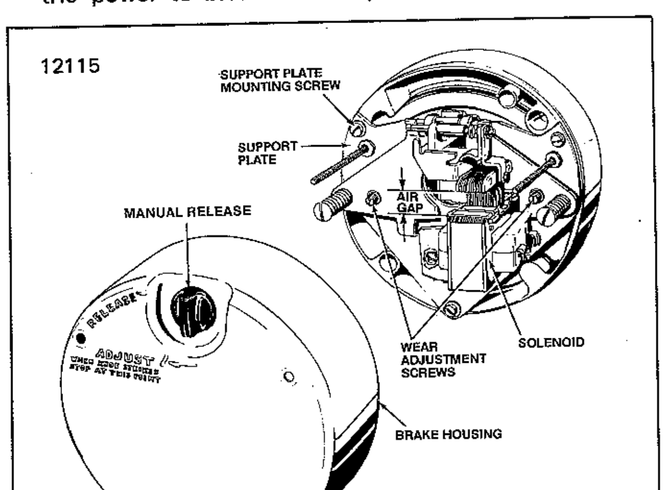


Figure 5-33. Series 55,000 Solenoid Disc Brake.

visual wear indicator on brake housing in "NORMAL" position indicates that brake is in proper adjustment.

When indicator is at "ADJUST" position, or if marked increase in stopping time is noted, adjustment for wear is necessary. To do so, first remove housing. Then turn both wear adjusting screws equal amounts approximately 1/8 turn clockwise until approximate solenoid air gap, as shown below, is reached.

Torque		Solenoid Air Gap			
lb.-ft.	Newton Meters	Series 55,300		Series 55,500	
		in.	cm	in.	cm
1.5	2.03	1-3/32	(2.77)	1-3/32	(2.77)
3	4.06	1-3/32	(2.77)	1-3/32	(2.77)
6	8.12	1/2	(1.27)	1-3/32	(2.77)
9	12.20	–	–	1/2	(1.27)
10	13.55	–	–	1/2	(1.27)
15	20.33	–	–	9/16	(1.42)

(2) Lining Replacement. Proceed by removing the three support plate mounting screws and support plate assembly. Remove stationary disc and remove worn lining. Install new lining. Reinstall stationary disc and support plate assembly.

Solenoid gap will now be less than indicated in above tabulation. To increase solenoid gap, turn wear adjustment screws equal amounts in counterclockwise direction until correct gap is obtained.

(3) Torque Adjustment.

CAUTION

Do not attempt to alter torque rating by readjusting solenoid gap.

(4) Coil Replacement.

WARNING

Lock open main disconnect switch before doing any work on brake coil.

Disconnect solenoid leads and insert screw driver between support plate and lever arm. Wedge apart and remove bearing and pin and solenoid lever with solenoid link and plunger. Remove plunger guide screw and washer and both plunger guides. Remove old coil and insert new coil. Reassemble and reconnect solenoid leads.

5. Models L and C Disc Brakes (Magnet type).

(a) General: Figure 5-34 shows the various parts of brake. Magnet coil works on 3-phase voltage usually taken from primary of motor. With power off, spring pressure on armature forces brake lining against housing, leaving an air gap between magnet and armature. With power on, magnet attracts armature, automatically releasing brake lining and

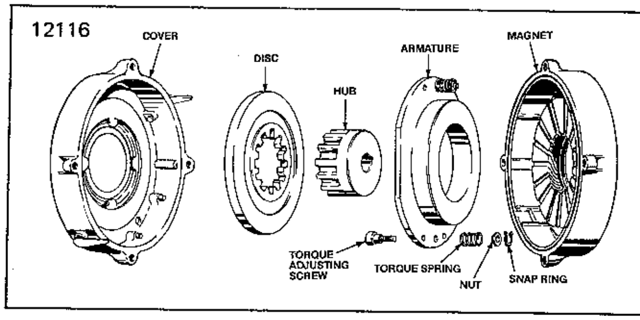


Figure 5-34. Typical Magnet Operated Disc Brake.

leaving an air gap between lining and housing. Brake can be set and released manually if desired. Torque setting can be adjusted, on model L brakes. Torque may be changed on Model C brakes by changing torque springs.

(b) Maintenance and Adjustment:

(1) Torque Adjustment of Model L brake. Adjusting screws on cover permit a continuously variable manual adjustment to 50% of rated torque. To decrease torque, turn both adjusting screws in counterclockwise direction. To increase torque, turn adjusting screws in the opposite (clockwise) direction. See Figure 5-35.

(2) Replacing Brake Disc. See Figure 5-34. Remove snap rings and adjusting nuts from torque adjusting screws. This allows for removal of armature from brake cover assembly. Brake disc may now be removed for replacement. Reassemble in reverse order.

6. Hoist Gearcase Mounted Disc Brakes.

(a) See SECTION VIII.

c. Brake Rectifier Panels.

1. General: The purpose of a brake rectifier panel is to provide direct current for operation of a D.C. brake when crane is supplied with A.C. power. Rectifier panel is a

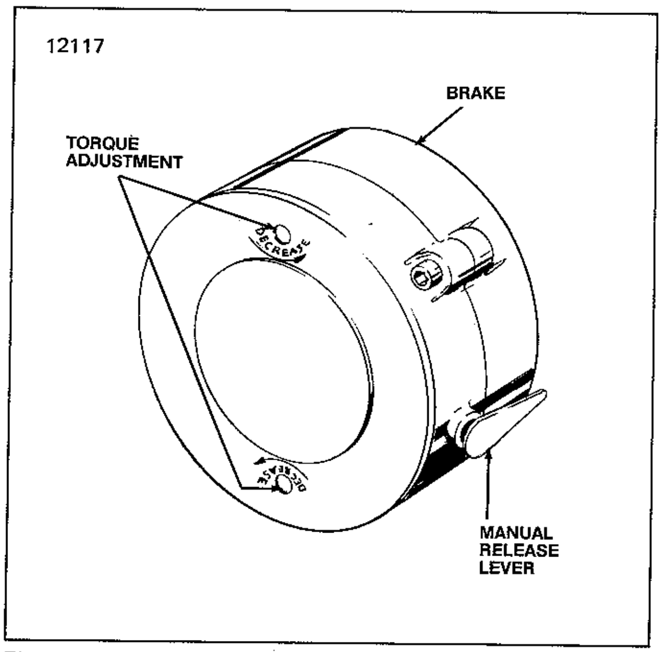


Figure 5-35. Typical Magnet Disc Brake Torque Adjustment.

self-contained unit assembly that provides two stages of operation for proper release (pick up) and setting (drop

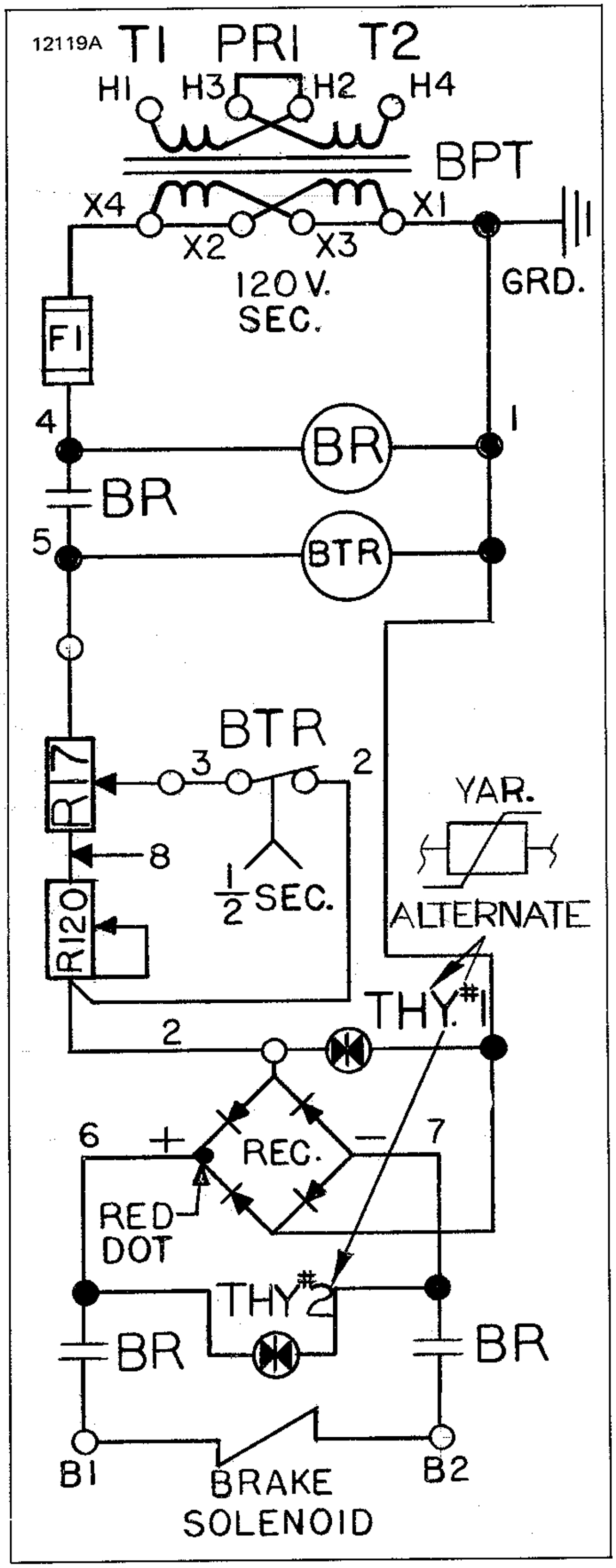


Figure 5-36. Elementary Wiring Diagram for a Typical Brake Rectifier Panel.

out) of brake. In first stage, approximately 95 volts D.C. is applied to brake coil to obtain quick brake release. Second stage, brought in after 1/2 second by a timing relay, reduces coil voltage to approximately 20 volts D.C., or just enough to maintain a released brake. Thus, when motor is turned off and brake coil voltage is removed, brake sets very quickly. First and second stage voltages are obtained through a series combination of two resistors, which are usually adjustable, although some rectifier panels use fixed resistors. Figure 5-36 shows a typical elementary wiring diagram for a brake rectifier panel using adjustable resistors. Figure 5-37 shows the one line external connection diagram for the rectifier panel.

2. Adjustments: Resistors in rectifier panel have been factory adjusted for proper release and setting of brake.

The following procedure should be followed if further adjustment is needed for some reason. Refer to wiring diagram in Figure 5-36.

(a) Check external wiring to see that wires "T1" and "T2" are connected to motor terminals and B1 and B2 are connected to brake.

(b) Check transformer (BPT) to see that it is connected for proper operating voltage (see transformer nameplate).

(c) Remove cover on resistor enclosure and set tap on wire "2" as near as possible to wire "2" end of resistor "R120".

(d) Set tap on wire "3" as near as possible to wire "8" end of resistor R17.

(e) Apply voltage to rectifier panel (and motor) which will energize brake rectifier through T1-T2, and observe brake action.

(f) If brake releasing action is satisfactory, (about 1/4 seconds) tap on wire "3" may be left in this position.

(g) If brake fails to release rapidly enough, advance tap on wire "3" toward "5" end of R17 approximately 1-1/2" (3.81 cm) and try brake again.

(h) Failure of brake to operate (release) after performing steps a through g, may be caused by one or more of the following:

(1) Open circuit in panel wiring.

(2) Open circuit in wiring between motor and panel.

(3) Open circuit in wiring between brake and panel.

(4) Brake torque (spring) too strong.

(5) Brake magnet air gap too large.

(6) Open brake coil.

(7) Defective rectifier.

(i) When releasing characteristics have been satisfactorily adjusted, operate brake and observe setting (drop-out) characteristics. It is required that brake set as quickly as possible. Tap for wire "2" on resistor "R120" controls this operation.

