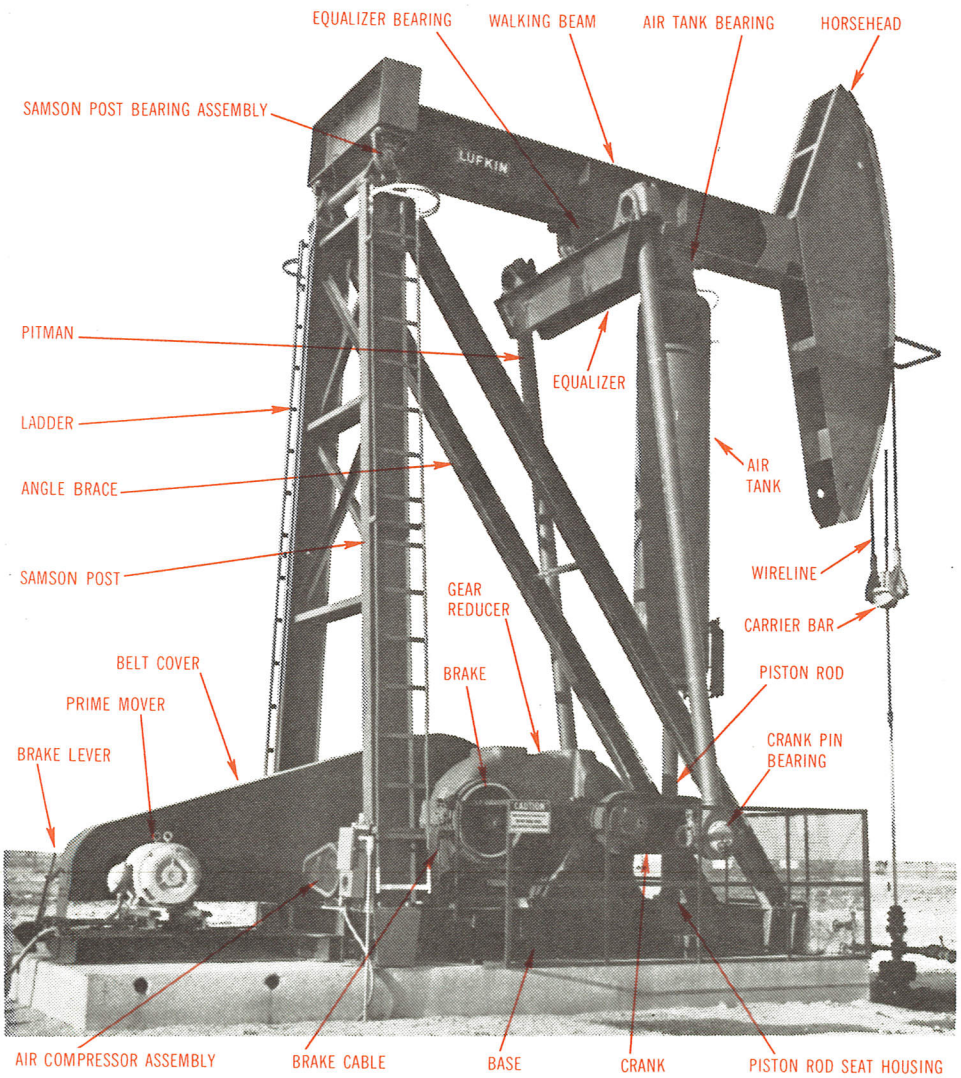
LUFKIN

AIR BALANCED PUMPING UNITS



OPERATOR'S MANUAL A-82

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PREFACE

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

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

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I. INTRODUCTION

A. EQUIPMENT DESCRIPTION

The Lufkin Air Balanced Pumping Unit utilizes compressed air for counterbalance. Counterbalance is easily adjustable while the unit is in operation. The compact and relatively light weight design of the unit makes it suitable for all types of installations including platform installations and trailer mounted mobile test units.

An air compressor furnished with the unit supplies the necessary air pressure for counterbalance. On gas engine driven units the compressor is belt driven by an air operated clutch. The compressor runs only when the system is in need of air. On electric motor driven units the air compressor is driven by a separate motor which is controlled by an adjustable pressure switch.

The counterbalance air tank assembly consists of a cylinder and piston and rod assembly enclosed in a pressure vessel or air tank. The air tank is attached to the walking beam and the piston rod is attached to the pumping unit base. When the unit is on the down stroke, the air in the system is further compressed thereby storing energy to be released on the up stroke when the rods and fluid are being lifted. Air pressure in the system is adjusted to give the optimum counterbalance required to balance out the up stroke and down stroke torque load on the gear reducer.

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

The Lufkin Air Balanced Pumping Unit must be properly installed and maintained for satisfactory service. Your Lufkin Air Balanced Pumping Unit will give many years of dependable service when properly maintained and operated within its load and torque ratings.

B. SAFETY FIRST

All mechanical sucker rod pumping units, of necessity, have large and heavy rotating parts. It is essential that all personnel involved in the erection, operation, and maintenance of pumping units use extreme care, at all times, when working near these heavy rotating parts, failure to do so can cause severe bodily injury or death.

Even a temporarily stationary pumping unit has components which can start moving from the effect of gravity or air pressure in the counterbalance air tank. All personnel should stay clear of the cranks and other elements which may start moving. Times of particular danger from rotating or moving parts would be during unit erection, stroke change, general unit maintenance, well servicing, and while taking dynamometer cards. It is essential to prevent rotation of the cranks stopped in any position for the purpose of service or maintenance of any kind. The air pressure must be bled from the system before any part of the unit is to be disassembled. On units equipped with the positive stop brake, the pawl can be

engaged in a notch in the drum to prevent crank rotation. On units without the positive stop brake, thread a sturdy chain through the hole in the brake drum nearest the brake trunnion and then around the trunnion; snug up the chain and attach the hook end around a link.

Chains and cable slings used in the erection of the unit shall have a load test certification tag attached and must not be used for loads beyond that certified to be safe. A visual daily inspection of chain and cable slings and a monthly inspection verified by a signed report are required.

CAUTION: STAY CLEAR OF ROTATING CRANKS AND OTHER PARTS THAT MAY START MOVING, OTHERWISE SERIOUS PERSONAL INJURY OR DEATH MAY OCCUR.

II. FOUNDATION

A. GENERAL

The foundation should be constructed in accordance with a current foundation plan only. A copy of this plan is shipped with the unit. The foundation plan gives the minimum foundation area required to install the pumping unit and the minimum depth required to install the foundation anchor nuts. Consideration should be given to increasing the size and depth of the foundation in areas where soil conditions are abnormally poor.

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

All types of foundations must be level or damage to the unit may result.

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

Refer to API RP 11G for additional information about the installation of pumping units.

B. WELL HEAD CLEARANCE

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

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

C. ALIGNMENT MARKS

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

D. TYPES OF FOUNDATIONS

1. Poured Concrete

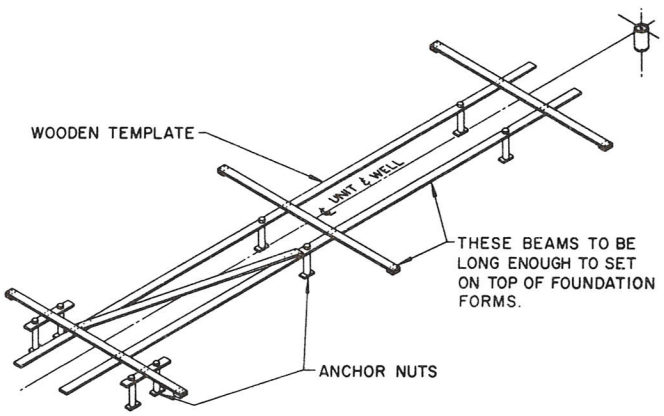


Figure 1

Build the form and place steel reinforcing bars and wire mesh as required to meet local standards for good concrete practice.

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

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

2. Precast Concrete

Precast blocks, also referred to as reinforced concrete portable foundations, are frequently used for air balanced units. The well site should be graded for proper drainage and consideration should be given to the size of the block with respect to bearing strength of the soil. The site should be leveled and then topped with a minimum of two inches of sand or pea gravel and again leveled. Place the concrete blocks on the leveled fill the proper distance back from the well and with the centerline of the block aligned with the well center.

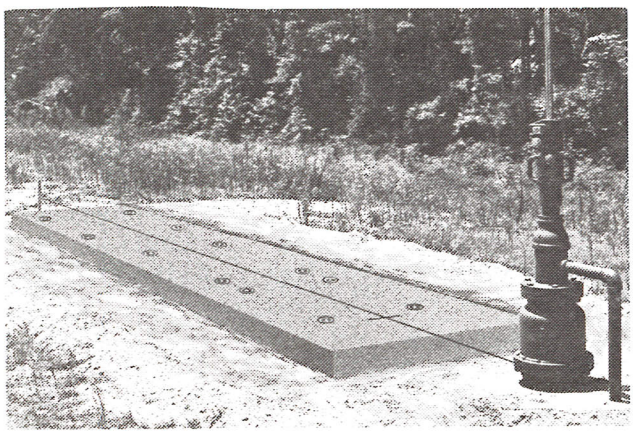


Figure 2

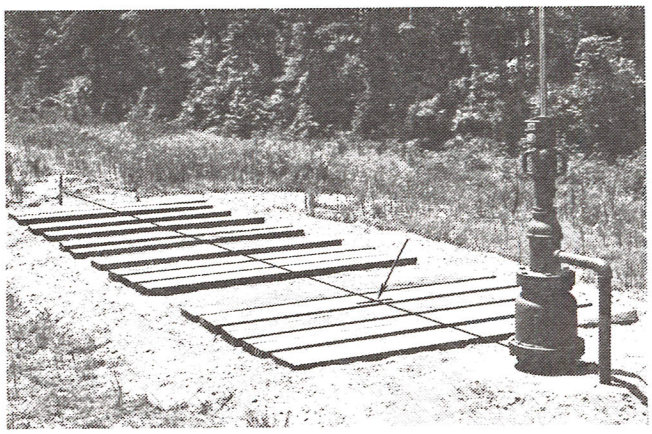


Figure 3

3. Board Mat

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

4. Uniset

Special portable bases called "Uniset bases" are available which allow the base to be set directly on the ground. Soil conditions must be considered before setting a Uniset base. The soil should be firm and stable with a soil bearing pressure of a 1000 pounds per square foot minimum and should be well drained. Two earth anchors are usually required at the rear of the base to hold it in position. See Fig. 4 for a view of the bottom of a Uniset base.

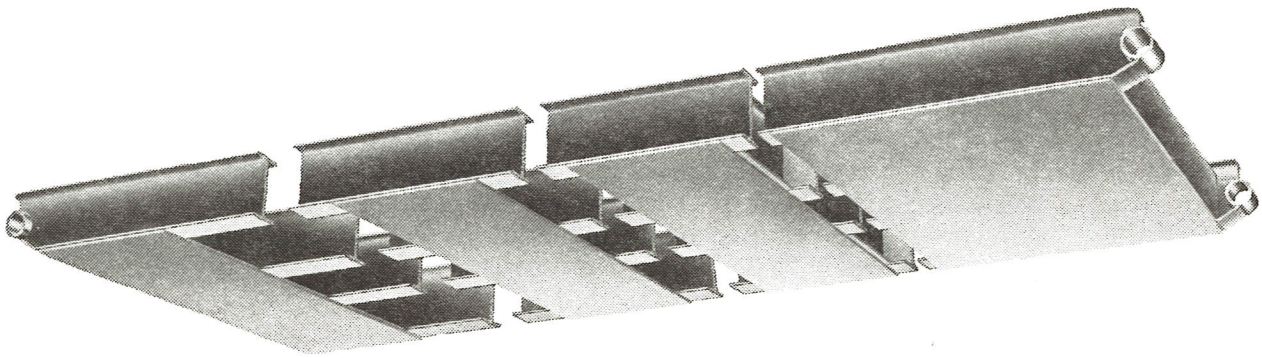


Figure 4

E. GROUTING CONCRETE FOUNDATIONS

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

III. ERECTION OF UNIT

A. EQUIPMENT REQUIRED

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

B. UNIT ERECTION PROCEDURE

The following picture and word description of the erection of an air balanced pumping unit gives the general sequence to be followed along with precautions and alignment checks.

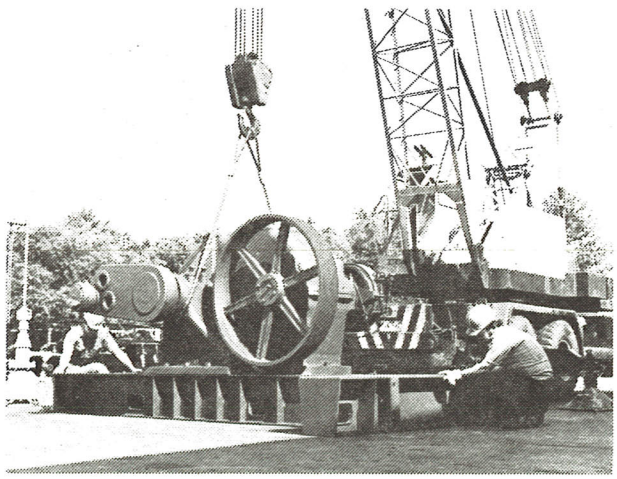


Figure 5

1. Set base on foundation

In most cases the gear reducer is installed on the base at Lufkin. Lift the base in a level position and place on foundation. Align center line marks on the bottom flanges of the front and rear base cross members with the center line mark on the foundation. Position the front cross member of the base the correct distance from the center of the well head. If unit is to be grouted in, wedge spacers are inserted several places along the main base members at this stage. See Figure 5.

