

LUFKIN

MARK II PUMPING UNITS



OPERATOR'S MANUAL M-75

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PREFACE

The purpose of this manual is to provide a word and picture description of the erection of a LUFKIN Mark II Pumping Unit. Familiarity with the contents of this manual will provide the means for a safe, fast, and efficient installation. Recognizing that some of the procedures recommended herein will not be followed exactly, safety must be stressed. Safety must not be sacrificed for expediency.

Design of this machine is such as will permit its safe operation when performing the work for which it was designed, in the manner described in the instructions, when adequately maintained and with the care that a reasonably prudent person would use.

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I. INTRODUCTION

A. EQUIPMENT DESCRIPTION

The LUFKIN Mark II "Unitorque" Pumping Unit employs a kinematic mechanism made much like the tried and proven structural components of the conventional pumping unit. The unique design of the LUFKIN Mark II furnishes one of the most advanced and trouble free systems of rod pumping available today providing for mechanical advantages not previously thought possible.

All individual components of the unit and the unit as a whole represent the very best engineering design, production facilities, quality control, and field experience that Lufkin Industries' over 50 years of pumping unit manufacturing experience can bring to you.

The LUFKIN Mark II Unit must be properly installed and maintained for satisfactory service. Your LUFKIN Mark II Unit will give many years of dependable service when properly maintained and operated within its load and torque ratings.

B. SAFETY FIRST

ALL MECHANICAL SUCKER ROD PUMPING UNITS, OF NECESSITY, HAVE LARGE AND HEAVY ROTATING PARTS. IT IS ESSENTIAL THAT ALL PERSONNEL INVOLVED IN THE ERECTION, OPERATION, AND MAINTENANCE OF PUMPING UNITS USE EXTREME CARE, AT ALL TIMES, WHEN WORKING NEAR THESE HEAVY ROTATING PARTS. FAILURE TO DO SO CAN CAUSE SEVERE BODILY INJURY OR DEATH.

EVEN A TEMPORARILY STATIONARY PUMPING UNIT HAS COMPONENTS WHICH CAN START MOVING FROM THE EFFECT OF GRAVITY. ALL PERSONNEL SHOULD STAY CLEAR OF THE CRANKS AND COUNTER-WEIGHTS OR OTHER ELEMENTS WHICH MAY START MOVING. TIMES OF PARTICULAR DANGER FROM ROTATING OR MOVING PARTS WOULD BE DURING UNIT ERECTION, STROKE CHANGE, COUNTERBALANCE CHANGE, GENERAL UNIT MAINTENANCE, WELL SERVICING, AND WHILE TAKING DYNAMOMETER CARDS. IT IS ESSENTIAL TO PREVENT ROTATION OF THE CRANKS STOPPED IN ANY POSITION FOR THE PURPOSE OF SERVICE OR MAINTENANCE OF ANY KIND. THREAD A STURDY CHAIN THROUGH THE HOLE IN THE BRAKE DRUM NEAREST THE BRAKE TRUNNION AND THEN AROUND THE TRUNNION; SNUG UP THE CHAIN AND ATTACH THE HOOK END AROUND A LINK. ANOTHER COMMONLY USED SAFETY PROCEDURE IS TO PLACE HEAVY TIMBERS UNDER CRANKS. IF THE LONG END OF THE CRANKS ARE STRAIGHT DOWN, NO ROTATION WILL START PROVIDED THE CARRIER BAR HAS NOT YET BEEN ATTACHED TO THE POLISHED ROD OR THE WELL IS CLAMPED OFF. ON UNITS EQUIPPED WITH THE POSITIVE STOP BRAKE, THE PAWL CAN BE ENGAGED IN A NOTCH IN THE DRUM TO PREVENT CRANK ROTATION.

CHAINS AND CABLE SLINGS USED IN THE ERECTION OF THE UNIT SHOULD HAVE A LOAD TEST CERTIFICATION TAG ATTACHED AND MUST NOT BE USED FOR LOADS BEYOND THAT CERTIFIED TO BE SAFE. A VISUAL DAILY INSPECTION OF CHAIN AND CABLE SLINGS AND A MONTHLY INSPECTION VERIFIED BY A SIGNED REPORT ARE REQUIRED.

CAUTION: STAY CLEAR OF ROTATING CRANKS AND COUNTER-WEIGHTS AND PARTS THAT MAY START MOVING, OTHERWISE SERIOUS PERSONAL INJURY MAY OCCUR.

II. FOUNDATION

A. GENERAL

The Mark II foundation should be constructed in accordance with a current foundation plan only. A copy of this plan is shipped with the unit. The foundation plan gives the minimum foundation required for soil with a minimum bearing strength of 1500 lbs per square foot. Increase the size of the foundation proportionally for soils with less bearing strength.

Grade the site for the foundation for adequate drainage. Poor drainage usually results in the foundation settling unevenly causing undue stresses in the unit base and subsequent failure.

Foundation hold down bolt locations along with size and number required are shown on the plan. Locations are shown with respect to the well head. Hold down clamps are usually furnished with the unit. Recommendations for tightening bolts given in Section IX should be followed.

B. WELL HEAD CLEARANCE

Carrier bar clearance from the bottom of the pumping unit base is shown on the foundation plan. This should be considered when the grade height of the foundation is established. At least 32 inches clearance is required between the carrier bar and well head stuffing box with the polish rod at the bottom of the stroke if clearance to sling a dynamometer beneath the carrier bar is desired.

The polish rod should be vertical to minimize stuffing box wear and to aid in the alignment of the unit.

C. ALIGNMENT MARKS

The pumping unit base has center marks on the edges of the bottom flanges of the front and rear cross members. The foundation (including poured concrete, pre-cast concrete, and board mat) must also have a center line and a lateral line (or mark) showing the distance between the polished rod and front cross member on the unit base. Strike a center line from front to rear of the foundation by stretching a chalk line from the center of the well head across the top of the block and midway between anchor nuts. The initial alignment involves matching the center lines on the base and foundation and placing the base the proper distance from the polished rod.

D. TYPES OF FOUNDATIONS

1. Poured Concrete

The foundation print shows the minimum area and depth of concrete along with steel requirements to support the pumping load. These recommendations should be followed closely.

After the steel is placed in the form, prepare a wooden template as shown in Fig. 1, drill the template using the foundation plan for anchor nut locations. Screw the hold down bolts into the anchor nuts and locate template over foundation form so that anchor nuts will be flush with the top of the concrete. A hex nut may be used on the hold down bolts on the top side of the template to hold anchor nuts tightly against template.

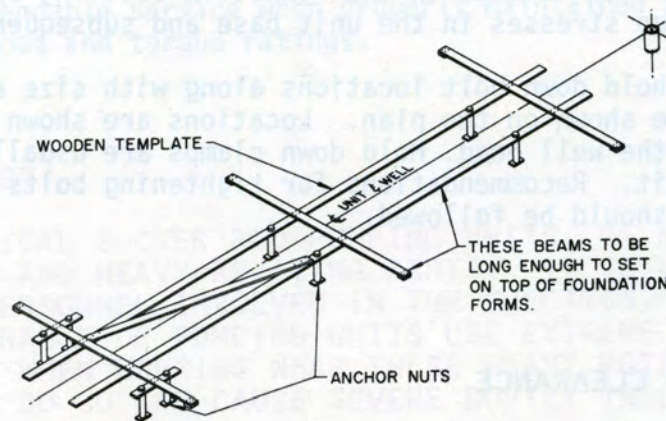


Figure 1

After anchor nuts are properly located, pour foundation and dress off smooth and level. When this type of foundation is used, it must be allowed to set a sufficient time to attain adequate strength before tightening foundation bolts. Note the center line and cross mark used to locate the base on the foundation in Fig. 2.

2. Precast Concrete

Precast blocks are used frequently for standard base units and two-point base units discussed in II. D.4. The site should be graded for proper drainage and consideration should be given to size of the block with respect to bearing strength of the soil. The Mark II unit furnished with a standard base (not two-point) transmits an up load to the rear of the foundation; this must be considered in the design of the precast blocks for adequate strength. The loading on the foundation of a two-point installation is down at both front and rear of the unit.

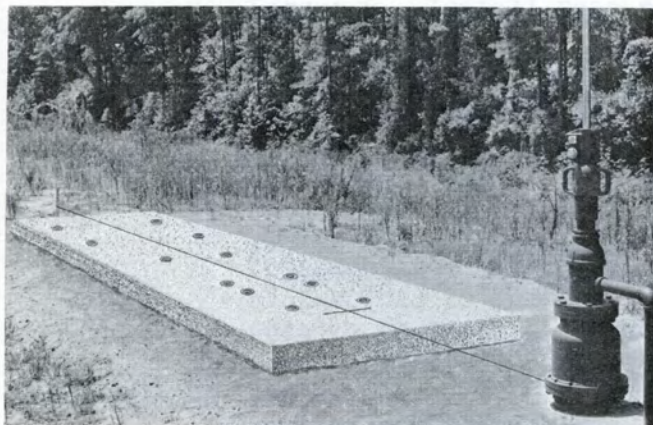


Figure 2



Figure 3

3. Board Mat

A board mat type foundation as illustrated in Fig. 3 may be used with a portable base unit. The installation plan furnished with the unit gives timber size and spacing in relation to the well head along with suggested subsoil preparation. Earth anchors must be provided at the rear of the base to hold the unit down. Note the centerline and cross mark on the timbers used to locate the unit base; the cross mark is the distance from the well head to the first cross member of the base. Board mat foundations may also be used for two-point installations.

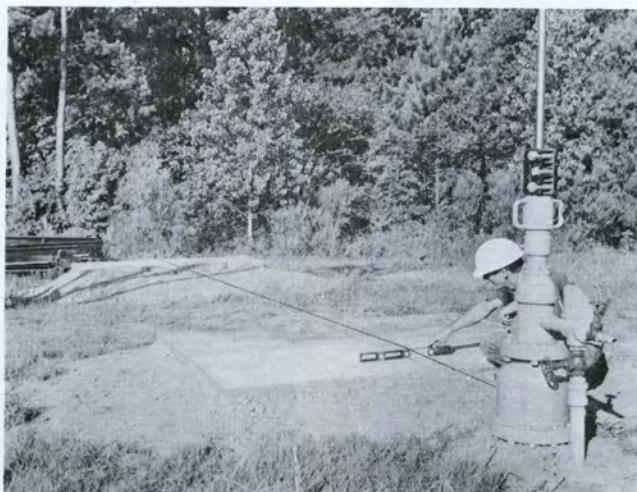


Figure 4

4. Two-point Foundation

A special designed base for the Mark II Pumping unit lends the unit to a very economical two-point installation. A foundation support is required only at the front and rear of the unit. The loads transmitted to the foundation are down at both ends of the base.