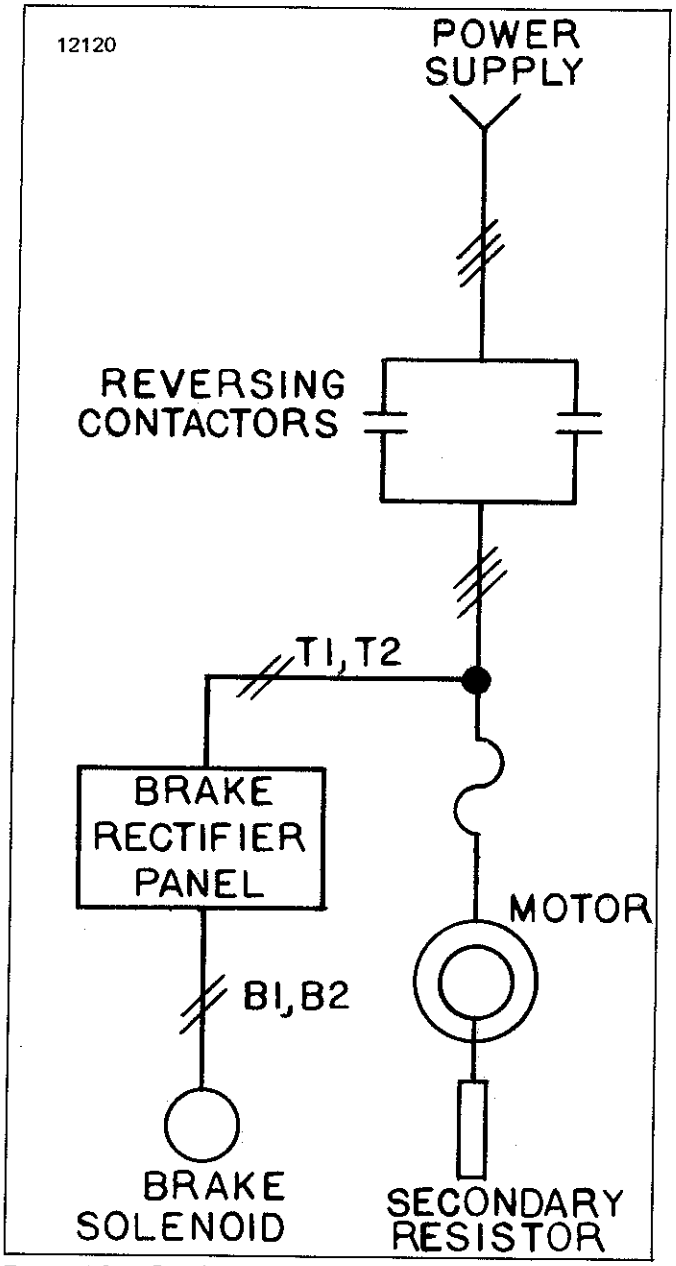


Figure 5-37. One-Line Diagram for D.C. Rectified Brake and Panel.

(j) Moving tap on wire "2" toward point "8" on resistor R120 will make brake stay released longer after motor is turned off. Moving tap toward other end of R120 speeds up brake setting. The ideal setting is one which gives quick setting and also keeps brake released through possible line voltage dips.

(k) The tap was initially set at end of resistor R120 at point "2". If brake remained released with motor on, test to see if it is possible to manually cause brake to set by pulling on brake magnet armature with 10 to 20 pounds (45 to 90 newtons) pull.

(l) If it was possible to cause brake to set, move tap on resistor R120 toward wire "8" end a small amount and repeat step (k) until it is not possible to manually cause brake to set with 10 to 20 pounds (45 to 90 newtons) pull on magnet armature.

CAUTION

When performing tests (k) and (l) above, observe extreme caution in working around moving parts, such as brake drum, motor shaft and rope drum.

d. Electric Load Brakes:

1. General: Load brakes can be mechanical or electrical. Mechanical load brakes are described elsewhere in this manual. Eddy-current brakes AB-701 through AB-709 are normally used as electrical load brakes in conjunction with eddy-current hoist control described under Paragraph 5-4a. Control Operating Instructions. Eddy brakes consist basically of a rotating member keyed to a straight-through shaft and a stationary field assembly. Shaft is supported by an anti-friction bearing in each end bell (see Figure 5-38). An air gap exists between smooth surface of rotor and pole, or segmented surface, of stationary field assembly.

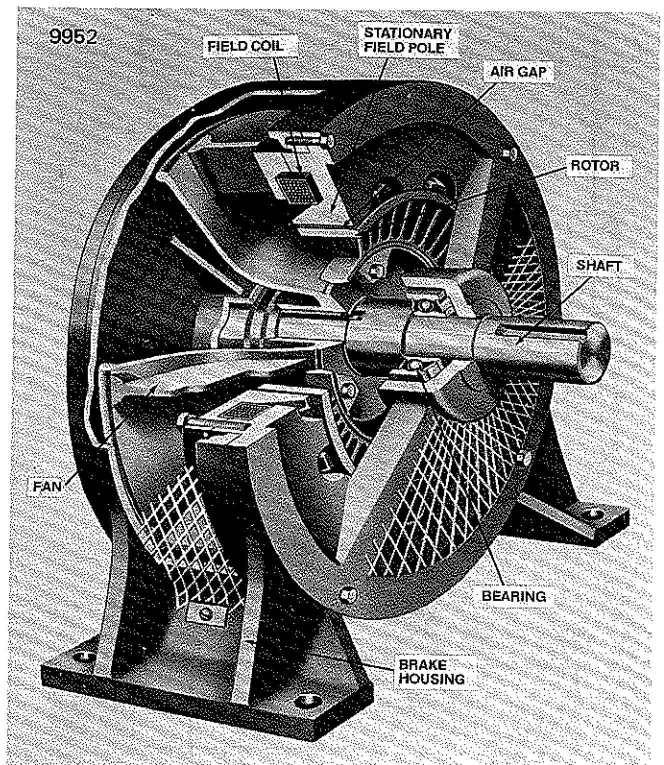


Figure 5-38. Typical Eddy-Current Brake.

Brake rotor revolves at the speed of motor. As field coil is energized by a D.C. excitation voltage (obtained from eddy-current control panel), a magnetic field is established between the poles or teeth. As rotor revolves, magnetic lines of force are cut in air gap and eddy-currents are generated in rotor which in turn produce a braking torque as a function of speed and field coil excitation. A typical speed-torque relationship is shown in Figure 5-39.

2. Maintenance: General maintenance of eddy-current brakes will consist of the following:

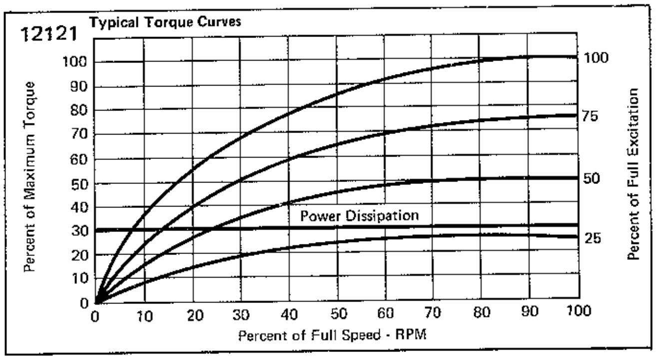


Figure 5-39. Typical Speed-Torque Curve for Eddy-Current Brake.

WARNING

Lock open main disconnect switch on crane before starting any maintenance work.

(a) Cleaning: A certain amount of foreign matter enters with cooling air and accumulates inside, the amount depending on the purity of surrounding air and cleanliness of exposed surfaces. Thus, the eddy-current brake will require periodic cleaning. To do so, remove air intake screen (Figure 5-38). Use compressed air to dislodge and remove foreign matter. Repeat this procedure as often as necessary to keep unit clean.

If, after operating for a long time, compressed air does not sufficiently remove all foreign matter, disassemble whole unit and use compressed air and cleaning solution.

(b) Lubrication: Units equipped with ball bearings were sufficiently lubricated at factory to require no further lubrication for 2000 hours, if operated under reasonably normal conditions, in an area free of acid fumes, excessive humidity, dust, dirt or any foreign matter harmful to bearings and lubricant. Operating and atmospheric conditions existing in the area of installation must be considered when determining how often lubrication is necessary. If operating under favorable conditions that do not warrant frequent lubrication, the grease inlets should be equipped with plugs that are replaced with grease fittings only during lubrication. Refer to Figure 5-40.

The following steps constitute the procedure for lubricating ball bearings:

(1) Clean the exterior of the unit around the grease and drain plugs.

(2) Remove drain plugs. If grease holes are plugged, remove these plugs and install grease fittings in their place.

(3) Slowly introduce grease into the bearings until clean grease appears at drain hole.

(4) Before replacing drain plugs operate the unit for approximately 15 minutes to expel any excess grease from ball bearing chambers. Then wipe off all grease from around drain holes and grease fittings. Replace drain plugs.

(5) If unit is being operated under reasonably normal conditions and does not require frequent lubrication, replace grease fittings with plugs as a precaution against personnel overlubricating bearings.

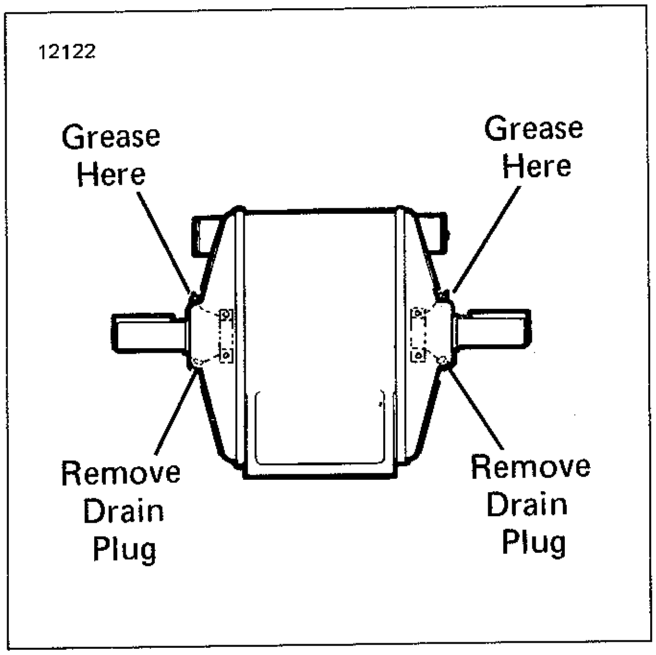


Figure 5-40. Eddy-Current Brake Bearing Lubrication.

Recommended Greases

Company	Grease
Texaco	Premium RB No. 2
Shell	Alvania No. 2
Gulf	Gulfcrown No. 2
Texaco	Multifak No. 2
American Oil Co.	Amolith No. 2

e. Resistors.

1. General: Resistors are normally used with A.C. and D.C. motors to limit peak torque and peak current as they accelerate, and to provide a means for speed control of motors. These features are obtained for a D.C. series motor by varying resistance in series with motor armature, and for an A.C. wound rotor motor by varying resistance in series with motor secondary. Taps on resistors provide for decreasing the resistance in steps as motor accelerates. Inasmuch as resistors convert electrical energy to thermal energy (heat), they are mounted outside of control panel enclosure so that the heat is more readily dissipated. Resistor enclosures are ventilated to allow free passage of cooling air. Depending upon HP, duty cycle and application, resistor could be of punched grid or edgewound construction. Edgewound resistors, which are most commonly used, are made by mounting a spiral wound stainless steel resistance element on a refractory core-insulated steel support member. Each resistor unit is then called a tube. Figure 5-41 shows a typical 5-speed point secondary resistor for a 20 hp (20.27 hp) wound rotor motor used on a mechanical load brake hoist. The resistor assembly consists of 8 tubes, with terminals marked per resistor

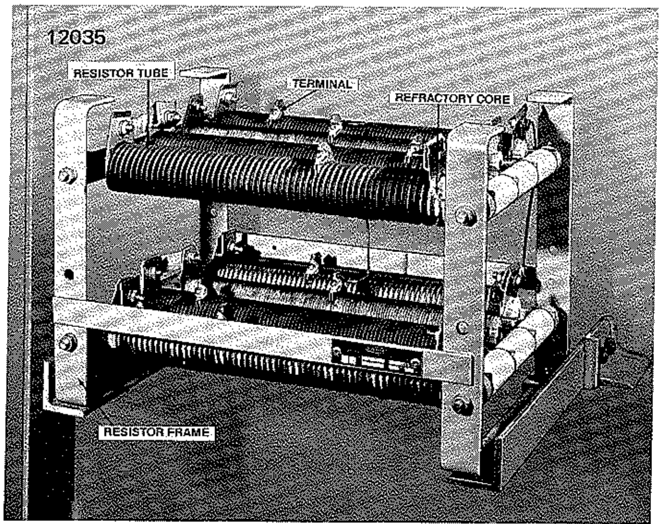


Figure 5-41. Typical Secondary Resistor.

wiring diagram. Type AVA wire is used for connection to control panel.