2. Install gear reducer on base

If it is necessary to install the reducer on the base, engage the brake using the shipping screw and positive stop pawl - see "Brake Installation and Adjustment" in Section XI. Attach slings to the gear reducer. Do not allow sling to bear against the slow speed shaft oil seal or breakage will result. Clean the top of the base and the bottom of the gear reducer.

Do not stand under any part of the load to prevent a serious injury in case the load were to be dropped. Place the gear reducer on the base and install the bolts but leave them loose so reducer can be shifted for alignment.

3. Rotate cranks

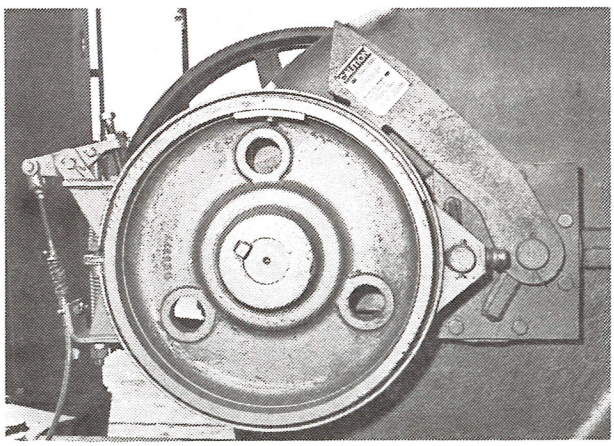


Figure 6

The cranks should now be rotated to the horizontal position so that the crank pin holes extend past the front or low speed end of the reducer. Clear all objects and personnel away from the sweep of the cranks. Attach a lifting line to one of the cranks around the crank pin bearing assembly or through one of the pin holes; use padding around the line in the pin hole to avoid damage to the finished bore. Disengage the positive stop pawl and loosen the shipping screw to allow the cranks to be rotated.

After the cranks are in the required position, engage the positive stop pawl and tighten the shipping screw for added safety. See Figure 6.

4. Align the gear reducer

Use tape and measure the distance from the crank shaft to the samson post bolt holes as shown. Position the gear reducer on the base until the distance from the crank shaft to the samson post bolt holes on the base is the same on each side of the unit. See Figure 7.

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

5. Brake system installation and adjustment

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

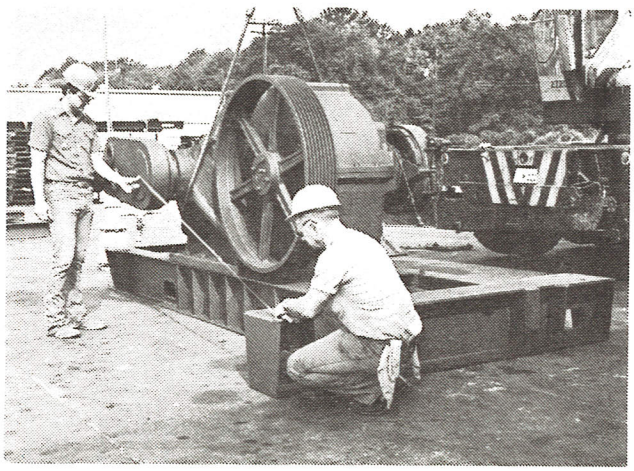


Figure 7

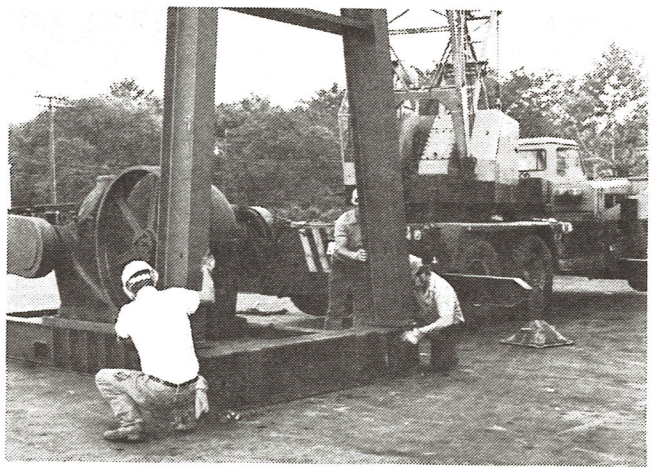


Figure 8

6. Install samson post

Lift the samson post with a sling attached to the top cross member. Position the post so that the eight holes near the top for the angle brace connections face toward the gear reducer. Install the bolts attaching the post to the base but leave them loose until the angle braces are installed. See Figure 8.

7. Ladder installation

The ladder attaches directly to the samson post or to brackets attached to the post leg as shown in Figure 9. Install bolts and tighten following the recommendations given under "Fasteners" in Section IX.

Figure 9

Figure 10

8. Install samson post braces

Attach the angle braces to the bolt holes near the top of the samson post and to the holes near the front of the structural base. Leave the bolts loose. Install the short cross brace between the braces as shown in Figure 10. All bolts, including the post to base bolts, may now be tightened following the recommendations given under "Fasteners" in Section IX.

9. Bolt samson post bearing assembly to walking beam

Attach the samson post bearing assembly to the walking beam using the bolts and "elastic stop" nuts provided. See Figure 11. Tighten the bolts using the recommendations given under "Fasteners" in Section IX.

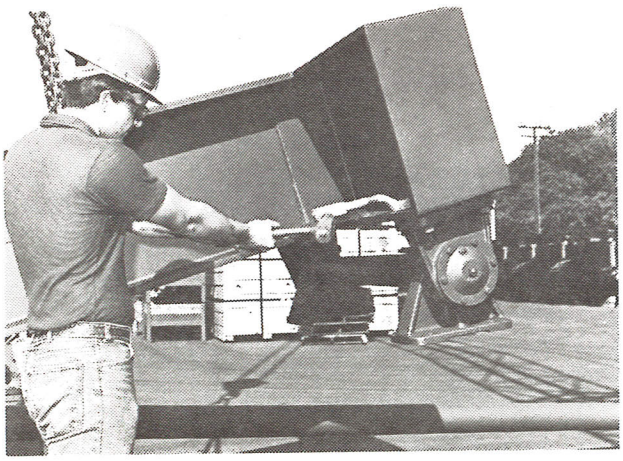


Figure 11

Figure 12a

10. Install pitman on equalizer

Remove the caps from the upper connection on both pitman side members. Match mark the caps before removal since they are machined with the lower part of the connection and are not interchangeable; the caps should be reinstalled exactly as they were shipped. Clean the inside of the caps and lower part

of the connections thoroughly. Scrape off the preservative and paint that is on the inside surface or the caps will not tighten properly. See figure 12a.

Select the pitman with the pipe for lubricating the equalizer bearing and position it on the end of the equalizer which has the hose for connecting the pipe to the bearing. The hose connects to the bearing retainer cap that has the threaded fitting near the bottom. The other bearing retainer cap has a relief fitting near the top of the assembly.

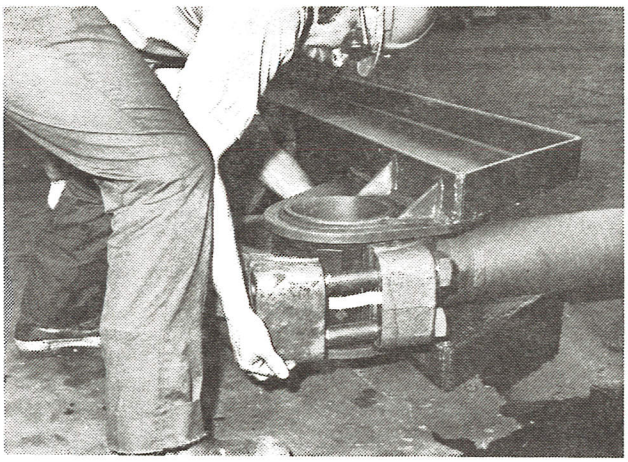


Figure 12b

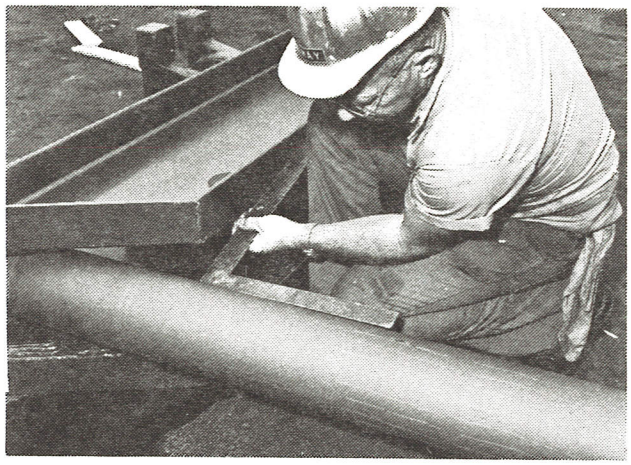


Figure 12c

Figure 12d

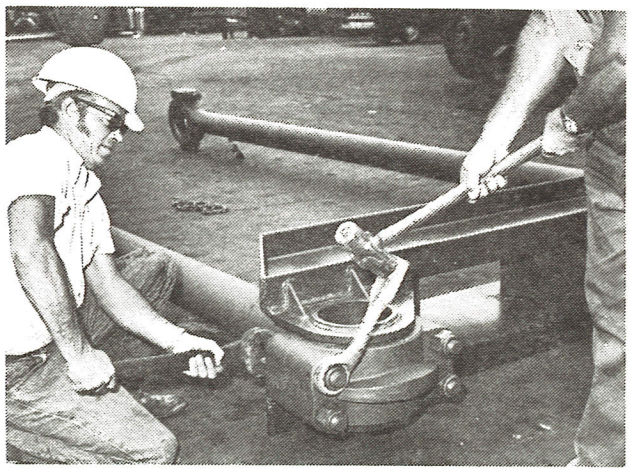


Figure 12e

Each end of the equalizer is fitted with a rubber cushion. Turn the flats on the cushions so they will be next to the gap between the cap and lower part of the upper connection. Install the caps, figure 12b, square up the pitmans with the equalizer, figure 12c, check the spacing between the pitmans top and bottom, figure 12d, and finally tighten nuts until the caps are pulled down metal to metal against the lower part of the upper connection, figure 12e.

The rubber hose for bearing lubrication may now be connected between the bearing assembly and the pipe on the pitman. Check the relief fitting on the bearing assembly to be sure it is free of paint or other foreign material.

11. Attach the equalizer and pitman assembly to the walking beam

Block up under the equalizer so that the equalizer brackets fit flush against the bottom of the walking beam as shown in Figure 13a. Install the bolts and tighten following the recommendation given under "Fasteners" in Section IX.

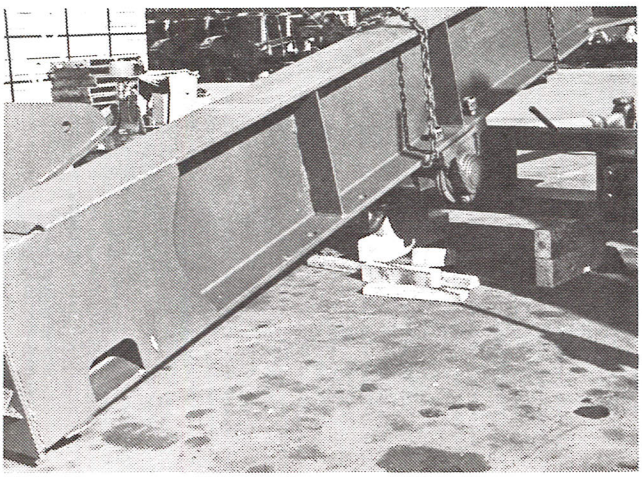


Figure 13a

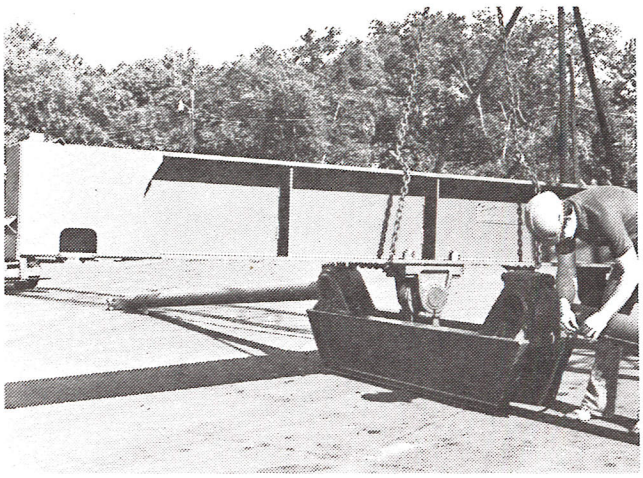


Figure 13b

On some units it may be impractical to block up high enough under the equalizer to get the equalizer brackets to fit flush against the beam. It may be necessary to leave the upper pitman bolts loose and swing the pitmans out to the side as shown in Figure 13b. The unit will have to be carefully aligned before tightening the upper pitman bolts if this procedure is used.

