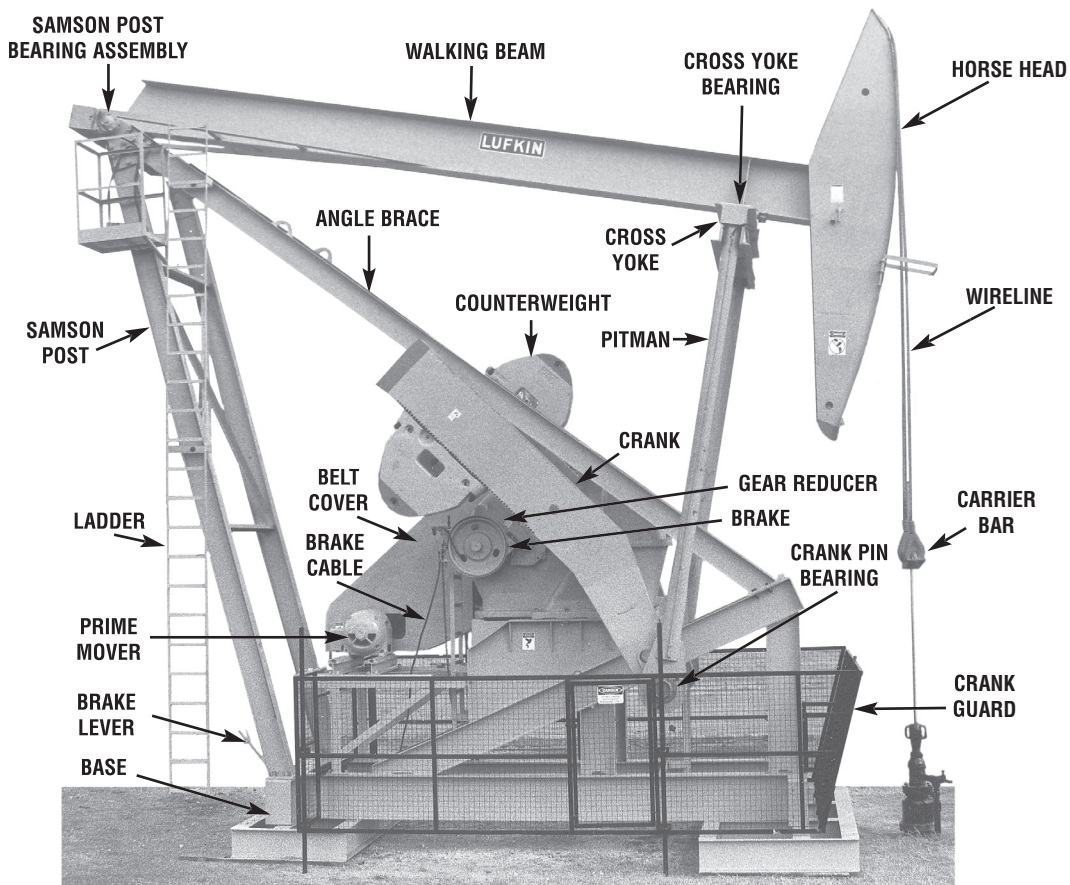


LUFKIN

MARK II PUMPING UNITS



INSTALLATION MANUAL M-09

⚠️ **WARNING:** Failure to use this manual for guidance could result in injury to personnel and/or damage to equipment.

LUFKIN

INDUSTRIES, INC.

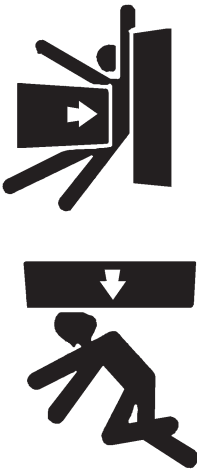

P.O. BOX 849, LUFKIN, TEXAS 75902-0849

PHONE: 936/634-2211

TWX: 910-880-4201, SALES & PURCHASING

WARNING

The LUFKIN Mark II Pumping Units are designed to give many years of dependable service. Like all machines with moving parts, there are “potential” hazards associated with its use. These hazards can be reduced if the machine is properly installed, operated and maintained. All personnel who install, operate or maintain the unit must read this manual and must be trained to use the machine in an appropriate and safe manner. Should any questions arise concerning the maintenance or operation of the machine, contact LUFKIN Industries, Inc. at 1-936/634-2211.

POTENTIAL HAZARD	EFFECT	PREVENTION
 <p style="text-align: center;">MOVING LOADS OR PARTS</p>	<p>Will cause severe injury or death.</p>	<p>Do Not allow personnel to stand under moving loads or parts.</p> <p>Set brake, engage pawl and chain brake drum during installation and maintenance to prevent movement of counterweights and cranks.</p> <p>Keep clear of counterweight and crank swing area and other parts that may start moving.</p> <p>Do Not operate pumping units without proper guards in place.</p> <p>Do Not service well without removing the horsehead.</p> <p>Properly install the horsehead latch bolt, safety bar and/or hinge pin.</p>
 <p style="text-align: center;">ELECTRICAL CONTACT</p>	<p>Can cause severe injury or death.</p>	<p>Keep pumping units at least 10 feet away from all overhead wires.</p> <p>Lockout/tagout ALL energy sources.</p> <p>All electrical work must be performed by a qualified electrician.</p>

FOREWORD

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. It is designed for operation in a counterclockwise direction of rotation only, when viewing the unit from the side with the well head to the right. The unique design of the LUFKIN Mark II furnishes one of the most advanced and trouble free systems of rod pumping available today providing mechanical advantages previously thought to be impossible.

These LUFKIN pumping units have been designed to rigid LUFKIN standards and exceed API (American Petroleum Institute) standard requirements for pumping unit design. In addition, all individual components of the unit and the unit as a whole represent the very best engineering design, production facilities, quality and field experience that almost a century of LUFKIN INDUSTRIES’ experience can bring to you. Your LUFKIN unit will give many years of dependable service when properly installed, maintained and operated within its load and torque ratings.

To avoid confusion, some of the more common terms used concerning pumping units are defined as follows:

Front: is the well head (horsehead) end.

Rear: is the prime mover end.

Left & Right: are determined by standing at the rear of the pumping unit and facing the well head.

Crank Sweep or Crank Swing: is the circular area centered about the crankshaft where the cranks and counterweights will rotate when in motion.

NOTE: Some of the photographs and illustrations used in this manual are representative and may not look exactly like the parts with which you are working.

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INSTALLATION MANUAL

LUFKIN MARK II PUMPING UNITS

1. SAFETY

Before proceeding with the installation, operation or maintenance of a pumping unit, familiarize yourself with Federal, State and Local laws, your company's safety regulations and the safety section of this manual. For your protection and to prevent equipment damage, please heed the product safety signs attached to the pumping unit.

1.1 HAZARD IDENTIFICATION

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

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

CAUTION: Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury or damage to the unit.

1.2 SOME POTENTIAL HAZARDS

Failure to heed the following WARNINGS could result in severe bodily injury or death to personnel:

- Pumping units have large and heavy rotating parts. Even a temporarily stationary pumping unit has components that can start moving from the effect of gravity. Times of particular danger are during unit installation, stroke change, counterbalance change, general unit maintenance, well servicing and while taking dynamometer card readings.

Whenever performing maintenance on, or working around the pumping unit, always lockout/tagout all energy sources and secure the cranks against rotation. All personnel must stay alert and keep clear of the crank swing area and other potential moving parts.

- Never stand under the horsehead during installation or removal of the head. Double check the horsehead for proper installation on the walking beam, including the installation of the safety bar, hinge pin and/or the latch bolt before rotating the unit.

Remove the horsehead before servicing the well, remembering to first remove safety bar, hinge pin and/or latch bolt.

- Do not stand under moving parts or loads being lifted. Always attach guide ropes to parts to aid in initial alignment of parts or assemblies.

- All electrical work must be performed by a qualified electrician. Regularly inspect and maintain electric motors, automatic timers or any other electrical device.

Be aware of power line locations, keeping unit and service equipment at least ten feet away.

- Do not assume a stationary unit is not operational. Automatic timers can start units in motion without warning.
- LUFKIN does not recommend installation of or maintenance on pumping units during thunderstorms. Exercise extreme caution during icy conditions and other inclement weather.

1.3 COMMONLY USED SAFETY PROCEDURES FOR SECURING CRANKS

DANGER: Do not enter the crank swing area to chain the drum or engage the pawl.

Always install the unit and perform maintenance with the cranks at the 6 o'clock position when possible. If the cranks with counterweights are straight down, no rotation will start if the carrier bar is not attached to the polished rod, or if the polished rod has been securely clamped at the stuffing box to hold the well load and all energy sources have been locked out/tagged out.

It is essential to prevent rotation of the cranks stopped in any position. Never use the brake alone as a safety stop. Always use as many other methods as possible for back ups along with your company's lockout/tagout procedure.

1.3.1 Installing the Brake Pawl (Figure 1)

Set the brake with the cranks in the desired position.

CAUTION: Abrupt braking may damage the gear teeth in the reducer. A slow, even pull on the brake lever is recommended.

On units equipped with the positive-stop brake, the pawl must be engaged in a notch in the drum to prevent crank rotation. Inspect the pawl and drum prior to engage-

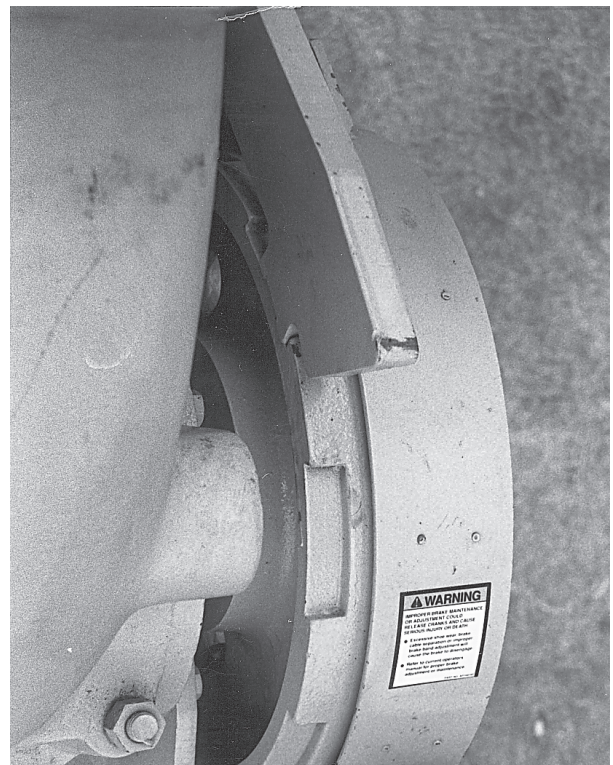
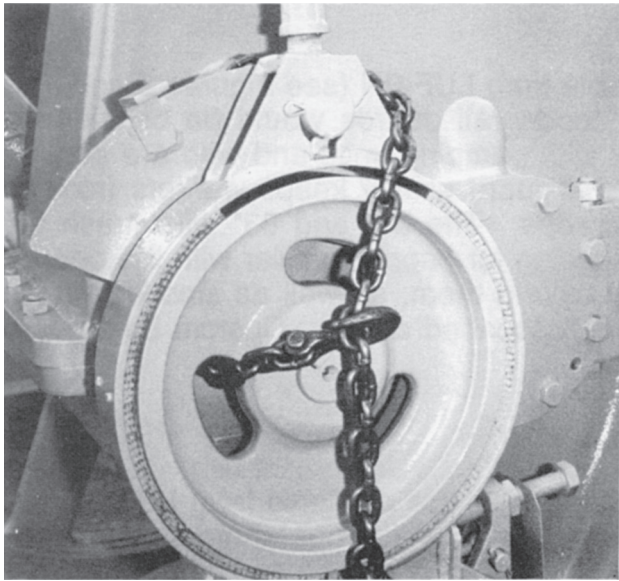


Figure 1

ment for possible damage caused by previous misuse. Engage the pawl only after the unit is stopped.

CAUTION: Do not allow the well load to rest on the pawl tooth. If this is done, you will need a crane to lift the load in order to disengage the pawl.



1.3.2 Chaining the Brake Drum (Figure 2)

Thread a sturdy (never less than 3/8 grade 8 alloy) chain through the hole in the brake drum nearest the trunnion and then around the trunnion. Snug up the chain and attach the hook end around a link. Be sure the chain is working against the direction of rotation.

WARNING: Faulty chains and slings could fail and cause severe bodily injury or death.

Figure 2

1.4 GUARDING OF UNITS

DANGER: Contact with large moving parts will cause severe injury or death. Do not operate pumping units without proper guards in place. The purpose of guards is to provide a safety barrier between the moving parts of the pumping unit and people who are familiar with the operation of pumping units. They also provide a barrier between the moving parts and animals. When pumping units are operated where they are accessible to the general public, it may be necessary to place the pumping unit with guards in an enclosed area with a locked entrance. The enclosure must prevent entry of unauthorized persons. Federal, State and local regulations may require specific types of guarding, dependent upon the location of your unit; therefore, the type of guarding needed is known only by the user who must choose the proper guarding. It is essential that the user of the pumping unit comply with all applicable safety requirements. For additional information on guarding of pumping units, refer to API RP11ER.

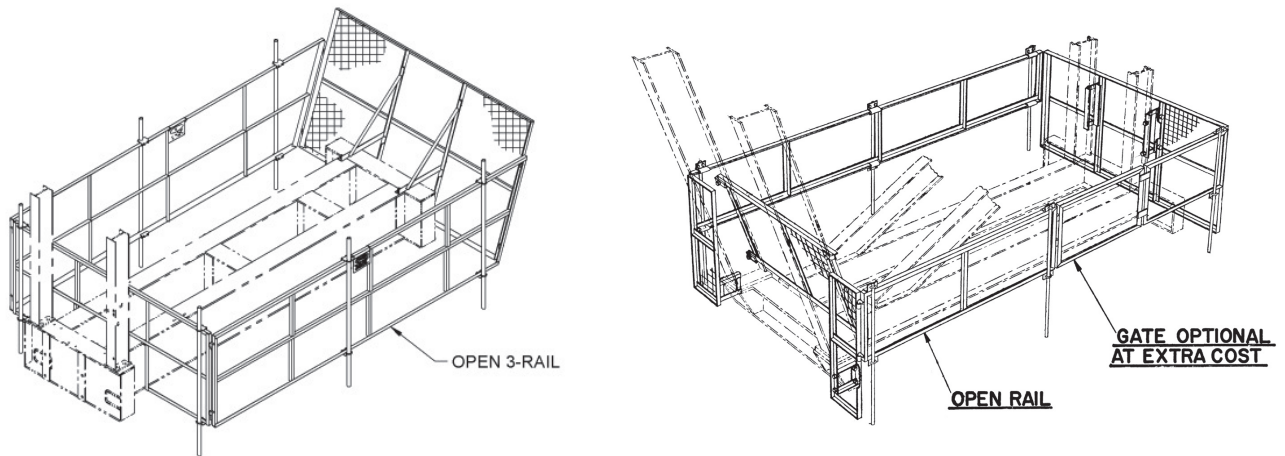


Figure 3

1.4.1 Crank Guards

Crank guards are available from LUFKIN. Under normal operating circumstances, the open rail and open 3-rail guards (Figure 3) would be considered minimum guarding for people who are familiar with pumping units and who are accustomed to working around them. Basically, this type guard simply keeps workers from accidentally wandering or falling into the crank sweeps. The wire mesh guards (Figure 4) would normally be considered adequate guarding for people familiar with the operation of pumping units and accustomed to working around them, as well as smaller animals that might be able to move through the guards described above. Custom built guards are available to meet customer requirements.

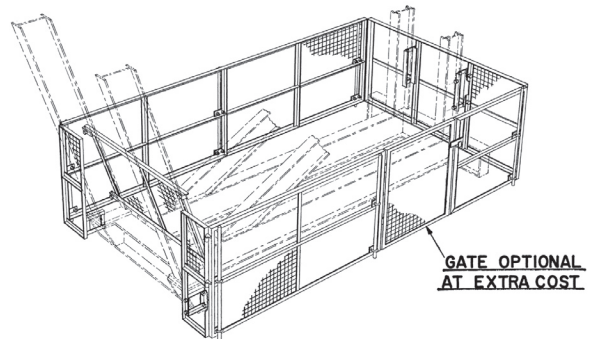


Figure 4

1.4.2 Horsehead Guards

Horsehead guards (see Figure 5) are available from LUFKIN. This guard is designed to keep people who are familiar with the operation of pumping units from accidentally wandering into the area below the horsehead and carrier bar. This type guard is required where the horsehead or the carrier bar descends to 7 ft. or less from grade or work platform (Refer to API111ER).