The foundation print specifies the minimum size block for soil with a bearing strength of 1500 pounds per square foot. Increase block size as required to meet soil conditions.

Poured concrete, precast concrete or board mat type of foundations may be used for two-point installations. In all cases provisions must be made to keep the base from shifting on the foundation. Hold down clamps are generally used with concrete foundations and earth anchors are used with board mat foundations. See Fig. 4 for a typical installation. Concrete blocks must be level. A chalk line is shown down the center of the foundation to locate the unit base. Also a cross mark locating the front cross member of the base is shown.

E. GROUTING CONCRETE FOUNDATIONS

When the base is to be grouted in place, unit erection and alignment must be done with the base supported on spacers or wedges above the concrete. After final alignment, work grout in under the base and allow to set before tightening hold down bolts.

III. ERECTION OF UNIT

A. EQUIPMENT REQUIRED

Hook heights required and maximum weights to be lifted are given in the Addendum, Section X, Table 2. This information may be used to select gin pole or crane equipment necessary for the erection of the unit.

B. UNIT ERECTION PROCEDURE

The following picture and word description of the erection of a Mark II pumping unit gives the general sequence to be followed along with precautions and alignment checks.

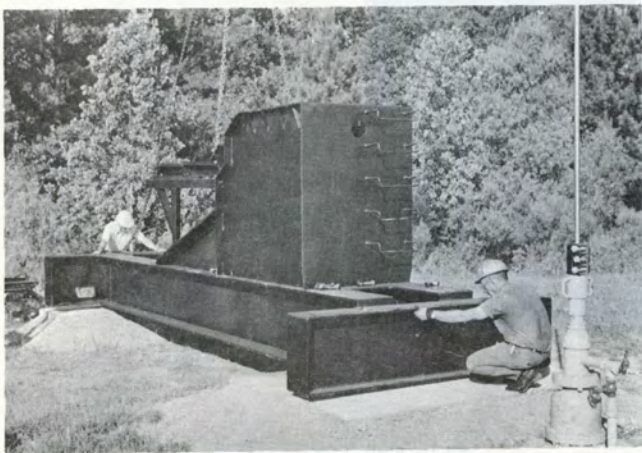


Figure 5

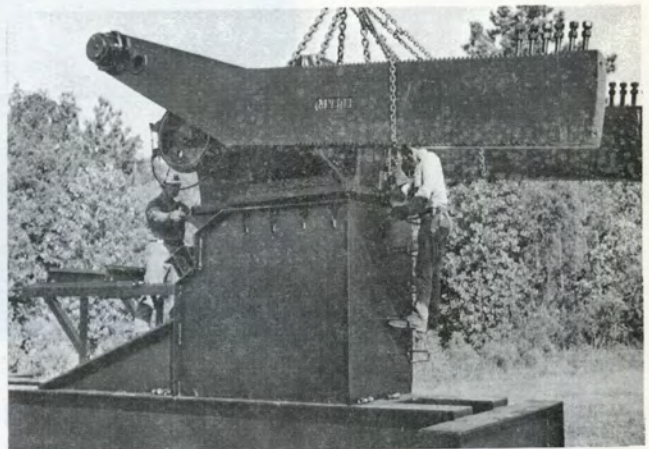


Figure 6

1. Figure 5 - Set base on foundation

Lift the base in a level position and place on foundation. Align center line marks on the bottom flanges of the front and rear base cross members with the center line mark on the foundation. Position the front cross member of the base the correct distance from the center of the well head. If unit is to be grouted in, wedge spacers are inserted several places along the main base members at this stage.

2. Figure 6 - Install gear reducer on sub-base

Engage the brake using the shipping screw and positive stop pawl - see "Brake Installation and Adjustment" in Section XI. Attach slings to the gear reducer and both cranks to stabilize the load. Do not allow sling to bear against the slow speed shaft oil seal or breakage will result. Clean the top of the sub-base and the bottom of the gear reducer. Do not stand under any part of the load to prevent a serious injury in case the load were to be dropped. Place the gear reducer on the sub-base and install the bolts but leave them loose so reducer can be shifted for alignment. See procedure III. B.4 for tightening instructions.

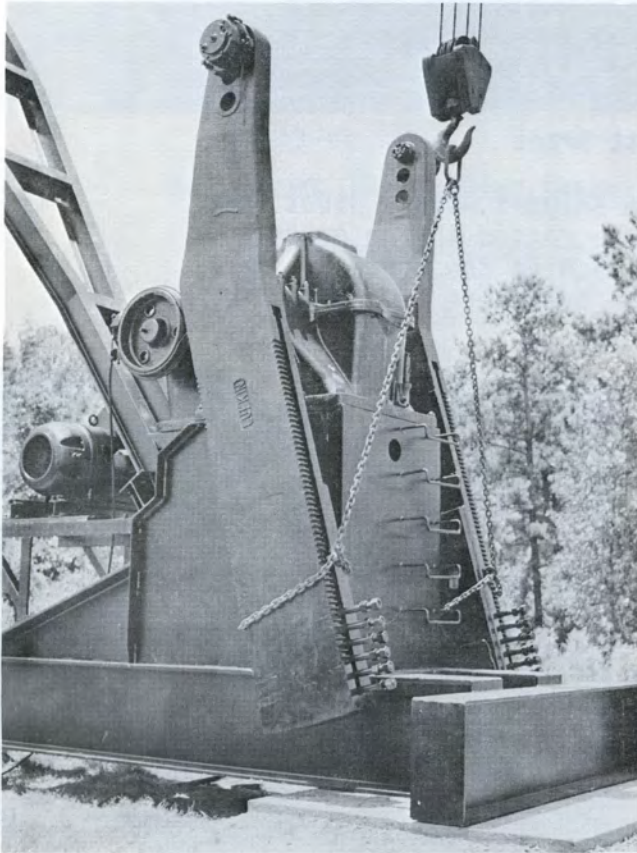


Figure 7

3. Figure 7 - Rotate cranks

The cranks should now be rotated to a safe position; long end down. Clear all objects and personnel away from the sweep of the cranks, disengage the positive stop pawl and then gradually loosen the shipping screw allowing the cranks to rotate slowly until they stop at bottom dead center. Make sure that you are safely in between the two crank sweeps during the operation.

When it becomes necessary to rotate the cranks to another position attach chains or cables to both cranks as shown. Use a long sling to minimize excessive stress on the sling and cranks. Engage the positive stop pawl and set the brake using the shipping screw after the cranks are in the desired position.



Figure 8

4. Figure 8 - Align the gear reducer.

Use a piece of wire with a hook on each end to attach a tape at the slow speed shaft as shown. Position the gear gear reducer on the sub-base until the distance from the crank shaft to the samson post bolt holes on the base is the same on each side of the unit.

Tighten the bolts attaching the gear reducer to sub-base following the recommendations given under "Fasteners" in Section IX.

5. Figure 9 - Brake system Installation and Adjustment

Follow the procedure outlined in Section XI. for the installation of the brake control lever and brake cable and for the adjustment of the brake.

6. Figure 10 - Assemble Samson Post Brace

The post and brace assembly are shipped with a pivot bolt in place allowing the brace to be raised to the proper position. Install all bolts attaching the brace to the post, but leave them loose. See procedure III. B.8. for tightening instruction.

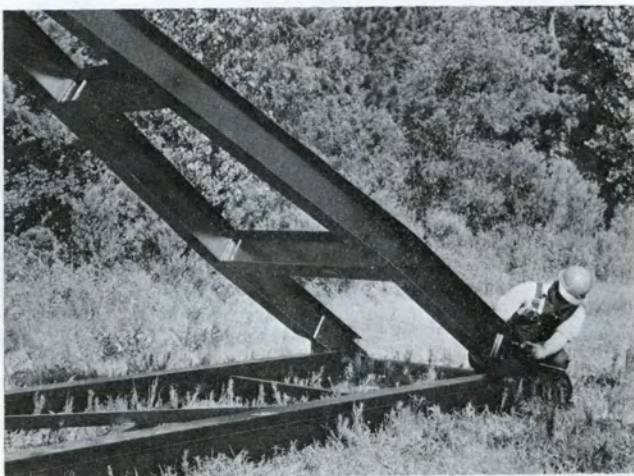


Figure 10

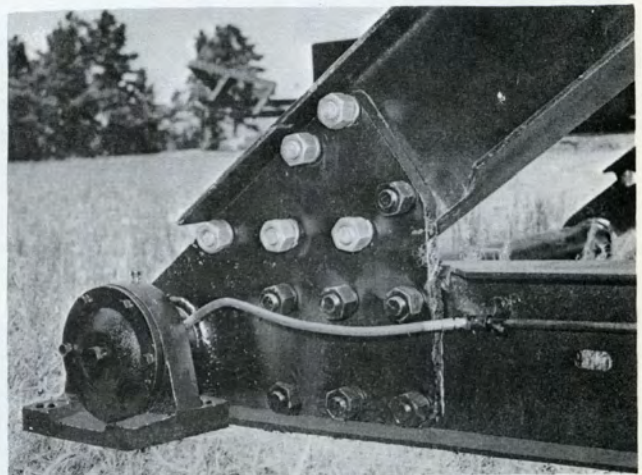


Figure 11

7. Figure 11 - Samson Post Bearing Ground Oiling Hoses

Install the ground oiling hoses as shown; one hose goes to each bearing assembly. Care should be taken to keep the fittings clean so dirt is not introduced into the bearing.

8. Figure 12 - Install Samson Post Assembly

Lift the post assembly with a sling attached near the top cross member of the brace. This will hang the post in a near level position for easy attachment to the base. Install the bolts attaching the angle brace and main post members to the base. Tighten these bolts and the bolts at the samson post bearing assembly following the recommendations under "Fasteners" in Section IX.