12. Lift walking beam, samson post bearing assembly, equalizer, and pitman assembly

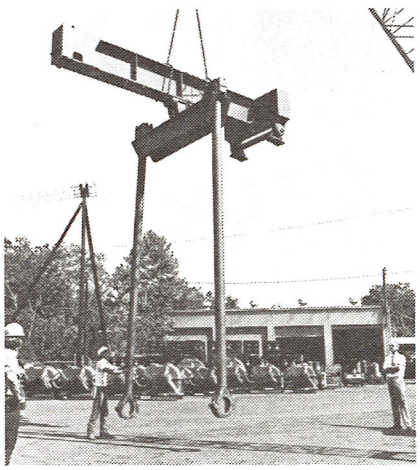


Figure 14

Figure 15

Arrange a double sling just in front of the equalizer and about half way between the equalizer and samson post bearing. The beam will hang in a a near horizontal position as shown in Figure 14.

13. Bolt samson post bearing assembly to top of samson post

    Position the walking beam over the unit and install the bolts attaching the samson post bearing assembly to the top of the samson post as shown in Figure 15. Do not tighten the bolts until the pitmans are attached to the crank pins and an alignment check is made.

14. Clean lower pitman connections and crank pin bearing housings

    Scrape off the preservative and paint from the machined surfaces on the lower pitman connections and the crank pin bearing housings. Failure to properly clean these surfaces will result in the pitman becoming loose after the unit is in operation. See figures 16a and 16b.

15. Connect pitmans to crank pin

    Lower the walking beam until both pitmans seat on the crank pin housings as shown in Figure 17a. Secure the pitman latch as shown in Figure 17b but do not fully tighten the latch bolt at this point.

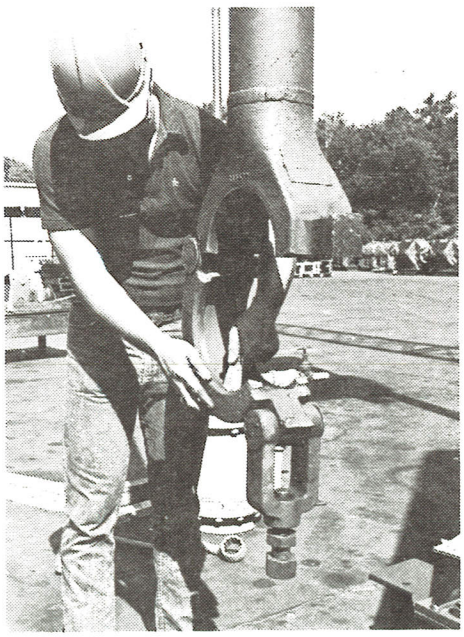


Figure 16a

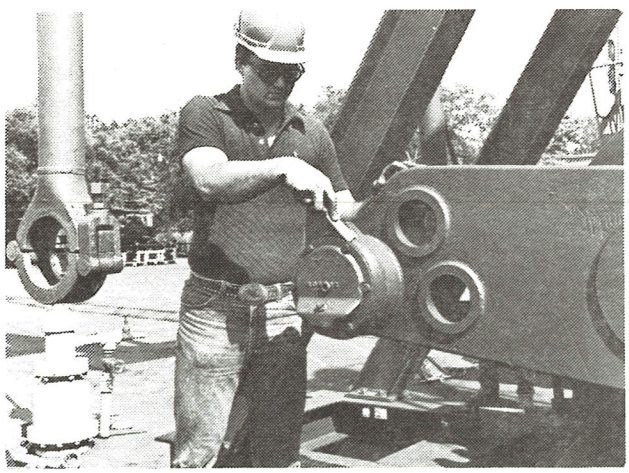


Figure 16b

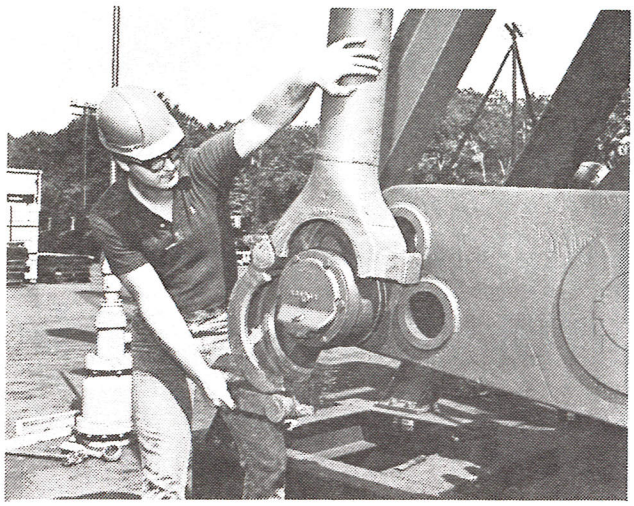


Figure 17a

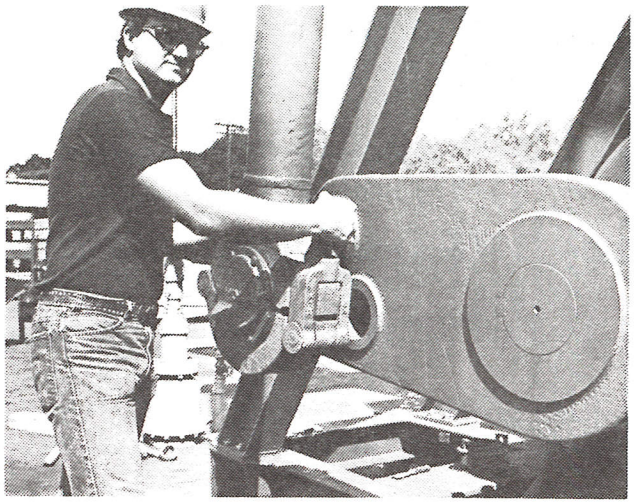


Figure 17b

16. Install lubrication hoses at the top of the air tank assembly

Install the ground oiling hose from the pipe on the tank to the fitting near the bottom of the air tank bearing retainer. Check to see that the pipe on the tank to which the hose is attached has an alemite grease fitting on the bottom end. See Section XIII., "Ground Oiling System".

If the unit is equipped with an upper cylinder lubrication system, install the valve and oiling hose as shown in Section XIV.

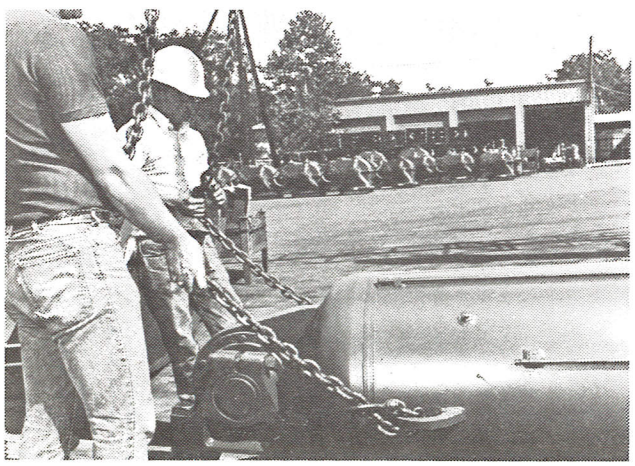


Figure 18a

Figure 18b

17. Install air tank assembly

Attach a sling to the two lifting lugs near the top of the tank. See Figure 18a. The sling should be long enough so that it will pass on either side of the walking beam as shown in Figure 18b.

Position the air tank so that the bull plug near the top of the tank faces to the rear of the unit. The name tag near the bottom of the tank will face toward the well.

Check to see that the piston rod seat is inserted in the piston rod retainer welded to the base. See Figure 18c. The piston rod seat is an amber colored disk of polyurathane material.

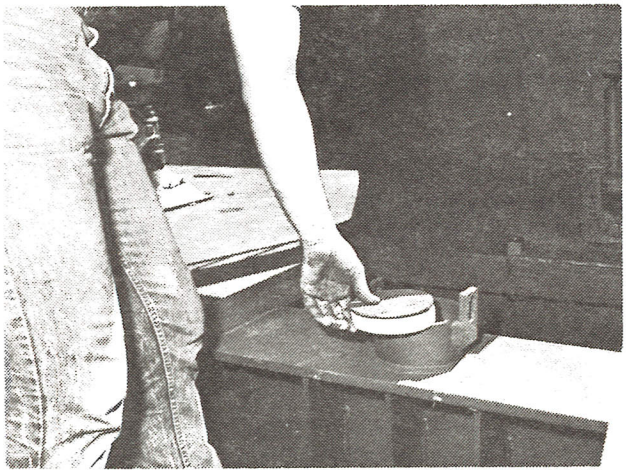


Figure 18c

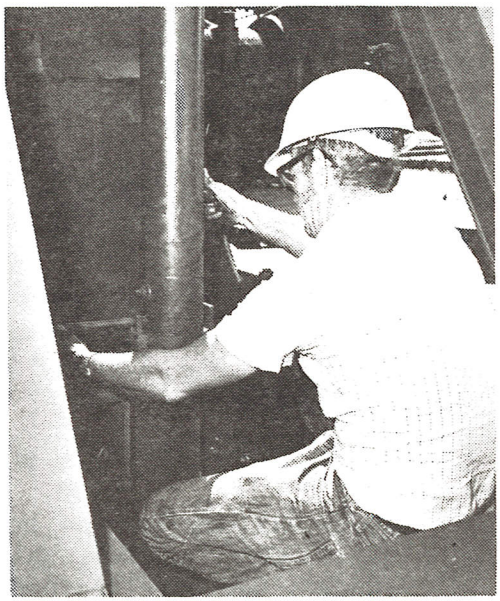


Figure 18d

Lower the air tank assembly until the piston rod rests on the piston rod seat on the base. Turn the piston rod if necessary to position the connection for the air hose to your left side as viewed in Figure 18d. Install the bolt attaching the piston rod to the piston rod housing. Do not tighten the nut against the lugs on the piston rod housing; use the jam nut provided to tighten the nut. The purpose of the bolt is to keep the piston rod from rotating. The bolt must be free to move in the slots in the lugs.

Should it be necessary to lower the piston rod further than the air tank assembly can be lowered, then loosen the clamp bolts on the shipping bracket and allow the piston rod to slip downward. See Figure 18e. It may be necessary to remove the plug near the bottom of the piston rod or a plug in the air tank before the rod will slip down.

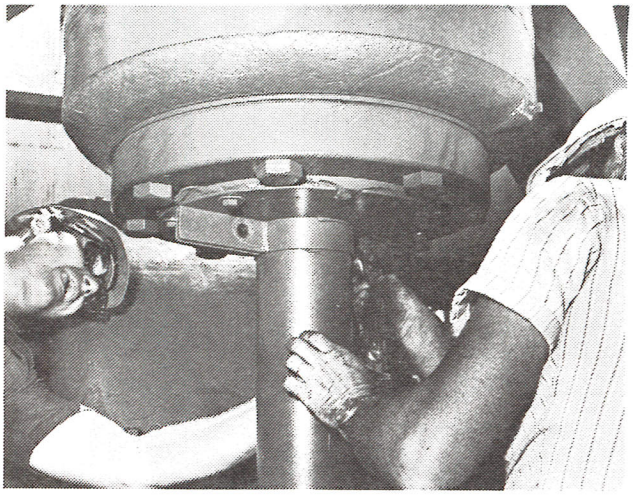


Figure 18e

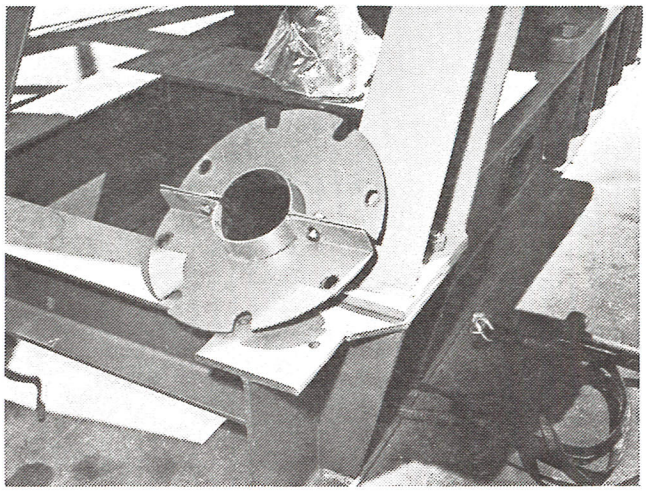


Figure 18f

After the piston rod is secured to the piston rod housing remove the shipping bracket completely and replace all cap screws. See Figure 18f.

Remove one of the plugs in the side of the tank and raise the air tank assembly so that the brackets can be bolted to the walking beam. Tighten the bolts following the recommendations given under "Fasteners" in Section IX.

18. Install wire line assembly on horsehead

Check the top of the horsehead around the arch plate and the guide lugs for weld splatter that may not have been removed. Install the wireline and retainer plate as shown on Figure 19. Allow the wire line to extend past the top of the head as shown to make it easier to install. Tighten the bolt for the retainer plate following the recommendations given under "Fasteners" in Section IX.