Figure 5

1.4.3 Belt Guards

Belt guards are furnished with each unit. They are designed to cover exposed sheaves and belts and to provide a barrier between these items and people who are familiar with the operation of pumping units. Replacement belt guards are available from LUFKIN.

1.4.4 Prime Mover Guards

Exposed flywheels of prime movers must be guarded. Guards are available from LUFKIN. These guards are designed to keep people who are familiar with the operation of pumping units from accidentally walking or falling into the flywheel.

1.5 PROPER CLOTHING AND TOOLS

Snug fitting clothing is recommended. Remove jewelry. Wear hard hats, side-shield safety glasses and safety shoes (see Figure 6).

Use proper tools for the job. Tools are designed for specific purposes and must be used properly. Always keep tools clean and in good condition.

Anytime you perform work at such a height that a fall could possibly inflict injury, you should wear a safety harness. When possible, use a man lift or some other type of approved safety basket.

Refer to your company's safety regulations concerning clothing and tools.



Figure 6

1.6 TRAINING

It is essential that only properly trained personnel, under competent supervision, be allowed to work with this equipment. Training programs are an important part of safe and correct operation. Training also provides the knowledge necessary to maximize the performance of your equipment. LUFKIN INDUSTRIES, INC. recognizes the importance of training and conducts training schools to help familiarize your personnel with safe operating and maintenance procedures. These training schools are held at corporate headquarters in Lufkin, Texas. There is a small charge for this service. The dates for each school are available upon request by contacting your nearest LUFKIN sales office (see back cover of this manual).

2. INSTALLATION EQUIPMENT SIZING CHARTS

The following charts are a general guide to assist in selecting the proper equipment for installing your LUFKIN pumping unit. If there are further concerns or questions about the weight of a part, contact LUFKIN. An example for using the charts would be as follows:

What is needed to set an M-114D-143-86 pumping unit with a wide skid base?

- (1) In the top section of Table I, go to the 86" stroke to see that the minimum hook height needed would be 23'-9". Also, account for any additional height needed due to the bottom of the pumping unit steel base sitting above ground level.
- (2) Also, in this section of Table I, notice the weight of the unit base is 9,660 lbs. Go to the reducer size in the lower section of Table I and see that a M114D reducer with cranks weighs 8,750 lbs. Since all M114D units with 62" radius cranks and smaller reducers are normally shipped mounted to the unit base, you must add (9,660 + 8,750 = 18,410 lbs.) to get the heaviest total lift needed.
- (3) If you are moving a reducer with counterweights and auxiliary weights attached, refer to the lower section of Table 1, third column. These weights reflect the reducer, the largest cranks, the four largest counterweights and the maximum number of the largest auxiliary weights.

Table I

Approximate Weight and Hook Data for Installation Purposes

<u>MAXIMUM STROKE</u>	<u>+MINIMUM HOOK HEIGHT</u>	<u>**APPROX.WT.(LBS) WIDE SKID BASE</u>
192"& 216"	40' - 0"	8,160
168"	33' - 6"	9,520
120" & 144"	30' - 0"	12,080
100"	28' - 0"	9,660
86"	23' - 9"	9,660
74"	23' - 0"	7,750
64"	18' - 6"	4,770

+ Bottom of the unit base to the top of the horsehead with the beam horizontal

<u>REDUCER SIZE</u>	<u>*WEIGHT W/CRANKS (LBS)</u>	<u>***WEIGHT W/CRANKS & COUNTERBALANCE WEIGHTS (LBS)</u>
M1824D	52,100	83,255
M1280D	46,850	78,000
M912DS	41,350	72,500
M912D	40,600	71,755
M640D	37,650	68,800
M456D	34,450	65,600
M320D	22,350	40,450
M228D	16,100	30,245
M160D	11,500	22,355
M114D	8,750	19,600
M80D	8,750	19,600

* LARGEST CRANK USED WITH REDUCER

** NORMALLY M114D REDUCERS WITH 62" CRANKS AND SMALLER ARE SHIPPED MOUNTED ON THE BASE; ADD THE WEIGHT OF THE REDUCER WITH CRANKS TO THE BASE WEIGHT FOR TOTAL LIFT.

*** ASSUMING HEAVIEST COUNTERWEIGHTS & AUXILIARY WEIGHTS.

3. FASTENERS

3.1 "METAL-TO-METAL" GRIP

Bolting is a vital part of an oil field pumping unit. The surfaces under the bolt head, nut and the contacting surfaces must be flat, clean and free of burrs so the bolted members join in "metal-to-metal" contact. Bolts which are properly tightened during unit installation 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 failures and injury to personnel. Table II gives recommended tightening torques.

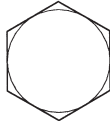
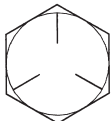
Since high-capacity torque wrenches are not commonly available, the larger size bolts are usually hammered tight. Use a box-end wrench with a striking face and tighten the bolts until the hammer blows feel solid. Bolts will fail in fatigue from inadequate tightening rather than from being pulled in two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

WARNING: Proper eye protection must be worn; flying metal could cause damage to the eyes.

TABLE II

Proper Tightening Torques

Nuts and Cap Screws with "Metal-to-Metal" Grip

	Grade 2 	Grade 5 
3/8 - 16 NC	19 to 21 ft.lb.	30 to 32 ft.lb.
1/2 - 13 NC	47 to 51 ft.lb.	71 to 79 ft.lb.
5/8 - 11 NC	92 to 102 ft.lb.	143 to 157 ft.lb.
3/4 - 10 NC	164 to 180 ft.lb.	253 to 279 ft.lb.
7/8 - 9 NC	159 to 176 ft.lb.	409 to 451 ft.lb.
1 - 8 NC	238 to 262 ft.lb.	612 to 676 ft.lb.
1 1/8 - 7 NC	336 to 372 ft.lb.	866 to 958 ft.lb.
1 1/4 - 7 NC	475 to 525 ft.lb.	1064 to 1176 ft.lb.
1 1/2 - 6 NC	826 to 912 ft.lb.	1849 to 2049 ft.lb.

3.2 "ELASTIC" GRIP

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

4. FOUNDATION

4.1 GENERAL

The foundation should be constructed in accordance with the current foundation drawing shipped with the unit. The foundation drawing gives the minimum foundation required for soil with a minimum bearing strength of 1500 pounds per square foot. Consideration should be given to increasing the size and depth of the foundation in areas where the soil conditions are abnormally poor.

Grade the foundation site for adequate drainage and to provide a level foundation. Poor drainage usually results in the foundation settling unevenly, causing undue stresses in the unit base and subsequent failure. Refer to API RP11G for additional information about the installation of pumping units.

CAUTION: Poor preparation of the site and/or concrete can cause pumping unit base breakage.

NOTE: For applications where units are elevated above grade, field modifications to crank guards and ladders will be required per API RP11ER. Upon your request, LUFKIN will design special guards and ladders based upon your special needs.

4.2 TYPES OF FOUNDATIONS

Poured concrete - poured on site
Precast concrete blocks

Board mat - portable units only
Fabricated steel pads - 2 pt. units only

CAUTION: Specially designed bases for the two-point pumping unit require support only at the front and rear of the unit. Only units that are designated as two-point are suitable for two-point foundations. Refer to the foundation drawing shipped with the unit or contact LUFKIN.

4.3 WELL HEAD CLEARANCE

Carrier bar clearance from the bottom of the steel base is shown on the foundation drawing. This should be considered when the grade height of the foundation is established. If clearance to sling a dynamometer beneath the carrier bar is desired, at least 32 inches of clearance is required between the carrier bar and well head stuffing box, with the carrier bar at the bottom of the stroke.

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

4.4 ALIGNMENT MARKS (Figure 7)

Mark a centerline from the front to the rear of the foundation that extends from the center of the well through the center of the foundation. Place a cross mark perpendicular to the centerline the distance shown on the foundation drawing from the center of the well to the

front cross member of the unit base. This distance is normally referred to as the set-back dimension. The steel base has center marks on the edges of the bottom flanges of the front and rear cross members. The initial alignment involves matching the center lines on the base and foundation and placing the base the proper distance from the polished rod.

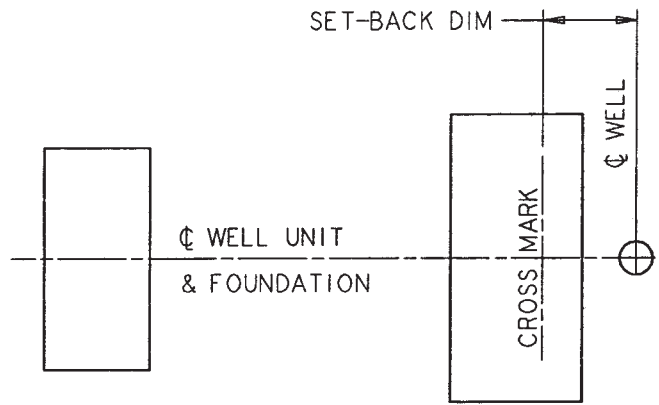


Figure 7

5. UNIT INSTALLATION

CAUTION: Before proceeding with the installation of a pumping unit, you and your crew should fully discuss the job to be done. Make sure everyone is aware of the dangers involved (see Figure 8). Review the Safety Section (Section 1) of this manual.

During installation, clean all bolted joints of foreign materials, including paint, to insure good contact between the parts.

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

5.1 BASE INSTALLATION (Figure 9)

WARNING: Do not stand under the load while installing base.



Figure 8

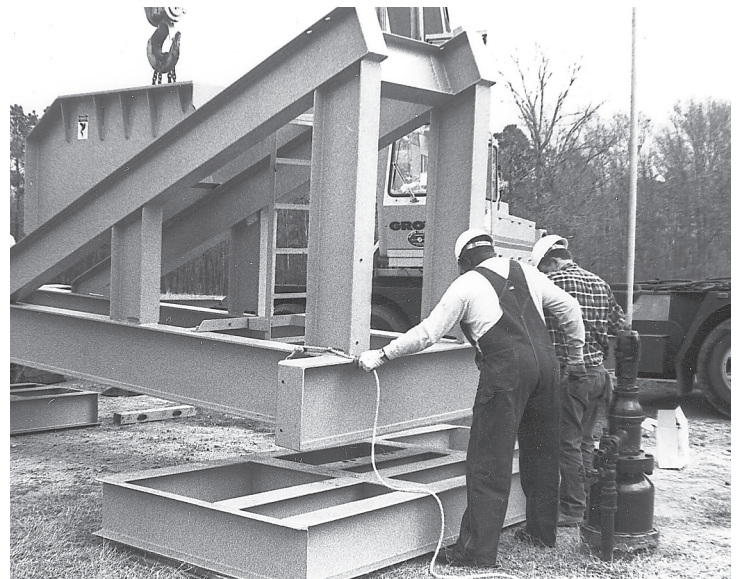


Figure 9

On larger units, bolt the sub-base ladder onto the unit base. On some units, the sub-base ladders are mounted at the factory. Check the bolts for tightness.

Lift the base in a level position and place on the foundation. Align the center line marks on the bottom flanges of the front and rear 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 you have a two piece base (unit base and prime mover base), the prime mover base will be positioned next. See Section 15 for an illustration of the different types of unit and prime mover bases. Remove the bolts from the joint plates. Join the bases together, tightening the bolts according to the recommendations given in Section 3. Locate and install foundation hold-down clamps and bolts. Snug tighten. Final tightening of the foundation bolts will be done after unit alignment (Procedure 5.27).

5.2 REDUCER INFORMATION

Reducers are shipped from the factory with the brake linings engaged against the brake drum with an installation and shipping screw. Due to shipping requirements, the larger reducers are shipped separate from their bases. Also, some of the larger reducers are shipped without the crank pins mounted in the cranks. Mount the crank pins per Section 5.3.

5.3 CRANK PIN INSTALLATION

With emery cloth, remove any paint and foreign material from the crank pin, crank pin hole and the mating surfaces between the crank and the crank pin nut. Clean these same areas with an approved solvent (per your company's quality policy.)

CAUTION: Improper cleaning of the crank pin and crank pin hole, as well as improper tightening of the crank pin, can cause damage to the pumping unit.

With a 1 in. brush, apply three very light stripes of non-drying machinist blue equally spaced down the length of the pin. Remove any excess with a clean, lint-free cloth – a thick stripe will give a false indication of good contact. Install the crank pin bearing assembly in the crank pin hole without smearing the machinist blue. Thread the crank pin nut onto the crank pin and use a hammer wrench to tighten the nut until it will no longer rotate. To ensure proper contact between the crank pin and crank pin hole, use a sledge hammer to turn the wrench one additional cotter pin notch.

Remove the crank pin bearing assembly and inspect the crank pin hole. Disregarding the area where the groove around the crank pin was not in contact with the crank pin hole, machinist blue should be present along 85% of the hole's length. If it is less than this, contact your nearest Lufkin Service organization for advice.

Clean the crank pin as described above and apply a light coat of clean oil to the crank pin hole. Wipe away any excess with a clean hand. Line up the crank pin bearing assembly with the crank pin hole. With a single motion, insert the assembly into the crank and thread the crank pin nut onto the crank pin (Figure 10.)

CAUTION: Do not install the crank pin without properly applying oil film in the hole.

Using a hammer wrench and your body weight, tighten the crank pin nut until it will no longer rotate (Figure 10). Mark the location of the hole in the crank pin on the crank pin nut. Use at least a 14-lb sledge hammer to turn the nut two cotter pin notches. Watching carefully, hammer the wrench until the hole in the crank pin lines up with the third cotter pin notch. Continue to tighten only if the nut can be turned to the next notch.

WARNING: Proper eye protection must be worn; flying metal could cause damage to the eyes.

Install the cotter pin. Never back the nut off to insert the cotter pin. If you have turned the nut too far, remove the crank pin (Procedure 8.2) and repeat all of the installation procedure.

After the crank pins are mounted in the cranks, install the reducer per Section 5.4.



Figure 10

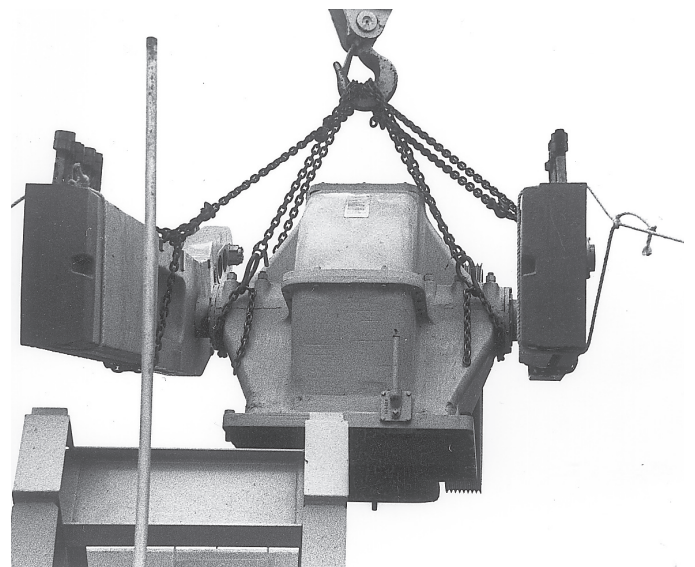


Figure 11

5.4 REDUCER INSTALLATION (Figure 11)

WARNING: The reducer with cranks is an assembly made up of heavy rotating parts. Be certain the cranks are locked against rotation. (Refer to Section 1.3 of this manual for proper procedures.) Do not stand under the load while installing; exercise extreme care.

To install the reducer on its sub-base, attach slings to the reducer and both cranks to stabilize the load. Do not allow the sling to bear against the slow speed shaft oil seal or breakage will result. Clean the top of the sub-base. Support the reducer in a safe manner to clean the reducer's mounting surface. Use the centerline marks on the front and rear of

the reducer for initial alignment. Place the reducer on the sub-base and install the bolts from the bottom, leaving them loose so the reducer can be shifted for alignment.