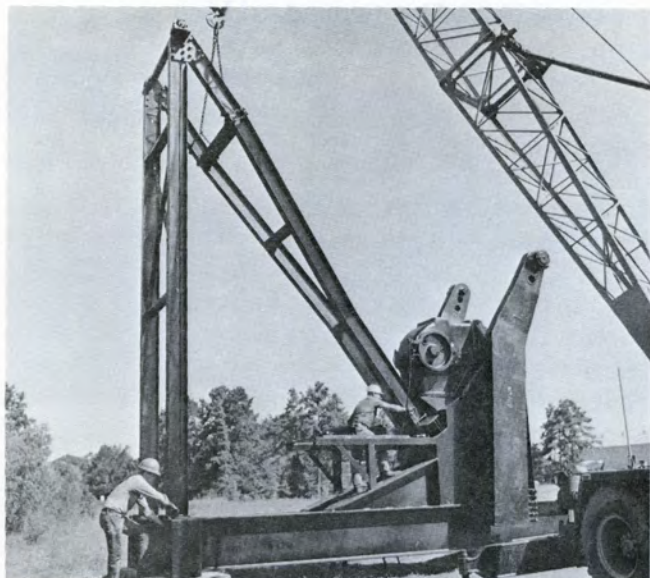


Figure 12



Figure 13

9. Figure 13 - Ladder Installation

The ladder attaches directly to the samson post or to brackets attached to the post leg as shown. Install bolts and tighten following the recommendations given under "Fasteners" in Section IX.

10. Figure 14 - Rotate Cranks

Position the cranks so that the crank pin holes are at bottom dead center in preparation for the installation of the walking beam, cross yoke, and pitman assembly. Use the procedure describes in 3 above to attach the sling. Engage the positive stop pawl (See Section XI) and set the brake using the brake control lever before releasing the lifting line. Use extreme caution to stay clear of the crank sweep with the cranks in this position to avoid serious personal injury.

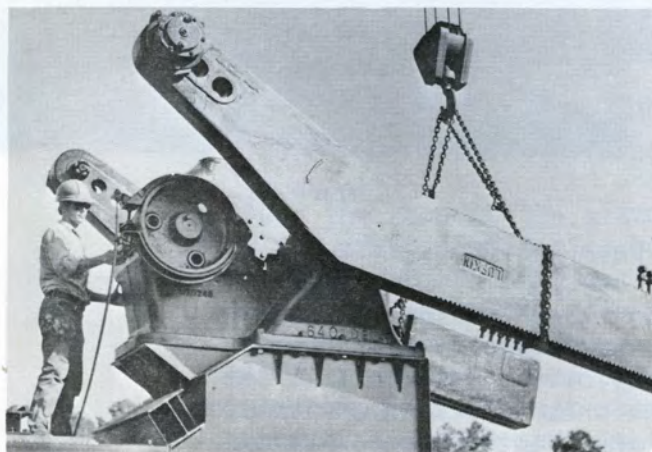


Figure 14



Figure 15a

11. Figure 15a, 15b, - Assemble Cross Yoke and Pitmans

Position the pitmans on the ground as shown in Figure 15a, spaced several inches farther apart than the distance between the vertical spacers in the cross yoke on either

side of the cross yoke bearing assembly. The ground oiling lines on the pitmans should be up. Lower the cross yoke over the pitmans.

CAUTION: Be sure there is a rubber cushion against the top of the pitman side member pocket at each end of the cross yoke. If the unit is operated without these cushions serious damage may result.

Lift each pitman side member and pull it away from the cross yoke as far as it will go as shown in Figure 15b. This positions the side member so that the pivot pins welded to the pipe contact the outer retaining strips on the ends of the cross yoke. In this position the side members will swing down to a vertical position as the assembly is later lifted.

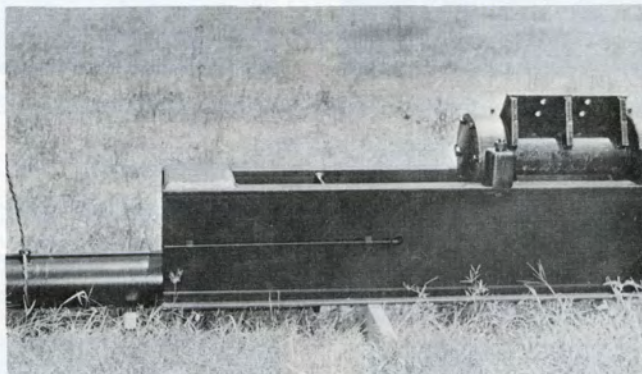


Figure 15b

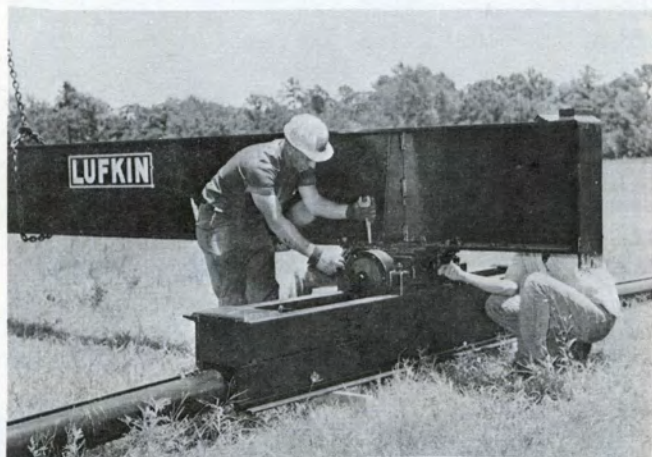


Figure 16

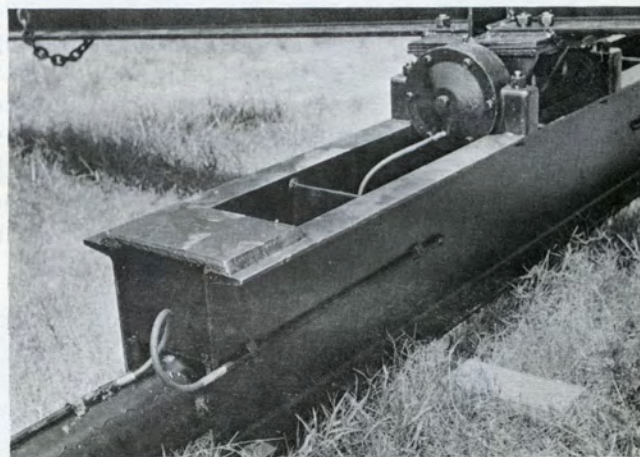


Figure 17

12. Figure 16 - Assemble Walking Beam and Cross Yoke.

The hole pattern in the bottom flange of the beam and cross yoke bearing seat is unsymmetrically arranged so that they bolt together one way only. The front of the bearing seat bears against the shear block on the bottom flange of the beam. Install and tighten the six bolts following recommendations given under "Fasteners" in Section IX.

13. Figure 17 - Cross Yoke Bearing Lubrication Hoses

Install the hoses before the assembly is lifted for convenience. Two hoses are required for each bearing.



Figure 18



Figure 19

- 14. Figure 18 - Lift Beam, Cross Yoke and Pitman Assembly

Use a double sling to help stabilize the lift. The balance point for most assemblies is around the "LUFKIN" nameplate attached to the beam. As the assembly is lifted, the pitman side members will swing down to a vertical position.

- 15. Figure 19 - Connect Walking Beam to Samson Post Bearing Housings

Align holes in the rear cross beam with the holes in the bearing housings and install bolts. Shims are furnished for alignment purposes but are not installed at this time. Tighten the bolts following the recommendations given under "Fasteners" in Section IX.

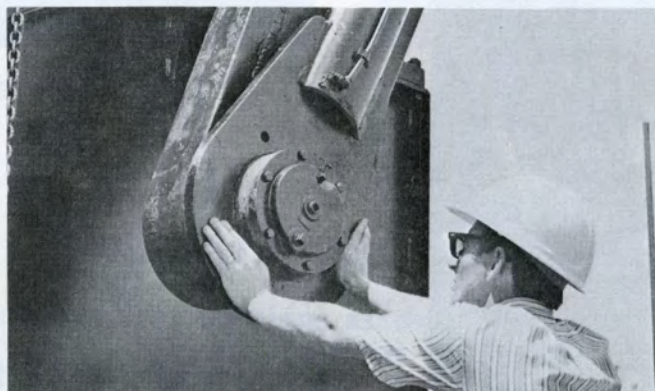


Figure 20

- 16. Figure 20 - Connect Pitmans to Crank Pins

Clean the bore of the pitman end connection and the outside of the crank pin bearing housing. Scrape off all paint and remove any burrs that would prevent the parts from assembling. Remove the three cap screws from the bearing housing outer flange. Line up the holes in the bearing housing flange with the holes in the lower pitman connection and push the pitman connection on. Do not use a hammer as this will damage the bearing. Install and tighten cap screws per "Fasteners" in Section IX.

Lower the beam and cross yoke allowing the upper end of the pitmans to seat against the rubber cushions in the cross yoke. Care should be taken to see that both pitmans go all the way into the cross yoke pockets and do not bind in some intermediate position.