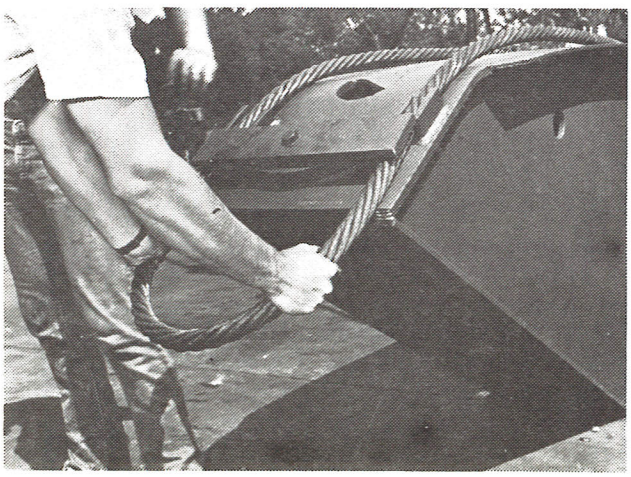


Figure 19

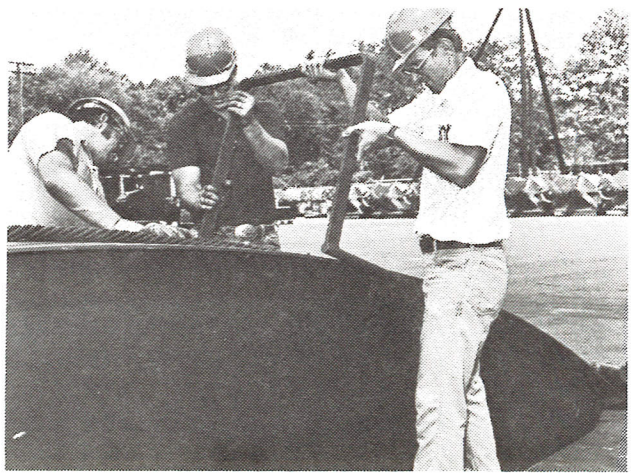


Figure 20

19. Install wire line bail

Insert the bail into the pipe sockets welded to the side of the horsehead. Wireline bails are furnished on units with 120 inch strokes and larger. The purpose of the bail is to prevent the wire line from sliding off the side of the head if the line becomes slack for any reason. See Figure 20.

20. Install horsehead on beam

Turn the adjusting screws out so they are flush on the inside of the head to avoid damage to the screws. Also remove the horsehead retainer bar shown just above the adjusting screw in Figure 21a. Observe that the handle on the retainer bar must be turned to a horizontal position to be removed or installed. Attach a lifting line through the cut out hole at the top of the head and raise into position on the beam as shown in Figure 21b. Refer back to Figure 13a and 13b and note the bar and angle spacer welded to the top flange of the beam. Lower the head so that the vertical seat plate in the head fits between the bar and angle spacer on the beam. The horsehead retainer bar may now be installed. The bar passes through the angle welded to the front plate on the walking beam. Remember to turn the handle to the horizontal position to install the retainer bar. When the handle is turned to the vertical position it is locked into position.

Figure 21a

Figure 21b

21. Adjust position of horsehead on beam

Loosen the two bolts that attach the spacer plate to the bottom flange of the beam. Use a plumb bob or accurate level to adjust the head to a vertical position. See Figure 22a. Tighten both adjusting screws firmly against the lower flange of the walking beam and lock into position with the jam nuts. See Figure 22b. Also re-tighten the bolts that attach the spacer bar to the bottom flange of the beam. The purpose of the spacer bar is to allow the head to be removed and replaced to the same position without the necessity of re-adjusting the position of the head.

Figure 22a

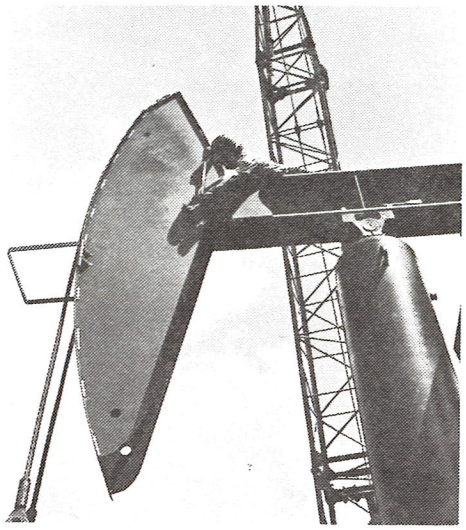


Figure 22b

22. Lower cranks and check alignment

Remove all objects away from the crank sweep, air tank, and other moving parts of the unit. Take precautions to be sure that all personnel are away from the crank sweep, air tank, and other moving parts of the unit. Disengage the positive stop pawl from the brake drum. Stand behind the gear reducer and slowly release the shipping screw on the brake allowing the cranks to rotate to the bottom or six o'clock position. See Figure 23a.

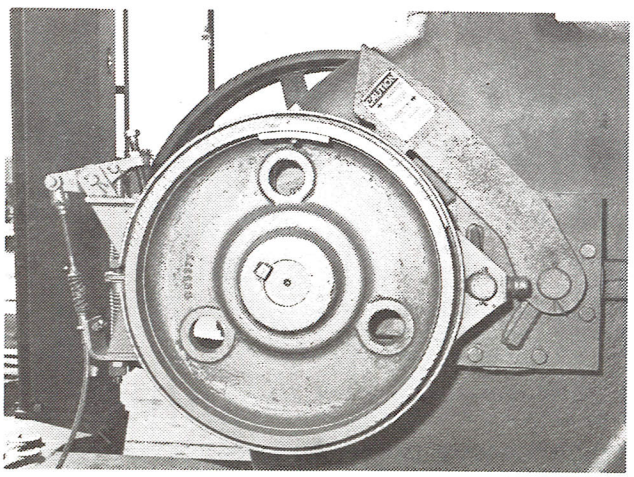


Figure 23a

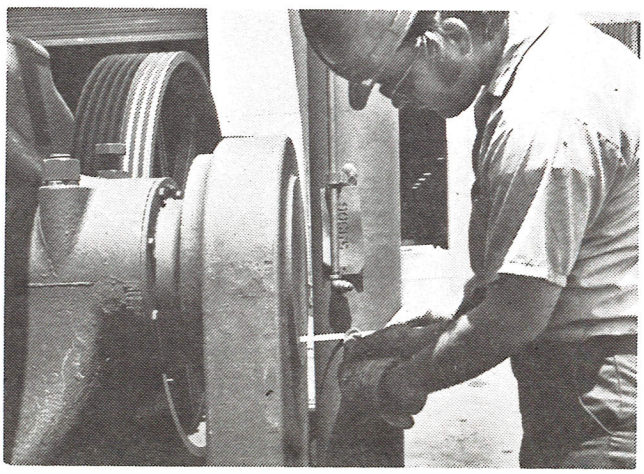


Figure 23b

Compare the distance between the end of the crank shaft and pitman side member on both sides of the unit. Also compare the

distance between the air tank and angle brace on both sides of the unit. See Figure 23c.

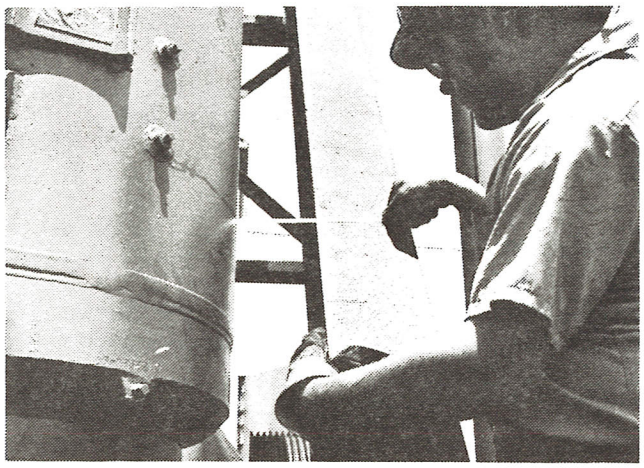


Figure 23c

If the distances are not the same the unit is not properly aligned and must be corrected. Failure to properly align the unit will cause the air tank assembly to lean sideways and result in premature cylinder wear. Check to see that the bolts attaching the samson post bearing assembly to the top of the samson post and the lower pitman connections are both loose. Attach a winch line around the walking beam just behind the horsehead and pull the beam over until the distances between the crank shaft and pitmans and between the air tank and angle braces are equal on both sides of the unit. Tighten the bolts attaching the samson post bearing assembly to the top of the samson post and tighten the pitman latch bolts following the instructions given under "Fasteners" in Section IX.

23. Check unit alignment with well

Figure 24

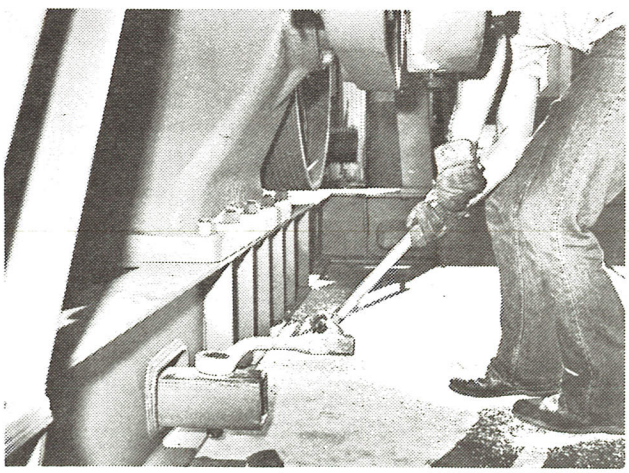


Figure 25

Lower a plum bob from the center of the top of the head down to the polish rodas shown in Figure 24. Establish the distance from the string to the center of the wire rope and account for this when checking the alignment from the polished rod. Be sure that the alignment has been corrected before making this check. Move the base on the foundation if adjustment is required.

24. Install foundation hold-down clamps

Install foundation hold down clamps as shown in Figure 25 and tighten bolts according to the recommendations given under "Fasteners" in Section IX.

25. Install air compressor

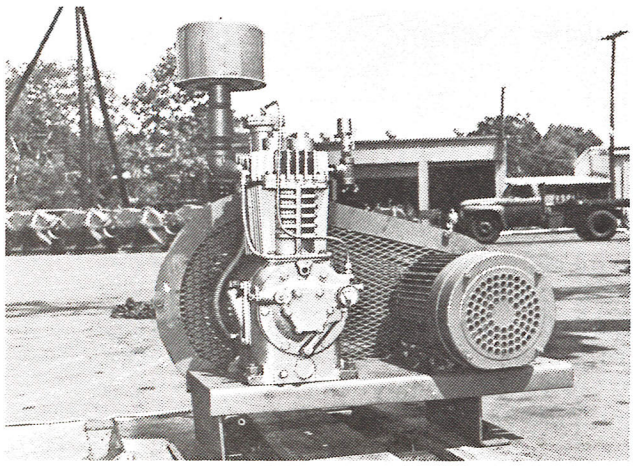


Figure 26a

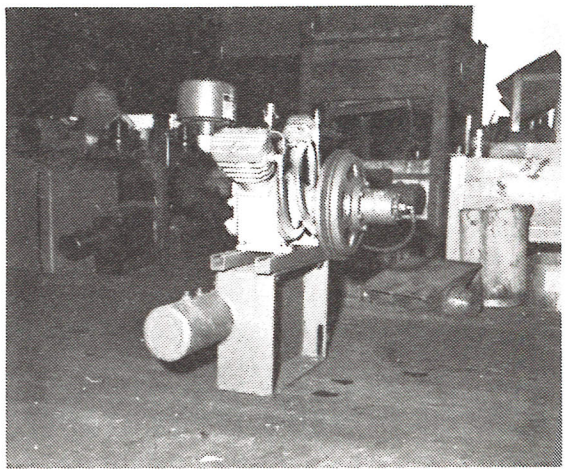


Figure 26b

The compressor will either be electric motor driven as shown in Figure 26a or a clutch driven assembly as shown in Figure 26b.

The electric motor driven assembly installs on the rear cross beam of the base between the samson post legs as shown in Figure 26c. The clutch driven assembly installs at the rear of the gear reducer as shown in Section XV.

Both assemblies attach to the base with four bolts. Tighten the bolts following the recommendations under "Fasteners" in Section IX.

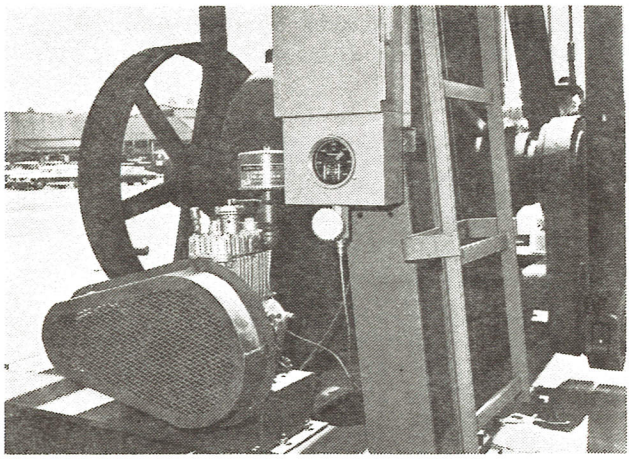


Figure 26c

Install the drive belt for the clutch driven compressor before the main drive belts are installed. The belt tension is adjusted by moving the compressor or its sub-base. The tension should be just tight enough to run the compressor without slipping. When the clutch is disengaged the belt runs on the idler sheave in the clutch and should be loose.