5.5 REDUCER ALIGNMENT (Figure 12)

Shift the reducer on the sub-base until the distance from the crankshaft to the Samson post bolt holes on the base is the same on each side of the unit. Tighten the bolts that attach the reducer to the sub-base, following the recommendations given under "Fasteners" in Section 3.



Figure 12

5.6 CRANK ROTATION

DANGER: This machinery is made up of heavy parts that will be rotating during this operation. Personnel must exercise extreme care when working around the sweep of the cranks. Clear all personnel and objects from the crank sweep area before proceeding.

To rotate the cranks to a safe position, remove the chains from the reducer but not the cranks. Disengage the positive-stop pawl, if engaged, and lock into the disengaged position using the locking bolt and nut where provided. Clear the crank sweep area. Slowly loosen the installation and shipping screw. Use the crane to allow the cranks to slowly rotate to bottom dead center. Remove the chains from the cranks. While the cranks are in this position, it is safe to connect the brake system.

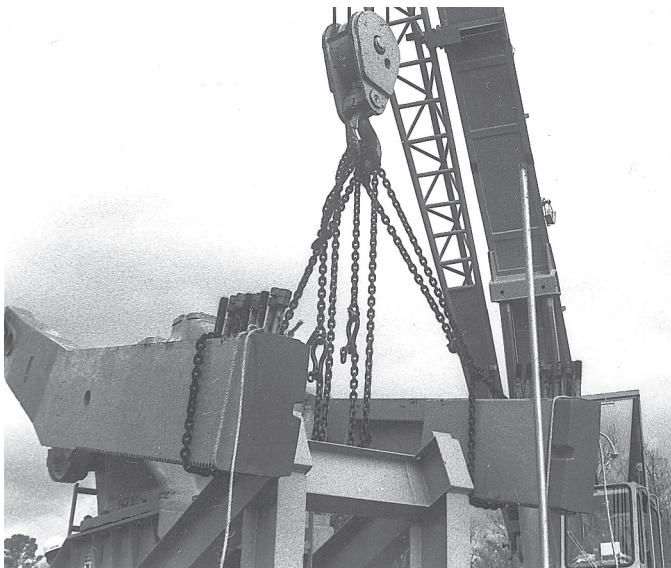


Figure 13

NOTICE: Anytime it becomes necessary to rotate the cranks to another position, attach chains to both cranks as shown in Figure 13. Use a long sling to minimize excessive stress on the sling and cranks. After the cranks are in the desired position, set the brake, engage the positive-stop pawl and chain the drum.

5.7 BRAKE SYSTEM INSTALLATION AND ADJUSTMENT

WARNING: The brake is not intended as a safety stop but is intended for operational use only. When maintenance is to be conducted on or around the pumping unit, the cranks and counterweights must be securely fixed in a stationary position. (Refer to Section 1.3 of this manual.)

The Mark II units are shipped with the type "B" brake (Figure 14). Some of the units have a fabricated trunnion located horizontally from the high speed pinion, while others have the trunnion mounted in the housing and located vertically from the high speed pinion.

Features of the type "B" brake are: 1) an installation and shipping screw used for locking the brake for shipping purposes; 2) two adjusting nuts provided to adjust each lining independently.

The following procedures outline the installation of the brake control assembly and brake cable and the adjustment of the brakes:

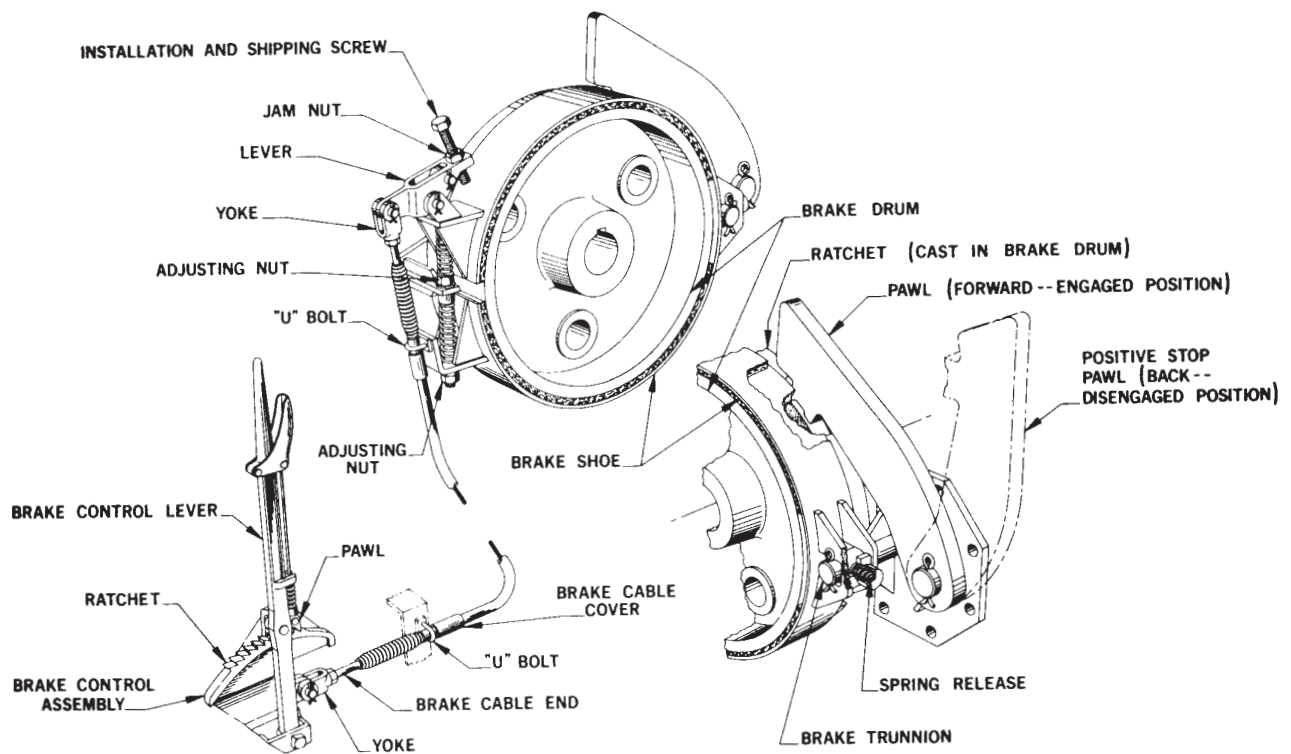


Figure 14

- (1) Units are shipped from the factory with the brake linings engaged against the drum.
- (2) Attach the brake control assembly to the base.
- (3) Attach the brake cable to the base or hi-prime bracket, using the U-bolt provided.
- (4) Move the brake control lever forward to locate the pin hole on the lever into the fork of the yoke on the end of the brake cable. Install the pin and cotter pins.
- (5) The adjustment of the brake is set at the factory but may require final adjustment once the brake control assembly is installed.

With the installation and shipping screw backed out flush with the lever, adjust the position of both linings with the adjusting nuts until they just clear the drum. The spring release on the trunnion should pull the lining away from the drum near the trunnion.

- (6) Using the brake control lever, engage the brake. 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. When adjusting the yoke, care should be taken not to cause the brake cable to over travel internally in the cable cover. Should this occur, move both yokes the same amount in opposite directions.
- (7) Check the brake lining clearance after all adjustments are complete and readjust if needed.
- (8) Make sure the brake drum key is tight.
- (9) Set the brake before continuing with unit installation.

5.8 MASTER COUNTERWEIGHT INSTALLATION

WARNING: This machinery is made up of heavy parts that can rotate unexpectedly. Extreme care must be exercised when working around the sweep of the cranks.

If installing counterweights on previously assembled units, locate the cranks straight down. Set the brake, engage the pawl and chain the drum. Lockout/tagout all energy sources.

Clean the mounting surfaces of the counterweights and cranks of any foreign materials. Units are usually shipped with the counterweight bolts located on the top side of the cranks. Half of these will need to be removed and placed on the opposite side of the cranks. Slide the counterweight bolts into the T-slot of the crank through the opening near the crankshaft.

Using the auxiliary weight bolt holes, lift the counterweight with a sling as shown in Figure 15, or if provided, use the single chaining hole positioned at the center of gravity of the counterweight.

WARNING: Do not stand under any part of the load while installing counterweights. To avoid injury to fingers and hands, hold the bolts with large channel lock pliers or other suitable tool.

On symmetrical weights, the recess for the adjusting pinion should be located toward the long end of the crank. On asymmetrical weights, the curved side must be located toward the long end of the crank (see Figure 16). Line the counterweight bolts up with the holes in the weights and slowly swing the weight into position against the face of the crank. Install the counterweight bolt nuts and tighten according to the recommendations given in the Section 3. Install a second nut as a jam nut and hammer tighten.

WARNING: Improperly tightened counterweight bolts can allow the counterweights to move on the crank. Impact movement of the counterweights could break through the stop on the crank end and damage the unit or cause serious injury or death to personnel.



Figure 15

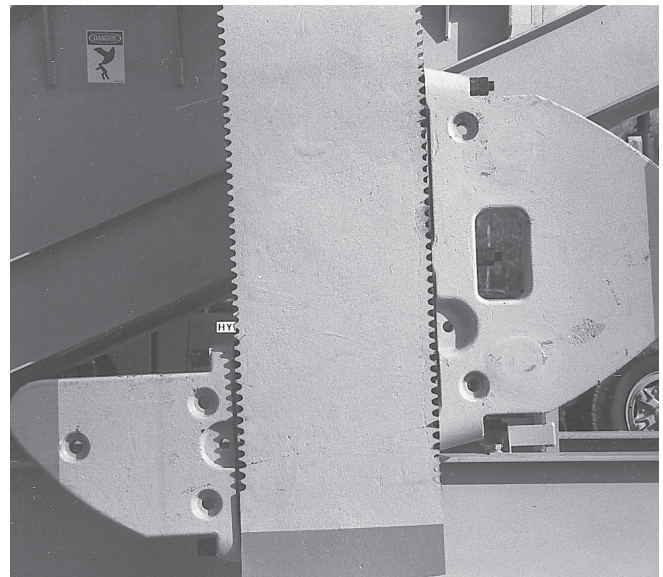


Figure 16

5.9 AUXILIARY WEIGHT INSTALLATION

WARNING: Do not stand under any part of the load while installing the auxiliary weights.

Install the auxiliary weights with the cranks down. Support the weight by passing a chain through one of the mounting holes. Lower the weight in between the reducer and the crank until a bolt hole lines up with the corresponding hole in the master counterweight. Insert a bolt so that the threads point away from the reducer (Figure 17). Continue to lower the weight until the remaining holes line up. Insert another bolt as described above. Remove the chain and install the remaining bolt(s). Tighten all bolts according to the recommendations given under "Fasteners" in Section 3.



Figure 17

5.10 PRIME MOVER INSTALLATION

WARNING: Do not stand under any part of the load while installing the prime mover; do not place fingers and hands between the prime mover and the slide rails.

Place the slide rail bolts in the T-slots near the reducer end so the belts can be easily installed after positioning the prime mover. Guide the slide rails onto the bolts. Space the slide rails to match the mounting holes of the prime mover. Install and space the mounting bolts in the T-slots on the slide rails to match the mounting holes of the prime mover. Slowly lower the prime mover onto the mounting bolts. To prevent injury to fingers and hands, use pliers or other tools to position the bolts. Install the nuts but do not tighten until the belt alignment is completed.

Some bases are tailor-made for a particular engine. These do not use slide rails. The engine feet mount directly to the T-slots on the base.

5.11 "V-BELTS" INSTALLATION AND ALIGNMENT

WARNING: Be certain the prime mover cannot be started during this procedure.

Install a matched set of belts. Use 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 in Figure 18. Shift the prime mover as required and then tighten the bolts that attach the prime mover to the slide rails. Tighten the belts by using the adjustment screws until the belt tension is uniform across the width of the belts. Check the tension by slapping the belts in the middle of the span. They should be lively and springy. Tighten the bolts attaching the slide rails to the T-slots, following the recommendations given under "Fasteners" in Section 3.

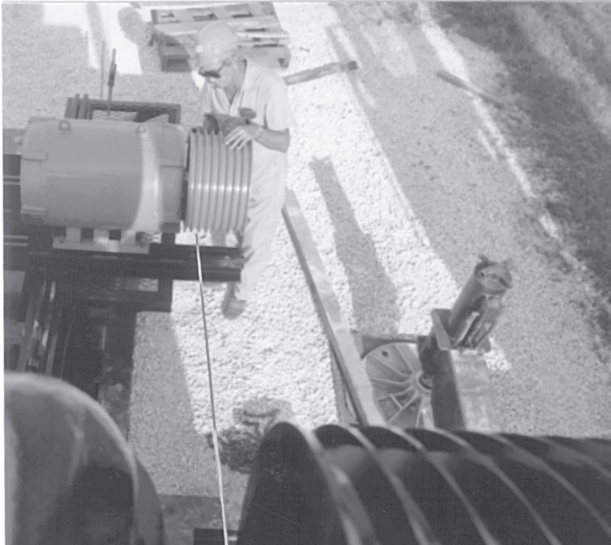


Figure 18



Figure 19

5.12 BELT COVER INSTALLATION

WARNING: Be certain the prime mover cannot be started during this procedure.

Remove the bottom pan (Figure 19) from the belt cover and install the cover (Figure 20). The front support fits over two slow-speed shaft studs on the reducer and is retained by the jam nuts that are located on the reducer studs. The rear belt cover support fits on the prime mover base. Check inside the cover to be sure the sheaves and belts have adequate clearance. The cover can be shifted side-ways to adjust clearance, but do not over shift and allow the sheaves to rub against the belt cover. Replace the bottom pan. Some belt covers are equipped with a center support or a wind brace, which should be attached at this time. Tighten all bolts following the recommendations given under "Fasteners" in Section 3.

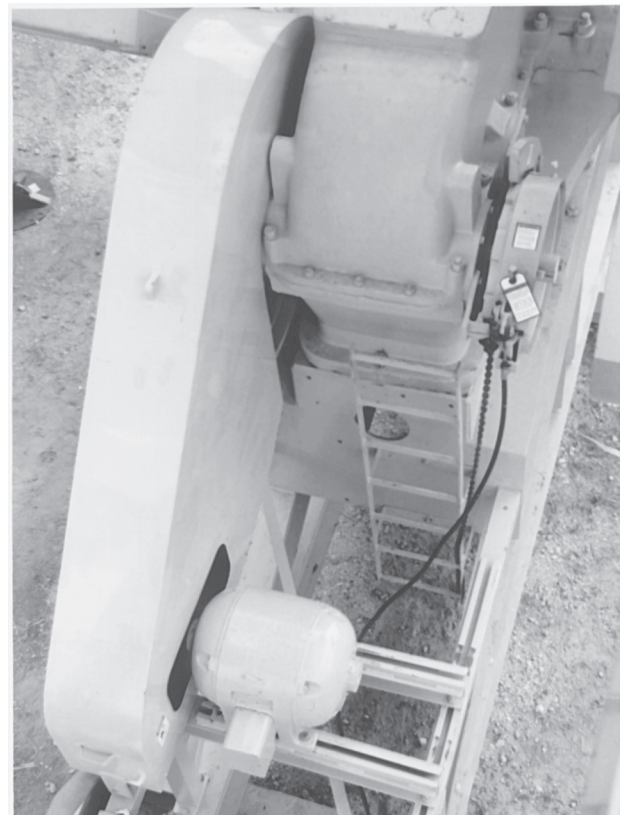


Figure 20

NOTE: It is essential that the user of the pumping unit comply with all applicable safety requirements concerning the guarding of belts and sheaves. For additional information concerning belt guards, see API RP11ER.