2. Maintenance:

WARNING

Lock open main disconnect switch on crane before starting any work on a resistor. Also make sure that the unit has cooled down to room temperature.

Resistors need very little maintenance. Terminals should be checked periodically to make certain that connections are clean and secure.

If any of the tubes need replacement, refer to crane electrical data sheet and resistor wiring diagram to obtain replacement tube part number and tap settings. After new tube is installed and terminals are properly located, check the resistance of each step for all three phases by means of an ohmmeter. These measurements should agree with values shown on resistor wiring diagram. When measuring resistance, make certain that all external wiring is disconnected from resistor, and that resistor has cooled down to room termperature.

3. Wiring Schematic: Typical wiring diagram for 5-point resistor is shown on Figure 5-42. A loose connection between any resistor step and panel could result in improper functioning of the control and cause overheating either of resistor or motor.

f. Contactors.

1. General: Contactors are normally used for reversing, accelerating and mainline control, and are located in hoist, trolley, bridge and mainline panels. See Figure 5-43 for location of contactors in a typical hoist-trolley control panel. Coil style number, voltage and frequency are marked on the side of contactor coil, normally rated for 110 volt, 60 Hz.

2. Maintenance: A systematic and periodic maintenance program will provide the assurance of long life, reliable

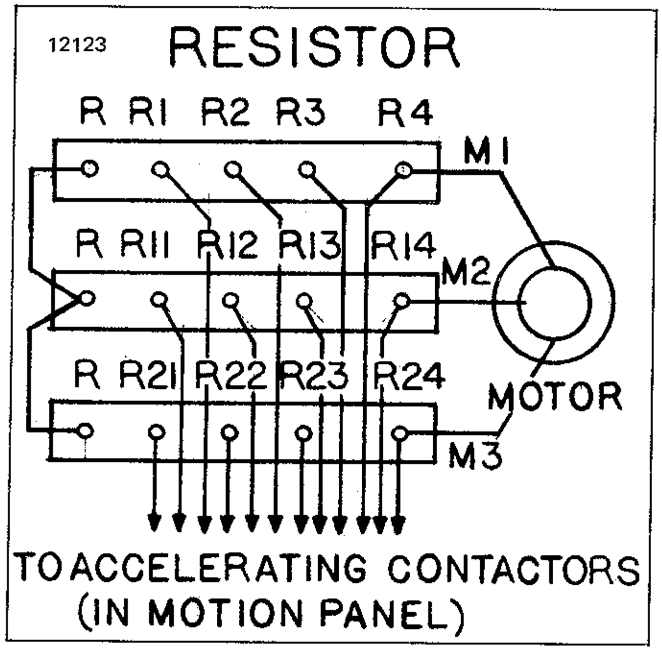


Figure 5-42. Wiring Diagram for 5 Point Secondary Resistor.

performance and minimum down time. Any plan of preventive maintenance should include inspection, cleaning, and replacement of worn or faulty parts as necessary. Figure 5-44 shows a typical size 2 contactor unassembled. For maintenance requirements, proceed as follows:

WARNING

Lock open main disconnect switch on crane before undertaking any work on a contactor. Disconnect power and control wires from contactor.

(a) Contacts:

(1) Inspection: Loosen the two arc box assembly screws located immediately below nameplate and remove arc box. Contacts are now visible.

(2) Replacement: After removing arc box and having replacement contacts at hand, remove moving contact carrier by compressing overtravel spring and displacing carrier from crossbar. Stationary contact carriers are removed by only loosening retaining screw and sliding out of carrier.

To replace contact carriers, reverse above procedure making certain that stationary carriers are secure, moving carriers are free to move, overtravel springs are seated and crossbar moves freely when arc box is in position.

Silver-cadmium oxide contact buttons require no dressing or lubricant throughout their life.

IMPORTANT – Replace all contacts as a group to avoid misalignment.

(b) Coil: To replace coil, loosen assembly screws located to immediate left and right of arc box.

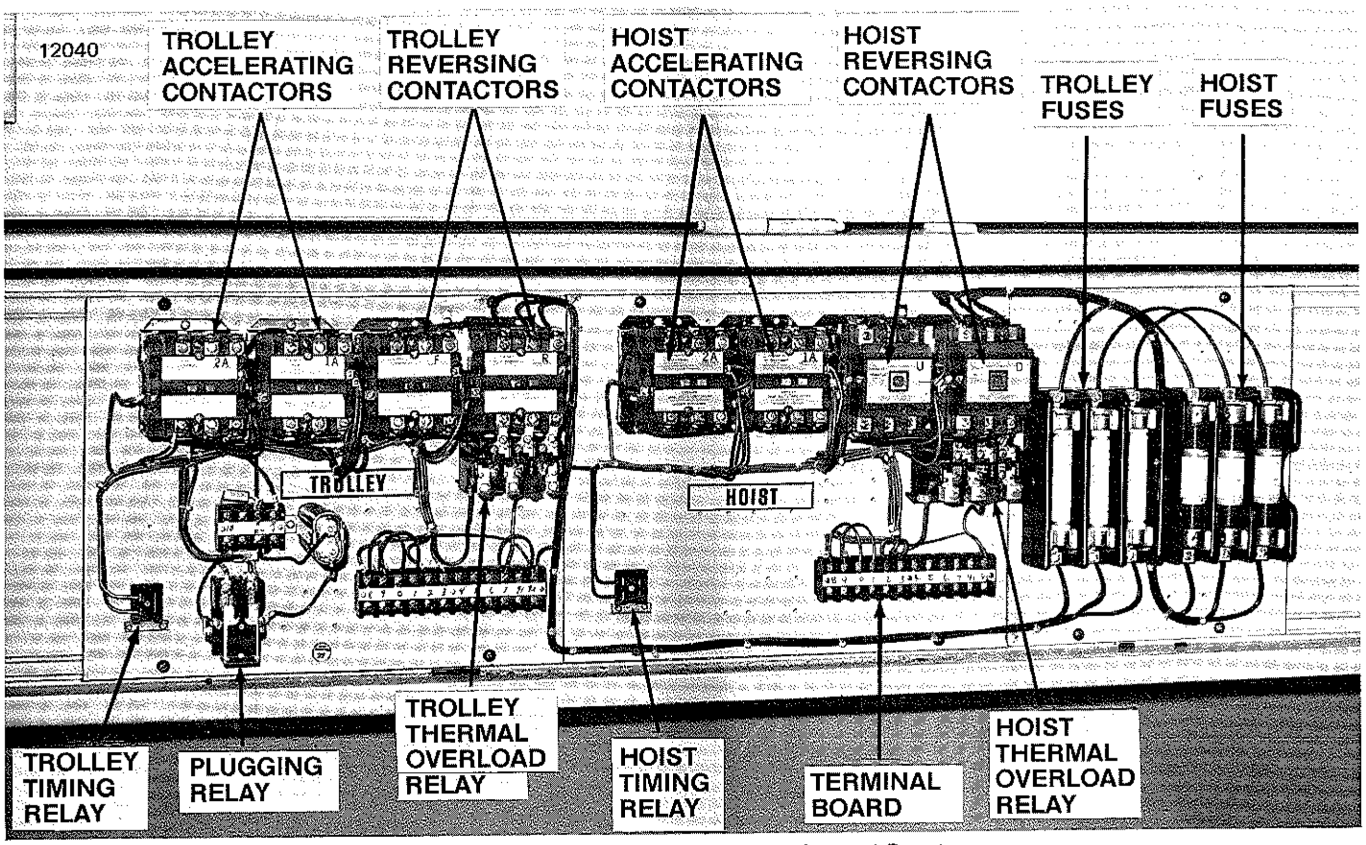


Figure 5-43. Typical Hoist-Trolley Control Panel.

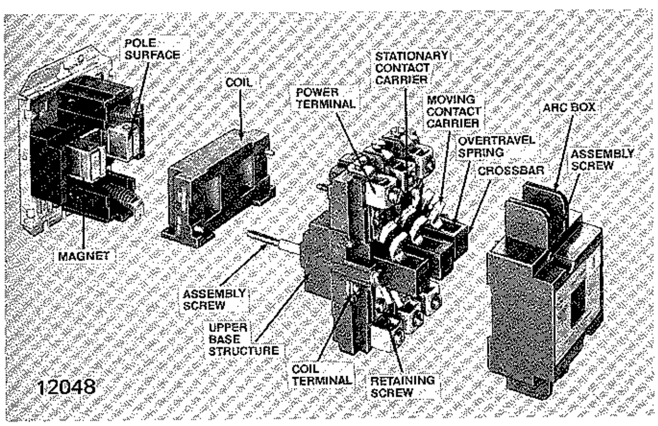


Figure 5-44. Typical Contactor Unassembled.

Pull loosened upper base structure forward. Pull coil from upper base, plug in new coil and replace upper base structure. Check interlock installation when repositioning upper base.

Tighten assembly screw.

(c) Magnet-Armature Assembly: The self-alignment and permanent air-gap features of magnet-armature make replacement maintenance unnecessary. Mating pole surfaces should be kept clean.

(d) Electrical Interlocks: Each L-56 interlock as shown on Figure 5-45 is normally used with contactors and has two contacts — one normally open and one normally closed. These two contacts are electrically isolated allowing each interlock to control two circuits.

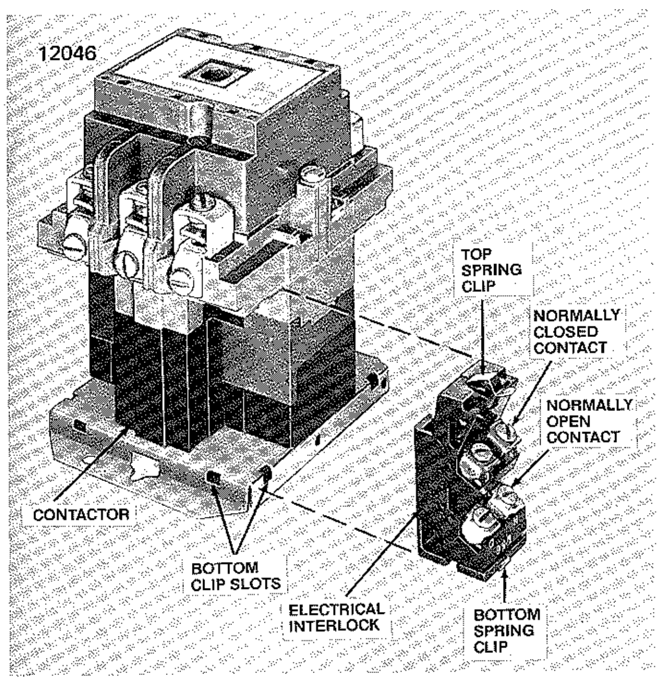


Figure 5-45. Electrical Interlock for Contactor.

Interlocks will fit in any of four contactor cavities provided, and in either of two positions in each cavity.

To insert interlock when positioned as shown, insert bottom spring clip on interlock into one of the two clips slots in base plate. Push interlock into cavity until top spring clip snaps, locking interlock firmly in place. To remove interlock, push top spring clip down and guide interlock out by first pulling out top end slightly.

(3) Connection Diagram: Typical connection scheme for a 3-pole contactor with one L-56 interlock is shown on Figure 5-46.