26. Make up air systems connections

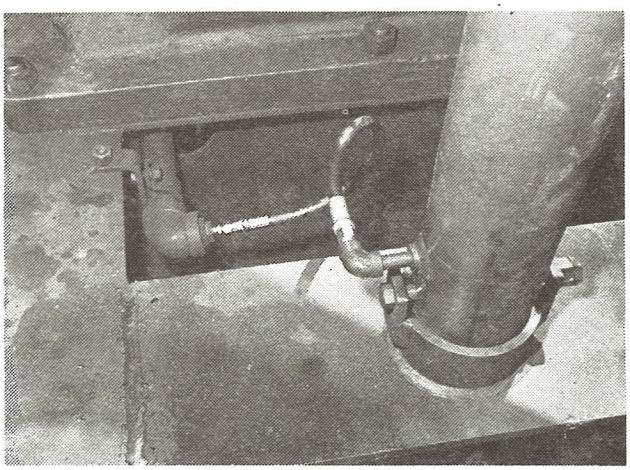


Figure 27a

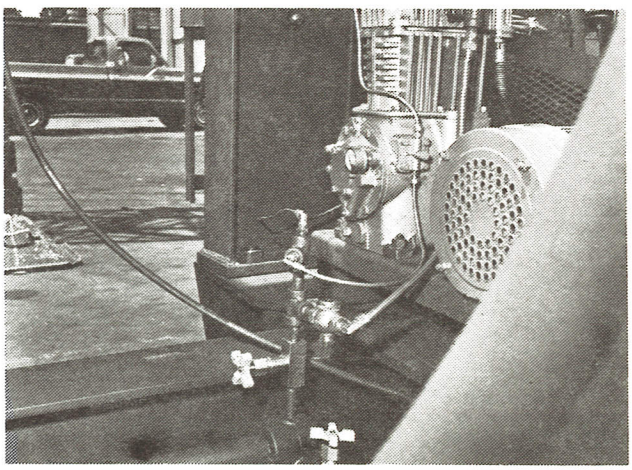


Figure 27b

Use the Permatex thread sealer provided on all fittings. Install the flexible hose from the water collector pipe to the coupling near the bottom of the piston rod as shown in Figure 27a. On the 240 inch stroke units a valve is furnished to be installed between the hose and piston rod.

Install the drain valve and cut-off valve at the rear of the water collector pipe as shown in Figure 27b. The compressor discharge line may now be installed along with the check valve. Check that the arrow on the check valve points in the direction of air flow. On some compressor assemblies the check valve is

part of the pre-assembled air system and only the line from the compressor assembly to the water collector pipe has to be installed.

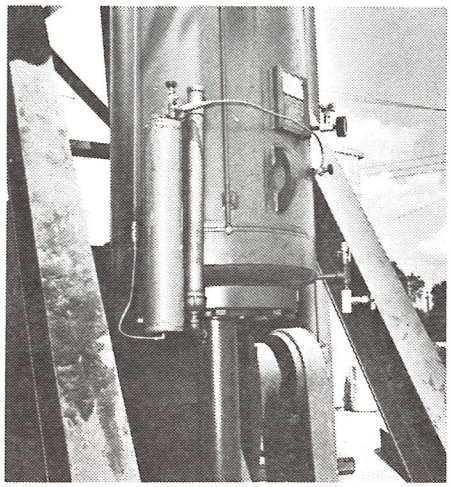


Figure 27c

The A-456D-365-120 and larger units are equipped with an additional air cylinder lubrication system. This system is provided on the longer stroke units so that oil is pumped to the top of the piston in the air tank faster than it would be through the normal pump up action of the piston rings and "U" cup arrangement. See Figure 27c and Section XIV for the general arrangement of the piping for the air actuated cylinder lubrication system.

27. Install prime mover base

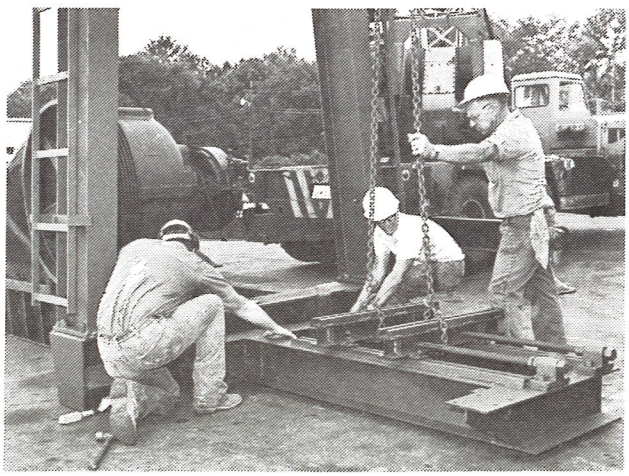


Figure 28

Prime mover bases bolt to the rear of the unit base through joint plates as shown in Figure 28. The joint plates are slotted to allow a small amount of alignment adjustment. After the prime mover base is in position install the foundation hold

down clamps and tighten as recommended under "Fasteners" in Section IX.

28. Install prime mover

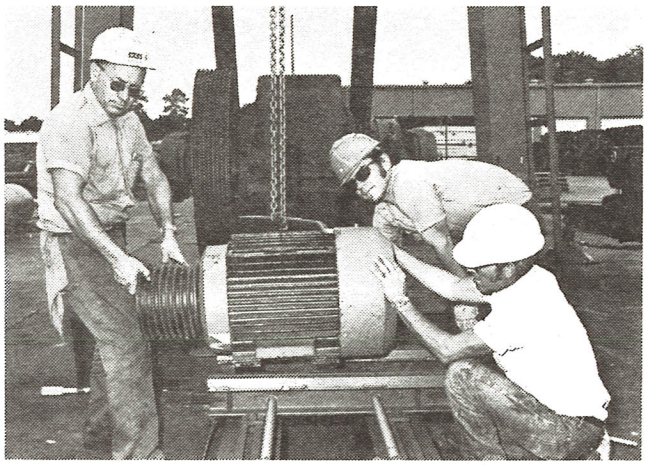


Figure 29

Install the "T" head bolts provided in the "T" slots on the cross rails or beams on which the prime mover will be placed. Lower the prime mover positioning the "T" head bolts as required as shown in Figure 29. Use a plier or other tool to avoid injury to the fingers and hands when positioning the "T" head bolts. Place the nuts on the "T" head bolts but do not tighten until the drive sheaves are properly aligned.

29. Install sheaves, belts, belt cover, and brake control lever

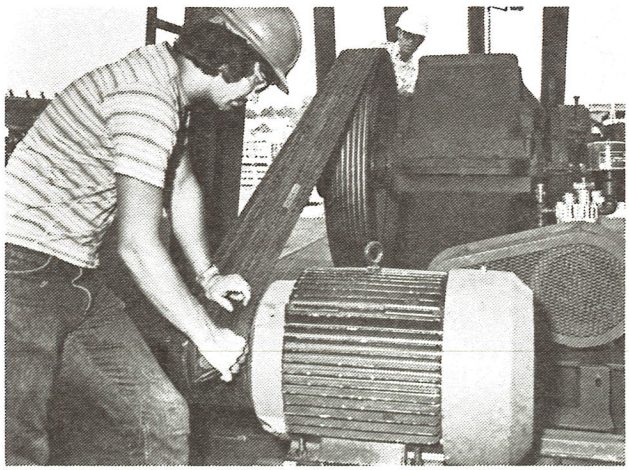


Figure 30a

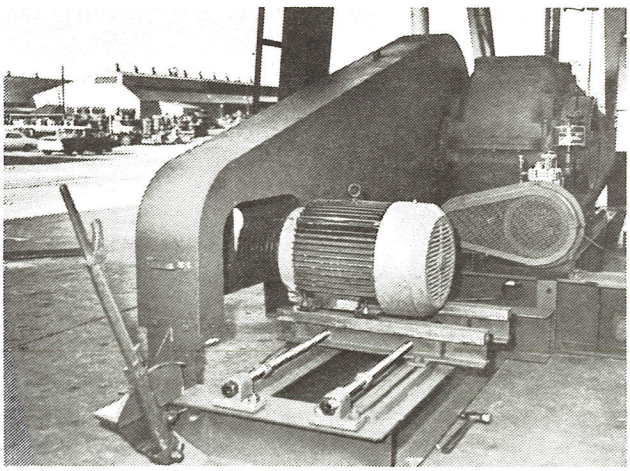


Figure 30b

Units are usually shipped with the sheave installed on the gear reducer. Check the tightness of the cap screws in the mounting

hub and also drive the gibb key in a small amount to be sure it is tight.

Install the prime mover sheave after cleaning the shaft and hub bore. Tighten the cap screws in the hub evenly and then tighten the set screw holding the key in place. Do not use oil or any part of this assembly.

Move the prime mover forward on the base so that the belts can be installed easily without using pry bars or other tools. Use a string to line up the inside faces of the sheaves as shown in Figure 30a. The bolts attaching the prime mover to the "T" slots may now be tightened.

Use the adjusting screws or pusher screws to move the prime mover to tension the belts. A few pounds of finger pressure on one belt midway between the sheaves should deflect the belt about one inch when the belts are properly tensioned.

Use the string against the inside edges of the sheaves to make a final check on the alignment and then tighten the bolts attaching the cross rails to the "T" slots on the base. Tighten the bolts as recommended under "Fasteners" in Section IX.

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

Install the brake control lever on the prime mover base as shown in Figure 30b. Connect the brake cable and make adjustments as required or described under "Brake System Installation and Adjustment" in Section XI.

30. Gear reducer lubrication

See Section VI for lubricant specifications and amount required and select the viscosity of oil recommended for your climate. Fill the reducer by removing the inspection cover over the high speed gear. Check the level of oil at the dip stick at the front of the gear reducer as shown in Figure 31.

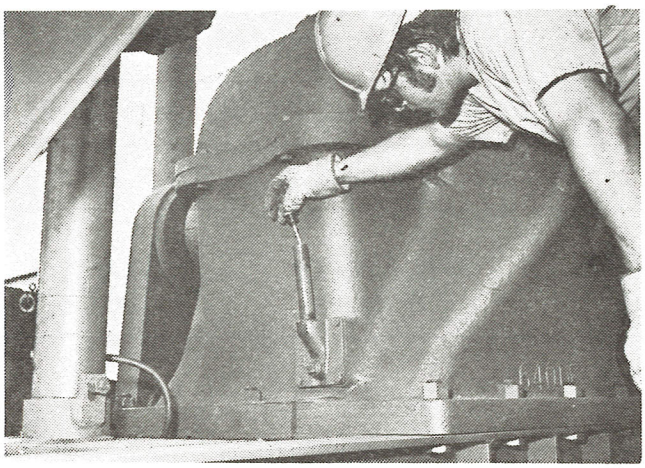


Figure 31

31. Air cylinder lubrication

Figure 32

Use a mineral oil with rust and oxidation inhibitors and an anti-foam agent. The viscosity of the oil should be equivalent to a SAE 30 weight motor oil; SUS at 210°F of 70 to 85. The oil should be a non-detergent type.

Fill the oil reservoir through the oil stand pipe to the stroke length mark on the dip stick corresponding to the stroke length being used. See Figure 32. Add additional oil according to the following chart.

During the initial lubrication procedure and at the time of the monthly re-lubrication cycle, some of the oil may splash over the oil reservoir onto the piston rod. This is a temporary condition and will cease when the oil pumps to the top of the piston.

AIR CYLINDER LUBRICATION INSTRUCTIONS				
Quarts of Oil to Add Past Stroke Length Mark on Oil Gauge				
Initial Lubrication Period				
Piston Dia.*	At Initial Filling	After First 8 Hours	After Second 8 Hours	Every 2 Weeks
8"	1	1	1	1
10"	2	2	2	2
11"	2	2	2	2
12"	3	3	3	3
13"	3	3	3	3
14-1/2"	4	4	4	4
*See Lufkin catalog or See Size Stamped on Piston Rod.				

It should be remembered that the stroke length mark stamped on the oil gauge at the factory is provided primarily for the initial lubrication procedure and does not indicate an "exact" running level. Due to the many factors which affect this oil level such as piston to cylinder clearance, manufacturing tolerances on structural components, viscosity of the oil being used, and etc. two identical units will often maintain different levels.

Therefore, after the initial lubrication procedure has been completed and it is observed that the oil level and the oil reservoir has stabilized at, say, 1/4" below the mark stamped on the gauge at the factory, it is not necessary to add oil up to the mark. If oil is added under these conditions, it will simply be pumped above the piston and the level will again stabilize at 1/4" below the mark.

On units equipped with the upper cylinder lubrication system, add four quarts of oil to the reservoir on the side of the air tank as shown in Figure 32.

32. Complete installation of ground oiling system

Connect the hoses to the air tank bearing, equalizer bearing and samson post bearings as shown in Section XIII. The list of parts show the length of hose required at each location and also lists all other parts and fittings.