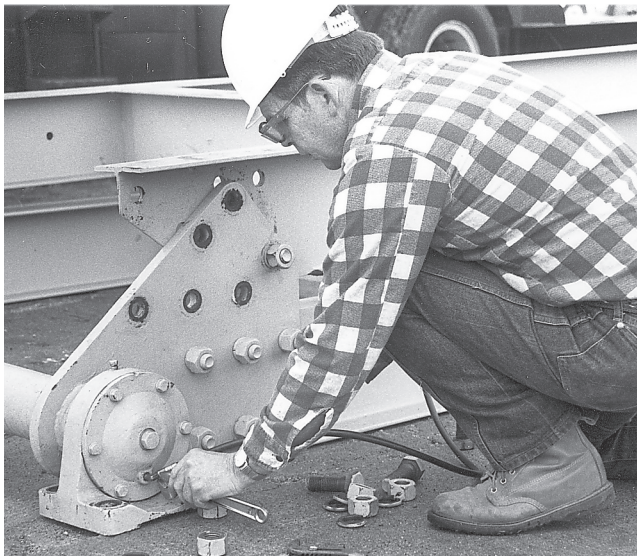


Figure 21



Figure 22

5.13 SAMSON POST AND BRACE ASSEMBLY

Install the ground oiling hoses as shown in Figure 21. Connect the hose from the ground oiling pipe on the post leg to the bearing assembly, one on each side of the unit.

The post and brace assembly is shipped with pivot bolts in place to allow the brace to be raised for proper alignment with the bolt holes in the bearing plate. The rest of the bolts are located in a part sack or bucket.

Lift the brace, as shown in Figure 22, to align the bolt holes. Install the bolts so the nuts are on the outside, making it easier to tighten later after the ladder is installed. Snug, but do not tighten, the bolts.

5.14 SAMSON POST INSTALLATION

WARNING: Do not stand under any part of the load while installing Samson post.

Lift the post assembly with a sling attached near the top of the assembly. This will hang the post in a near level position for easy attachment to the base, as shown in Figure 23. Install the bolts attaching post and brace assembly to the base. Tighten the foot bolts according to the recommendations given under "Fasteners" in Section 3.

5.15 LADDER INSTALLATION

WARNING: Do not stand under any part of the load while installing ladder.

A ladder installation diagram is furnished with all Mark II pumping units. It is located in the information packet. The ladder or ladders and platforms attach directly to the Samson

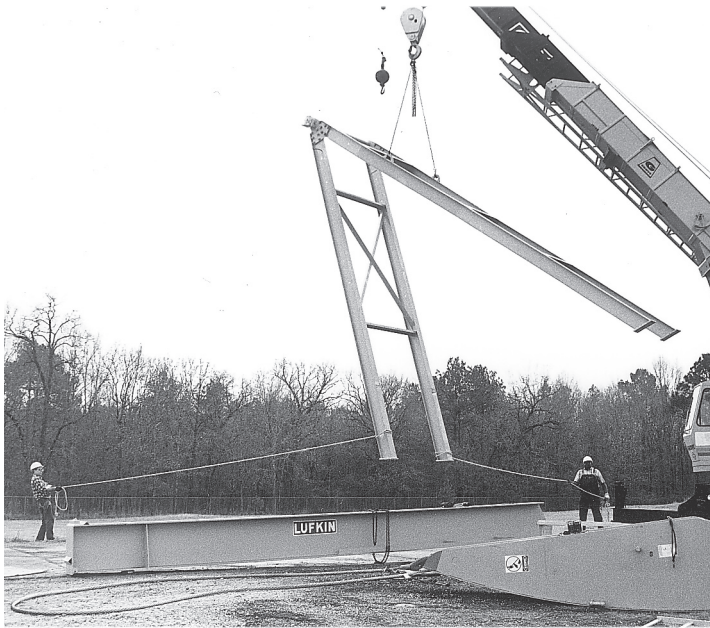


Figure 23



Figure 24

post as shown in Figure 24. On larger units, the ladders and platforms may also attach to the Samson post brace. Install the bolts and tighten, following the recommendations given under "Fasteners" in Section 3. Also, tighten the bolts between the post and brace legs at this time.

On smaller units, a clamp-on type loop is furnished with our ladders to provide support for a person when working in the area of the Samson post bearing. The loop position is adjustable and must be located in such a position to insure maximum safety to personnel.

WARNING: Never use the ladder while the unit is in operation.

5.16 PREPARATION FOR WALKING BEAM INSTALLATION

DANGER: The cranks will be rotated during this operation. Stay clear of the sweep of the cranks while the cranks are in this position.

The following is a description of how to rotate the cranks to position the crank pin holes at bottom dead center. Use chains on both cranks. (See Notice in Section 5.6) Remove the slack in the chains. Clear the crank sweep area of all objects and personnel. Release the brake lever. Slowly raise the cranks to the desired position. Reset the brake, install the pawl and chain the drum. (Refer to Section 1.3 of this manual.). Slowly release the load from the chains and remove the chains from the cranks.

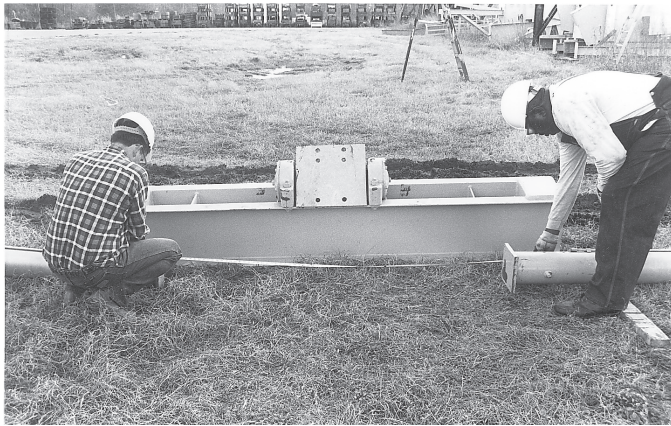


Figure 25



Figure 26

5.17 CROSS YOKE AND PITMANS ASSEMBLY

Position the pitmans on the ground as shown in Figure 25. Be sure that the ground oiling lines are on the top side. Space the upper ends of the pitmans several inches farther apart than the vertical spacers located inside each end of the cross yoke.

CAUTION: Be sure there is a hard rubber cushion inside and against the top of the pitman pocket located at each end of the cross yoke. If the unit is operated without these cushions, serious damage will result.

Lower the cross yoke over the pitmans as shown in Figure 26. After the cross yoke is in position, lift the pitmans slightly and pull away from the cross yoke as far as they will go. This positions the pitmans so that the pivot pins, which are welded to the pitman, will contact the outer retaining strips located in the cross yoke. When properly installed in this position, the pitmans will swing down to a vertical position when the assembly is lifted after being attached to the walking beam.

At this point, install the cross yoke bearing lubrication hoses (Figure 27). There are two hoses per side. Remove the plug in the bearing housing cover with a screwdriver. Attach the hose to the cover and to the elbow that is turned to the inside of the cross yoke. Attach the other hose to the pipes on the cross yoke and on the pitman. Repeat this procedure for the other side.

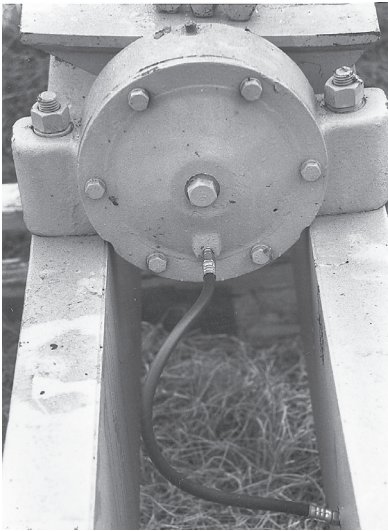


Figure 27



Figure 28

5.18 WALKING BEAM TO CROSS YOKE BEARING ASSEMBLY (Figure 28)

Notice the hole patterns in the cross yoke bearing plate and the lower flange of the walking beam are asymmetrical so that they can be bolted together only one way.

WARNING: Do not stand under any part of the load while positioning walking beam.

Lift the walking beam and line up the beam with the holes in the cross yoke bearing plate. The front of the plate bears against a shear block on the bottom of the walking beam. Install and tighten the bolts, following the tightening recommendations given under "Fasteners" in Section 3.

5.19 WALKING BEAM TO SAMSON POST CONNECTION

WARNING: Do not stand under any part of the load while installing assembly.

With the cross yoke and pitmans assembled to the walking beam, the balance point for most assemblies is usually around the "LUFKIN" nameplate which is attached to the walking beam. Use a double sling, as shown in Figure 29, to help stabilize the load. Slowly lift the



Figure 29



Figure 30



Figure 31

assembly and allow the pitmans to swing down to a vertical position. Stop the lift when the crank pin connections are at eye level. Visually check the alignment of the crank pin connections to insure that the pitmans are installed correctly and/or that the cross yoke is straight. If this alignment cannot be attained, contact the nearest LUFKIN representative.

Align the holes in the rear cross beam with the holes in the Samson post bearing housings. Install the bolts and tighten per the recommendations in "Fasteners" in Section 3.

A package of shims is furnished for alignment purposes but are not installed at this time. The shims are usually located in the rear cross beam. In some cases, they are located in the parts sack.

5.20 PITMAN/CRANK PIN CONNECTION (Figure 30)

CAUTION: Do not hammer the pitman lower connection onto the crank pin bearing box. This could result in damage to the crank pin bearings.

Clean the contact surfaces between the pitman lower connection and the crank pin bearing box. Remove the capscrews from the bearing housing outer flange. The pitman ends should fit easily on the crank pin bearing boxes. If the pitman does not fit the crank pin squarely, slowly lift or lower the walking beam to get the proper alignment. Align the capscrew holes and install the capscrews, tightening them per Section 3.

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.

5.21 PITMAN ALIGNMENT CHECK

With the cranks still in a vertical position, check the spacing between the pitman side member and the end of the crankshaft or between the pitman side member and the crank pin pad on each side of the unit as shown in Figure 31. These distances should be within $\frac{1}{8}$ of an inch of each other.

Follow the instructions given in Figure 32 if alignment adjustment is required. Be sure the same number and thickness of shims are used under both pads of the bearing housing being shimmed to prevent misalignment of the bearing.

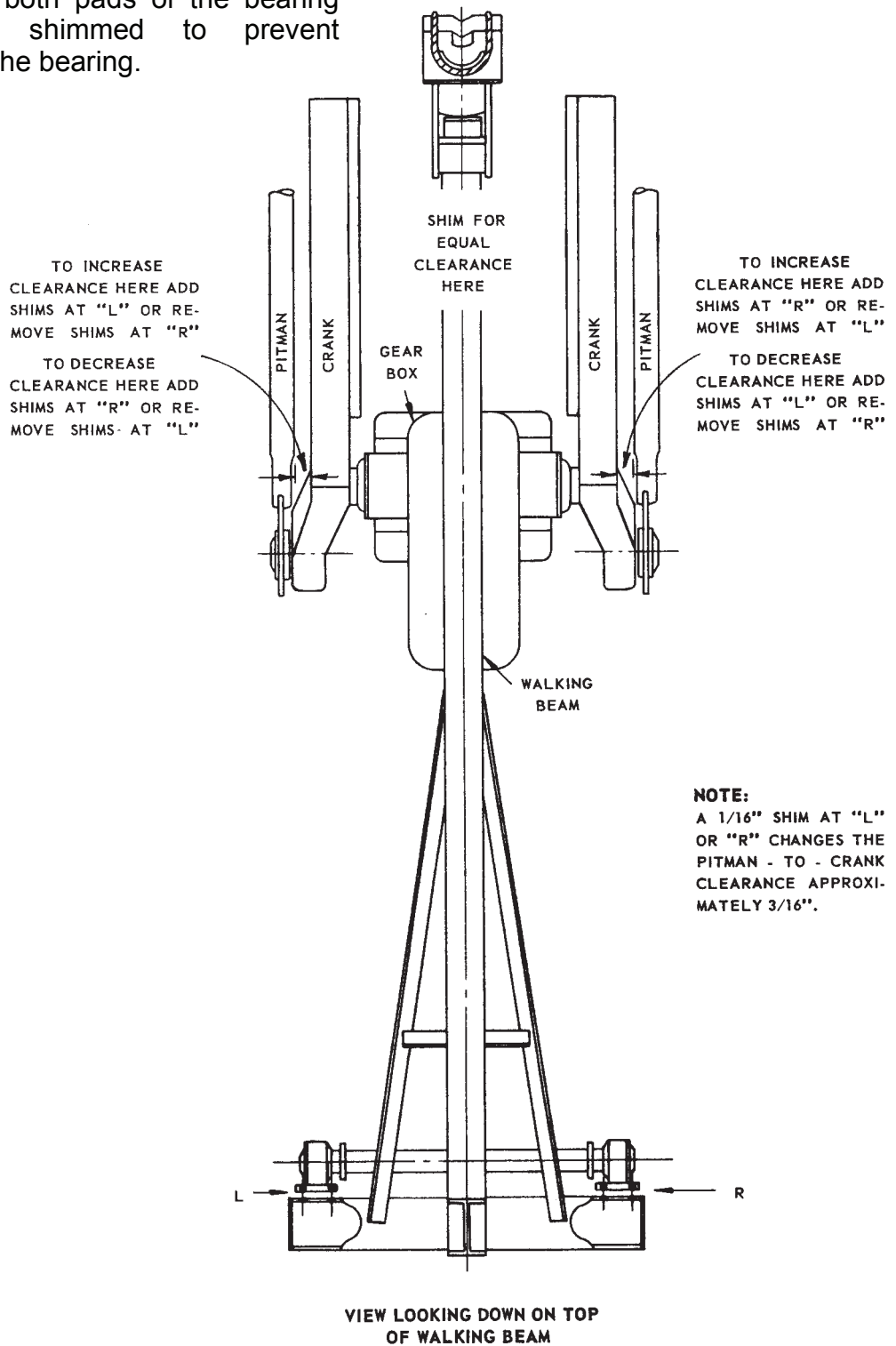


Figure 32

5.22 BEARING ASSEMBLY LUBRICATION (Figures 33, 34 and 35)

Crank pin, cross yoke and Samson post bearing assemblies are lubricated at the factory; however, it is a good practice to check the assemblies. The grease fittings for the crank pin bearings are located on the crank pin bearing housing. The grease fittings for the cross yoke bearings are located on one of the pitman arms. The grease fittings for the Samson post bearings are located near the bottom of the Samson post legs. Using a grease as specified in Section 12.3, pump grease into the bearing assembly until it overflows through the relief fitting. Lubrication lines are prelubricated; therefore, only a small amount of grease should be required for this check.

Pump the grease in slowly to avoid damage to the seals.

CAUTION: Damage will occur to the cross yoke bearing, Samson post bearing or crank pin bearing if the unit is operated with improper amount or type of lubricant in the assemblies.

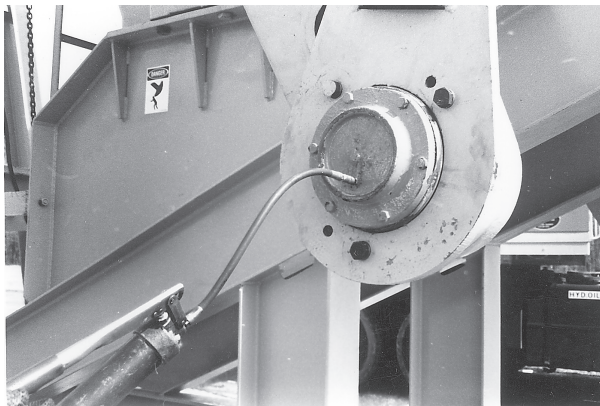


Figure 33



Figure 34

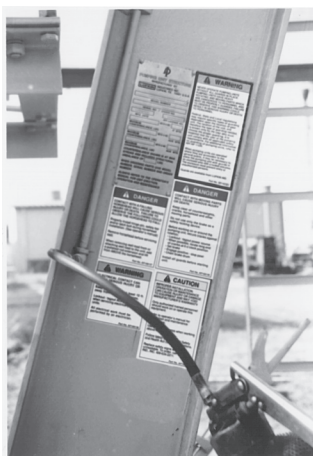


Figure 35

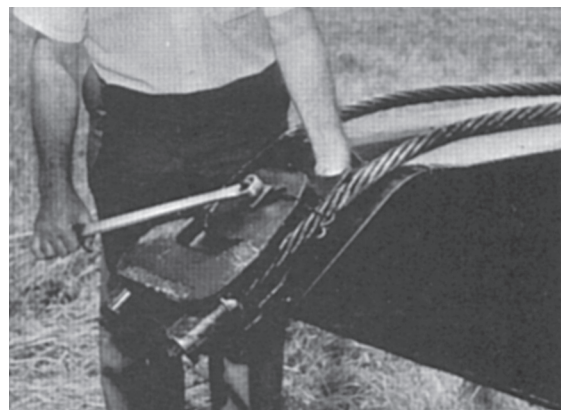


Figure 36

5.23 WIRELINE INSTALLATION

Two basic types of wireline assemblies are furnished on Mark II units. Figure 36 shows the installation of a two-piece line utilizing an equalizer sheave that 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.