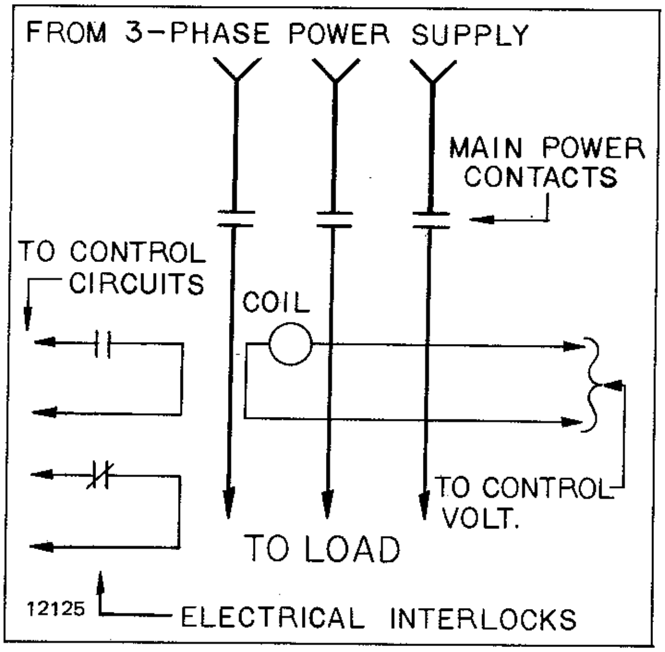


Figure 5-46. Contactor Connection Diagram.

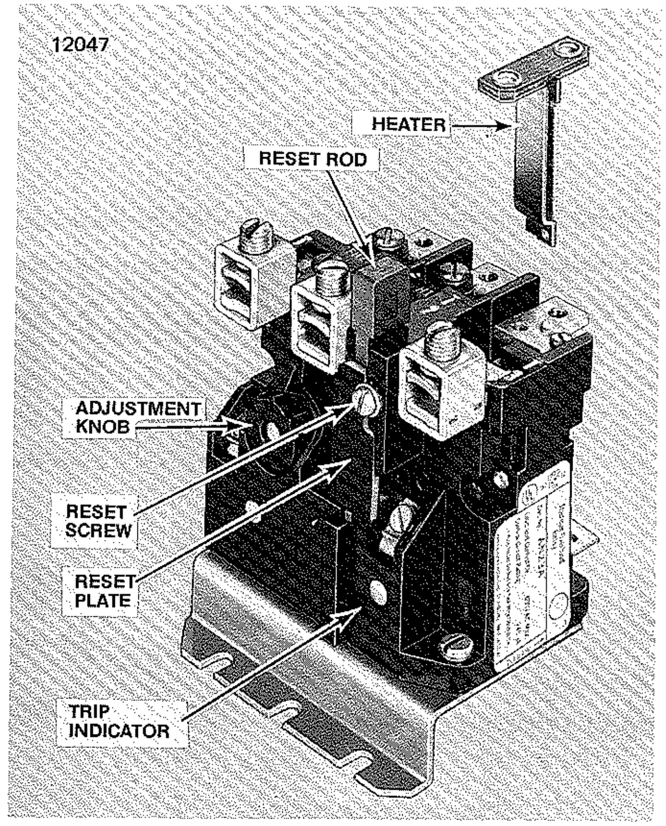


Figure 5-47. Typical Thermal Overload Relay.

g. Overload Relays: Overload relays are used to provide running over-current protection for hoist, trolley or bridge drive motors. Most cranes will use thermal overload relays, but another type sometimes used are magnetic overload relays. Descriptions and instructions for each type are included below.

1. Thermal Overload Relays:

(a) General: Figure 5-43 shows the location of 3-pole thermal overload relays in a typical hoist-trolley control panel. If a motion has more than one motor, each motor will have one 3-pole overload relay.

The thermal overload relay, shown on Figure 5-47 is a 3-pole, bi-metallic, ambient non-compensated type relay, installed in a vertical position directly below the reversing contactors. Do not tamper with this relay as it has been accurately calibrated at factory. Bimetal elements are electrically heated by a series of small replaceable heating elements, called heaters, connected directly in motor circuit to be protected.

The current of an overloaded motor increases heat generated in heaters sufficiently to cause actuating bimetals to bend. Bimetal bends against a trip bar, which in turn opens a control contact that is connected in the control circuit of motor. This turns off control and motor. Time required for overload to trip depends upon magnitude of overload, the greater the overload, the shorter the time to trip. Performance of the thermal overload relay is designed to allow motor starting currents to flow during the normal starting period but will trip when subjected to a smaller sustained overloads.

(b) Adjustments:

(1) Manual or Automatic Reset. Relay may be set for either "HAND" or "AUTO" reset by slightly loosening the screw holding the reset plate, moving plate to proper position "HAND" or "AUTO", marked on moulded case and retightening screw.

All overload relays as shipped with crane are normally set for automatic reset.

(2) Trip Setting. The trip rating of a specific heater element can be adjusted over a range of 85% to 115%. This is accomplished by turning adjustment knob on bottom of relay to respective stop position.

Overload relays as shipped with crane are normally set at 100% trip position. As a general rule, this setting should not be changed.

(c) Trip Indication. An immediate visible indication of trip is standard on the overload relay. When an overload causes relay to operate, a trip indicator projects out through a small opening at bottom of relay (see Figure 5-47).

CAUTION

Do not tamper with this trip indicator as it is an integral part of calibration and tampering therewith may cause change in trip characteristics.

(d) Replacement of Heaters. Each heater is identified by a code marking stamped on heater. Replacement and installation of heaters are quite simple.

WARNING

Lock open main disconnect switch on crane before replacing or installing heaters.

Select proper heaters from Electrical Data Sheet furnished with crane. Make sure that connecting surfaces are clean. Install or replace heaters by using two screws. (See Figure 5-47.)

2. Magnetic Overload Relays.

(a) General: Like the thermal overload relay, the magnetic overload relay has inverse trip time characteristics; unlike thermal relays, its minimum operating current is independent of temperature changes or cumulative heating. When used, a separate magnetic overload relay is provided for each phase of motor to be protected. Also, usage of magnetic overloads entails the added requirement that motor control be provided with undervoltage protection.

For description that follows, refer to Figure 5-48. Operating coil carries motor current. This current produces an electro-magnetic force on a moveable iron core tending to raise the core. Under normal conditions, upward electro-magnetic force caused by current is not great enough to lift core due to restraining effect of piston seated at bottom of dashpot. Therefore, relay remains inoperative. When current increases to trip point setting of relay, electro-magnetic force is able to unseat piston, raise core, and operate contacts. Upward motion of the core, however, is retarded by the viscous flow of a silicone fluid through a valve in the piston. The core rises slowly until piston reaches an increased dashpot diameter, where it is suddenly freed; this allows the core to snap up and impart its motion to trip pin, which opens contacts with a quick, positive break.

Standard models reset automatically. As soon as the current is interrupted, the core quickly drops, returning contacts to their normal position.

(b) Maintenance: Maintenance of the relay will consist of checking and cleaning contacts, and checking and adding dashpot fluid if required.

(1) Adding dashpot fluid (See Figure 5-49). Overload relays, as shipped with crane, do not contain dashpot fluid. Dashpot fluid is shipped separately (usually in a package inside panel enclosure). This fluid has to be added during start up. Fluid level has to be checked from time to time. To add fluid to the relay, remove dashpot and core assembly by swinging spring clamp forward. Then remove dashpot cover by pulling on core.

Add the silicone fluid (usually blue) with dashpot cover removed, but with piston and core in place. Fill dashpot to top of the three round projections on piston. Fluid must be free of dirt or grit, and dashpot and piston must be absolutely clean.

(c) Adjustments:

(1) Operating Current Adjustment. Calibration lines on core correspond to current values stamped on nameplate (see Figure 5-49). After dashpot and core assembly are removed, and filled with fluid to proper level, the core is screwed up or down until line corresponding to desired operating current is flush with edge of dashpot. Desired ring setting is indicated on Electrical Data Sheet, a copy of which is included in Custom Parts Identification Manual.

(2) Operating Time Adjustment. Relays are set for minimum time delay when shipped. To increase time delay, if required, remove piston from dashpot and decrease opening of adjustment valve. See Figure 5-50.

CAUTION

Do not attempt to change position of diamond shaped valve cover. This cover holds the steel balls of check valve in place.

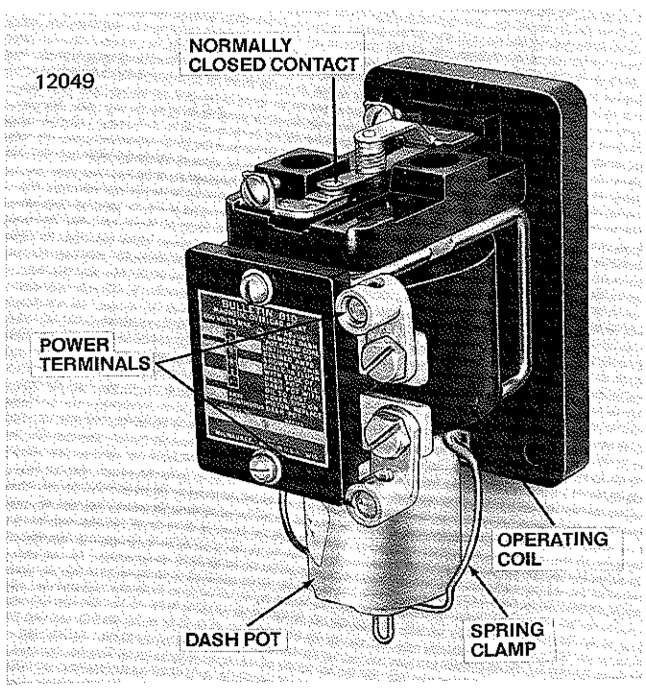


Figure 5-48. Typical Magnetic Overload Relay.

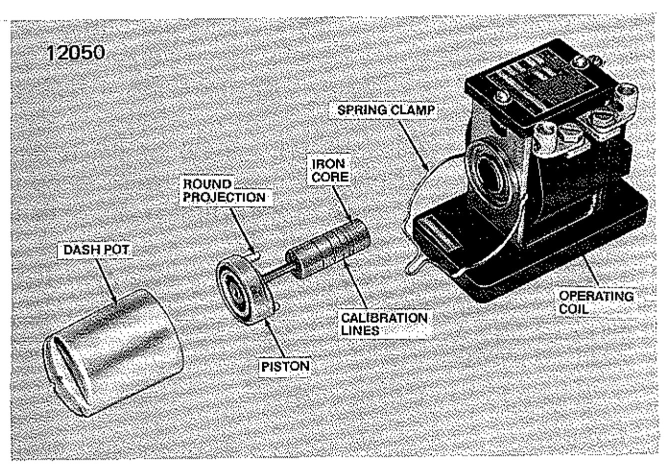


Figure 5-49. Magnetic Overload Relay Unassembled.

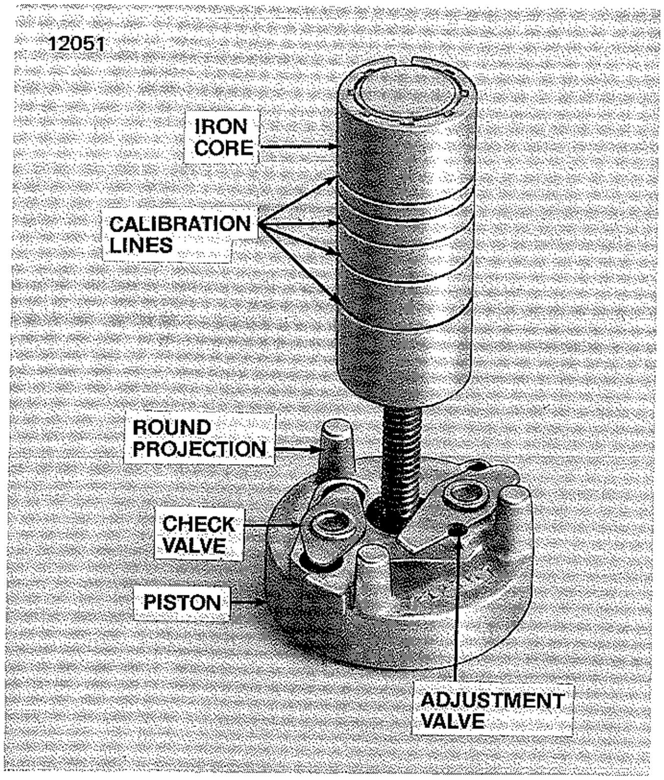


Figure 5-50. Magnetic Overload Relay Core Assembly.

h. Timing Relays.