Figure 21a

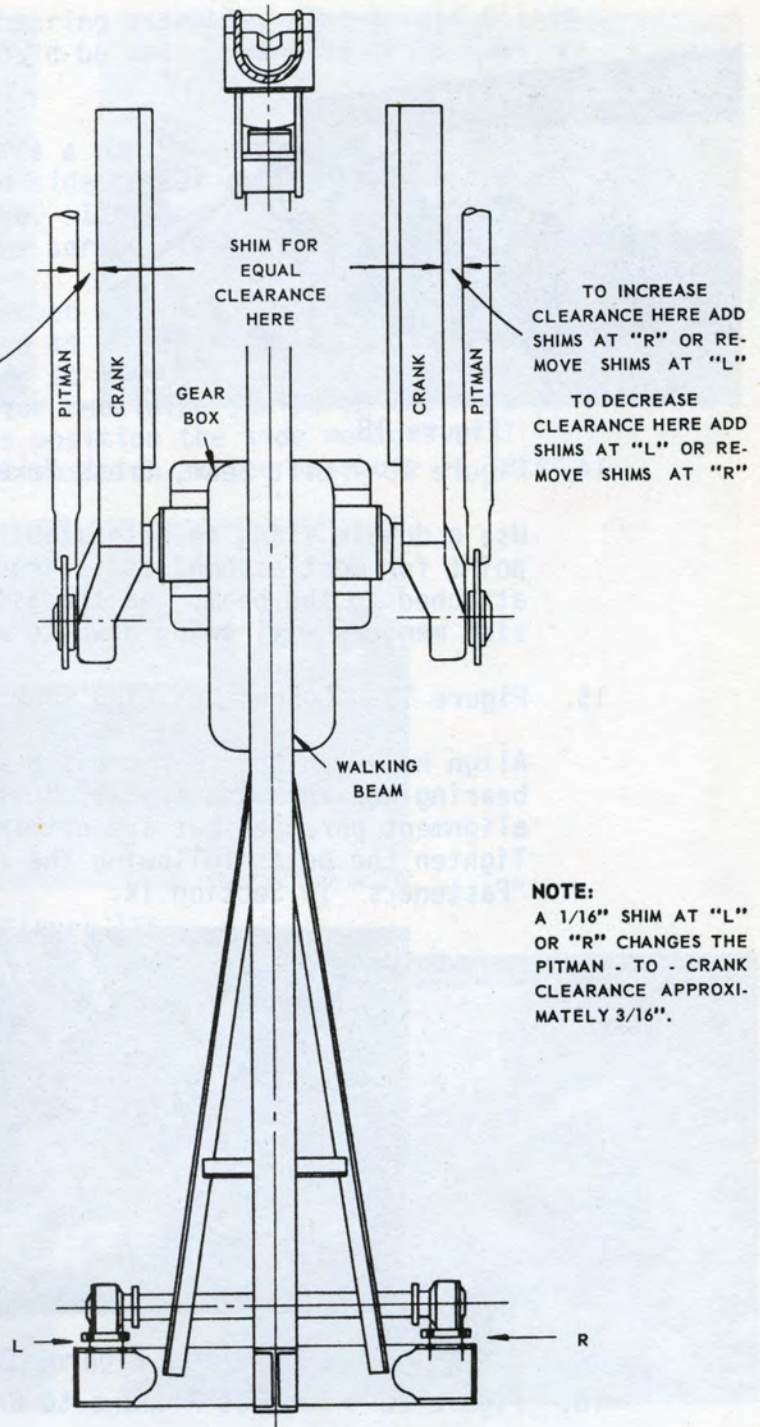


Figure 21b

17. Figure 21a, 21b - Alignment Check

With the cranks still in a vertical position, check the spacing between the pitman side member and crank on each side of the unit as shown in Figure 21a. Follow the instruction given in Figure 21b, if alignment adjustment is required. Be sure that the same number and thickness shims are used under both pads of the bearing housing being shimmed to prevent misalignment of the bearing.



Figure 22a



Figure 22b

18. Figure 22a, 22b - Install Wireline on Horsehead

Two basic types of wireline assemblies are furnished on Mark II units. Figure 22a shows the installation of a two-piece line utilizing an equalizer sheave which attaches to the horsehead. The bottom side of the sheave bears against the curved wireline seat welded to the head. A hook on the bottom of the sheave extends under the top plate on the head. A single bolt with a large washer retains the assembly.

Figure 22b illustrates the installation of a one-piece wire line assembly. The line fits directly against the curved wireline seat and is held by a retainer and one bolt. Note how the loop in the line is held well beyond the top of the head to make installation of the retainer easier. Tighten the retaining bolt per "Fasteners" in Section IX.

19. Figure 23 - Install Wireline bail

The purpose of the bail is to prevent the wireline from sliding off the side of the head in the event slack occurs in the line. Bails are furnished on all sizes of Mark II units. Simply drop the pins on the bail into the pipe sockets on the side of the horsehead.

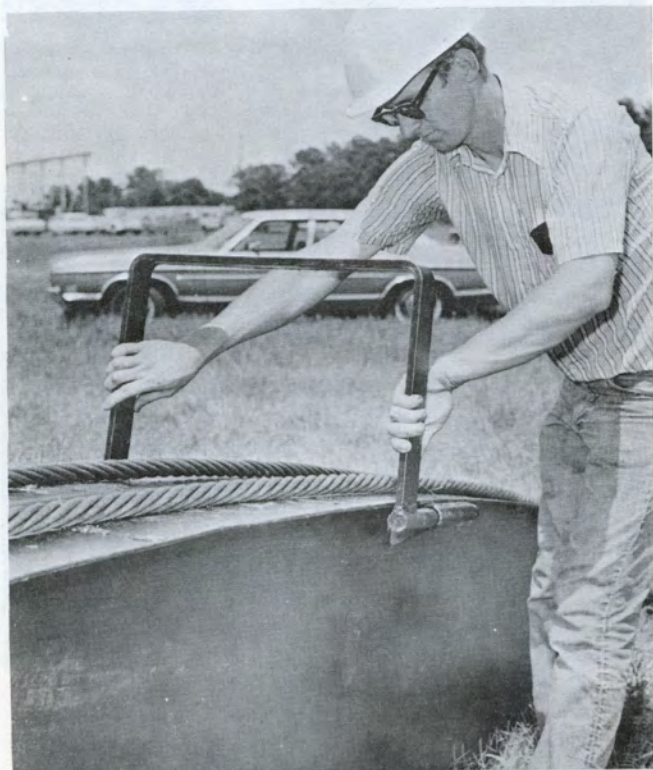


Figure 23



Figure 24

20. Figure 24 - Install Horsehead

Before lifting the head, turn the horsehead adjusting screws on the side of the head out until they are flush on the inside. Lift the head and place it on the beam. The rocker plate on the inside of the head fits between the heavy seat bar and the angle iron spacer on the top flange of the walking beam. Allow the head to swing down so that the bumper plate in the head contacts the front plate in the beam. Be sure that the rocker plate in the head fits firmly against the top flange of the beam and is between the seat bar and angle spacer.

Units that are 100 inch stroke length and larger are equipped with horsehead safety bars. The bar installs thru the slots in the side of the head and thru the angle welded to the front plate of the beam. Reposition the roll pin in the bar to keep the bar from sliding out if required. The roll pin bears against the inside of the side plate of the head.

21. Figure 25 - Adjust Horsehead

Release the brake and allow the cranks to rotate until the walking beam is in a horizontal position. Take precautions to be sure that all personnel are clear of the crank sweep and all other moving parts of the unit. Reset the brake and engage the positive stop pawl (See Section XI). Use a plumb bob or accurate level to adjust the head to a vertical position. Tighten both adjusting screws firmly against the lower flange of the walking beam and lock into position with the jam nuts.



Figure 25



Figure 26

22. Figure 26 - Final Unit Alignment with Well

Lower a plumb bob from the center of the top of the head down to the polish rod. Establish the distance from the string to the center of the wire rope and account for this when checking the alignment from the polished rod. Be sure that Step 17 has been completed before making this check. Move the base on the foundation if adjustment is required.

Install foundation hold down clamps and tighten bolts according to the recommendations given under "Fasteners" in Section IX.

23. Figure 27 - Install Master Counterweights

Disengage the positive stop pawl and release the brake and allow the long end of the cranks to rotate straight down. Take precautions to be sure that all personnel are clear of the crank sweep and all other moving parts of the unit. Set the brake and engage the positive stop pawl.

Slide the counterweight bolts into the tee slot of the crank thru the cored hole near the crank shaft. Lift the counterweight with a sling as shown in Fig. 27. On symmetrical weights the recess for the adjusting pinion (See Fig. 38) goes toward the long end of the cranks. On small unsymmetrical weights, the curved part of the weight goes toward the long end of the crank. Line the counterweight bolts up with the holes in the weights and swing the weight into position against the face of the crank. To avoid injury to fingers and hands, hold the bolts with a large channel lock pliers or other suitable tool. Install the nuts and tighten according to the recommendations given under "Fasteners" in Section IX. Install a second nut as a jam nut.

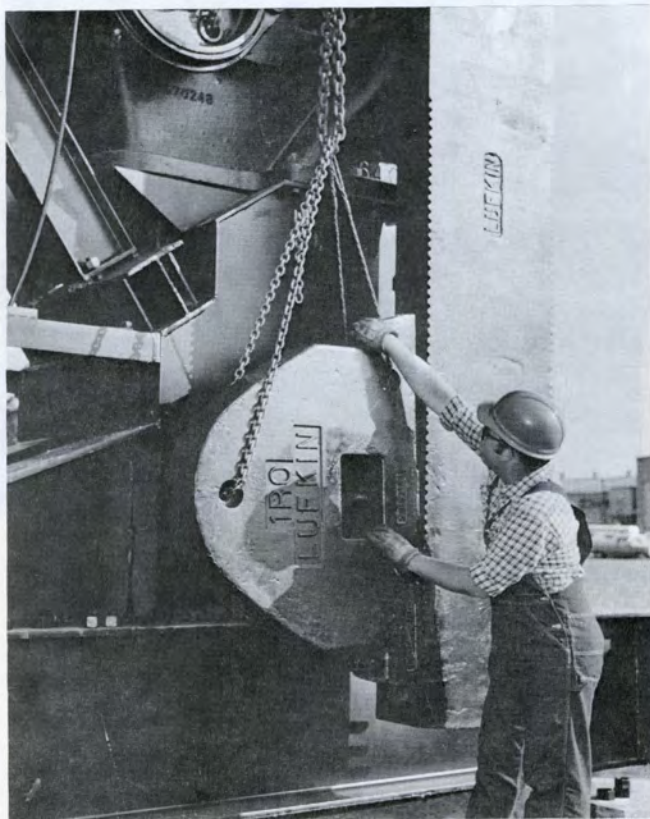


Figure 27



Figure 28

24. Figure 28 - Auxiliary Weight Installation

Pass a bar or chain thru the lifting hole in the top of the weight and lift into position on the inside face of the master weight. Use a bar as a pivot thru one bolt hole as shown and allow the weight to rotate down until the other bolt holes line up. Install two bolts, remove the pivot bar and install the third bolt. Tighten the bolts according to the recommendations given under "Fasteners" in Section IX.