In Figure 37, a one-piece wireline assembly is looped around the wireline seat that is located at the top of the horsehead. Loosely bolt the wireline retainer in place over the seat and the wireline. Stretch out the wireline by pulling on the carrier bar until the carrier bar is parallel with the bottom of the horsehead and the wireline is against the seat. Tighten the bolt holding the wireline retainer in place per Section 3.



Figure 37

5.24 WIRELINE BAIL INSTALLATION (Figure 38)

A wireline bail is furnished on all Mark II pumping units. The bail prevents the wireline from sliding off of the side of the horsehead in the event slack occurs in the wireline. To install the wireline bail, simply insert the pins on the bail into the pipe sockets on the side of the horsehead.



Figure 38



Figure 39

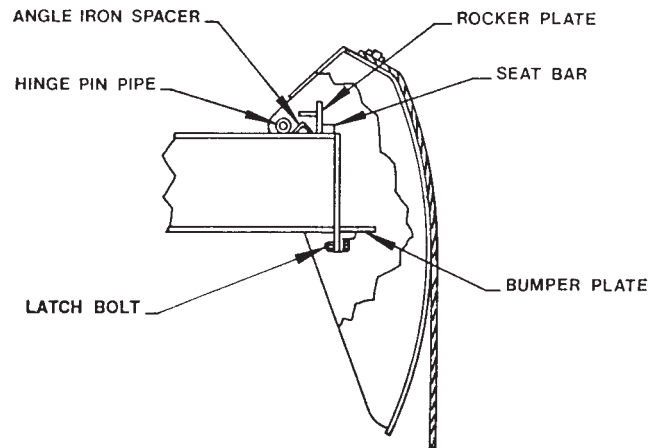


Figure 40

5.25 HORSEHEAD INSTALLATION

DANGER: The cranks will be rotated during this operation. Stay clear of the sweep of the cranks while the cranks are in this position.

Unchain the brake drum and disengage the brake pawl. After verifying that the crank sweep area is clear, release the brake. Use the crane to position the cranks so that the walking beam is in the horizontal position. Reset the brake, engage the brake pawl and chain the brake drum.

WARNING: Do not stand under any part of the load while positioning the horsehead. Do not place hands or fingers inside of the horsehead during installation.

Before lifting the horsehead, make sure the adjusting screws are flush with the inside of the side plates (Figure 39). Lift the horsehead and clean the wireline track of any foreign material. Place the horsehead on the beam, making sure the rocker plate inside the upper portion of the horsehead fits firmly against the top flange of the beam and is between the seat bar and the angle spacer (Figure 40).

Some of the smaller units are shipped with a hinge pin, which needs to be installed at this time. Insert the pin through the side plate and the hinge pipe that is located on top of the walking beam. Add the washers and the cotter pins to hold the hinge pin in place. Allow the horsehead to swing down so that the bumper plate inside the horsehead contacts the front plate of the walking beam.

Units with 100" stroke length and larger are equipped with a horsehead safety bar. (See Figure 41.) Install the bar through the slot in the side of the head and through the angle welded to the front plate of the beam. To keep the bar from sliding out, the roll pin, which is part of the bar, must go through the slot on the side plate and then rotate 90° to bear

against the inside of the side plate. Visually check that the safety bar is through the angle and not above or below it.

The units with shorter stroke lengths are equipped with a latch bolt (throat bolt). See Figure 40. These size units are normally shipped from the factory with the horsehead mounted to the walking beam. At this time, be sure that the latch bolt is installed. If the horsehead alignment is incorrect (procedure 5.26), the latch bolt will need to be loosened until the adjustments are made, then retightened.

WARNING: The safety bar, hinge pin, and/or the latch bolt must be installed and tightened at all times except during horsehead removal.

5.26 HORSEHEAD ADJUSTMENT

Use a level or a plumb bob, as shown in Figure 42, to check the vertical alignment of the horsehead. The horsehead may be adjusted by tightening the adjusting screws on either side of the horsehead until it is vertically aligned. Tighten the jam nuts to maintain the alignment. Tighten the latch bolt on units so equipped. Refer to "Fasteners" in Section 3.

NOTE: It is essential that the user of the pumping unit comply with all applicable safety requirements concerning the guarding of horseheads. Refer to API RP11ER. Guards are available from LUFKIN.

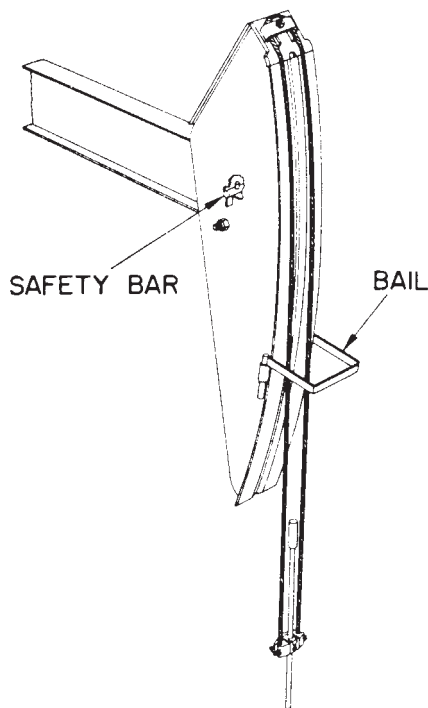


Figure 41



Figure 42



5.27 UNIT ALIGNMENT (Figure 43)

Using a rope, hold the carrier bar away from the polished rod. Do not stand under the horsehead. Lower a plumb bob from the center of the top of the horsehead down beside the polished rod. Alignment is achieved when the distance from the string to the center of the polished rod is the same as the distance between the string and where the center of the wireline will travel when connected to the well load. An alternate method can be used after complete unit assembly and before starting the unit. After applying the well load to the unit, use a level to check the vertical alignment of the polished rod in various stroke positions. Move the entire pumping unit on its foundation if adjustment is required.

DANGER: The cranks will be rotated during this operation. Stay clear of the crank sweep area and other moving parts of the unit.

Figure 43

After establishing the final alignment of the unit to the well:

- (1) Attach chains to both cranks (see Notice in Section 5.6). Remove the slack to support both cranks equally. Unchain the drum and disengage the pawl. (Refer to Section 1 of this manual.)

After making sure the crank sweep area is clear, release the brake. Use the crane to slowly lower the cranks to the bottom dead center position. Reset the brake.

- (2) Be sure all foundation hold-down clamps are installed and tighten the foundation bolts.
- (3) Check all other bolts to be sure they are tight.

Refer to Section 3 for bolt tightening recommendations.

5.28 REDUCER LUBRICATION (Figure 44)

See Section 12.1 and 12.2 for the lubrication specifications and the amount required. Check the oil level with the dip stick located at the front of the reducer. If the oil level is low, remove the inspection cover and add oil to the proper level.

CAUTION: Damage will occur to the reducer if it is operated with the improper amount or type of lubricant.



Figure 44



Figure 45

5.29 CRANK GUARD INSTALLATION

Never operate pumping units without guards in place. Guards are available from LUFKIN. Refer to Section 1.4 of this manual.

WARNING: Stay clear of crank swing area while installing guards.

A wire mesh front panel is standard on all Mark II units no matter what type of guards are ordered. Bolt the front panel to the brackets provided; bolt the brackets onto the front of the unit base (Figure 45). Tighten all bolts following the recommendations given under "Fasteners" in Section 3.

When crank guards are purchased from LUFKIN, a crank guard installation schematic is shipped with the unit. This shows the panel part numbers and their location relative to each other and to the well head. Other than hi-prime units, the rear panel has an opening

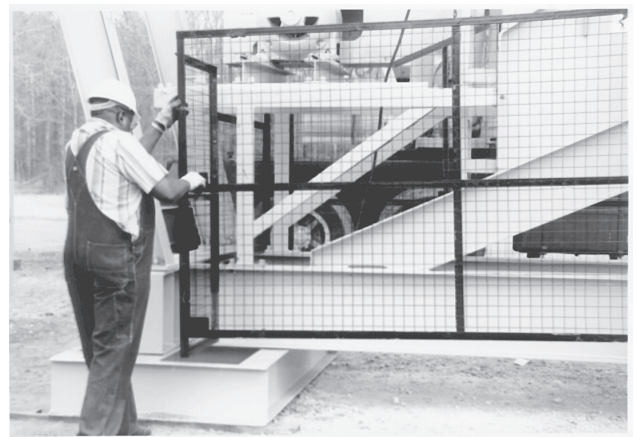


Figure 46

for the belt cover and is heel-clamped to the Samson post or base beam flanges where possible. The side panels are attached to the front and rear panels with hinges consisting of stationary hooks on the side panels and vertical pipe receptacles on the front and rear panels (See Figure 46). Whenever you choose to furnish your own guards in lieu of guards available from LUFKIN, insure they meet all Federal, State and local laws.

5.30 ATTACHING THE WELL LOAD

Hold the carrier bar away from the polished rod with a rope or chain. If necessary, attach a polished rod extension to the polished rod so it will rise above the horsehead. From above the horsehead, slowly lift the polished rod with the crane the length of the stroke.

WARNING: Always work the crane from above the horsehead. Catching the bottom of the horsehead with the crane could cause the horsehead to fall off the beam.

Remove the gate from the carrier bar and position the slot in the carrier bar around the polished rod. Replace the gate and secure the gate latch in the notch provided. Install the rod clamp at the carrier bar and tighten the bolts according to the clamp manufacturer's torque recommendations. Release the brake and slowly let the load down with the crane until the well load is on the unit and slack occurs in the chains. Reset the brake. Remove the rod clamp that was at the well stuffing box.

WARNING: Keep hands from between the polished rod clamp and the stuffing box in the event the polished rod clamp slips or the unit moves.

6. PRE-OPERATION

DANGER: Before operating any unit, review the safety section (Section 1) of this manual. Exercise extreme caution to remain clear of the crank sweep and other moving parts while performing any of the following tasks.

6.1 DIRECTION OF ROTATION

The LUFKIN Mark II pumping unit must rotate counterclockwise only. This is determined by looking at the unit from the side with the horsehead located to your right. Arrows are cast on the cranks indicating the correct direction of rotation.

6.2 FIRST CRANK REVOLUTION

DANGER: Contact with heavy rotating parts will cause serious injury or death. Stay clear of the crank swing and horsehead areas.

Clear the crank swing area of all obstructions left on the unit and foundation. The first revolution of the crank should be as slow as possible. Visually check for proper clearance between the cranks and the belt cover, crank guards and pitman side members. Bottom-hole-pump spacing should also be checked during the first revolution.

After clearance checks are complete, operate the unit for 30 minutes and retighten the V-belts.

CAUTION: To avoid damage to the unit, all bolts must be retightened after one week of operation.

7. COUNTERBALANCE ADJUSTMENT

7.1 DETERMINING THE REQUIRED COUNTERBALANCE

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.

DANGER: Do not enter the crank swing area or stand under the horsehead while performing any of the following tasks.

- (1) Polished rod dynamometer -
A dynamometer card analysis is the most accurate method for determining 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 reducer torque and counterbalance required for balanced conditions.
- (2) Ammeter -
A clip-on ammeter may be used to compare the upstroke and down stroke current on electrically powered units. When the counterbalance is adjusted so the current peaks are equal, the unit will be approximately in balance.
- (3) 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.
- (4) 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.
- (5) Tension in the belts -
Belt tension and consequently belt stretch increases with load which causes an apportionable amount of slack in the belts on the side opposite the direction of rotation of the prime mover. A visual comparison of the belt slack or sag on the upstroke and down stroke can be used to estimate counterbalance.

7.2 COUNTERWEIGHT ADJUSTMENT

WARNING: Stay clear of the crank swing area and do not stand under the load while adjusting counterweights.

7.2.1 Crank with Tooth Rack

Stop the unit with the cranks pointing away from the well and slightly downhill in the direction that the weights are to be moved. Set the brake, lockout/tagout all energy sources, engage the pawl and chain the brake drum. (Refer to Section 1.3 of this manual for proper procedures.) Loosen the counterweight bolts just enough to allow the weights to be moved. Use the pinion adjusting tool on units equipped with cranks which have teeth, as shown in Figure 47, to move the weights to the desired position. Some of the larger weights may have to be moved with the aid of a crane or a pry bar. The weight on the bottom of the crank may be moved in a like manner. After positioning the weights in the desired location, tighten the counterweight bolts and install a second nut as a jam nut. Follow the recommendations given under "Fasteners" in Section 3.

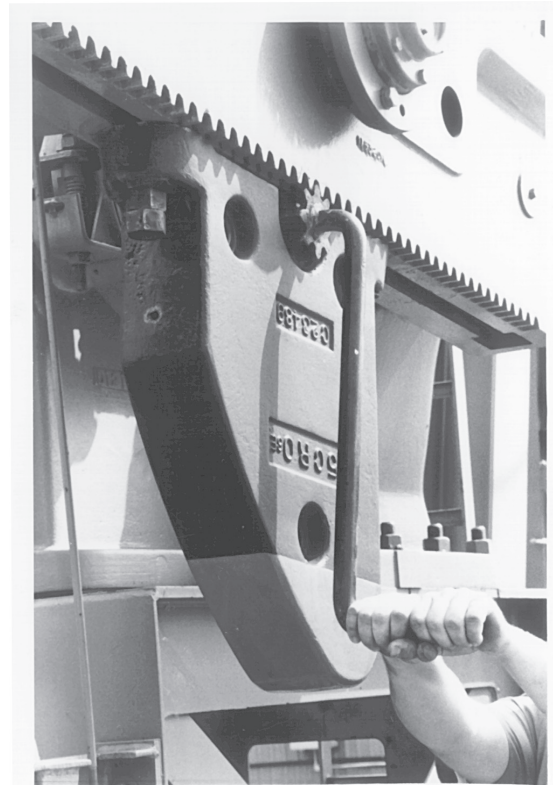


Figure 47

7.2.2 Cranks without Tooth Rack

Stop the unit with the cranks at the 6 o'clock (bottom dead center) position. Set the brake, lockout/tagout all energy sources, engage the pawl and chain the brake drum. (Refer to Section 1.3 of this manual for proper procedures) Attach chains as shown in Figure 48. Take up the slack in the chains with a crane. Loosen the counterweight bolts just enough to move the weights. Lift or lower the weights to the desired position and tighten the counterweight bolts. Install the second nut as a jam nut. Follow recommendations given under "Fasteners" in Section 3.

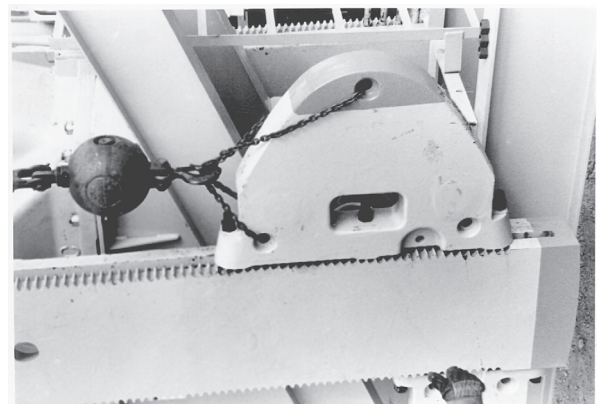


Figure 48

WARNING: Improperly tightened counter-weight bolts can allow the counterweights to move on the crank. Impact movement of the counterweights could break through the stop on the crank end and damage the unit or cause serious injury or death to personnel.

8. STROKE CHANGE

WARNING: Before performing a stroke change, review Section 1 (the Safety Section) of this manual. Stay clear of the crank swing area while performing any of the following tasks.

The following description of a stroke change is given while viewing the pumping unit from the side with the well head located to the right:

8.1 PREPARATION

Stop the unit with the counterweight end of the cranks in the bottom dead center position and set the brake.

CAUTION: Abrupt braking may damage the gear teeth in the reducer. A slow, even pull on the brake lever is recommended.