33. Check lubrication of bearings

Use a grease gun to pump grease into each bearing assembly until grease is visible at the pressure relief fitting on each

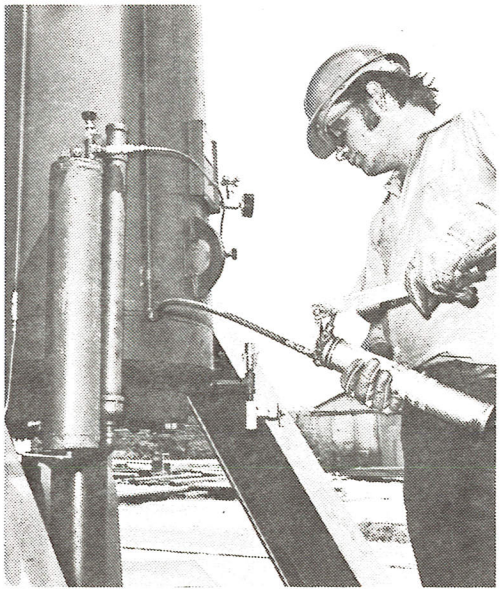


Figure 33a

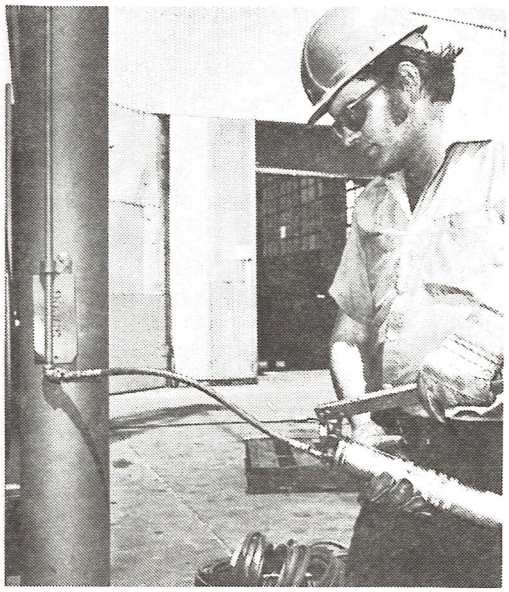


Figure 33b

bearing assembly. Check the relief fittings to be sure they are not clogged with paint on other foreign material. The ground oiling pipes on the air tank, pitman, and samson post are pre-lubed at the factory to prevent corrosion or condensation in the pipe and also to minimize the amount of grease required for the initial lubrication check. See Figures 33a, 33b, and 33c for the location of the lubrication points. See Section VI for grease specifications.

The crank pins on the air balanced units are lubricated with an EP140 oil. See Section VI for specifications. Remove the fill plug in the bearing cap and check to see that the oil level is up to the hole. See Figure 33d.

A plug with a drilled vent hole is furnished for this location. Be sure it is installed to prevent pressure build up in the assembly and subsequent damage to the oil seal.

Figure 33c

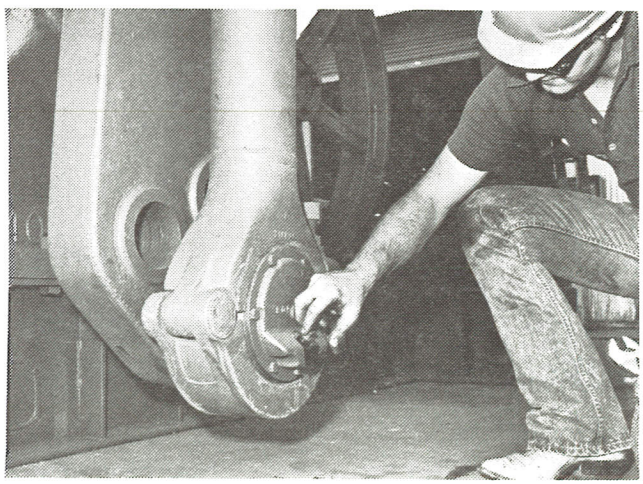


Figure 33d

34. Connect carrier bar to polished rod

Position the unit in the same stroke position as the bottom hole pump. Usually this is at bottom stroke position. Remove the gate from the carrier bar and slide the polished rod into the carrier bar slot. Replace the gate and secure the gate latch in the notch provided. Install the rod clamp and tighten bolts according to the clamp manufacturers torque recommendations. Remove the rod clamp on the well stuffing box. See Figure 34a and 34b.

35. Check tightness of bolts

Most structural failures on pumping units are caused by loose bolts. Check to be sure all bolts are properly tightened before attempting to start the pumping unit. See Figure 35.

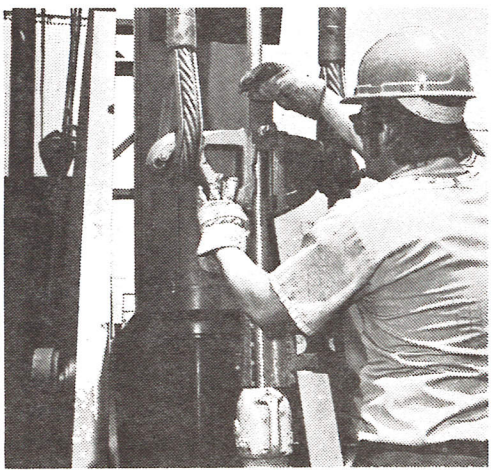


Figure 34a

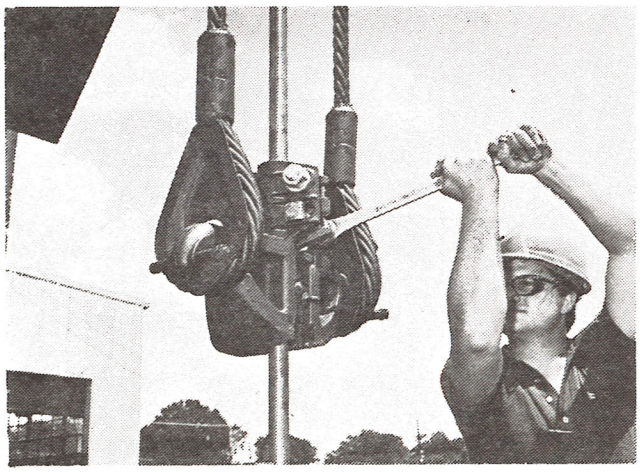
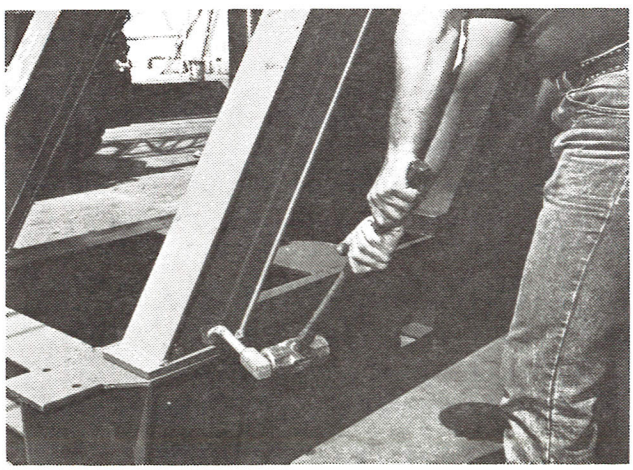


Figure 34b



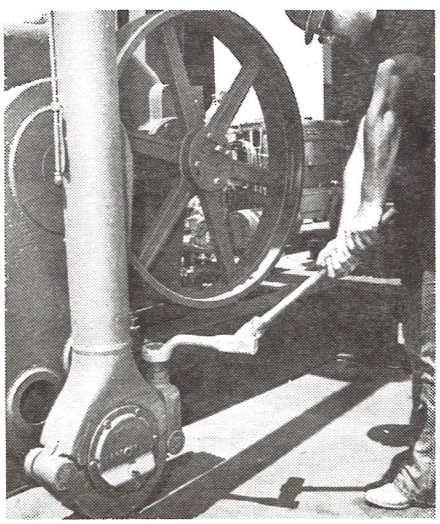
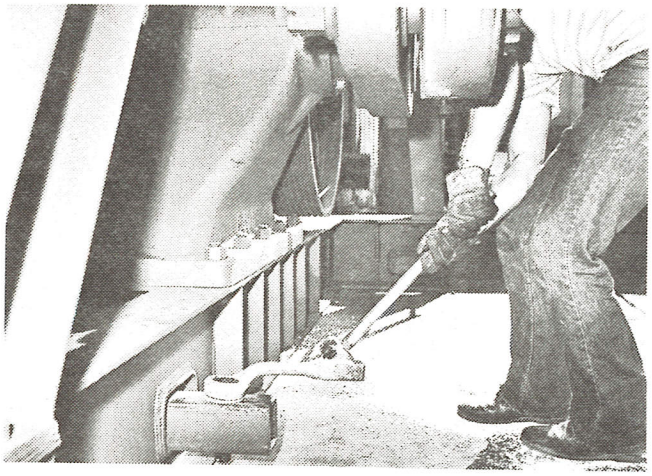
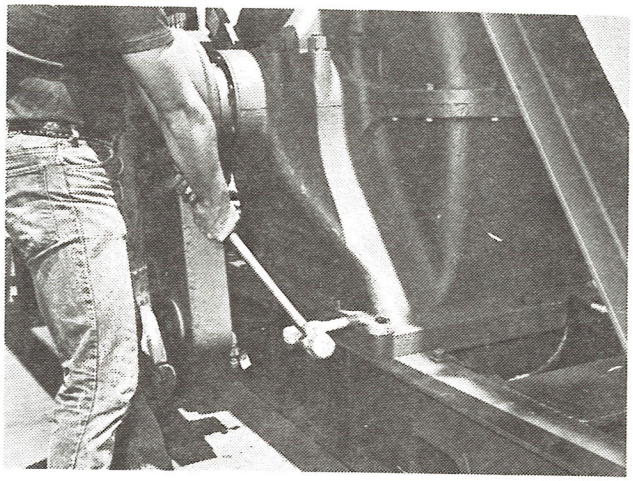


Figure 35
(continued on next page)





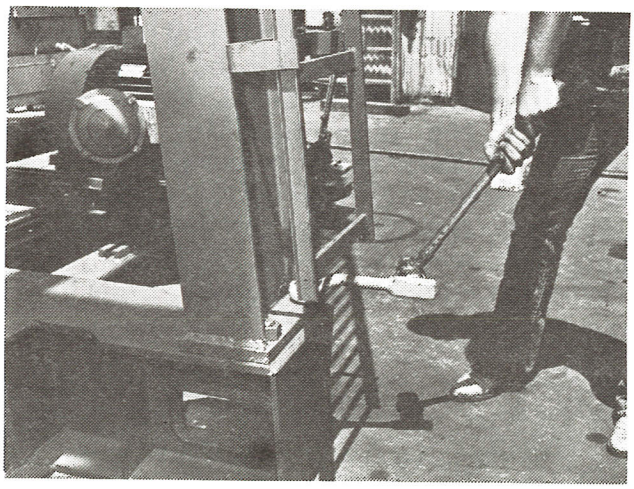


Figure 35

36. Install Crank Guards

Crank guards for the protection of personnel working around pumping units are recommended for all pumping units. Install the crank guards before starting the pumping unit. An assembly diagram is furnished to show how the guards are assembled. See Figure 36 for a typical crank guard installation.

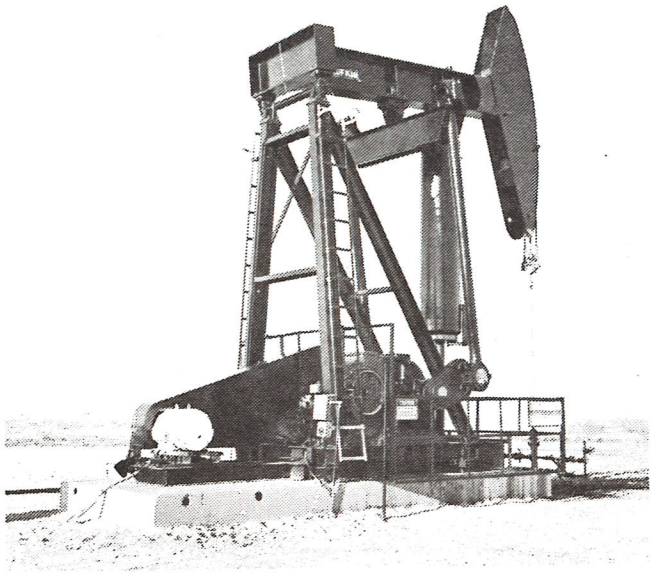


Figure 36

IV. OPERATION OF UNIT

A. PUMP UP COUNTERBALANCE AIR

The air pressure in the counter balance tank should be sufficient to raise the rods to the mid stroke position or until the walking beam is horizontal. An air compressor is furnished with the unit to supply the air pressure required. Check the oil level in the compressor before running the compressor. Be sure that the compressor cut-off valve installed at the rear of the water collector pipe is open. Disengage the positive stop pawl and release the brake. Cranks must be off of bottom dead center in order to start rotating as air pressure increases. See "Lubrication Specifications" in Section VI for the type of oil to use.

1. Electric motor driven compressor

   a. Pressure switch control

      Turn on the line switch and the compressor cut-off switch. The compressor should run and continue running until the air pressure reaches the pressure setting on the switch. Increase the switch setting to the point where the unit is balanced. See Section XV for illustration and identification of switches and valves.

   b. Murphy air pressure controller

      Open the pulsation dampener valve. Turn on the line switch and rotate the low pressure contact clockwise until it makes contact with the gage pointer. The compressor should run and continue to run until the pointer makes contact with the high pressure contact. Move the high pressure contact so that it touches the pointer to stop the compressor. See Section XV for illustration and identification of switches and valves.