25. Figure 29 - Install Prime Mover

The prime mover may be a slow speed engine, multicylinder engine, or an electric motor as illustrated. The installation procedure for each is similar.

Position the cross rails on the tee slots near the end toward the gear reducer so the belts can be installed. Space the cross rails to match the mounting holes on the motor. Similarly install and space the bolts in the tee slots on the cross rails. Carefully lower the motor onto the cross rails; guide the bolts into the holes in the motor feet using pliers or other tools to prevent injury to fingers and hands. Install the nuts but do not tighten until belt alignment is completed.

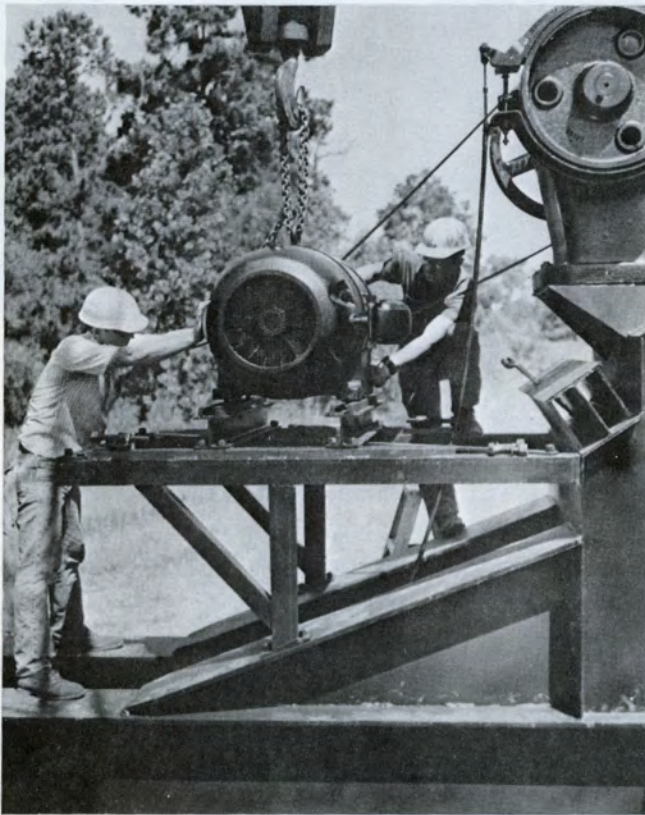


Figure 29

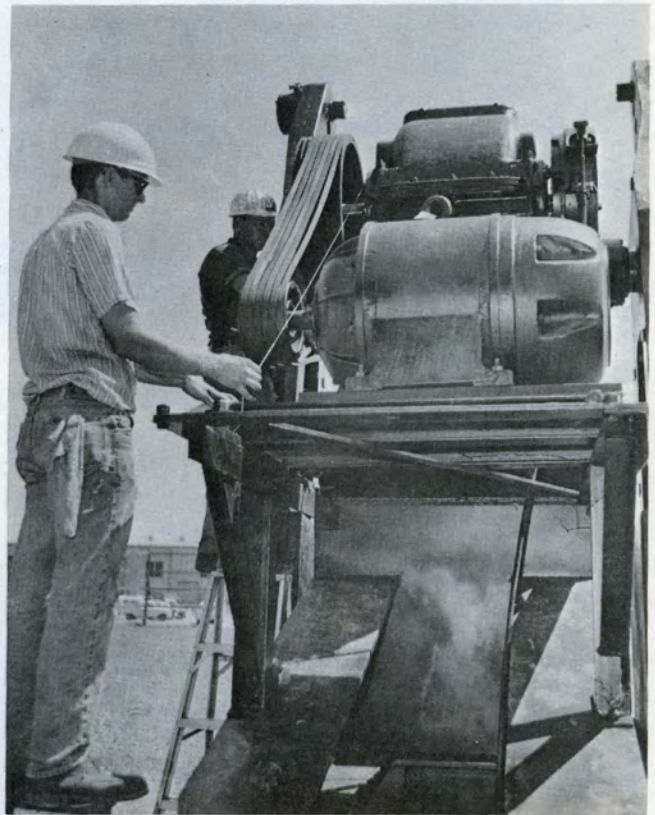


Figure 30

26. Figure 30 - Install and Align "V" Belts

Install a matched set of belts using the inside grooves if either sheave has an excess number of grooves. Use a string to line up the inside faces of the sheaves as shown. Shift the motor as required and then tighten the bolts attaching the motor to the cross rails. Tighten belts by using the adjusting screws; a few pounds of finger pressure on one belt midway between sheaves should deflect the belt one to two inches. Tighten the bolts attaching the cross rails to the tee slots following recommendations given under "Fasteners" in Section IX.

27. Figure 31 - Install Belt Cover

Remove the bottom pan from the cover and install the cover. The front support fits over two slow speed shaft studs on the reducer and is retained by the jam nuts furnished. The rear support fits on the base. Install the center support if furnished. Check inside the cover to be sure sheaves and belts have adequate clearance; the cover can be shifted sideways to adjust clearance. Replace the bottom pan and tighten all bolts following the recommendations given under "Fasteners" in Section IX.

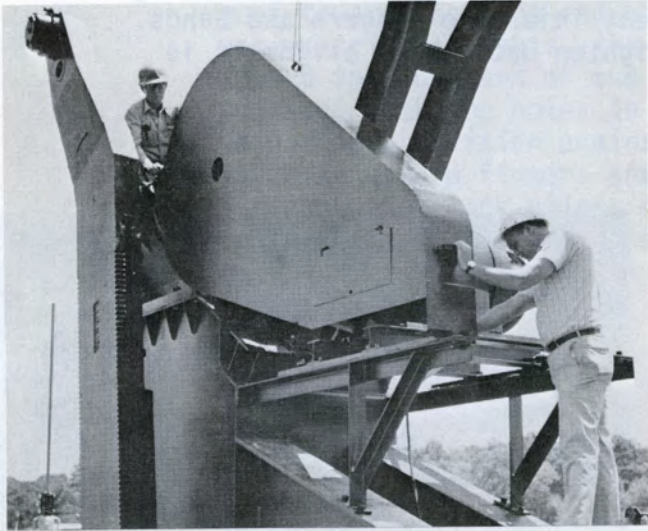


Figure 31

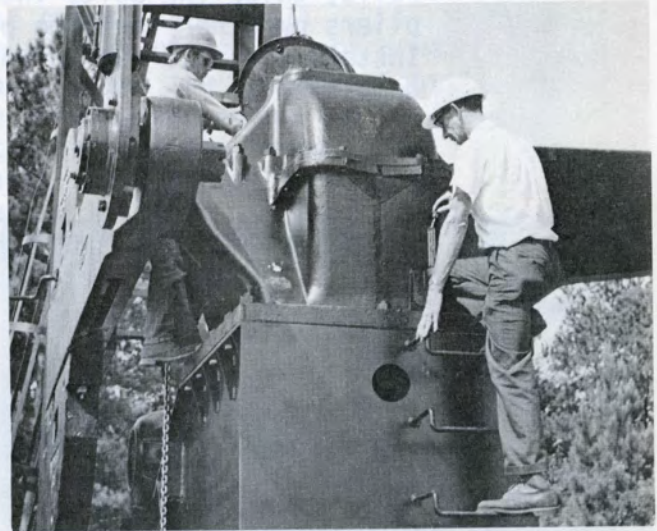


Figure 32

28. Figure 32 - Gear Reducer Lubrication

See Section III for lubrication specifications and amount required. Check oil level at the dip stick at the front of the gear reducer.

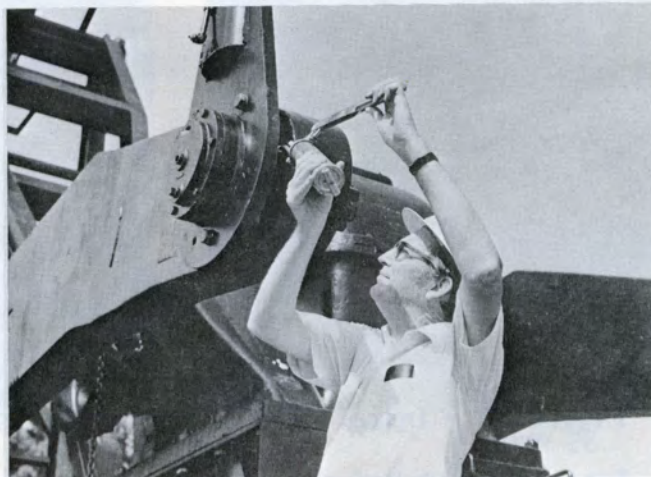


Figure 33

29. Figure 33 - Grease Crank Pin Bearings

Bearing assemblies are lubricated at the factory, however, it is a good practice to check the assemblies. Using a grease as specified in Section VI, pump grease into the bearing assembly until it overflows thru the relief fitting located in the upper part of the end cap. Pump grease in slowly to avoid damage to the seals.

30. Figure 34 - Grease Cross Yoke Bearing

Bearing assemblies are lubricated at the factory, however, it is a good practice to check the assemblies. The grease fittings for the cross yoke bearings are located on the pitman side members just above the crank pin bearings. Using a grease as specified in Section VI, pump grease into the bearing assembly until it overflows thru the relief fitting located in the bearing housing. Oil lines are pre-lubricated, therefore, only a small amount of grease should be required for this check. Pump grease in slowly to avoid damage to the seals.



Figure 34



Figure 35

31. Figure 35 - Grease Samson Post Bearings

Bearing assemblies are lubricated at the factory, however, it is a good practice to check the assemblies. The grease fittings for the samson post bearings are located near the bottom of the post legs. Using a grease as specified in Section VI, pump grease into the bearing assembly until it overflows thru the relief fitting located in the end cap on the bearing housing. Oil lines are pre-lubricated, therefore, only a small amount of grease should be required for this check. Pump the grease in slowly to avoid damage to the seals.