To clamp off the well load, place a polished rod clamp at the stuffing box and tighten according to the clamp manufacturer's torque recommendations.

Remove the crank guards. Attach chains to both cranks (see Notice in Section 5.6). Using a crane, take up the slack to remove the load from the brake. Slowly release the brake and lift until the crank pin end of the cranks are at a satisfactory working level. Reset the brake and engage the pawl. Lockout/tagout all energy sources and chain the drum. Be sure the cranks are secured against rotation. (Refer to Section 1.3 of this manual for proper precautions.)

Disconnect the carrier bar from the polished rod.

WARNING: Keep hands from between the polished rod and carrier bar in the event the polished rod clamp slips or the unit moves.

Attach chain(s) to the walking beam between the horsehead and cross yoke bearing and take up the slack, removing the load from the pitmans.

CAUTION: Do not over lift and put an upward load on the crank pins.

Leave the lower pitman connection attached to the crank pin bearing housing.

8.2 CRANK PIN REMOVAL

WARNING: Proper eye protection must be worn; flying metal may cause damage to the eyes.

Using a drive nut (furnished as an optional item) is the recommended way to drive out the crank pin. First, remove the cotter pin. Remove the crank pin nut using a box-end hammer-wrench (furnished with a set of wrenches as an option) and at least a 14-pound sledge hammer with a full length handle. Then thread the drive nut onto the pin until it bottoms out. Hammer against the head of the drive nut until the pin is loose. When the pin is loose, do not remove it from the hole. Remove the drive nut and install the original nut 3 or 4 threads deep. Follow the same procedure on the opposite crank pin.

If a drive nut is not available, then remove the cotter pin and loosen the crank pin nut as previously described. Do not remove the nut. Hammer as squarely as possible against the end of the pin. When the pin becomes loose, do not remove it from the hole. Follow the same procedure on the opposite crank pin.

Check the crank pin clearance in the hole and adjust the walking beam accordingly so when the pins are removed they will not fall nor pull up in a sudden motion. Remove the nuts and pull the crank pins out of the holes. The pitman side member will support the crank pin bearing assembly until the pin is installed into another hole. Inspect the crank pin and hole surfaces for rust and wear. These conditions may indicate that the pin was loose. Apply rust preventive to the crank pin bore after the pin is removed.

8.3 CRANK PIN INSTALLATION

With emery cloth, remove any paint and foreign material from the crank pin, crank pin hole and the mating surfaces between the crank and the crank pin nut. Clean these same areas with an approved solvent (per your company's quality policy.)

CAUTION: Improper cleaning of the crank pin and crank pin hole, as well as improper tightening of the crank pin, can cause damage to the pumping unit.

Adjust the walking beam to line up the crank pins with the proper holes for the stroke length desired.

With a 1 in. brush, apply three very light stripes of non-drying machinist blue equally spaced down the length of the pin. Remove any excess with a clean, lint-free cloth – a thick stripe will give a false indication of good contact. Install the crank pin bearing assembly in the crank pin hole without smearing the machinist blue. Thread the crank pin nut onto the crank pin and use a hammer wrench to tighten the nut until it will no longer rotate. To ensure proper contact between the crank pin and crank pin hole, use a sledge hammer to turn the wrench one additional cotter pin notch.

Remove the crank pin bearing assembly and inspect the crank pin hole. Disregarding the area where the groove around the crank pin was not in contact with the crank pin hole, machinist blue should be present along 85% of the hole's length. If it is less than this, contact your nearest Lufkin Service organization for advice.

Clean the crank pin as described above and apply a light coat of clean oil to the crank pin hole. Wipe away any excess with a clean hand. Line up the crank pin bearing assembly with the crank pin hole. With a single motion, insert the assembly into the crank and thread the crank pin nut onto the crank pin.

CAUTION: Do not install the crank pin without properly applying oil film in the hole.

Using a hammer wrench and your body weight, tighten the crank pin nut until it will no longer rotate. Mark the location of the hole in the crank pin on the crank pin nut. Use at least a 14-lb sledge hammer to turn the nut two cotter pin notches. Watching carefully, hammer the wrench until the hole in the crank pin lines up with the third cotter pin notch. Continue to tighten only if the nut can be turned to the next notch.

WARNING: Proper eye protection must be worn; flying metal could cause damage to the eyes.

Install the cotter pin. Never back the nut off to insert the cotter pin. If you have turned the nut too far, remove the crank pin (Procedure 8.2) and repeat all of the installation procedure.

8.4 PUTTING THE UNIT INTO OPERATION

Lower the walking beam until the cross yoke rests on top of the pitman side members. Check to see that the pitmans are all the way up in the cross yoke. Reattach the carrier bar to the polished rod.

WARNING: Keep hands from between the polished rod and carrier bar in the event the polished rod clamp slips or the unit moves.

Remove the chain(s) from the walking beam. Keeping the brake engaged, unchain the drum and disengage the pawl.

Slowly release the brake to transfer the well load back to the carrier bar. Be sure the load is not on the polished rod clamp at the stuffing box. Set the brake. Lockout/tagout all energy sources. Reinstall the crank guard panel or panels.

WARNING: Stay clear of the crank swing area while installing guards.

Remove the polished rod clamp at the stuffing box.

After a stroke length change, check the bottom-hole pump spacing. Also, the counterbalance should be checked and the weights repositioned as required for proper balancing.

9. WELL SERVICING

DANGER: Before performing any task around a pumping unit, refer to the safety section of this manual (Section 1). All mechanical sucker rod pumping units, of necessity, have rotating parts. Even a temporarily stationary pumping unit has components that can start moving from the effect of gravity. It is essential to prevent rotation of the cranks stopped in any position for the purpose of service or maintenance.

9.1 PREPARATION

WARNING: Do not attempt to service the well without first removing the horsehead.

Stop the unit with the walking beam in a near level position and the cranks pointing away from the well, set the brake and engage the pawl. Lockout/tagout all energy sources.

CAUTION: Abrupt braking may damage the gear teeth in the reducer. A slow, even pull on the brake lever is recommended.

To clamp off the well load, place a polished-rod clamp at the stuffing box and tighten according to the clamp manufacturer's torque recommendations.

Remove the crank guards.

Attach chains to the cranks. See Notice in Section 5.6. Using the crane, remove the slack from the chains. Remove the pawl and release the brake. Slowly lift the cranks until the well load is off the carrier bar. Reset the brake, engage the pawl, chain the drum and lockout/tagout all energy sources. (Refer to Section 1.3 of this manual for proper procedures.)

Disconnect the carrier bar from the polished rod.

WARNING: Keep hands from between the polished rod and carrier bar in the event the polished-rod clamp slips or the unit moves.

Put a long rope or chain through the carrier bar and put the gate back into the carrier bar. Be sure the rope or chain is long enough so the carrier bar can be held without lifting a person off the ground.

9.2 HORSEHEAD REMOVAL

WARNING: Under no circumstances should well servicing be attempted without first removing the horsehead. Be certain to remove the latch bolt, safety bar and/or the hinge pin before attempting to remove the horsehead. Do not stand under any part of the load while lifting.

Attach the chain to the horsehead. Loosen the adjusting screw on either side of the horsehead until they are flush with the side plates. Remove the latch bolt, safety bar and/or hinge pin. While holding the carrier bar away from the polished rod, slowly lift the horsehead from the beam. Place the horsehead on the ground a safe distance from the work area.

Keeping the brake engaged, remove the other safety precautions for securing the unit against rotation. Slowly release the brake to lower the cranks to the 6 o'clock position. Reinstall safety precautions to secure the unit against rotation before well servicing.

9.3 HORSEHEAD INSTALLATION

After well servicing is completed, reattach the chains to the cranks as previously described. Unchain the drum, disengage the pawl and release the brake. Slowly lift the cranks until the beam is in a near horizontal position as before. Set the brake, engage the pawl, chain the drum and lockout/tagout all energy sources. Remove the chain from the cranks and reattach to the horsehead. Reinstall and check the alignment of the horsehead as described in Procedure 5.25 and 5.26 of this manual.

WARNING: The safety bar, hinge pin and/or the latch bolt must be installed and tightened at all times except during horsehead removal.

9.4 PUTTING THE UNIT INTO OPERATION

Attach the chains to the cranks (see Notice in Section 5.6). Using the crane, remove the slack from the chains. Unchain the drum, disengage the pawl and release the brake. Slowly lift the cranks enough to re-install the carrier bar on the polished rod.

WARNING: Keep hands from between the carrier bar and polished rod clamp in the event that the polished-rod clamp slips or the unit moves.

Reset the brake. Remove the chain from the carrier bar and attach the carrier bar to the polished rod. Slowly release the brake to transfer the well load back to the carrier bar. Be sure that the load is not on the polished-rod clamp at the stuffing box. Reset the brake.

Remove the polished-rod clamp at the stuffing box.

Re-install all guards before attempting to operate the pumping unit. Check the bottom-hole-pump spacing.

10. PREVENTIVE MAINTENANCE

Preventive maintenance is essential to prolong the life of the unit and to prevent expensive failures. Many items can be checked by visual inspection and by listening for unusual noises. These items should be checked each time you go to the unit.

CAUTION: Never approach a pumping unit assuming that everything is all right. With time, some components could work loose and present a potentially dangerous situation. Always approach operating units from the rear.

The following visual inspections are recommended before approaching the unit:

- (1) Look at both crank pins to see if they have worked loose.
- (2) On units which are driven by slow-speed engines, look to see if the flywheel is loose.
- (3) Look at the counterweights to be sure they are tight.

- (4) Look at the cross yoke bearing to be sure it has not worked loose.
- (5) Look at the connections between the walking beam and post to the Samson post bearings to see if they are loose.
- (6) Inspect the vertical alignment of the unit with the well. See if the polished rod is working to one side of the stuffing box. Also, visually compare the distance between the pitman side-members and the cranks on each side of the unit. Check to see that the wireline is tracking properly on the horsehead. Also, look for obvious broken strands of wire fraying from the wireline. A change in alignment can be caused if the base shifts on the foundation due to loose hold-down bolts. Misalignment can also result from a foundation that has settled to an unlevel position.
- (7) Look for any obviously loose or missing bolts. Loose bolts will eventually fail in fatigue. This is the major cause of most pumping unit failures. Loose bolts can usually be located by looking for rust at the bolted joint and by checking for visual movement.

If any of the above conditions exist, the unit must be shut down immediately and the problem corrected.

WARNING: Do not perform any task on the unit until you review the safety section of this manual (Section 1). The cranks and counterweights must be secured against rotation.

11. SCHEDULED MAINTENANCE

There are several items that need checking on a regular basis to help extend the life of your pumping unit.

WARNING: Always secure the cranks against rotation or movement before performing any maintenance or while working around the pumping unit. Review the safety section (Section 1) of this manual. Do not use only the brake as a safety stop. The brake is intended for operational use only.

11.1 MONTHLY

11.1.1 Reducer

Check the reducer oil level. Remove the dipstick located at the front of the reducer. The oil level should be between the low and full mark on the dipstick. Loss of oil from the reducer is usually caused by seal leakage at the shafts or leakage at the parting line. If the oil level is low, remove the inspection cover and add oil to the proper level. (Refer to Section 12 for lubricant specifications.)

11.1.2 Structural Bearings

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

11.2 QUARTERLY

11.2.1 Belts and Sheaves

Belt alignment and tension should be checked and adjusted to prolong belt life. Under normal use belts will stretch and wear. Belts need replacing once they have exceeded their allowable stretch. Belt manufacturers suggest running new belts 30 minutes and then retightening. (Consult your belt supplier.) Refer to procedure 5.11.

Also, check the sheaves for wear, chips and cracks. Replace them if any of these conditions exist. Keeping sheaves in good condition will prolong belt life.

11.2.2. Brake

Inspect the brake lining 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 that pertain to the type brake existing on the unit.

Type "B" (Figure 49)

Some units in the field have the type "B" brake. Before adjusting the brake, refer to Section 1.3 of this manual for proper safety precautions.

- (1) Stop the unit with the long end of the crank in the 6 o'clock position. Lockout/tagout all energy sources. Clamp the polished rod at the stuffing box. Engage the positive stop pawl.
- (2) Position the brake lever in its forward (or disengaged) position.
- (3) Adjust the position of both linings with the adjusting nuts until they just clear the drum. The spring release on the trunnion should pull the lining away from the drum near the trunnion.
- (4) Using the brake control lever, engage the brake. 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. When adjusting the yoke, care should be taken not to cause the brake cable to over travel internally in the cable cover. Should this occur, move both yokes the same amount in opposite directions.

- (5) Check the brake lining clearance after all adjustments are complete and readjust if needed.
- (6) Make sure the brake drum key is tight.
- (7) Disengage the positive stop pawl, and remove the polished rod clamp at the stuffing box before attempting to restart the unit.

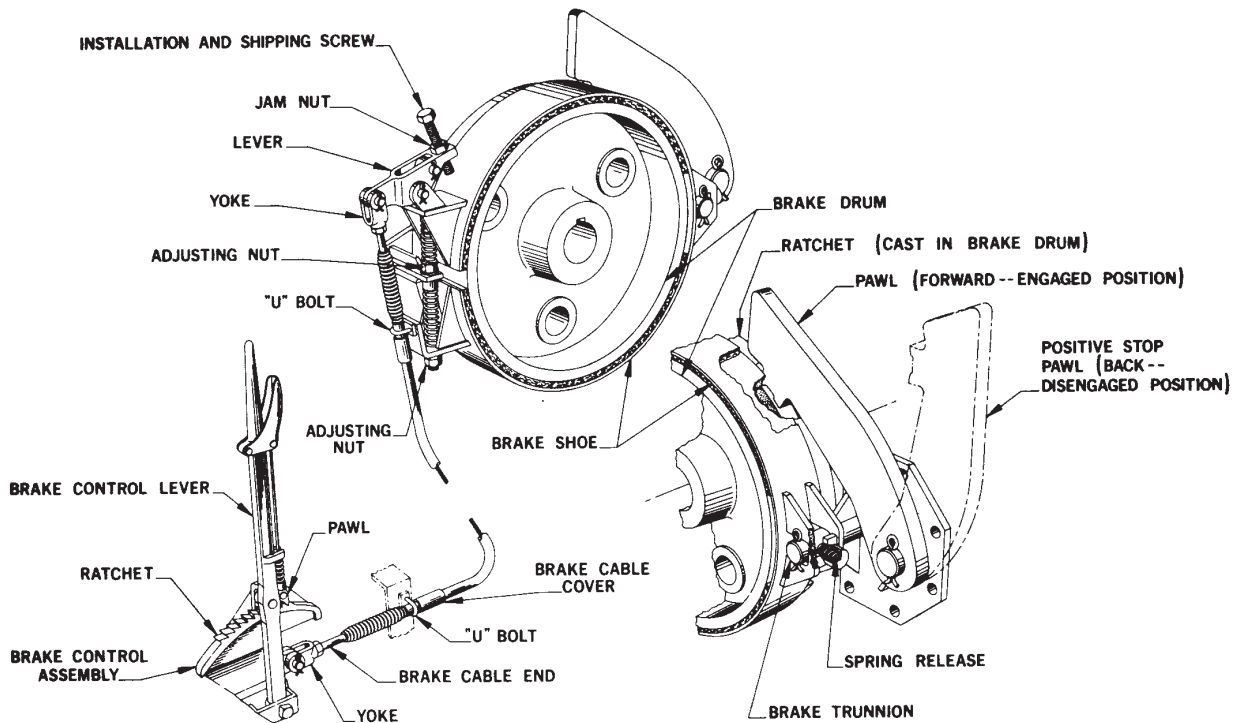


Figure 49

Type "C" (Figures 50 and 51)

Some units in the field have the type "C" brake. This type has some top and some side mounted trunnions. It has a single adjusting nut at the end of the adjusting screw that adjusts both brake linings simultaneously. Before adjusting the brake, refer to Section 1.3 of this manual for proper safety precautions.

- (1) Stop the unit with the long end of the crank in the 6 o'clock position. Lockout/tagout all energy sources. Clamp the polished rod at the stuffing box. Engage the positive-stop pawl.
- (2) Position the brake lever in its forward (or disengaged) position.