1. General: Time delay relays are normally used in multi-speed step control for both A.C. and D.C. applications. The function of such timers is to provide time delay between successive steps of accelerating resistors as the motor accelerates. When crane operator moves master switch handle or pushbutton suddenly from off position to extreme speed position, timers enable the control to remain in each successive resistor step for a definite time, thus limiting motor torque and current peaks to safe values.

Standard A.C. control uses one timer for 3-speed control and three timers for 5-speed control. Timers used on trolley or bridge drives have a 2 second delay, and those used on hoist drives have a delay of 1/2 second. Timing relays are normally located in the motion control enclosure.

All accelerating timers are solid state, hermetically sealed, compact units (see Figure 5-51), with fixed delay on energization. External connections are required only to terminals (1) and (2). Figure 5-52 represents a typical connection diagram for a timer.

2. Maintenance: Terminals (1) and (2) of timers are connected to external circuit by means of quick connect lugs. Normal inspection would include checking to see that connecting lugs are properly seated.

The entire timer must be replaced by a new unit if it malfunctions for some reason.

i. Limit Switches.

1. Geared Rotary Limit Switch.

(a) General: The geared rotary (or screw type) limit switch is used on hoists to limit upward travel of hook.

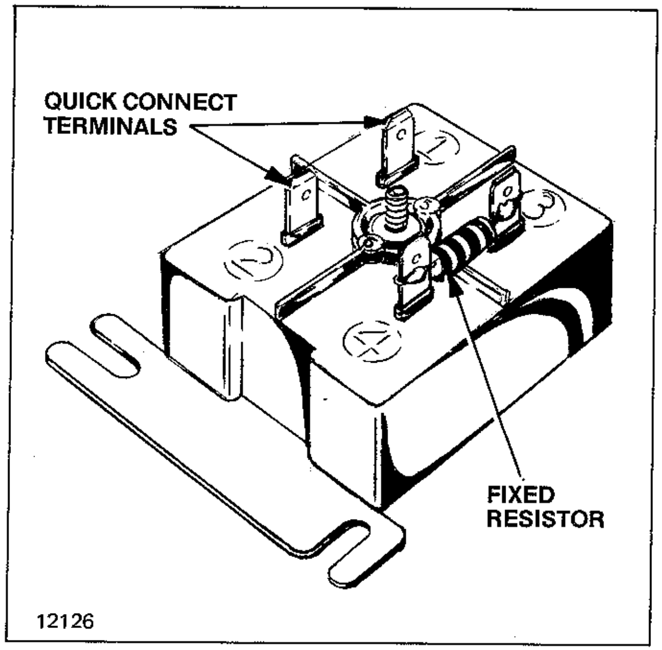


Figure 5-51. Typical Time Delay Relay.

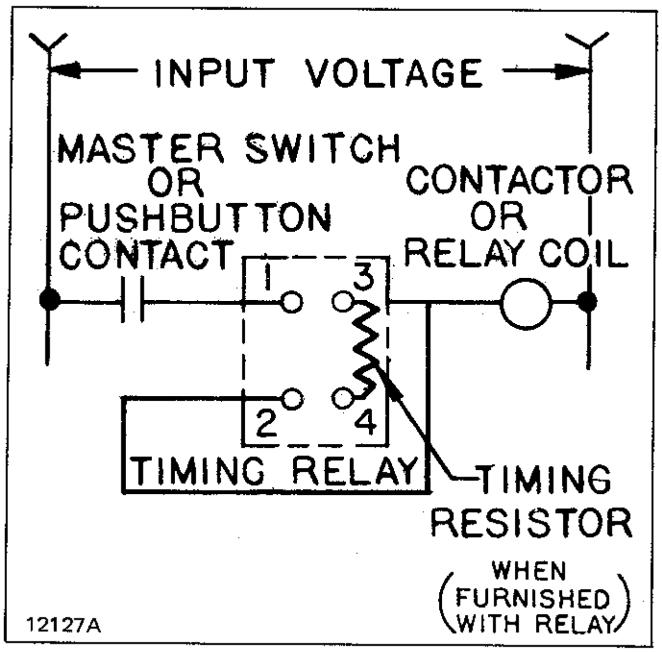


Figure 5-52. Connection Diagram for Time Delay Relay.

Operating mechanism consists of two adjustable cams driven by a shaft through gear reduction. Each cam operates contacts of one switch unit. Second switch and cam can be used to limit down travel of hook. Normally closed contacts of switch units are connected in the hoisting and lowering (if used) control circuits. Hoisting and lowering cams are adjusted so that switches trip at ends of upward and downward travel, and stop motion.

(b) Adjustment: Adjustment of rotary limit switch is accomplished as follows: (See Figure 5-53).

(1) Remove four cover screws and lift off enclosure cover.

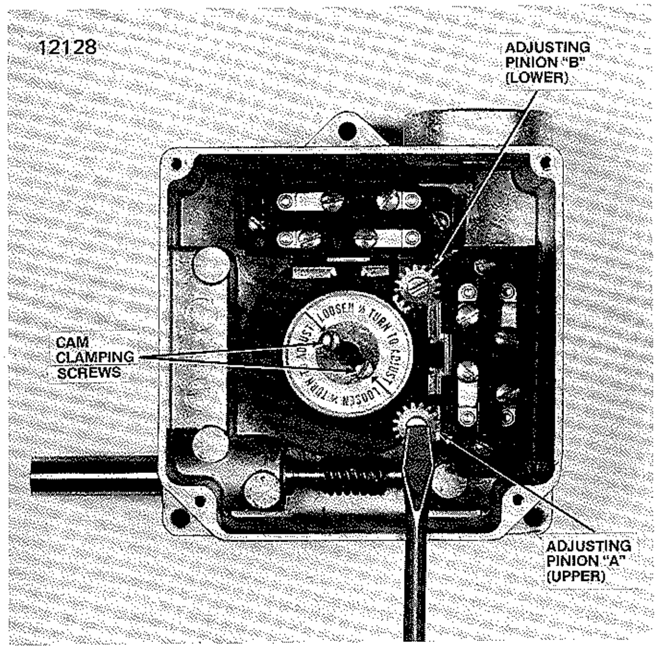


Figure 5-53. Geared Rotary Limit Switch.

(2) Operate hoist to raise lower block to upper limit of desired travel. Refer to crane clearance diagram for proper setting.

(3) Loosen two cam clamping screws on top of cam assembly one half turn each.

(4) Locate cam adjusting pinion "A" (upper) by referring to indicating arrow on insulation shield. Depress this screw with a screw driver until pinion teeth mesh with gear teeth on top cam. Rotate cam in direction cam turns when hoisting by turning screw driver until cam operates switch. White marker on gear teeth is directly over nylon roller that trips switch. When top operating cam has been adjusted so roller has tripped switch, test adjustment by operating hoist slowly at first. If satisfactory, increase toward full speed. Readjust if necessary, and repeat test.

(5) Operate hoist and run lower block to lower limit of desired travel. Make certain that at lowest point of hook travel a mininum of two turns of wire rope remain on rope drum.

(6) Locate cam adjusting pinion "B" (lower) by referring to indicating arrow on insulation shield. Depress this screw with a screwdriver until pinion teeth mesh with gear teeth on lower cam. Rotate cam in direction cam turns when lowering by turning screwdriver until cam operates switch. White marker on gear teeth of lower cam will be directly over nylon roller that trips switch and adjustment is complete.

(7) Retighten cam clamping screws, fold down insulating shields and replace cover. Test by operating slowly at first, and increasing to full speed if satisfactory. Readjust if necessary.

(c) Maintenance: Device has been permanently lubricated at factory. An increase in life may be obtained by occasionally placing a small quantity of gear grease on worm gear.

If a precision snap-action switch should be in need of replacement, remove the two mounting screws and replace switch.

(d) Connection Diagram: See Figure 5-27.

2. Power Circuit Limit Switches (see Figure 5-54).

(a) General: A power circuit limit switch is a device which protects against overhoisting a crane hook. Limit switch is mounted above trolley floor. When hook rises into danger zone, lower block lifts suspended reset weight. As the load of reset weight is removed from operating lever, tripping weight (an integral part of operating lever) operates switch. Normally closed power contacts are opened, and normally open contacts are closed. For a D.C. crane using a D.C. limit switch, this will disconnect motor armature and series brake from power line, and set up a dynamic braking circuit through a resistor that will quickly stop hook travel with a minimum of drift. For an A.C. crane using an A.C. limit switch, this will disconnect two power lines to motor, which is then quickly stopped by the setting of brake. Reversing crane controller lowers hook to return limit stop to "run" position by means of suspended reset weight.

(b) Maintenance:

WARNING

Lock open the main disconnect switch on crane before starting any work on limit switch.

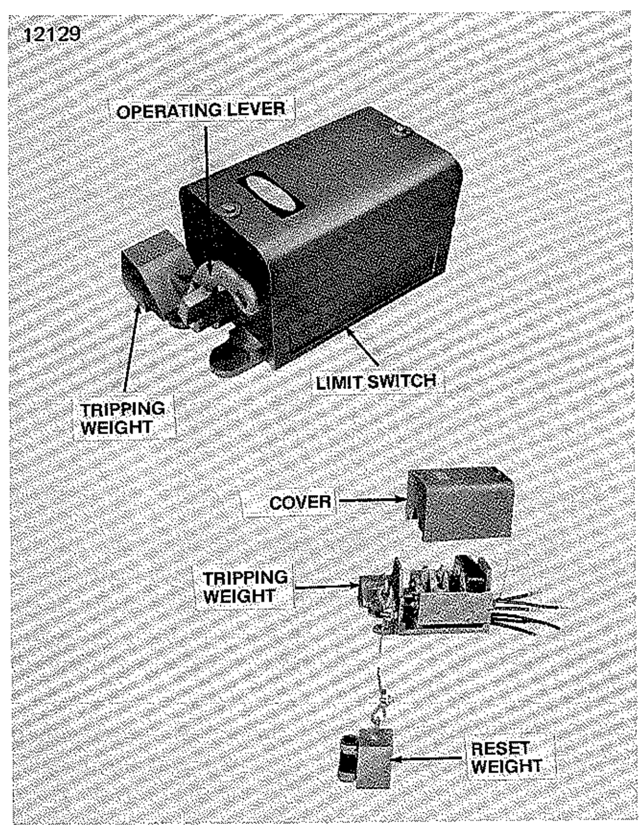


Figure 5-54. Block-operated Power Circuit Limit Switch.

Due to the high quality of materials used, limit switch needs very little maintenance. All parts are of non-corrosive materials. Contacts are hard-drawn copper, silver faced. Shaft is stainless steel. However, periodic check up and cleaning are recommended, and contacts should be replaced when worn out.

(c) Lubrication: Four oversized, double sealed ball bearings are permanently lubricated to minimize friction and reduce maintenance, so no additional lubrication is necessary.

(d) Typical Connection Diagram: See Figure 5-55.