32. Figure 36 - Install Crank Guards

Schematic installation instructions are furnished for the crank guards. A typical rail type guard is shown in Figure 36. Install all brackets and clamps and tighten bolts according to the recommendations given under "Fasteners" in Section IX. All guards must be in place before operating the unit.

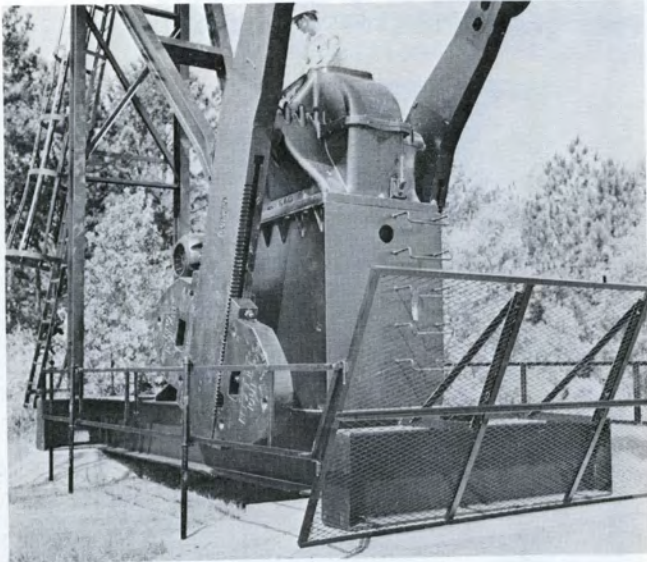


Figure 36

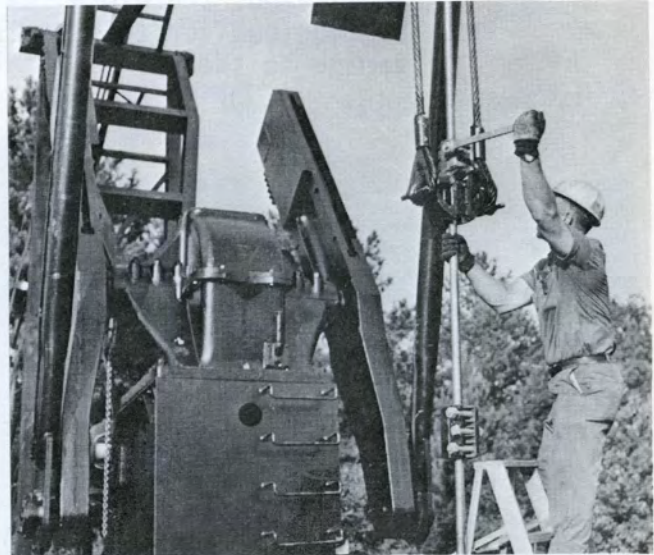


Figure 37

33. Figure 37 - Connect Carrier Bar to Polished Rod

Position the unit in the same stroke positions as the bottom hole pump. Usually this is at bottom stroke position. Remove the gate from the carrier bar and slide the polished rod into the carrier bar slot. Replace the gate and secure the gate latch in the notch provided. Install the rod clamp and tighten bolts according to the clamp manufacturers torque recommendations. Remove the rod clamp on the well stuffing box.

IV. OPERATION

A. STARTING THE UNIT FOR THE FIRST TIME

1. Before starting checks

Some of these items have been covered in the erection procedure but some time may have elapsed since the erection of the unit and other work may have been done on or around the unit so these items should be checked.

- a. Oil in gear reducer.
Running the reducer without oil at the proper level will result in severe damage.
- b. Clear crank sweep
Remove all tools, timbers or any other obstruction on the unit itself and on the foundation in the path of the cranks.

- c. All guards in place
Safety rules dictate that all guards must be in place before operating the unit.
- d. Disengage positive stop brake
The pawl must be disengaged from the brake drum before attempting to start the unit. See Section XI for further details.

2. Direction of Rotation

The Mark II Unit is designed to operate in only one direction of rotation. The cranks must rotate counter-clockwise when standing at the side of the unit with the well head to the right. An arrow cast on each crank indicates the correct rotation.

3. First Crank Revolution

The first revolution of the crank should be as slow as possible. Check for proper clearance between cranks and belt cover, crank guards, and pitman side members. Bottom hole pump spacing should also be checked during the first stroke.

B. COUNTERBALANCE ADJUSTMENT

1. Determining counterbalance required

Efficient operation, minimum torque loading, and maximum life of a pumping unit are all a result of proper counterbalance. Counterbalance requirements can be determined very accurately or estimated by several methods.

a. Polished rod dynamometer

Dynamometer card analysis is the most accurate method used to determine loading and counterbalance. This involves using a dynamometer to record the well load through a stroke cycle and then using torque factors to determine the gear reducer torque and counterbalance required for balanced conditions.

b. Ammeter

A clip-on ammeter may be used to compare the up stroke and down stroke current on electrically powered units. When the counterbalance is adjusted so that the current peaks are equal, the unit will be approximately in balance.

c. Vacuum Gauge

A vacuum gauge may be used to compare torque peaks on engine driven units much like the ammeter is used on electrically driven units. Vacuum pressure decreases as engine output increases.

d. Sound of the prime mover

A rough estimate of balance can be made by listening to the characteristic sound of the prime mover as it drives the unit. Some speed change will occur as the peak loads are approached; this speed change will cause the sound of the prime mover to change.

e. Tension in the belts

Belt tension and consequently belt stretch increase with load causing an apportionate amount of slack on the opposite side of the drive. A comparison of the belt slack or sag on the up and down stroke can be used to estimate counter-balance.

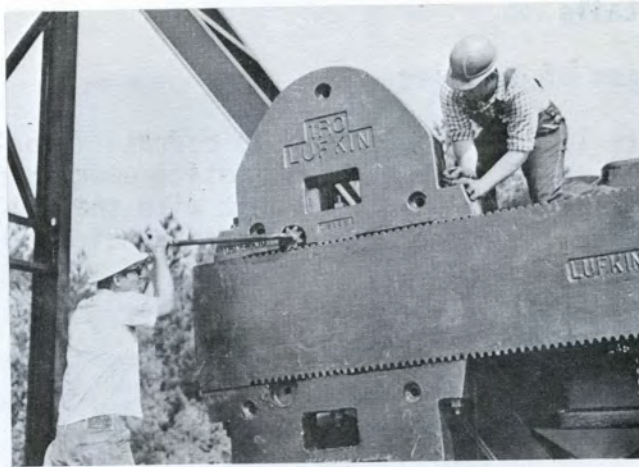


Figure 38

2. Figure 38 - Counterweight Movement

Stop the unit with the long end of the cranks pointing away from the well. The cranks should be in a horizontal position or slightly down hill in the direction the weights are to be moved as shown in Fig. 38. Set the brake and engage the positive stop pawl. Loosen the counterweight bolts just enough to allow the weights to move. Use the pinion adjusting tool as shown and move the weights to the desired position. The weight on the bottom of the crank may be moved likewise. Tighten the counterweight bolts following the recommendations given under "Fasteners" in Section IX and install the second nut as a jam nut.

C. STROKE CHANGE

Extreme caution must be exercised during the following procedure to prevent serious personal injury.

1. Preparation

Stop the unit with the counterweight end of the cranks in a horizontal position pointing away from the well and apply the brake. Place heavy timbers under the cranks and ease off on the brake until weight of crank is on the timber. Reset brake. Engage positive stop pawl on the brake drum if the unit is so equipped. On units not equipped with the positive stop feature thread a heavy chain through the hole in the brake drum nearest the brake trunnion and then around the trunnion. Snug-up the chain and attach the hook end around a link.

Clamp off the well and loosen the polished rod clamp on the carrier bar. Attach a gin pole or crane line to the walking beam just behind the horsehead and raise the beam until load is removed from the pitmans. Leave the lower pitman connection attached to the crank pin bearing housing.

2. Crank pin removal

Remove the cotter pin. Remove the crank pin nut using the box end hammer wrench provided with the unit and a sledge hammer.

Drive out the crank pin. The best procedure is to use a drive nut and a heavy sledge hammer. The drive nut is screwed on until it bottoms on the end of the pin. Hammer against the head of the drive nut until the pin is loose. When a drive nut is not available, hammer as squarely as possible against the end of the pin or against another hammer held on the end of the pin by a second person. The pitman side member will support the crank pin bearing assembly until the pin is installed in another hole. Apply rust preventative to the crank pin bore after the pin is removed.

3. Crank Pin Installation

Use solvent to clean the crank pin, crank pin hole, nut, and surface of crank against which the nut will seat. Also, remove paint, burrs, and other foreign matter. Inspect the crank pin and hole surfaces for fretting, rust, or wear. Any of these conditions indicate that the pin was loose. If loss of contact is more than 10%, the pin should be replaced or the hole reamed oversize for a new oversize pin.

Next apply a coat of light oil on the tapered pin, threads and crank pin hole. Wipe excess oil with a clean cloth. Insert the pin into the pin hole and install the nut.

Using the crank pin nut wrench, tighten the nut as tight as possible by hand. This establishes the zero or metal to metal position for the subsequent steps.

Using a sledge hammer on the wrench, turn the nut two cotter pin notches past the hole in the pin and watch carefully to line up with the third notch. Install the cotter pin. Never back nut off to insert cotter.

4. Putting unit into operation

Lower the walking beam until the cross yoke rests on top of the pitman side members checking to see that the pitmans are all the way up in the cross yoke.

Tighten the polished rod clamp and remove the clamp used to clamp off the well. Remove the chain from the brake drum or release the positive stop pawl as the case may be. REMOVE THE TIMBERS SUPPORTING THE CRANKS BEING CAUTIOUS TO STAY CLEAR OF THE CRANK SWEEP IN THE EVENT THE CRANKS START ROTATING.

After a stroke length change, the counterbalance should be checked and the weights positioned as required for proper balance.

V. PREVENTATIVE MAINTENANCE

Preventative maintenance is recommended to prolong the life of the unit and to prevent expensive failures. Many items can be checked routinely by visual inspection and by listening for unusual noise.

A. ALIGNMENT

Alignment of the unit can be checked visually by comparing the distance between the pitman side members and cranks on each side of the unit. Also, check to see that the wireline is tracking in the center of the horsehead. A change in alignment can be caused if the base shifts on the foundation due to loose hold down bolts. Misalignment can also be a result of a foundation that has settled to an unlevel position.