- (3) Adjust the position of both brake linings by loosening the jam nut and moving the adjusting nut until both linings just clear the drum. Retighten the jam nut.
- (4) Using the brake control lever, engage the brake. 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. When adjusting the yoke, care should be taken not to cause the brake cable to over travel internally in the cable cover. Should this occur, move both yokes the same amount in opposite directions.
- (5) Make sure the brake drum key is tight.
- (6) Disengage the positive stop pawl and remove the polished rod clamp at the stuffing box before attempting to restart the unit.

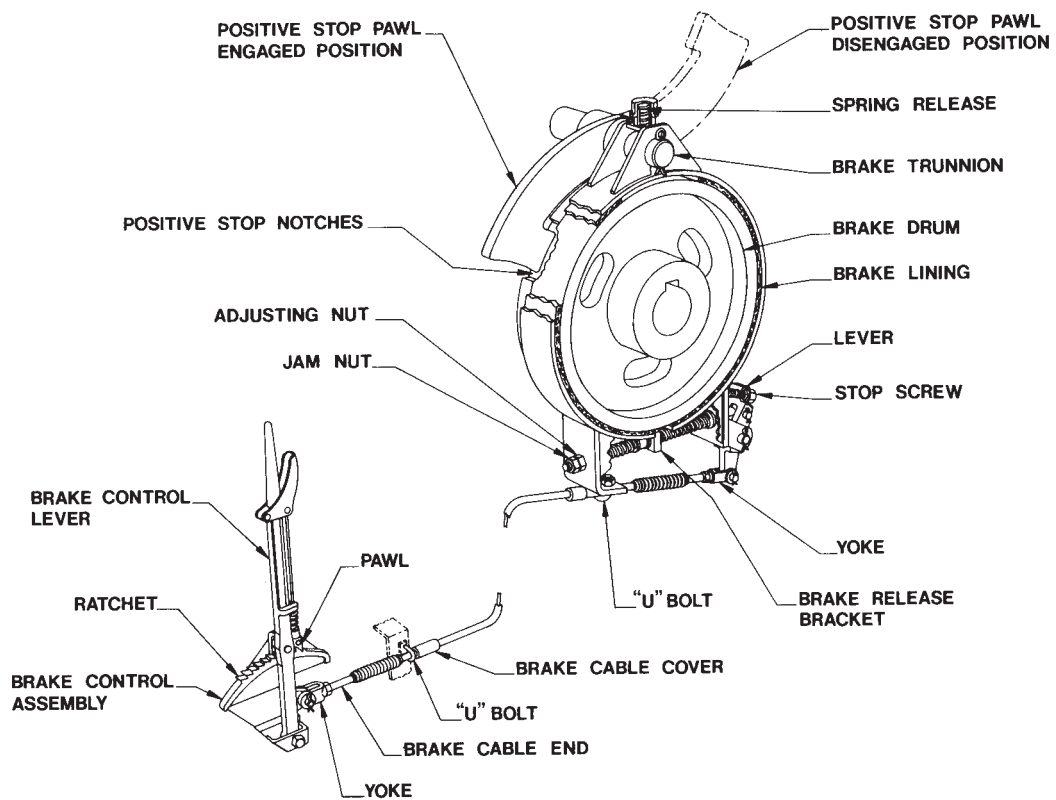


Figure 50

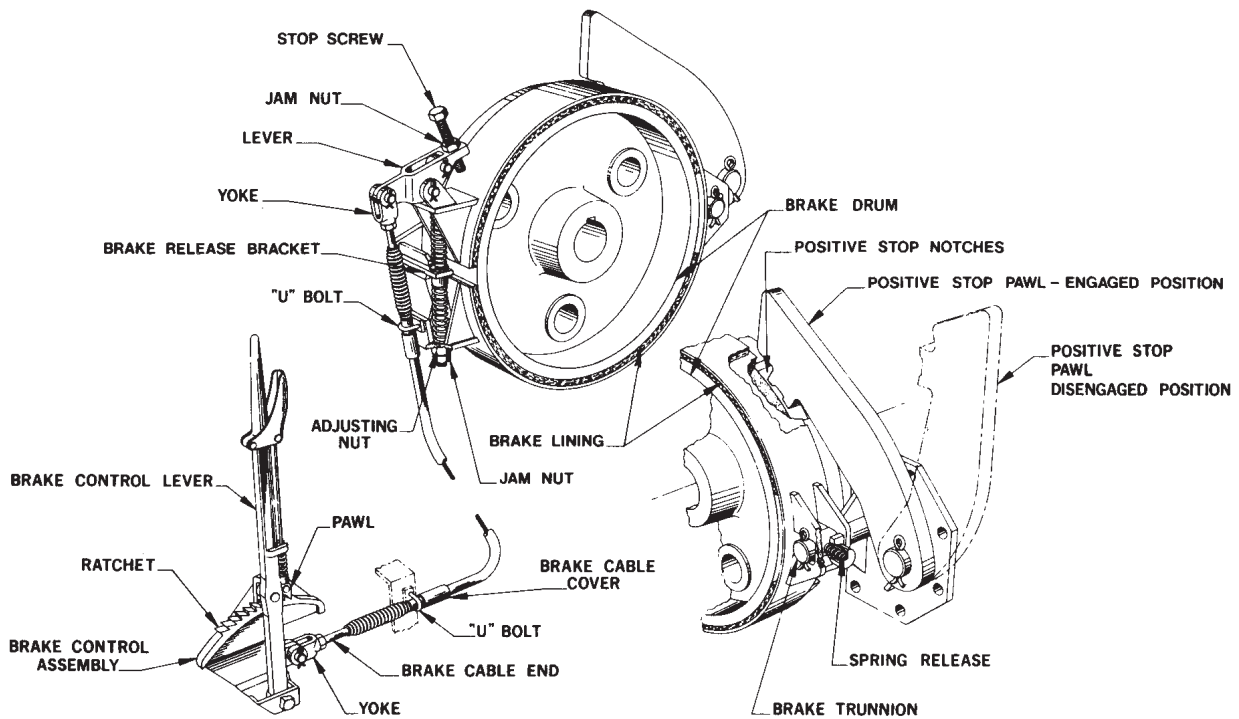


Figure 51

Type "A"

Some smaller and older units in the field may have the shoe type brake (see Figure 52). Before adjusting the brake, refer to Section 1.3 of this manual for proper safety precautions.

- (1) Stop the unit with the long end of the crank in the 6 o'clock position. Lockout/tagout all energy sources. Clamp the polished rod at the stuffing box.
- (2) Position the brake lever in its forward (or disengaged) position.
- (3) Adjust the position of both brake shoes by moving both adjusting nuts until both linings just clear the drum.
- (4) When the brake is disengaged, the pivot yoke of the cam should be at about a 30 degree angle to the right (see Figure 52). Simultaneously, the brake lever would be "full off", to the right of vertical.
- (5) When the brake is fully engaged, the lower end of the cam would be vertical or up to a 30 degree angle to the left (see Figure 52). Simultaneously, the brake lever has the ratchet engaged and several notches still "available" for engagement.

- (6) To achieve the proper engaged and disengaged positions of the cam and brake lever, either or both yokes can be adjusted in or out on the ends of the brake cable.
- (7) Be certain the rod end does not bottom out on the cable cover when engaging or disengaging the brake. When the yoke positions are established, tighten the jam nuts against the yokes.
- (8) Make sure the brake drum key is tight.
- (9) Remove the polished rod clamp at the stuffing box before attempting to restart the unit.

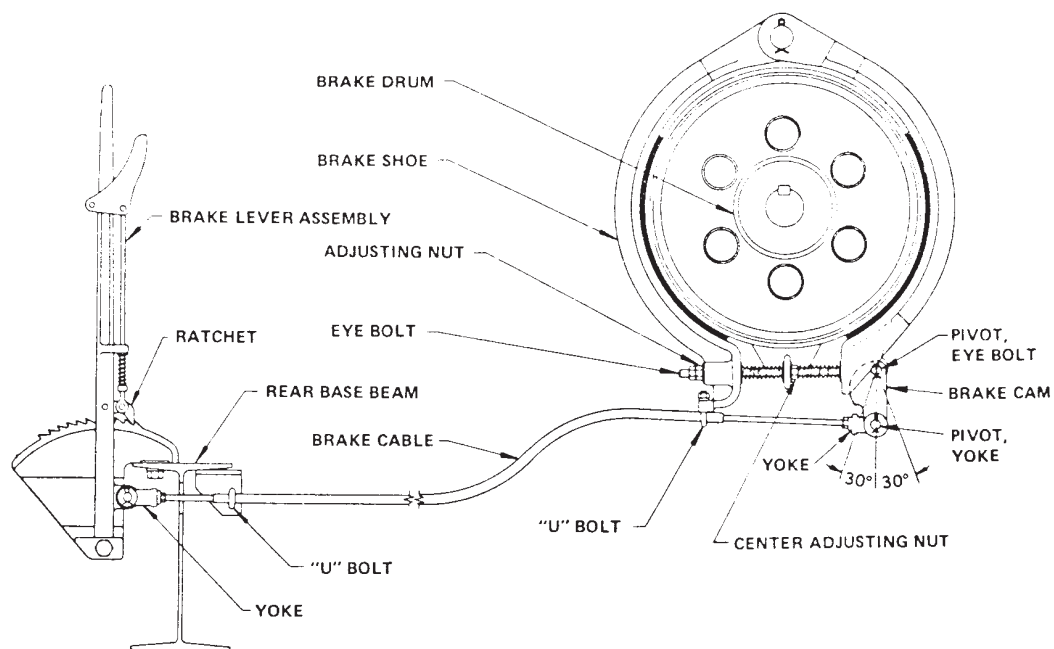


Figure 52

11.2.3 Brake Drum

Inspect the brake drum for cracks around the hub and key area. Also, look at the brake pawl notches to see if any of them have been chipped, cracked or broken out. Replace the drum if any of these conditions exist. (Contact LUFKIN.)

11.2.4 Brake Cable

Inspect the condition of the brake cable. If the rubber coverings at the ends of the cable are cracked, moisture will get into the cable and possibly freeze up its movement. Make sure the brake rods are not bent. Replace the cable if any of these conditions exist.

11.2.5 Crank Phase Marks

On the end of the crankshaft, there is a match mark placed partially on the shaft and partially on the crank. These should remain lined up. If for any reason they are not lined up, you should contact LUFKIN.

11.3 SEMI-ANNUALLY

11.3.1 Reducer

Check the gear tooth condition for abnormal wear. There are many modes of gear tooth failures. Only the most common are included in this section. The following is paraphrased from ANSI/AGMA 110.04, Nomenclature of Gear Tooth Failure Modes:

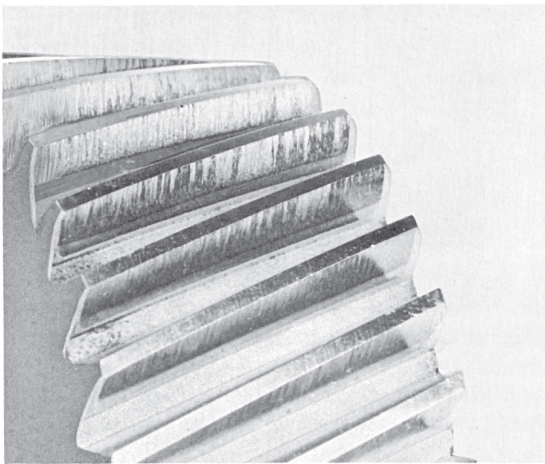


Figure 53

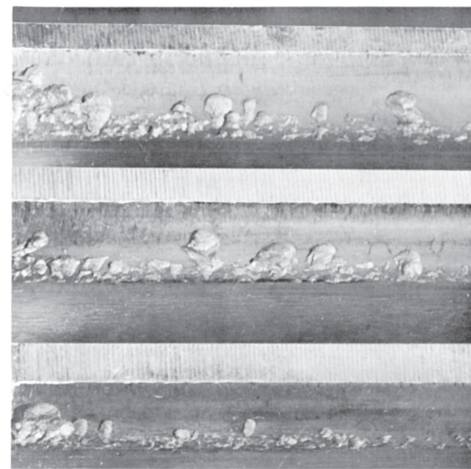


Figure 54

- (1) Score marks on the teeth are an indication that the film thickness of the oil is insufficient for the loads imposed. Score marks are vertical marks on the teeth from the top of the teeth to the root (see Figure 53).
- (2) Pitting is a type of surface fatigue which occurs when the endurance limit of the material is exceeded. It shows up as small cavities along the surface of the teeth. The type of pitting shown in Figure 54 is usually caused by torque overload. Continued overload may result in gear tooth failures.

For more detailed descriptions, illustrations, causes, and remedies, see ANSI/AGMA Standard 110.04. Note also, Figures 53 and 54 were extracted from "AGMA Standard Nomenclature of Gear Tooth Failure Modes" (AGMA 110.04), with the permission of the publisher, The American Gear Manufacturer's Association, Suite 1000, 1901 North Fort Myer Drive, Arlington, Virginia 22209."

Before the reducer oil has a chance to settle, collect a typical sample (about a pint) in a transparent container. A visual inspection will expose possible dirt, sludge, water emulsion or other forms of contamination. Also, keep a sample of new oil for comparisons. If the

lubricant has any of the following conditions, check with your oil supplier about replacement:

- (1) An acid or burnt odor would indicate oxidation of the oil to the point that it should be replaced.
- (2) If sludge is observed in the used sample, the oil should either be replaced or filtered to remove the sludge. Sludge is usually found in gear units that have not had their lubricants changed in a long time.
- (3) If water is found in the sample, the water should be completely drained from the sump. The presence of water in used oil can be detected by placing a drop or two on a heated metal surface. Bubbling and spattering will occur with as little as 0.1% of water present in the oil. More than approximately 0.2% water by volume suggests an oil change.

If a rigorous laboratory test of the oil is not practical, then replace the oil every 18 months as a precaution against a change in viscosity, a loss of the additive package or an increase in the acidic condition of the oil.

For lubricant specifications, see Section 12.1 of this manual.

11.3.2 Structural Bearings

Lubricate the structural bearings with grease as recommended in Section 12.3 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.

11.3.3 Wireline

Look for broken strands of wire fraying from the wireline. A rusty wireline should be cleaned and coated with a wireline lubricant as specified in Section 12.4.

11.3.4 Bolts

Check all bolts. Retighten as recommended in Section 3 of this manual. Loose bolts will eventually fail, which is the cause of most pumping unit failures.

11.3.5 Safety Signs and Tags

LUFKIN uses safety signs and decals for your protection. In the event any of the signs or decals are destroyed, damaged or become unreadable for any reason, refer to Section 14 for replacement part numbers and their location on the unit.

12. LUBRICANT SPECIFICATIONS

12.1 REDUCER

For ambient temperatures down to 0°F use an AGMA No. 5 EP (ISO VG220) premium mild, extreme-pressure lubricant (preferably a sulphur-phosphorous type) with rust and oxidation inhibitors and an anti-foam agent. The pour point of the oil should be 5°F or lower. For extremely cold temperature applications (down to -30°F), use an AGMA No. 4 EP (ISO VG150) premium mild, extreme-pressure lubricant (preferably sulphur-phosphorous type) with rust and oxidation inhibitors and an anti-foam agent. The pour point of the oil should be -15°F or less.

Synthetic gear lubricant may be required when units are operated intermittently or shut down for periods of time while subjected to ambient temperatures below 0°F. In comparison to mineral-based products, the viscosity of synthetic oil is less sensitive to temperature changes. Like their conventional counterparts, these should also be extreme-pressure lubricants that contain additives to reduce corrosion and foaming. The higher cost associated with synthetics should be evaluated relative to the operator's need for these characteristics.

12.2 REDUCER OIL CAPACITY

<u>MODEL</u>	<u>CAPACITY</u>	<u>MODEL</u>	<u>CAPACITY</u>
M1824D	165 GAL.	M320D	50 GAL.
M1280D	120 GAL.	M228D	34 GAL.
M 912D	107 GAL.	M160D	22 GAL.
M 640D	70 GAL.	M114D	17 GAL.
M456D	55 GAL.	M80D	17 GAL.

12.3 STRUCTURAL BEARINGS

CAUTION: Do not use soda-soap grease.