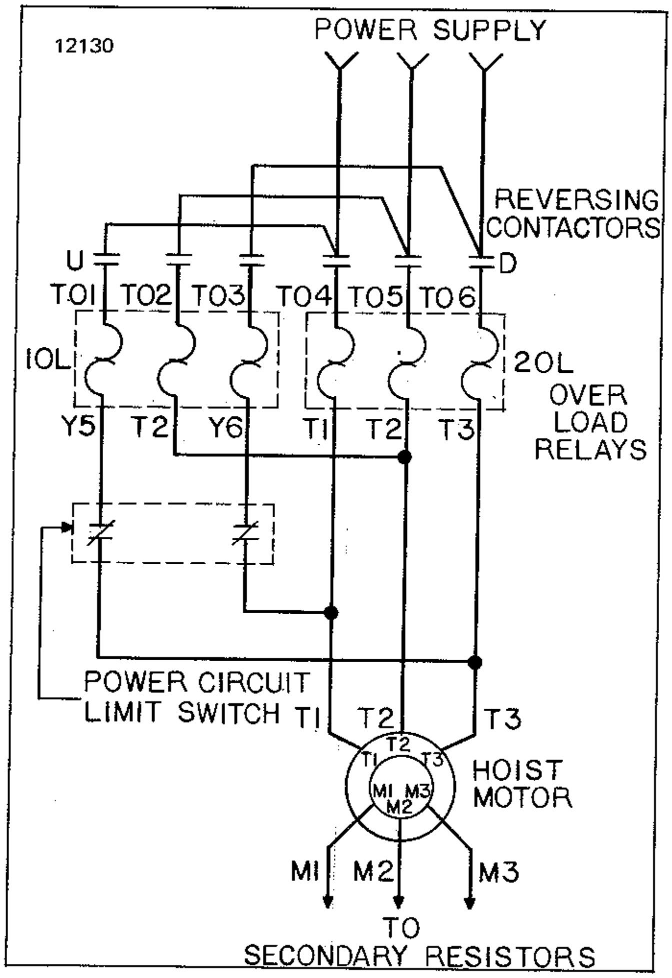


Figure 5-55. Connection Diagram for Power Circuit Limit Switch.

j. Master Switches.

1. General: Master switches are normally used to operate hoist, trolley and bridge motions in cab-operated cranes. Each individual motion has a separate master switch, although a joy-stick master switch may be used for certain applications to control two motions from one master.

Master switches are normally surface mounted, 5-point reversing, spring-return-to-off position, and are provided with a normally closed contact in the off position for use with controls having the optional feature of under-voltage protection.

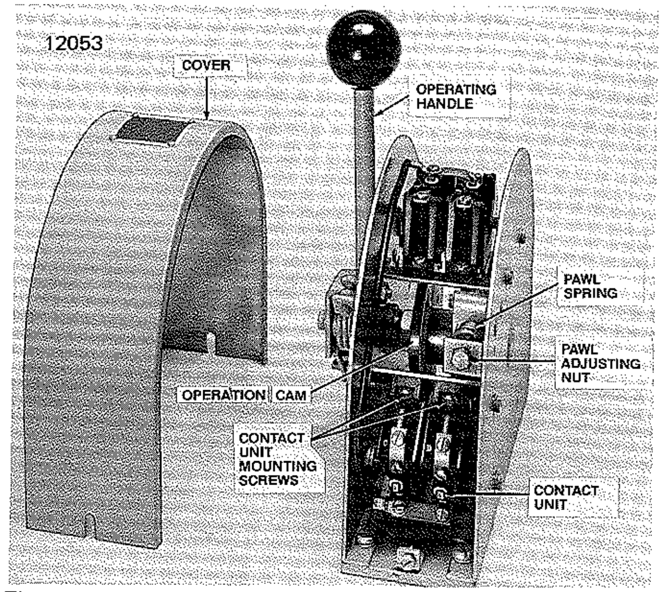


Figure 5-56. Typical Master Switch.

Figure 5-56 shows a typical master switch with cover removed.

2. Maintenance:

WARNING

Lock open the main disconnect switch on crane before starting any work on a master switch.

(a) Inspection. Depressing plunger guide and tilting it to open side of block releases plunger assembly. This permits contacts to be inspected for wear or pitting without removing block or disturbing connections.

(b) Replacement of Contacts. Silver contacts require very little maintenance, but must be replaced before silver is completely worn away. Filing or otherwise dressing contacts results only in the loss of silver and reduces normal contact life. Contact unit can be replaced by disconnecting terminal wires, removing two mounting screws and inserting a new unit. (See Figure 5-57.)

3. Adjustments:

(a) Operating Handle Tension. Pawl tension may be adjusted to provide either pronounced positioning, or easier operation with less "position feel". This is done by tightening or loosening pawl adjusting nut. See Figure 5-56.

(b) Lubrication. Self-lubricating bearing does not require any further lubrication during life time.

4. Contact Sequence. A diagram showing sequence of contact operation is shown in Figure 5-58.

k. Pendent Pushbutton Stations.

1. General. A pendent pushbutton station is normally used for floor-operated cranes. Station is usually suspended from crane bridge or trolley by means of a cable which provides necessary control connections from crane. Station contains two buttons for each motion, plus stop-reset

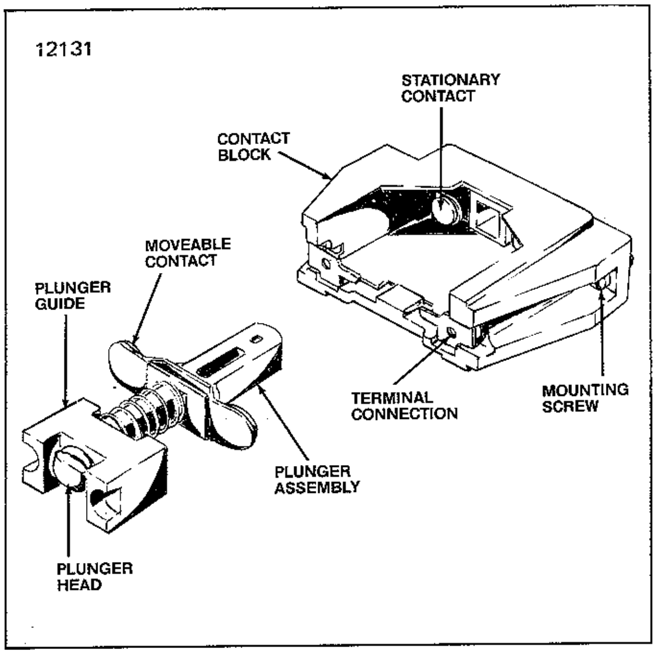


Figure 5-57. Master Switch Contact Block Assembly.

buttons on the top to control mainline contactor. Stop button is colored red while remaining buttons are black. Pushbuttons are of the spring-return-to-off position type, and are normally provided with contacts for 3 or 5 speed point controls. These contacts are arranged to operate in succession as button is more fully depressed, thus bringing in successive speed points in motor control.

2. Maintenance. Refer to Figure 5-59 for the maintenance instructions that follow.

WARNING

Lock open main disconnect switch on crane before doing any maintenance work on pushbutton station.

(a) Contacts. Contact block should be periodically inspected and cleaned. Moveable contact and spring can be replaced when worn out. This can be done without the use of any tool.

Check stationary contacts periodically. Replace complete contact block when stationary contacts are worn out.

(b) Return Spring. Check return spring for proper movement of plunger.

(c) Lubrication. No lubrication is required for the pushbutton station.

3. Contact Sequence. Internal diagram showing contact arrangement and sequence, for purpose of making connections from motor control, are as represented on Figure 5-60 for 5-speed pushbutton.

I. Radio Controls.

1. General: A radio control system is used for remote operation of a crane by radio signals. System is comprised

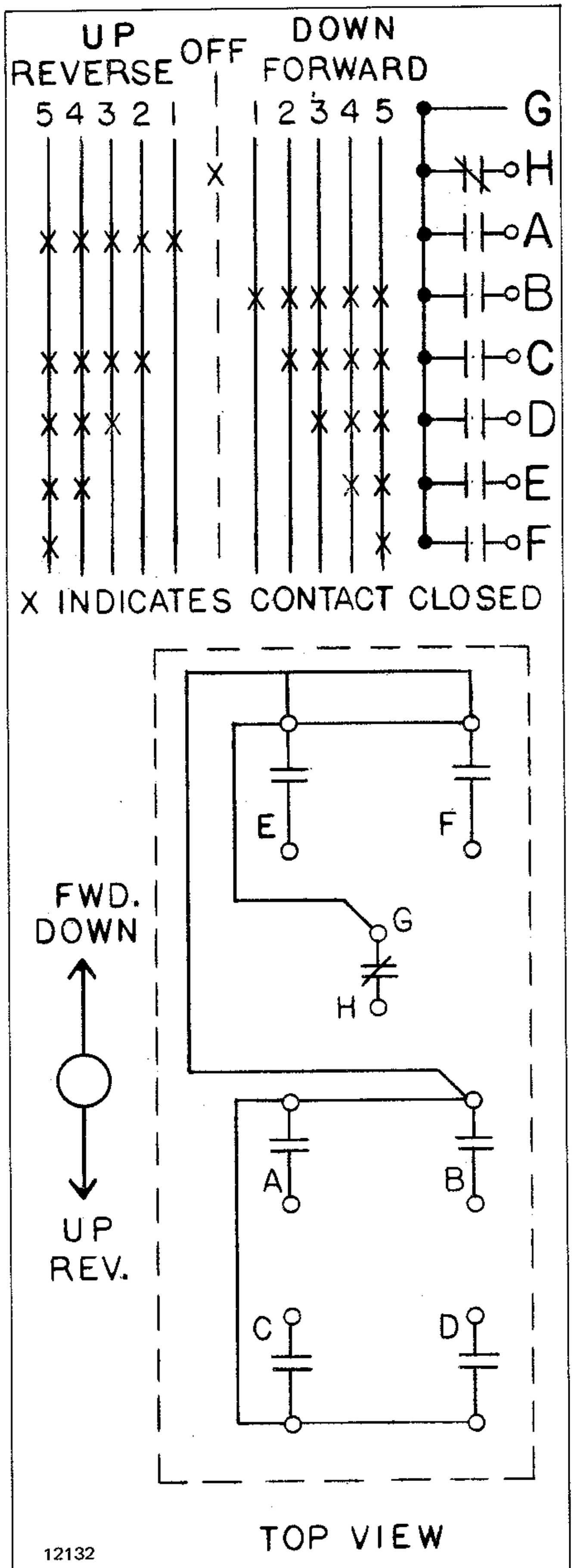


Figure 5-58. Master Switch Contact Sequence.

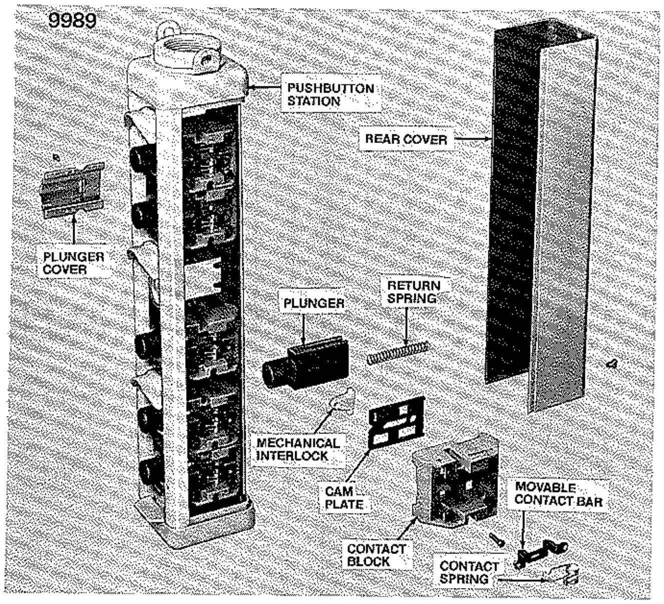


Figure 5-59. Pushbutton Station.

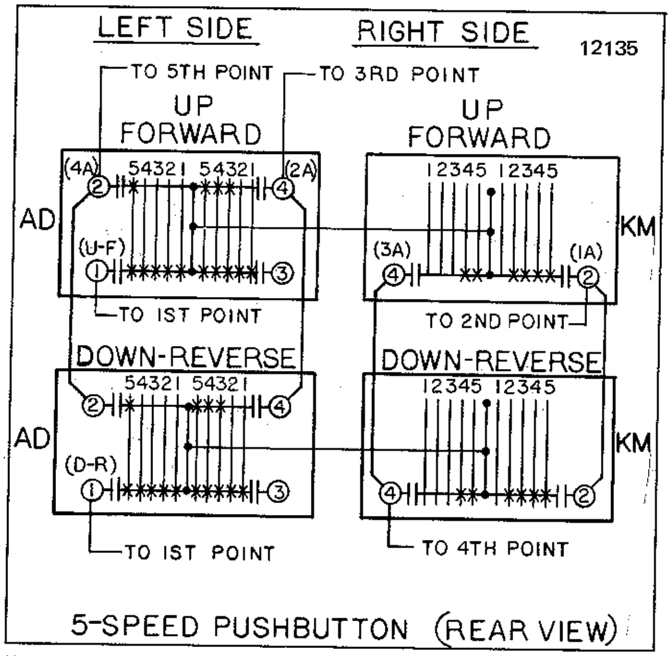


Figure 5-60. Internal Diagram for 5 Point Pushbutton Unit.

basically of a tone modulated portable FM transmitter and a narrow-band FM receiver and tone decoder modules. Transmitter operates from a rechargeable 12 volt nickel-cadmium battery, which has a life, between charges, of 8 hours under continuous duty, and longer with intermittent use. Receiver power supply is used on both A.C. and D.C. cranes. On a D.C. crane a converter is used to convert D.C. to A.C. Figure 5-61 shows a typical radio control system with description of components as follows:

(a) Transmitter Unit. Transmitter is a light, compact and rugged portable unit, designed for long life and reliable operation under industrial conditions. A flexible external omni-directional antenna is attached to transmitter case with a quick-disconnect terminal.