B. BOLTS

Loose bolts will eventually fail in fatigue. This is the major cause of most pumping unit wrecks. Loose bolts can usually be located by looking for rust at the bolted joint and by checking for visual movement. Bolts should be retightened as recommended in Section IX of this manual.

C. WIRELINE

Look for broken strands of wire fraying from the wireline. A rusty wireline should be cleaned and coated with a wireline lubricant.

D. BELTS

Belt alignment and tension should be checked and adjusted to prolong belt life.

E. BRAKE

Brake lining should be inspected for wear and clearance adjustment. When the brake control lever is fully engaged there should be several notches left on the ratchet. If adjustment is required follow the instructions in Section XI.

F. GEAR REDUCER

The gear tooth condition should be checked periodically for abnormal wear. Score marks on the teeth are an indication that the film thickness of the oil is not sufficient for the loads imposed. Score marks are vertical marks on the teeth from the top of the teeth to the root.

VI. LUBRICANT SPECIFICATIONS

A. GEAR REDUCER

For temperatures down to 0 degrees F., use an SAE 90 premium mineral gear oil with rust and oxidation inhibitors and with an anti-foam agent. Pour point of the oil should be 5 degrees F. or lower.

For temperatures down to -30 degrees F., use SAE 80 premium mineral gear oil with rust and oxidation inhibitors and with an anti-foam agent. Pour point of the oil should be -15 degrees or lower.

B. REDUCER OIL CAPACITY

<u>MODEL</u>	<u>CAPACITY</u>	<u>MODEL</u>	<u>CAPACITY</u>
1280D	120 GAL.	160D	22 GAL.
912D	107 GAL.	114D	17 GAL.
640D	70 GAL.		
456D	55 GAL.		
320D	50 GAL.		
228D	34 GAL.		

C. STRUCTURAL BEARINGS

For temperatures down to 0 degrees F., use a premium NLGI No. 1 lithium soap base grease with lead naphthanate extreme pressure additive. The oil in the grease should have a viscosity of approximately 1000 SSU at 100 degrees F. Do not use soda soap grease.

For temperatures down to -30 degrees F., use a premium NLGI No. 0 lithium soap base grease with lead naphthanate extreme pressure additive. Do not use soda soap grease.

D. WIRELINE

Clean the wire rope by wire brushing; do not use solvent. Apply a good wire rope lubricant that will penetrate and adhere to the rope. Do not use crude oil or lubricants that may be injurious to steel.

VII. SCHEDULED MAINTENANCE

A. WEEKLY

All bolting should be retightened after one week of operation. See section IX of this manual for tightening recommendations.

B. MONTHLY

1. Preventative maintenance check

All items under section V of this manual should be checked.

2. Gear reducer oil level

Gear reducer oil level should be checked. Stop the unit and remove the dipstick at the front of the gear reducer. The oil level should be between the low and full mark on the dip stick. Loss of oil from the reducer is usually caused by seal leakage at the shafts or parting line.

3. Structural bearings

Visually check the structural bearings for oil seal leaks. This includes the crank pin bearings, samson post bearings and cross yoke bearings. Do not confuse grease discharge from the bearing housing vents with seal leakage.

C. BI-ANNUALLY

1. Lubricate bearings

The structural bearings should be lubricated with grease as recommended in Section VI of this manual. Grease fittings are located at ground level. Pump grease in slowly to avoid pushing out the oil seals. Discharge from the vents located on each bearing housing indicates that the housing is full. See illustrations in Figures 33, 34, and 35.

2. Gear Reducer

Collect a typical sample of the gear reducer oil in a glass jar. A visual inspection will expose possible dirt, sludge, water emulsion or other forms of contamination. If the lubricant has an abnormal appearance or smell, check with your oil supplier about replacement.

VIII. LUFKIN SERVICE

A. LUFKIN SERVICEMEN

Lufkin has capable sales and servicemen throughout the oil producing areas of the world. These men are competent and experienced not only in the proper sizing of surface pumping units, but also in any service that may be needed. Contact the Lufkin Sales Office nearest you to inquire about the availability of Lufkin service.

B. REPAIR AND REPLACEMENT PARTS SERVICE

A complete line of repair and replacement parts are available from several warehouse locations as well as the manufacturing plant in Lufkin, Texas. Please order replacement parts from a parts list which is available for each pumping unit assembly. For parts needed, furnish the part number and name, unit designation, serial number, and Lufkin's shipping order number.

ADDENDUM

IX. FASTENERS

A. "METAL-TO-METAL" GRIP

Bolting is a vital part of an oil field pumping unit. The surfaces under the bolt head and nut and the contacting surfaces must be flat, clean, and free of burrs so that the bolted members join in "metal-to-metal" contact. Bolts which are properly tightened during erection and retightened about a week later will retain their grip under normal operating conditions. Improperly tightened bolts will break in fatigue and may cause serious wrecks and injury to personnel. Table I gives recommended tightening torques.

Since high capacity torque wrenches are not commonly available, the larger size bolts are usually hammered tight. Use a box end wrench with a striking face and tighten the bolts until the hammer blows feel solid. Bolts will fail in fatigue from inadequate tightening rather than from being pulled in two from excessive tightening torque.

B. "ELASTIC" GRIP

The grip is not always metal-to-metal. In applications such as foundation bolts, heel clamp bolts, and various bracket bolts the fasteners will be subjected to unavoidable cyclic loading. The tightening torques needed in these applications are extremely variable; however, they should be about half the values given in Table I. Bolts should always be over-tightened rather than under-tightened.

TABLE I

Proper Tightening Torques - Nuts and Cap Screws with "Metal-to-Metal" Grip.

<u>SIZE</u>	<u>TORQUE RANGE</u>
3/8 - 16 NC	15 to 24 ft. lb.
1/2 - 13 NC	32 to 44 ft. lb.
5/8 - 11 NC	59 to 74 ft. lb.
3/4 - 10 NC	99 to 116 ft. lb.
7/8 - 9 NC	153 to 175 ft. lb.
1 - 8 NC	225 to 256 ft. lb.
1 1/8 - 7 NC	320 to 360 ft. lb.
1 1/4 - 7 NC	452 to 510 ft. lb.
1 1/2 - 6 NC	780 to 880 ft. lb.

TABLE 2

X. WEIGHT AND HOOK DATA FOR ERECTION PURPOSES

<u>MAXIMUM STROKE</u>	<u>*MINIMUM HOOK HEIGHT</u>	<u>APPROXIMATE WT. (LBS) STANDARD BASE</u>	<u>APPROXIMATE WT. (LBS) TWO-POINT BASE</u>
216"	36' - 7"	-----	7,395
192"	36' - 7"	-----	7,395
168"	32' - 9"	-----	5,780
144"	29' - 5"	4,970	5,780
120"	29' - 5"	4,970	10,300
100"	28' - 7"	4,970	10,130
86"	21' - 8"	2,800	5,060
74"	21' - 7"	2,700	4,230
64"	18' - 3"	1,560	2,450

* BOTTOM OF BASE TO TOP OF HEAD WITH BEAM HORIZONTAL

<u>REDUCER SIZE</u>	<u>+ WEIGHT W/CRANKS (LBS)</u>
1280D	42,800
912D	37,000
640D	33,140
456D	23,710
320D	20,820
228D	14,849
160D	10,582
114D	9,548

+ LARGEST CRANK USED WITH REDUCER

NOTE: NORMALLY 228D REDUCERS AND SMALLER ARE SHIPPED MOUNTED ON THE BASE; ADD REDUCER WITH CRANK WEIGHT TO BASE WEIGHT FOR TOTAL LIFT.

XI. BRAKE SYSTEM INSTALLATION AND ADJUSTMENT

Two types of brakes are shown; the shoe type brake, Fig 9a, and the band type brake, Fig. 9b. Use the appropriate instructions.