2. Clutch driven compressor

Clutch driven compressors are "V" belt driven by a sheave on the floating hub assembly on the gear reducer or by a sheave mounted on the engine.

a. Floating hub drive

To pump up air on a unit equipped with a floating hub assembly, remove the six socket head cap screws that fasten the outer portion of the hub to the hub mounted on the shaft. Grease the assembly according to the instructions on the lubrication tag.

Start the engine, engage the clutch, and run the compressor until the required counterbalance pressure is reached. It may be necessary to adjust the air regulator valve to pump up the required air pressure. Turn the top adjusting nut clockwise to increase pressure. Stop the engine and replace the six cap screws and tighten according to the recommendations given under "Fasteners" in Section IX. See Section XV for illustration and identification of valves.

b. Engine drive

If the compressor is driven from a sheave mounted on the engine simply start the engine and the compressor will run. The air regulator valve may have to be adjusted to build up the required air pressure.

B. STARTING THE UNIT THE FIRST TIME

After the counterbalance air pressure has been built up several of the more critical checks should be repeated before starting the pumping unit.

1. Before starting checks

a. Oil in gear reducers

Remove the oil dip stick at the front of the reducer to check the oil level.

b. Oil in air cylinder

Remove the oil dip stick at the air tank and check the oil level. The level should be above the mark on the dip stick corresponding to the stroke length the unit will be operating in. At initial filling, oil is filled to the stroke length mark on the dip stick and then additional oil is added according to the instructions under "Cylinder Lubrication" in Section VI.

If the unit is equipped with an upper cylinder lubricator, verify that the four quart oiler is full. Check to see that the small valve at the side of the tank is open to

allow air to flow into the oiler. Also open the valve near the top of the tank so that oil will flow to the top of the piston.

c. Clear crank sweep

Remove all objects from around the unit. Be sure that the crank sweep is clear or the unit may be wrecked before it completes the first stroke.

d. All guards in place

The belt cover and all parts of the crank guards shall be installed before the unit is started.

e. Disengage positive stop brake

Disengage the pawl from the notches in the brake drum and swing the pawl away from the drum so that it cannot engage the brake drum.

2. Direction of rotation

The air balanced pumping unit is designed to rotate in either direction.

3. First crank revolution

Make the first crank revolution slowly and check for interference between pitman side members and cranks, cranks and crank guards, cranks and belt cover and all other moving parts. Listen for any unusual noises or bumps in the air tank at the very top or bottom of the stroke. Any problems should be corrected before running the unit.

C. COUNTER BALANCE ADJUSTMENT

1. Electric motor driven compressors

a. Pressure switch controls

The pressure switch has two adjustments. Adjust the cut out pressure so that the compressor stops when desired counter balance pressure has been reached. The differential setting determines the pressure at which the compressor will turn on. Since the pressure in the counterbalance tank varies from a maximum pressure at the bottom of the stroke to a minimum pressure at the top of the stroke, the differential setting should be set to a minimum value just below the differential pressure in the air system so that the compressor does not start and stop during each stroke of the unit. If the differential pressure is set too low the unit may run underbalanced before the compressor turns on.

If the pressure is built up too high during the adjustment of the pressure switch, it may be bleed off by opening the drain valve at the rear of the water collector pipe.

b. Murphy air pressure controls

The Murphy switch consists of a pressure gage with a pointer and two adjustable electrical contacts. When the pointer touches the contact on the left side of the gage, the air compressor starts. When the pointer touches the contact on the right side of the gage the compressor stops.

To set the control after the desired counterbalance air pressure has been obtained, first move both contacts away from the swing of the pointer. Open the pulsation dampener valve located just under the gage to the full open position. Observe the amount the pointer swings and then slowly close the pulsation dampener valve until the pointer swing is reduced to one half of full swing. Now move the contacts to just outside of the swing of the pointer and adjustment is complete.

Minor changes in counterbalance pressure can easily be made by turning the left contact clockwise until it contacts the pointer to start the compressor and add air or by opening the drain valve on the water collector pipe to decrease air pressure. Reset both contacts just outside of the swing of the pointer to complete the adjustment.

2. Clutch driven compressor

Clutch driven compressor air systems have two adjustment valves located on the small control tank built into the compressor sub-base. The air regulator valve controls the counterbalance pressure and the flow control valve regulates the pressure range in the control tank. The purpose of the control tank and flow control valve is to decrease the main air system pressure range to a smaller range within the control range of the air regulator valve.

To adjust the controls first close the flow control valve. Stop the compressor if it is running by counter clockwise rotation of the top adjusting nut on the air regulator valve. Loosen the lock nut before turning the adjusting nut. Now rotate the adjusting nut slowly clockwise until the compressor runs. Set the locknut.

Secondly, allow the compressor to run for a few minutes and then open the flow control valve 1/8 turn every other stroke of the unit until the compressor stops. Minor changes in the air regulator valve adjustment may be made without readjusting the flow control valve.

If the flow control value has to be opened near the full amount and the pressure range between the compressor start and stop puts the unit too far out of counterbalance, then adjustment of the differential setting on the air regulator valve is necessary. Loosen the large lock nut next to the body of the valve slightly and then turn the large nut counterclockwise to decrease the differential setting. One-eights of a turn is usually enough to change the differential setting the required amount. Repeat the adjustment procedure described above.

3. Determining couterbalance required

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

a. Polished rod dynamometer

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

b. Ammeter

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

c. Vacuum gauge

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

d. Sound of the prime mover

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

e. Tension in the belts

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

D. STROKE CHANGE

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

1. Preparation

Stop the unit with the cranks horizontal pointing toward the well. Clamp off the well. Chain the polished rod clamp to the well head so the polished rod will not move upwards if the well heads up. Bleed air from the air counterbalance tank until the carrier bar just leaves the rod clamp on top of the carrier bar. Set the brake and engage the positive stop pawl.

Loosen the latch bolts that hold the lower pitman connections against the bottom of the crank pin housing. Do not remove the lower pitman connections at this time. The beam should raise up until the carrier bar comes in contact with the rod clamp above the carrier bar. Add more air if required. The air pressure must be adjusted to support the beam and horsehead when the pitmans are disconnected from the crank pin bearings.

2. Pin hole change

a. Crank pin removal

Remove the cotter pin. Remove the crank pin nut using the box end hammer wrench provided with the unit and a sledge hammer. Drive out the crank pin. The best procedure is to use a drive nut and a heavy sledge hammer. The drive nut is screwed on until it bottoms on the end of the pin. Hammer against the head of the drive nut until the pin is loose. When a drive nut is not available, hammer as squarely as possible against the end of the pin or against another hammer held on the end of the pin by a second person.

Air balanced unit crank pins are also equipped with a hydraulic removal feature. Remove the center plug from the crank pin bearing end cap and apply grease to the alemite fitting in the end of the crank pin with a high pressure grease gun (10,000 psi). Maintain the pressure while hammering against the pin.

b. Crank pin installation

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

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

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

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

Attach the pitmans to the crank pin bearing assemblies. The drain and fill plugs on the end cap should be turned down. The cranks may have to be lowered in order to attach the pitmans or the beam may have to be lowered. To lower the cranks, very carefully release the brake until the cranks move into the desired position. To lower the beam, bleed air pressure from the counterbalance air tank until the pitmans seat against the crank pin bearing housings. Tighten the latch bolts following the recommendations under "Fasteners" in Section IX.

3. Air cylinder lubrication

It is very important to adjust the oil level in the air tank after a stroke change. Failure to do so will result in a damaged cylinder in a very short time.

a. Change from long stroke to shorter stroke

When the unit is operating in the short stroke the air tank does not travel as far as it does in the long stroke and the oil level in the oil reservoir must be increased so that the piston skirt dips into the oil. Add oil to the reservoir to bring the level up to the stroke length mark on the dip stick corresponding to the stroke length that the unit will be operating in. Add additional oil as designated in the column "At Initial Filling" in the Air Cylinder Lubrication Instructions in Section III.B.31. If the unit has been moved to another location or the air cylinder has been removed from the unit, repeat the entire procedure as given in the Air Cylinder Lubrication Instructions.

b. Change from short stroke to long stroke

When the stroke length is changed to a longer stroke the piston will dip further in the oil in the oil reservoir. The excess oil will splash out onto the piston rod. To avoid the splash and consequent undesirable oil on the unit and foundation, drain oil from the reservoir down to the mark on the dip stick corresponding to the stroke length that the unit will be operating in. Add additional oil as designated in the column "At Initial Filling" in the Air Cylinder Lubrication Instructions in Section III.B.31. If the unit has been moved to another location or the air cylinder has been removed from the unit, repeat the entire

procedure as given in the Air Cylinder Lubrication Instructions.

4. Putting unit into operation

Several precautions should be taken before putting the unit back into operation after a stroke length change.

a. Brake and polished rod clamp

Remove the chain securing the polished rod clamp to the well head. Remove the rod clamp. Disengage the positive stop pawl from the brake and release the brake.

b. Counterbalance air pressure adjustment

Add air to the counterbalance air tank until the walking beam is in the horizontal position. See IV.A. for instructions for the proper procedure to use to pump up counterbalance air.

c. Air cylinder lubrication check

Check the exact level of oil in the oil reservoir by reading the dip stick. Start the unit and adjust the counterbalance controls as necessary. After the unit has run for about thirty minutes, stop the unit and re-check the oil level in the oil reservoir. The oil level should decrease to near the mark on the dip stick corresponding to the stroke length in which the unit is operating. The decrease in oil level in the reservoir indicates that the piston rings and "U" cup are working properly to pump oil to the top of the piston. If the oil level in the reservoir does not decrease, then look for worn piston rings and cylinder or a ruptured "U" cup. Continued operation of the unit without proper cylinder lubrication will result in a scored cylinder.

V. PREVENTATIVE MAINTENANCE

A good preventative maintenance program is recommended to prolong the life of the unit and to prevent expensive repairs. Many items can be checked routinely by visual inspection and by listening for unusual noise.

A. Air system

1. Air counterbalance tank assembly

a. Air cylinder lubrication

Add the amount of oil to the oil reservoir every two weeks as specified in the Air Cylinder Lubrication Instructions in Section III.B.31. Check the oil level on the dip stick after adding the oil. Run the unit for thirty minutes and re-check the oil level to see if the level has decreased.

If the oil level does not decrease see IV.D.4.c. for recommendations.

b. Clean oil reservoir

Clean oil reservoir thoroughly at least twice a year. Clean more often if necessary. To clean oil reservoir drain oil by removing the 1/2" pipe plug. Then remove the 1/2" capscrews which secure the oil reservoir to the air cylinder, lower the reservoir and clean thoroughly with kerosene or solvent. Wipe dry and reassemble. Add oil to the mark on the oil gauge according to stroke length being used and put unit back in operation.

c. Drain condensate from air system

Drain condensate from the water collector pipe drain valve at the rear of the pipe once a month. Also drain condensate from the air compressor pressure control tank and from the main air tank through the drain valves near the bottom of the assemblies.

2. Air compressor

Check the oil level in the compressor crankcase weekly. Keep filled to the high level mark on the dip stick. Change the oil every six months or more often if the oil is dirty or contaminated with moisture. Refer to lubrication specifications in Section VI for the type of oil to use.

Check the air filter element weekly and replace as necessary. A dirty or clogged air filter will cause the compressor to use excess oil.

3. Air clutch

Add small amounts of SAE 30 weight oil through the fill plug in the clutch hub weekly.

B. Alignment

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

C. Bolts

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

D. Wireline

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

E. Belts

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

F. Brake

Brake lining should be inspected for wear and clearance adjustment. When the brake control lever is fully engaged there should be several notches left on the ratchet. If adjustment is required follow the instructions in Section XI. Replace the brake cable if it appears damaged or otherwise inoperable.

G. Gear Reducer

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

VI. LUBRICANT SPECIFICATIONS

A. Air System

1. Air cylinder

Use a good grade of mineral oil with rust and oxidation inhibitors and an anti-foam agent. The oil should have a viscosity comparable to SAE 30 motor oil. Do not use a detergent type oil.

2. Air clutch

Use SAE 30 motor oil

3. Floating hub assembly

Use a premium NLGI No. 1 lithium soap base grease with an extreme pressure additive. Do not use soda soap grease.

4. Air compressor

Use a non-detergent motor oil.
For temperatures below 0° use SAE 10W
For temperatures up to 80°F use SAE 20
For temperatures above 80°F use SAE 30

B. Gear Reducer

For temperatures down to 0°F use an AGMA No. 5EP (ISO VG 220) premium mild extreme pressure lubricant (preferably a

sulphur-phosphorous type) with rust and oxidation inhibitors and an anti-foam agent. Pour point of the oil should be 5°F or lower. For temperatures down to -30°F use an AGMA No. 4EP (ISO VG 150) premium mild extreme pressure lubricant (preferably sulphur-phosphorous type) with rust and oxidation inhibitors and anti-foam agent. Pour point of the oil should be -15°F or less.

Refer to API RP 11G for additional information about lubrication of pumping units.