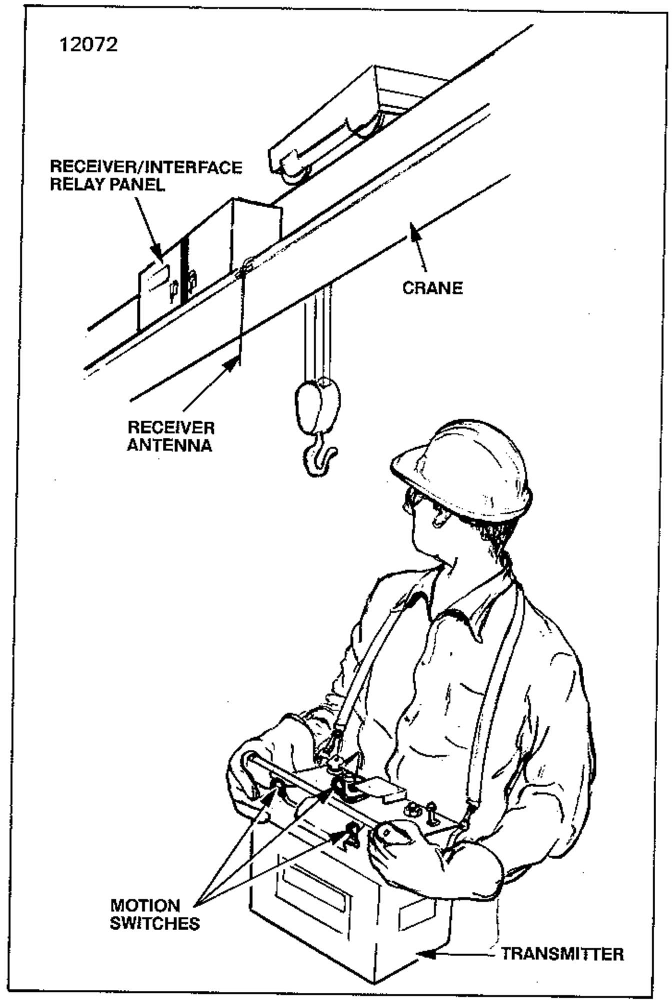


Figure 5-61. Typical Radio Control System.

No matter which direction the operator faces, the signal is transmitted at full strength to receiver unit. Electronic circuitry is 100% solid state. Motion switches to control hoist, trolley and bridge are spring return (dead-man) lever type, each permitting selection of up to five speeds in either direction.

Basic operation of transmitter is as follows: "Power" switch supplies power to transmitter. The next step is to energize main "On" switch. The third step is to energize mainline line contactor on crane by activating RESET/AUX switch, which energizes reset control circuitry in receiver. Motion switches can now be operated to generate additional tones to modulator for activating function controls in receiver.

(b) Receiver Unit. The receiver unit, consisting of receiver panel and interface relay panel, is normally housed in one cabinet and is mounted on crane. Electronic components are mounted on circuit boards, forming plug-in-type modules for easy maintenance. All circuitry, as in transmitter, is solid state, assuring maximum reliability throughout life of equipment.

(c) The receiving antenna, a whip type, is connected to receiver by a coaxial cable. Signal transmitted by portable transmitter is picked up by receiver antenna and fed through coaxial cable to FM receiver. Interface relay panel provides necessary contacts to control crane motions in accordance with signals received.

2. Maintenance:

(a) Battery. Transmitter battery should be recharged as necessary.

To replace battery, grasp battery holder and pull away from transmitter. Place fresh battery in holder and press toward transmitter case till seated properly.

If battery is not placed properly in holder, unit will not operate. A protection diode has been included in the transmitter regulation circuit so that reversed polarity will not damage its circuit.

(b) Antenna. Make certain that transmitter antenna wire is seated firmly in place.

(c) Receiver. All active units are of the modular plug-in type for fast efficient replacement of malfunctioning components. Each module is keyed to a particular operation. For instance, if hoist fails to operate on second point lowering, replace corresponding module only.

5-6 THE ELECTRICAL DATA SHEET AND WIRING DIAGRAMS. The purpose of this Paragraph is to briefly describe the Electrical Data Sheet (or EDS), and Electrical Wiring Diagrams, which have been prepared for your crane in our Electrical Engineering Department. Copies are included in your Custom Parts Identification Manual.

a. The Electrical Data Sheet is your prime source of information should you have questions regarding any electrical feature of your crane. The EDS is, in a sense, a master bill of material for all electrical components used on your crane, though it contains other useful electrical information as well.

A blank electrical data sheet form is shown on Figure 5-62. As you will note, top section contains basic general information, such as crane serial number, crane customer and location, power supply data, mode of operation and its location, and environment in which crane will operate. Below this general heading are separate columns for listing electrical components for each motion. Component quantities and part numbers, or purchase order numbers for items acquired from other manufacturers, along with other pertinent data, are included for each type of equipment (such as motors, brakes, limit switches, etc.) in accord with labelling shown in column at left side of page.

The complete electrical data sheet generally includes a second page, and more, if necessary, to provide data on motion fuses, control enclosures, crane accessories and special features.

b. The Electrical Wiring Diagrams are provided as a set and include the following:

1. Control Panel Wiring Diagrams.
2. Crane Interconnection Wiring Diagram.
3. Supplementary Wiring Diagrams.

Control panel wiring diagrams, similar to typical example shown in Figure 5-63 are provided for each crane motion. Figure 5-63 is for a reversing-plugging control used for bridge or trolley motions and with operation by master switch. For other types of controls, layout is the same, with elementary diagram, including operating station and external features, on right side of sheet, and connection diagram with wire table on left. Connection diagram shows control panel components arranged as they are mounted on the panel. On control panel diagrams provided for your crane, elementary diagram will show the operating device (either master switch or pushbuttons) and other external features actually used on your crane.

The typical crane interconnection wiring diagram shown on Figure 5-64 is for a standard 3 motion cab-operated crane, with 5-speed point bridge and trolley, and eddy-current braking control on the hoist. This diagram shows the complete electrical interconnection system for all crane components, including motors, control panels, master switches, runway and cross conductor systems, etc. Table at upper left will list all of the other wiring diagrams required for the crane. Layout of the interconnection diagram for your crane will be similar. If it is floor operated, a pushbutton station, generally shown at the right side of the sheet, will replace master switches and "Start" – "Stop" pushbutton station. Additional sheets, if required, may be added to show special features or accessories.

Supplementary wiring diagrams will be included, as required, for brakes, brake rectifier panels, resistors, control panels designed to meet special requirements, and for some accessories.

5-7 OPTIONAL ELECTRICAL ACCESSORIES. Your crane may be equipped with any one or all of the below listed accessories. A brief description of each is provided.

a. Warning devices. On cab-operated cranes, one warning device is furnished as standard. This is a foot operated gong. Electric bells, sirens, gongs, flashing lights, etc., can also be used, for both floor and cab-operated cranes. They may be installed to be operated by pushbutton, by foot switch, or automatically when one or more designated motions is operated.

b. Lifting Magnets. Lifting magnets are devices that are attached to the hook for the purpose of lifting scrap metal, steel plates or other metal products. Magnets may be installed on either cab or floor operated cranes. On cab-operated cranes, they are operated by a "lift-drop" master switch. On floor operated cranes, magnets are operated by "lift" – "drop" pushbuttons. A cable reel, mounted on trolley, is used to provide power from trolley to magnet. On alternating current operated cranes, a rectifier is required to convert A.C. to D.C. to operate magnet.

c. Signal Lights. Some crane users require the use of signal lights for various purposes. Examples of some uses would be:

1. Signal light to indicate main switch on crane is closed.
2. Signal light to indicate main line contactor is closed.
3. Signal light to indicate crane is in service with operator on duty.
4. Signal light to indicate crane is not in service, and men are working on crane.