For ambient temperatures down to 0°F, use a premium NLGI No. 1 lithium, soap-base grease with an extreme-pressure additive and a base oil viscosity equivalent to AGMA No. 7(414-506 cSt. At 40°C.) For ambient temperatures down to -30°F, use a premium NLGI No. 0 lithium complex, soap-base grease with an extreme-pressure additive and a base oil equivalent to AGMA No. 5 (198-242 cSt. At 40°C.)

12.4 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.

CAUTION: Do not use crude oil or lubricants that may damage the wireline.

13. LUFKIN SERVICE

13.1 PERSONNEL

LUFKIN has capable sales and service personnel throughout the oil producing areas of the world. These people 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.

13.2 REPAIR AND REPLACEMENT PARTS

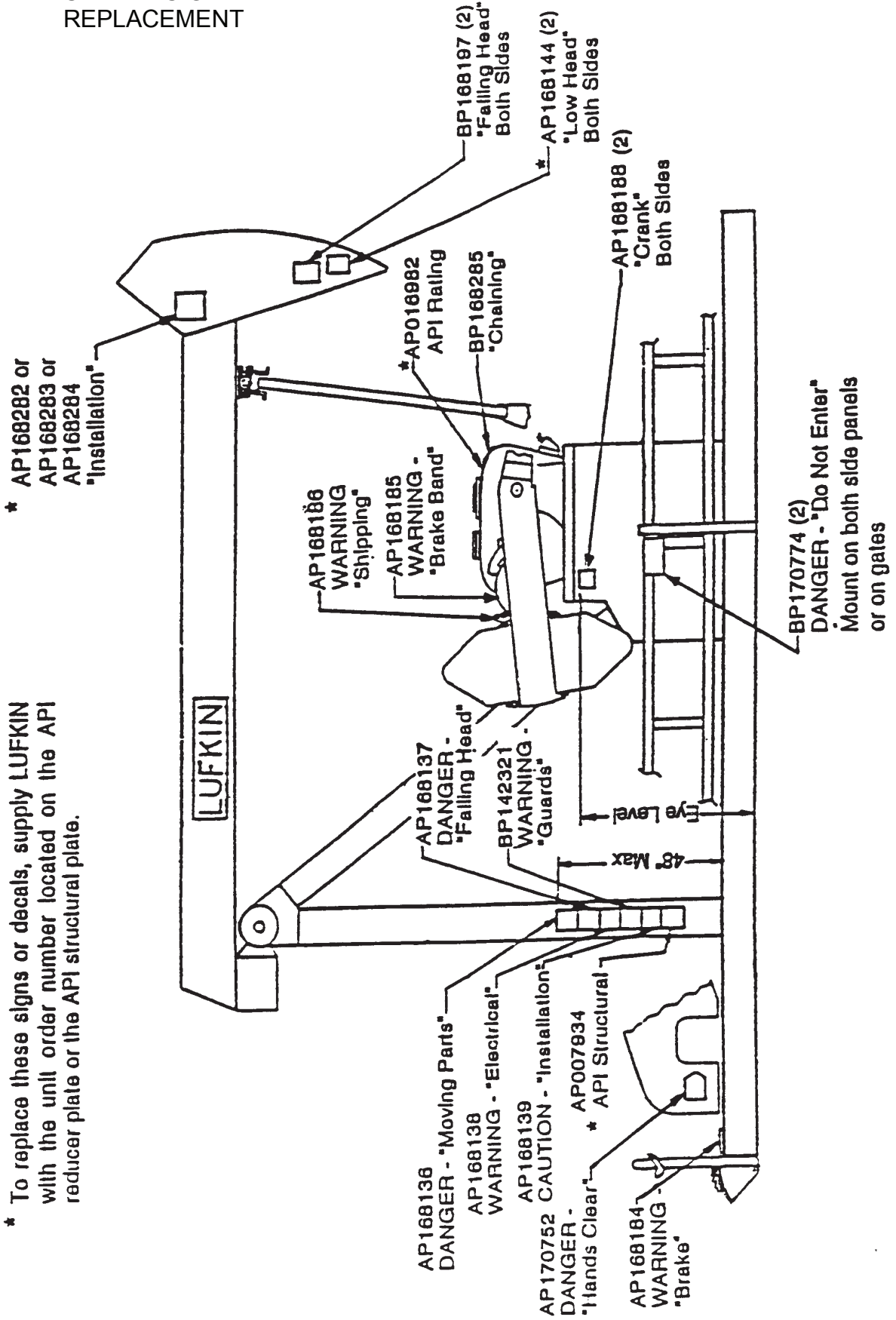
WARNING: For repair or modification to a LUFKIN pumping unit, use only original LUFKIN parts that meet LUFKIN specifications. (Consult your nearest LUFKIN sales office.)

A complete line of repair and replacement parts are available from several warehouse locations as well as our manufacturing plant in Lufkin, Texas. A parts list is available for most pumping unit assemblies. When parts are needed for a particular unit, furnish the complete unit designation, serial number and LUFKIN's shipping order number.

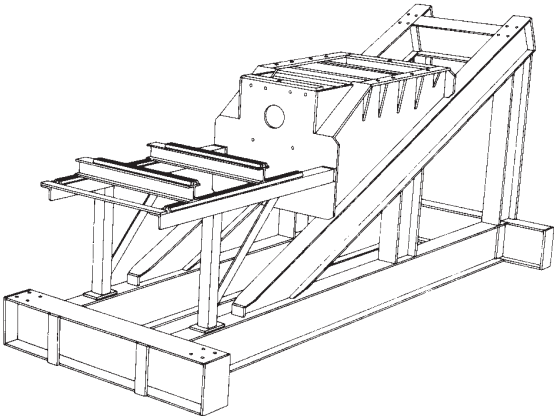
14.

SAFETY SIGN
REPLACEMENT

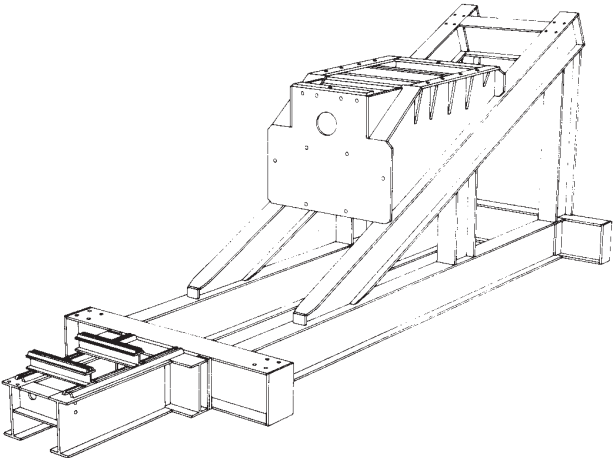
* To replace these signs or decals, supply LUFKIN with the unit order number located on the API reducer plate or the API structural plate.



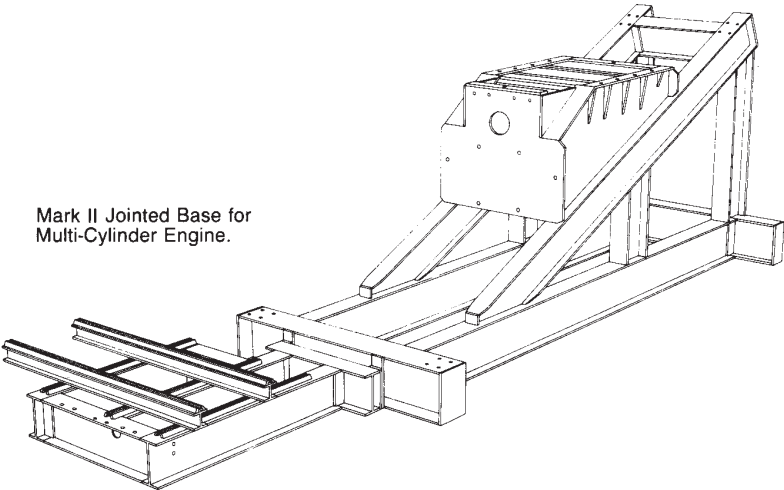
15. BASE ILLUSTRATIONS



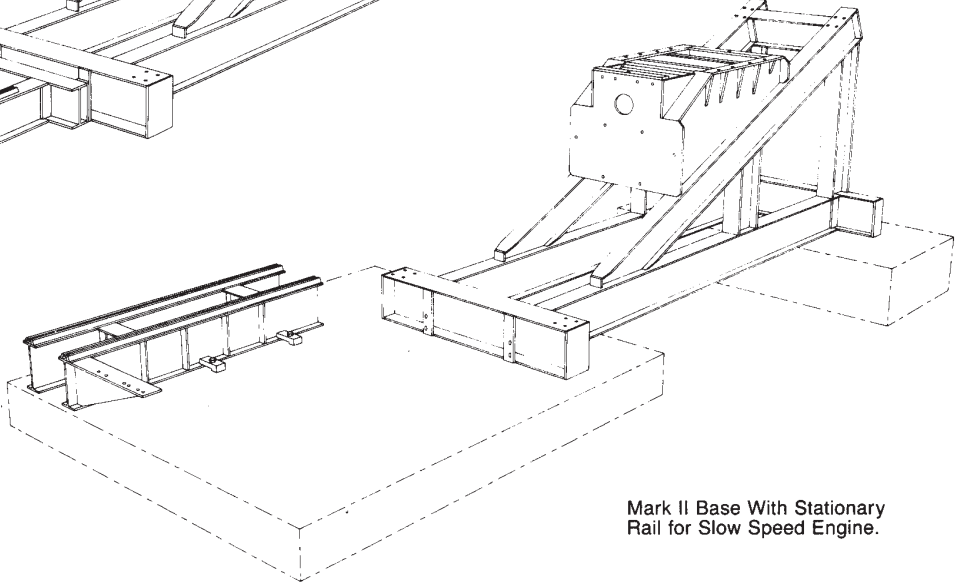
Mark II Base with Hi-Prime Bracket for Electric Motor.



Mark II Jointed Base for Electric Motor.



Mark II Jointed Base for Multi-Cylinder Engine.



Mark II Base With Stationary Rail for Slow Speed Engine.

LIMITED WARRANTY

All NEW LUFKIN INDUSTRIES, INC. ("LUFKIN") oilfield machinery and equipment ("products") are sold by LUFKIN or its dealer upon the following warranty and agreement given by LUFKIN or its authorized dealer. THE WARRANTIES SET FORTH ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES AND CONDITIONS WHETHER STATUTORY, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND WARRANTIES ARISING FROM COURSE OF DEALING, USAGE, OR TRADE and are exclusive and in lieu of any other obligation on the part of LUFKIN or its authorized dealer. LUFKIN neither assumes nor authorizes any person to assume for it any other liability in connection with the sale of such products. The obligation of LUFKIN or its authorized dealer under this warranty, is limited to the following:

- LUFKIN warrants to the ORIGINAL PURCHASER ("PURCHASER") of the pumping unit, subject to the conditions herein stated, that the pumping unit shall be, upon delivery, free from manufacturing defects. This Warranty shall run for a period of five (5) years from the date of shipment from LUFKIN's plant. In the event the pumping unit fails to operate properly due to a manufacturing defect (or) a manufacturing defect is discovered during the warranty period, LUFKIN shall only be obligated to repair or replace the pumping unit, at LUFKIN's option, free of charge, F.O.B. LUFKIN's plant, or other designated place of repair or replacement. Repair or replacement by LUFKIN shall not extend the warranty period. LUFKIN will have no liability under this Warranty unless LUFKIN receives written notice from PURCHASER of the defect within thirty (30) days after discovery of the defect. LUFKIN may waive the requirement of written notice and accept oral notice of a timely reported defect. LUFKIN shall not be liable under this Warranty and this Warranty will be null and void if the pumping unit, or any part thereof, was damaged, subjected to abuse, altered, misused or if the pumping unit, or any part thereof, was improperly stored, installed, maintained, repaired or operated. Repair or replacement of the pumping unit, or any part thereof, shall fulfill all obligations of LUFKIN. The Warranty provided in this paragraph is subject to the following exceptions.
- LUFKIN's warranty is limited to one (1) year (subject to the terms and conditions stated above) with respect to parts that are subject to wear under normal operating conditions (including, but not limited to contact type oil or grease seals, hoses, belts, elastomeric parts, wireline, brake lining, brake cables, etc.).
- LUFKIN extends no warranties with respect to the design of the pumping unit or the component parts, materials or accessories manufactured, furnished or supplied by individuals or entities other than LUFKIN (including, but not limited to prime movers, compressors, valves, electrical components, etc.). LUFKIN agrees that any warranty which is given to LUFKIN on such components by the manufacturer thereof shall be extended to the PURCHASER but only to the extent permitted by the terms of such warranties.

The remedies provided above are the exclusive remedies of PURCHASER for failure of LUFKIN to meet its warranty obligations, whether claims of PURCHASER are based on contract, in tort (including negligence) or otherwise. Upon expiration of the applicable warranty period, all obligations of LUFKIN for breach of warranty will terminate. The provisions of this warranty shall be governed in accordance with the laws of the State of Texas.

Subject to and without waiving the foregoing, Purchaser agrees that neither LUFKIN, nor its affiliates, vendors, suppliers, agents, or subcontractors, either individually or jointly, shall be liable to PURCHASER, its affiliates, or any other person or entity whether due to LUFKIN's negligence or otherwise, and will not be responsible to PURCHASER in contract, in tort (including negligence) or otherwise for loss of use of equipment or plant, loss of profits or revenues, claims of any customers of PURCHASER, or any special, indirect, incidental or consequential loss of damage whatsoever. The obligation of LUFKIN arising out of the work performed hereunder, will be limited to remedies under the limited warranty set forth above. IN NO EVENT SHALL THE PURCHASER OR ANY OTHER PERSON OR ENTITY BE ENTITLED TO RECOVER FOR INDIRECT, SPECIAL, EXEMPLARY, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO INCONVENIENCE, RENTAL OF REPLACEMENT EQUIPMENT, LOSS OF PROFITS OR OTHER COMMERCIAL OR ECONOMIC LOSS.

PURCHASER agrees to protect, defend, indemnify and save LUFKIN, its subcontractors and affiliates and their employees performing services under this Agreement harmless from and against all liabilities, loss, expense, claims, demands, and causes of action of every kind and character arising out of or in connection with this Agreement, or the work to be performed hereunder, without limit and without regard to the cause or causes of action thereof OR THE NEGLIGENCE OF ANY PARTY OR PARTIES, INCLUDING LOSSES ATTRIBUTABLE TO LUFKIN'S NEGLIGENCE, arising in connection herewith in favor of PURCHASER or third parties on account of bodily injury, death or damage to property.

PURCHASER agrees that whenever any representative of LUFKIN shall be on the premises of PURCHASER or at any place other than LUFKIN's facility, for the purpose of inspecting, repairing or servicing of the equipment sold herewith, the PURCHASER shall indemnify and hold LUFKIN harmless from all claims, suits or actions arising from or growing out of the inspecting, repairing or servicing of such equipment and from all expenses of defending against such claims, suits or actions.

PURCHASER acknowledges and agrees, on its own behalf and on the behalf of its assigns and successors, that the Texas Deceptive Trade Practices—Consumer Protection Act, Subchapter E of Chapter 17 of the Texas Business and Commerce Code (the "DTPA"), is not applicable to this transaction. As such, PURCHASER's and LUFKIN's rights and remedies with respect to this transaction, and with respect to all acts or practices of the other, past, present or future, in connection with this transaction, shall be governed by legal principles other than the DTPA. Accordingly, PURCHASER acknowledges and agrees as follows:

PURCHASER HEREBY IRREVOCABLY WAIVES, TO THE FULL EXTENT PERMITTED BY LAW, ANY AND ALL RIGHTS AND CLAIMS THAT PURCHASER MAY NOW HAVE, OR TO WHICH IT MAY OTHERWISE IN THE FUTURE HAVE BEEN ENTITLED, UNDER THE TEXAS DECEPTIVE TRADE PRACTICES—CONSUMER PROTECTION ACT, TEX. BUS. AND COM. CODE § 17.41 ET SEQ., ("DTPA"), ARISING OUT OF ANY ACT, CONDUCT, REPRESENTATION OR OMISSION OF LUFKIN, ITS EMPLOYEES OR AGENTS, HERETOFORE OR HEREAFTER TAKEN, DONE OR OMITTED TO BE DONE IN CONNECTION WITH THIS TRANSACTION OR SUBSEQUENT RELATED TRANSACTIONS.



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