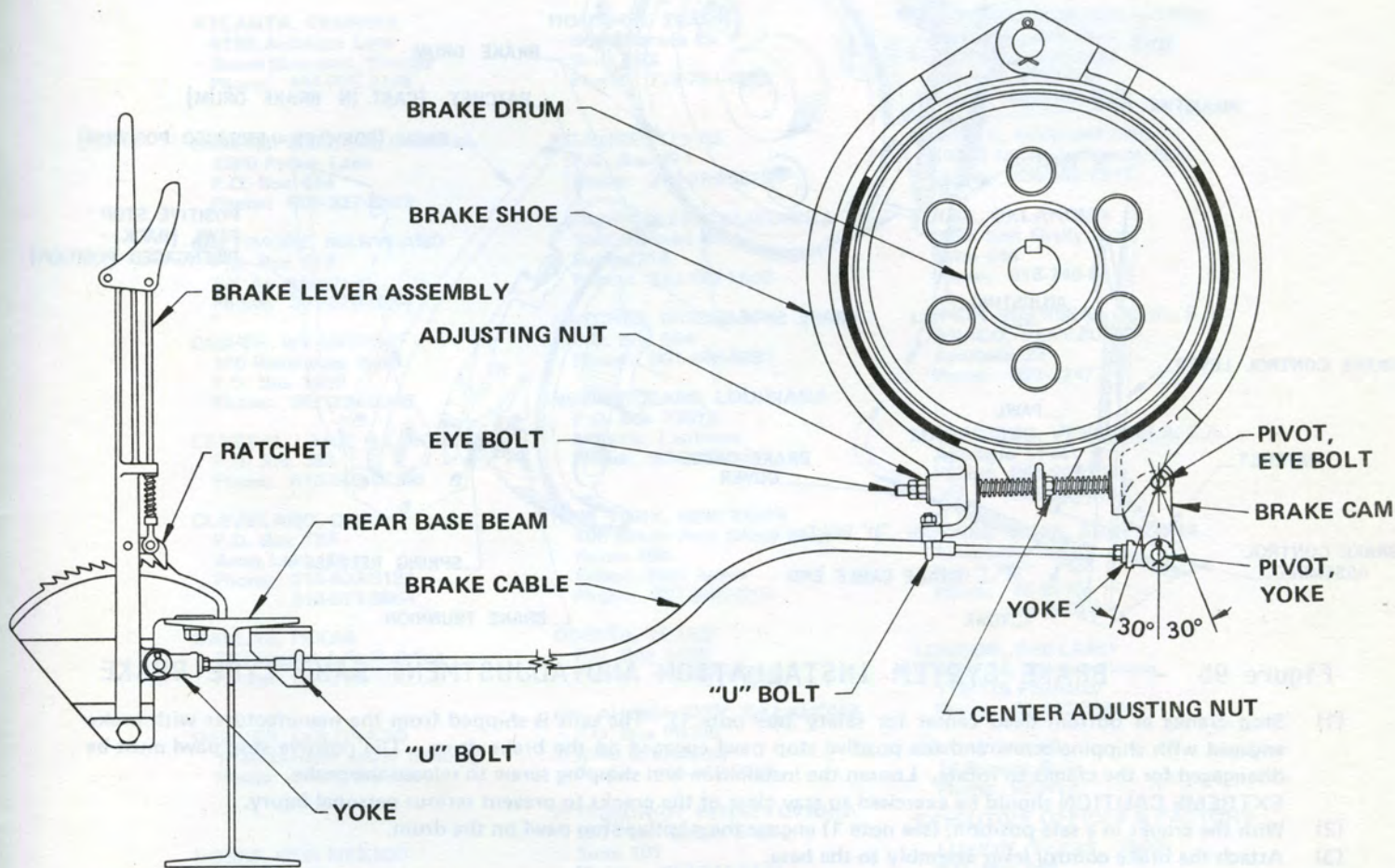


Figure 9a - BRAKE SYSTEM INSTALLATION AND ADJUSTMENT-SHOE TYPE BRAKE
STOP CRANKS AT BOTTOM DEAD CENTER FOR SAFETY

- (1) Attach brake lever assembly to base.
- (2) Unwrap brake cable from drum and position free end near lever assembly.
- (3) Adjust the position of both brake shoes by moving both adjusting nuts until the linings of both shoes just clear the drum.
- (4) Attach the rear end of the brake cable cover to the base with the "U" bolt.
- (5) "Pin" the yoke on the cable end to the brake lever.
- (6) Position the brake lever in its forward disengaged position.
- (7) When the brake is disengaged, the yoke pivot of the cam should be at about a 30 degree angle to the right, see Sketch. Simultaneously, the brake lever would be "full off", to the right of vertical.
- (8) When the brake is fully engaged, the lower end of the cam should be at about a 30 degree angle to the left, see Sketch. Simultaneously, the brake lever would have the ratchet engaged and several notches still "available" for engagement.
- (9) To achieve the proper engaged and disengaged positions of the cam and brake lever, either or both yokes can be screwed in or out on the ends of the brake cable.

At the same time, movement of the rod interior of the brake cable should be kept away from a bottoming condition within the cable. When the yoke positions are established, tighten the jam nuts against the yokes.

- (10) Check brake drum gib key for proper tightness.

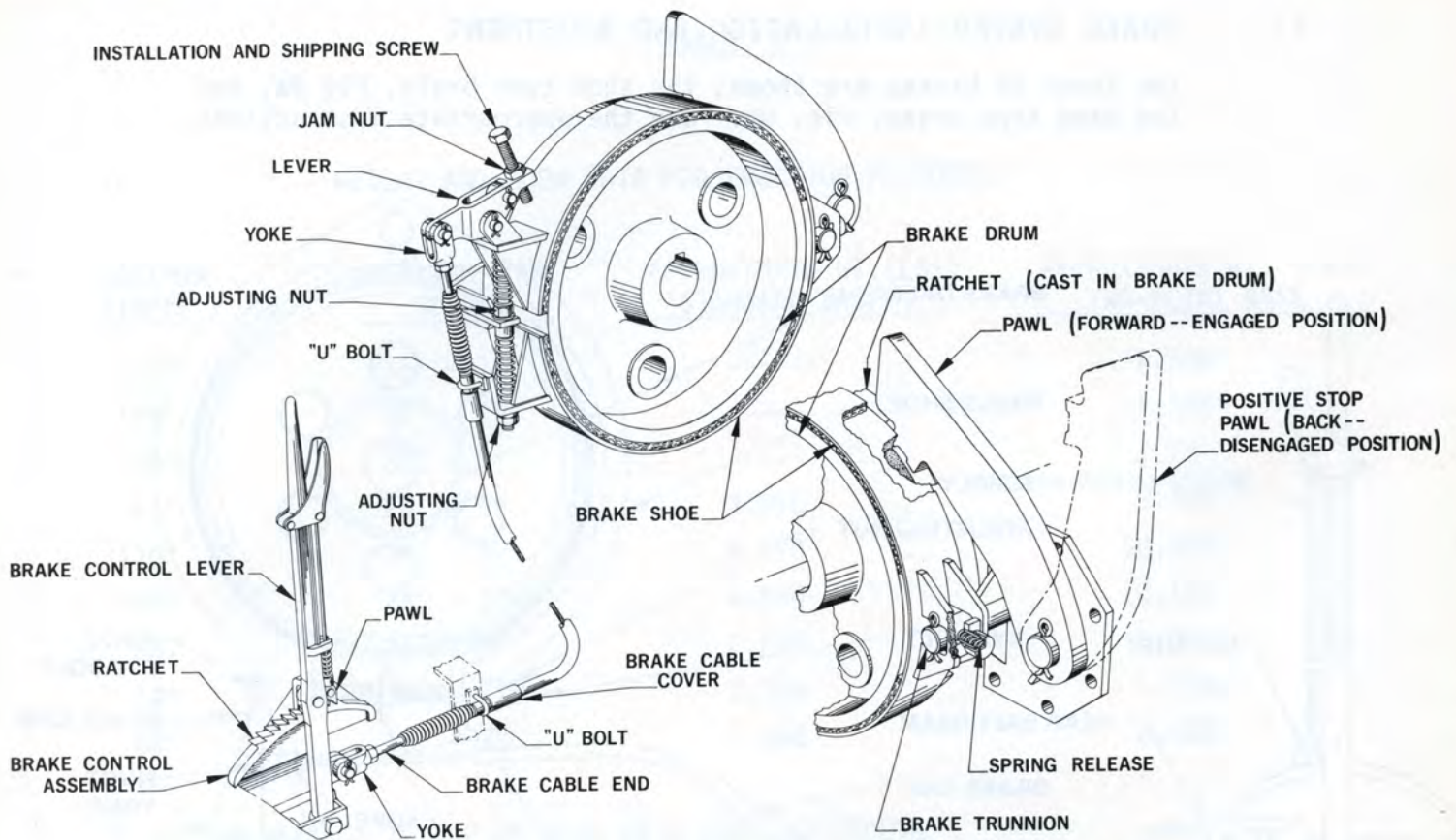


Figure 9b - BRAKE SYSTEM INSTALLATION AND ADJUSTMENT-BAND TYPE BRAKE

- (1) Stop cranks at bottom dead center for safety (see note 1). The unit is shipped from the manufacturer with brake engaged with shipping screw and the positive stop pawl engaged on the brake drum. The positive stop pawl must be disengaged for the cranks to rotate. Loosen the installation and shipping screw to release the brake. **EXTREME CAUTION** should be exercised to stay clear of the cranks to prevent serious personal injury.
- (2) With the cranks in a safe position, (see note 1) engage the positive stop pawl on the drum.
- (3) Attach the brake control lever assembly to the base.
- (4) The brake comes from the factory adjusted but may require final adjustment with the brake lever installed. Loosen the installation and shipping screw to release the brake. Adjust the position of both brake shoes with the adjusting nuts until the lining just clears the drum at the top and bottom. The spring release on the trunnion should pull the lining away from the drum near the trunnion. Trunnion position may be changed if necessary to increase this clearance. Loosen the cap screws attaching the trunnion to the bearing carrier. Engage the brake using the installation screw and move the trunnion away from the brake until adequate clearance is obtained. Retighten cap screws.
- (5) Attach the brake cable cover to the base near the brake lever using the "U" bolt provided.
- (6) Disengage the brake, move the brake control lever to the maximum forward position, and position the yoke on the end of the brake cable so that it can be pinned to the brake control lever.
- (7) Now engage the brake using the brake control lever. Full engagement should occur with several notches of the ratchet on the brake assembly still remaining to compensate for subsequent lining wear and cable stretch. Further adjustment to meet this condition may be made by repositioning the cable yoke on the brake control lever end. Care should be taken when adjusting the yoke not to cause the brake cable to overtravel internally in the cable cover. Should this occur, move both yokes the same amount in opposite directions.
- (8) Recheck brake lining clearance after all adjustments are complete.
- (9) The brake installation and shipping screw should be screwed out flush with the bottom of the lever and locked with the jam nut.
- (10) Check brake drum key for proper tightness.
- (11) Subsequent lining clearance adjustment for wear should be made only after stopping the cranks in a safe position and engaging the positive stop pawl.
- (12) Disengage the positive stop pawl before attempting to start the unit. The brake should be engaged using the brake control lever when engaging or disengaging the positive stop pawl to prevent accidental drum rotation.

NOTE 1: This statement is true for all LUFKIN units provided that the pitman side members are not connected to the crank pin bearings. This statement is also true for all LUFKIN units provided that the well load has not been connected to the carrier bar with the exception of the Air Balanced Unit which must include no air pressure. Under any other conditions it is advisable that the cranks be allowed to rotate freely until they stop. Set the brake, engage the positive stop pawl, and proceed with any adjustment required.

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WARRANTY AND SERVICE POLICY

Lufkin pumping units are guaranteed to be free from defective material and workmanship for a period of 12 months after installation, but the warranty period will expire 18 months from shipping date. Intermittent service is considered continuous for computing the period of operation. This warranty is void if the equipment is operated above rated capacity, is abused or improperly installed. Any part or parts proving defective due to faulty materials or workmanship will be replaced "NO CHARGE", FOB Lufkin; customer to pay the freight from Lufkin to location. When a Lufkin service man is used, and it is found that the breakdown is due to defective materials or workmanship, no charge will be made for services within the warranty period. This warranty is void if work is done or parts replaced without specific authorization from Lufkin or a Lufkin representative.

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