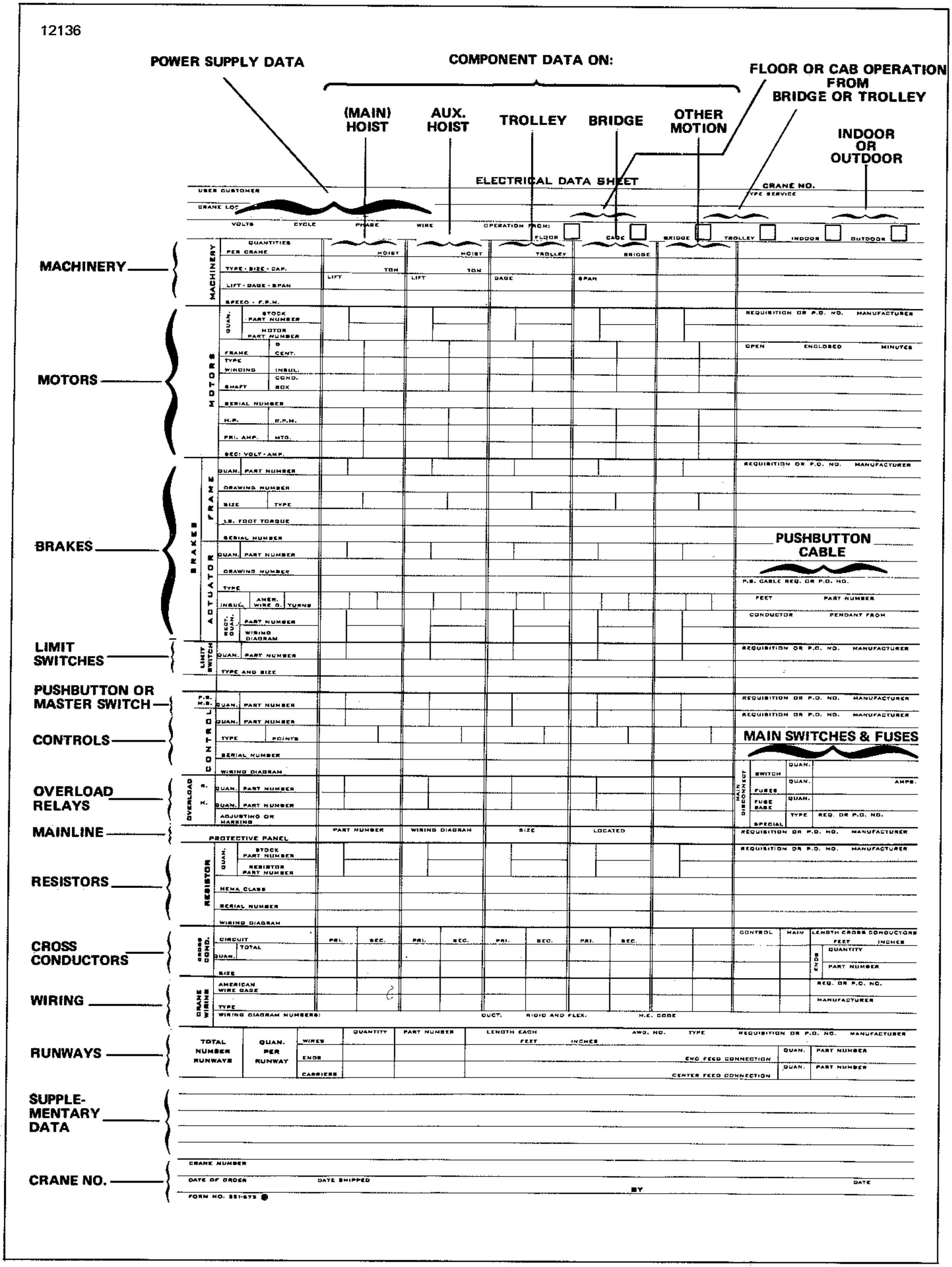
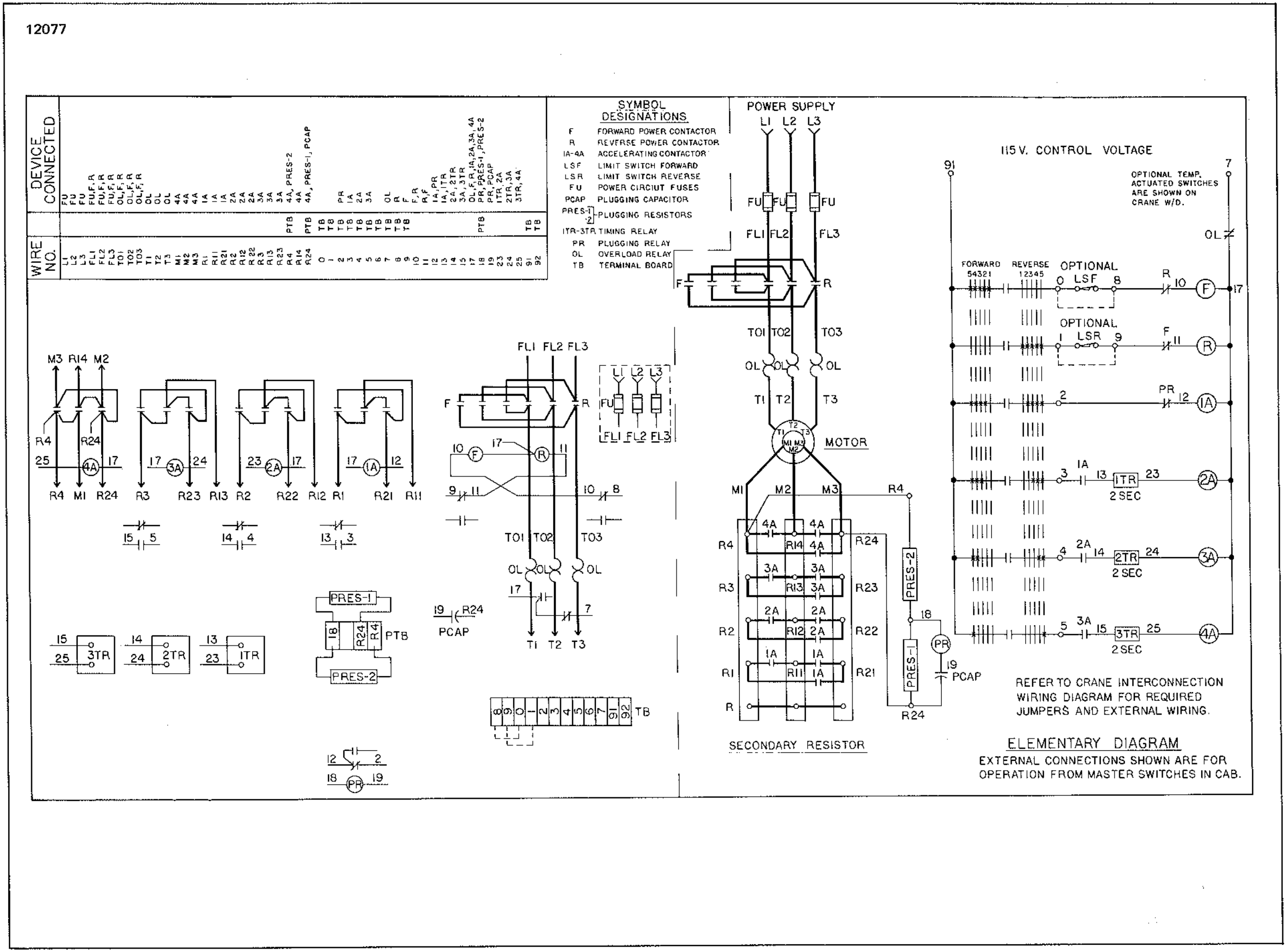


Figure 5-62. Electrical Data Sheet Form.



WIRE NO.		DEVICE CONNECTED
L1		FU
L2		FU
L3		FU
FL1		FU,F,R
FL2		FU,F,R
FL3		FU,F,R
T01		OL,F,R
T02		OL,F,R
T03		OL,F,R
T1		OL
T2		OL
T3		OL
M1		4A
M2		4A
M3		4A
R1		1A
R11		1A
R21		1A
R2		2A
R12		2A
R22		2A
R3		3A
R13		3A
R23		3A
R4	PTB	4A, PRES-2
R14		4A
R24	PTB	4A, PRES-1, PCAP
0	TB	
1	TB	
2	TB	PR
3	TB	1A
4	TB	2A
5	TB	3A
6	TB	
7	TB	OL
8	TB	R
9	TB	F
10		F,R
11		R,F
12		1A,PR
13		1A,1TR
14		2A,2TR
15		3A,3TR
17		OL,F,R,1A,2A,3A,4A
18	PTB	PR,PRES-1,PRES-2
19		PR,PCAP
23		1TR,2A
24		2TR,3A
25		3TR,4A
91	TB	
92	TB	

SYMBOL DESIGNATIONS

F	FORWARD POWER CONTACTOR
R	REVERSE POWER CONTACTOR
1A-4A	ACCELERATING CONTACTOR
LSF	LIMIT SWITCH FORWARD
LSR	LIMIT SWITCH REVERSE
FU	POWER CIRCUIT FUSES
PCAP	PLUGGING CAPACITOR
PRES-1, -2	PLUGGING RESISTORS
1TR-3TR	TIMING RELAY
PR	PLUGGING RELAY
OL	OVERLOAD RELAY
TB	TERMINAL BOARD

Figure 5-63. Typical Control Panel Wiring Diagram.

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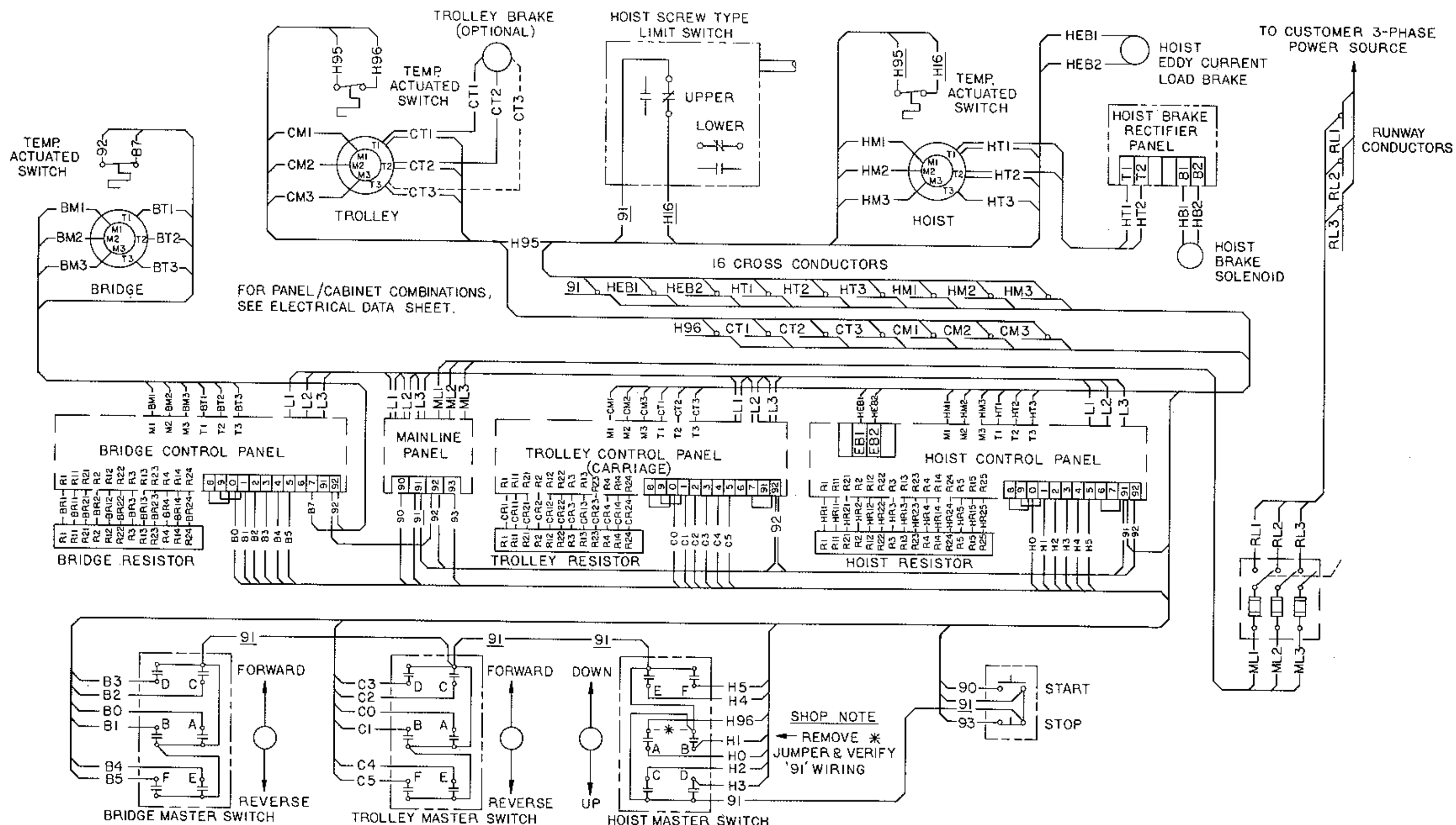

MASTER SWITCH HANDLE LOCATIONS SHOWN AS VIEWED BY OPERATOR. IF ANY MASTER SWITCHES ARE MOUNTED WITH HANDLE ON OPPOSITE SIDE, BOTH WIRES SHOWN AT CONTACT "A" ARE INTERCHANGED WITH THOSE AT "B".

Figure 5-64. Typical Crane Interconnection Wiring Diagram

5. Signal light to indicate magnet is energized.

d. Air Conditioner. On cranes used in environments where ambient temperature is high, air conditioners may be installed to keep cab at a comfortable working temperature. Air conditioners may be provided with filters to keep out impurities where surrounding air is not suitably clean.

e. Cab Heaters. Cab heaters may be furnished where additional warmth is required for operator comfort. A 2000 watt heater is a standard optional device. Heating is by natural convection.

f. Crane Lights. To provide lighting in area beneath crane, crane lights may be installed. They can be either mercury vapor or incandescent type. All fixtures are mounted to be resistant to mechanical shock to provide long lamp life. Lights are arranged for servicing from bridge platform.

g. Receptacles. Outlet receptacles may be installed to provide convenient sources of electrical power on crane for maintenance and other purposes. On A.C. cranes, additional transformer capacity is required.

h. Trolley and Bridge Limit Switches. Trolley and bridge limit switches may be provided to limit travel of bridge or trolley. They are normally connected to shut off bridge or trolley motor, whichever applies, and in direction of travel only.

i. Weighing Devices. Weighing devices may be furnished to advise operator how much load is on hook. Readout may be a digital display, calibrated scales, or printed on a card or continuous tape. The system consists of a load cell generally mounted on trolley to measure load on upper block, or it may be mounted on lower block. A brushless cable reel is required if load cell is mounted on lower block. Another brushless reel or festooned cable, is required to transfer load cell output from trolley to bridge mounted electronic panel, where load cell information is converted into output information for display or printer readout.

A variation on this system is to provide a relay output only from the electronic panel to indicate a hook overload condition. Relay would be connected in hoist control circuit to stop hoist and prevent further lifting of overload.

j. Communication Equipment. Communication equipment may be provided to enable crane operator to communicate with someone on operating floor or elsewhere. One system utilizes main runway conductors.

A radio system could also be provided. Sound powered telephones can be used for crane intercom systems.