1. Oils for enclosed gear reducers

   Oils have been selected by oil company lubrication engineers to meet the API recommended practice as given in API RP 11G, "Installation and Lubrication of Pumping Units". See chart on the following page.

2. Reducer oil capacity, gallons

MODEL	CAPACITY	MODEL	CAPACITY
2560D	235	456D	55
1824D	165	320D	50
1280D	120	228D	34
912D	107	160D	22
640D	70	114D	17

C. Bearings

1. Structural bearings

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

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

2. Crank pin bearings

   For temperatures down to 0°F., use an EP140 extreme pressure oil with an extreme pressure additive and a pour point of +15°F. or lower. If available, the use of a heavier oil (viscosity up to 6600 SUS at 100°F) is recommended.

   For temperatures down to -30°F., use an EP80 or EP90 extreme pressure oil with an extreme pressure additive and a pour point of -10°F or lower.

OILS FOR ENCLOSED GEAR REDUCERS
(SELECTED BY OIL COMPANY LUBRICANT ENGINEERS)

	EXTREME PRESSURE (MILD) GEAR OILS	
	AGMA NO. 4EP ISO VG 150	AGMA NO. 5EP ISO VG 220
AMOCO	PERMAGEAR NO. 150	PERMAGEAR NO. 220
ARCO	PENNANT NL 150	PENNANT NL 220
CHEVRON	NL GEAR COMP. 150	NL GEAR COMP. 220
CITGO	EP COMPOUND 150	EP COMPOUND 220
CONOCO	GEAR OIL 150	GEAR OIL 220
EXXON	SPARTAN EP 150	SPARTAN EP 220
GULF	EP LUBRICANT HD 150	EP LUBRICANT HD 220
MARATHON	MP GEAR COMP. 571	- - - - - -
MOBIL	MOBILGEAR 629	MOBILGEAR 630
PACER	GOLDEN "G" 4 EP	GOLDEN "G" 5 EP
PHILLIPS	- - - - - -	ALL PURPOSE GEAR 85 W-90
DIAMOND SHAMROCK	INDIGO 72	INDIGO 84
SHELL	OMALA 150	OMALA 220
SKELLY	MP GEAR 80-90	GP GEAR 90
SOHIO	GEAR EP 85	GEAR EP 90
SUN	SUNEP 1060	SUNEP 1070
TEXACO	MEROPA 150	MEROPA 220
UNION	EXTRA DUTY NL GEAR LUBE 4 EP (700)	EXTRA DUTY NL GEAR LUBE 5 EP (1000)

D. Wireline

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

VII. SCHEDULED MAINTENANCE

A. Weekly

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

Every two weeks lubricate the air cylinder as recommended in V.A.1.a. Lubricate the air clutch hub as recommended in V.A.3.

B. Monthly

1. Preventative maintenance check

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

2. Gear reducer oil level

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

3. Structural bearings

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

C. Bi-annually

1. Lubricate bearings

The structural bearings should be lubricated with grease as recommended in Section VI of this manual. Grease fittings are located at ground level. Pump grease in slowly to avoid pushing out the oil seals. Discharge from the vents located on each bearing housing indicates that the housing is full. Tapered roller crank pin bearings should be relubricated as required to maintain oil level by removing fill plug and adding oil until reservoir is full.

2. Gear reducer

Collect a typical sample of the gear reducer oil in a glass jar. A visual inspection will show possible dirt, sludge,

water emulsion or other forms of contamination. If the lubricant has an abnormal appearance or smell, check with your oil supplier about replacement.

3. Air system

a. Air cylinder

Clean the oil reservoir as outlined in V.A.1.6.

b. Air compressor

Change oil in the compressor crank case and install a new air filter as recommended in V.A.2.

VIII. LUFKIN SERVICE

A. Lufkin servicemen

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

B. Repair and replacement parts service

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

ADDENDUM

IX. FASTENERS

A. "Metal-to-Metal" Contact

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

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

B. "Elastic" Grip

The grip is not always metal-to-metal. In applications such as foundation bolts, heel clamp bolts, and various bracket bolts the fasteners will be subjected to unavoidable cyclic loading. The tightening torques needed in these applications are extremely variable; however, they should be about half the values given in Table 1. Bolts should always be over-tightened rather than under-tightened.

TABLE I

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

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

X. ERECTION EQUIPMENT REQUIRED

MAXIMUM STROKE	*MINIMUM HOOK HEIGHT	STANDARD UNIT BASE WEIGHT (LBS)
240"	38' - 0"	6840
216"	35' - 0"	4714
192"	32' - 0"	4350
168"	30' - 0"	3180
144"	26' - 0"	3030
120"	23' - 0"	2230
100"	20' - 0"	1851
86"	18' - 0"	1550
74"	17' - 0"	990
64"	16' - 0"	860

* BOTTOM OF BASE TO TOP OF HEAD WITH BEAM HORIZONTAL

REDUCER SIZE	+WEIGHT W/CRANKS, CRANK PINS, SHEAVE, BRAKE AND OIL (LBS.)
2560D	47,067
1824D	31,626
1280D	28,898
912D	17,973
640D	15,659
456D	12,926
320D	9,951
228D	7,255
160D	4,886
114D	3,402

+ LARGEST CRANK AND SHEAVE USED WITH REDUCER
NOTE: AIR BALANCED UNITS ARE NORMALLY SHIPPED WITH GEAR REDUCERS MOUNTED ON BASE.

XI. BRAKE SYSTEM INSTALLATION AND ADUSTMENT

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

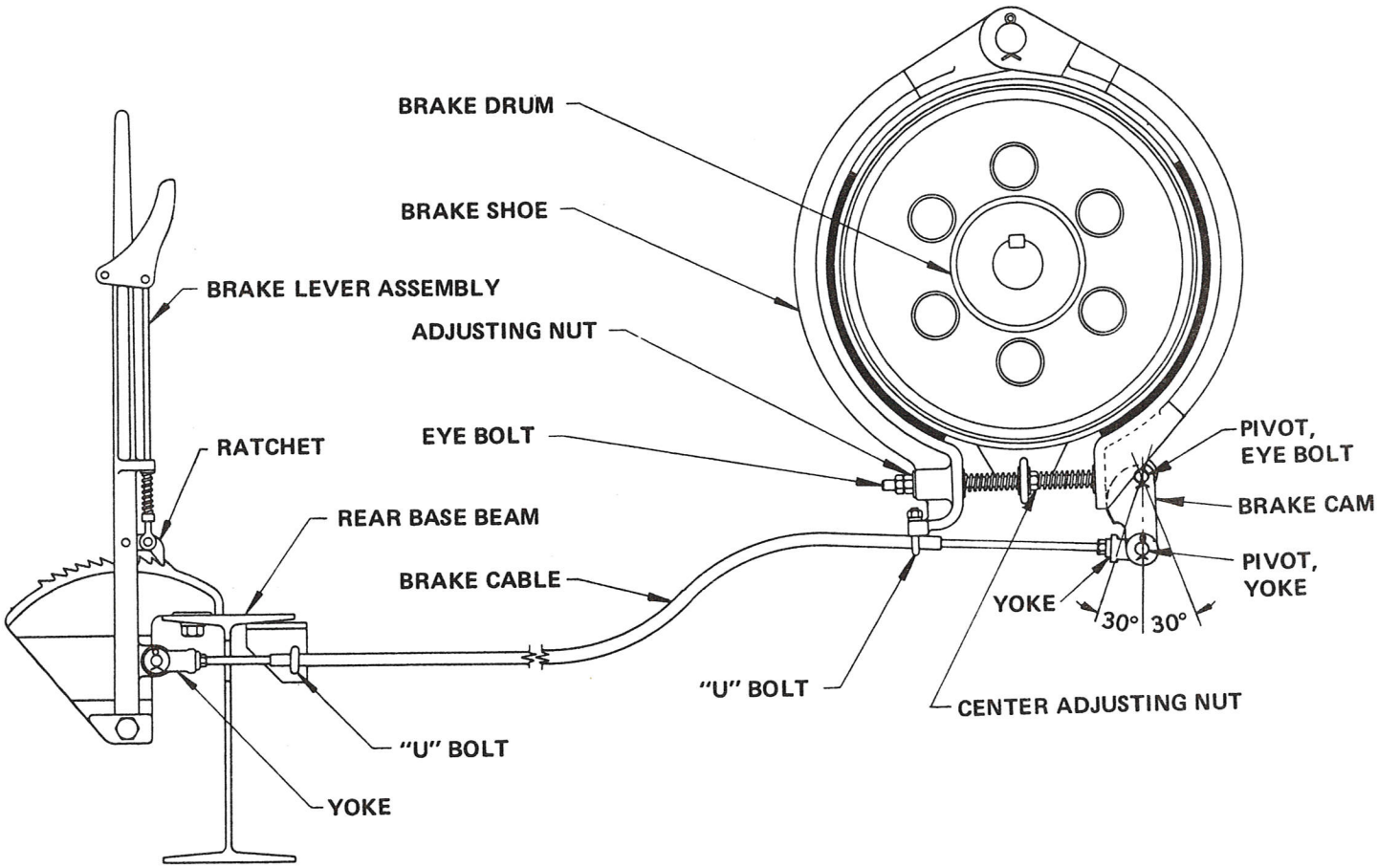


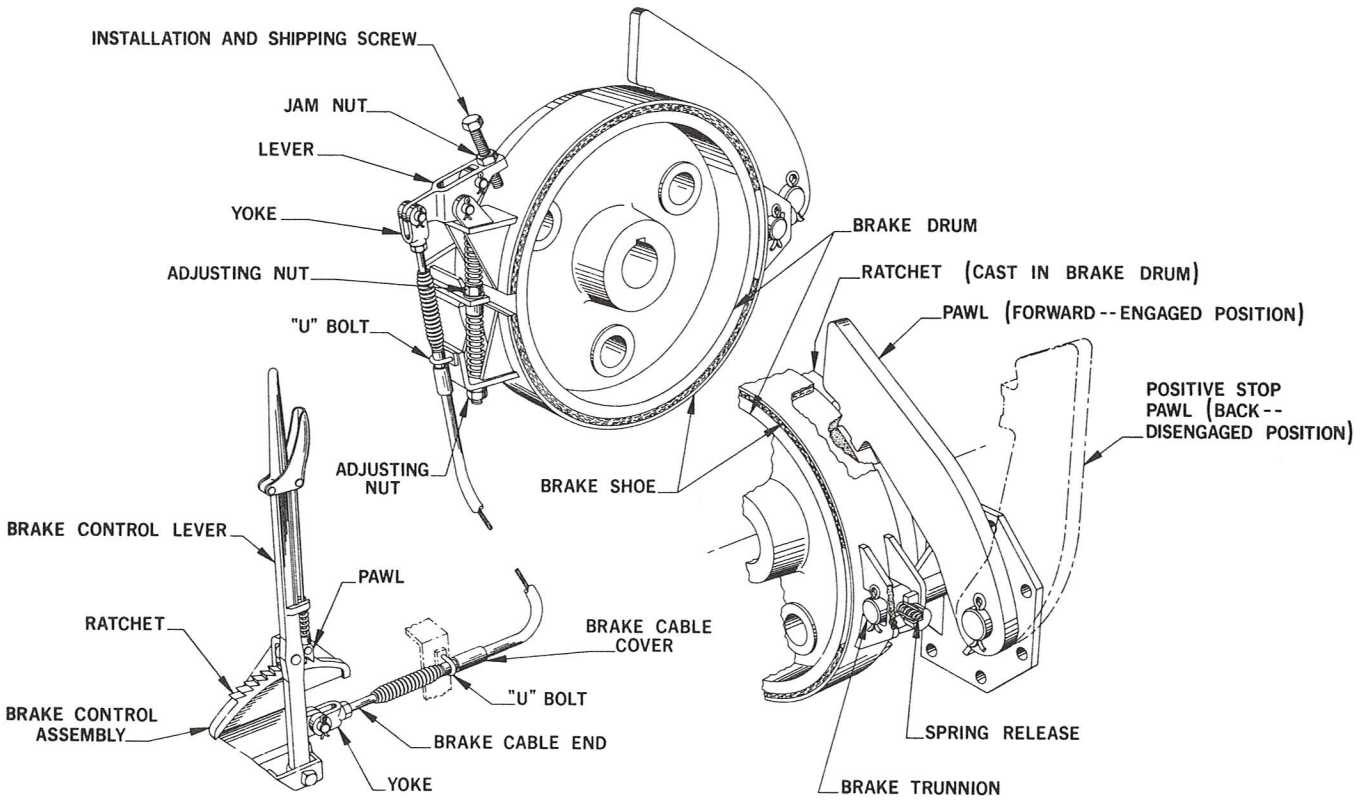
Figure 9a - BRAKE SYSTEM INSTALLATION AND ADJUSTMENT-SHOE TYPE BRAKE

STOP CRANKS AT BOTTOM DEAD CENTER FOR SAFETY

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

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

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



BRAKE SYSTEM INSTALLATION AND ADJUSTMENT-BAND TYPE BRAKE

(1) Stop cranks at bottom dead center for safety (see note 1). The unit is shipped from the manufacturer with brake engaged with shipping screw and the positive stop pawl engaged on the brake drum. The positive stop pawl must be disengaged for the cranks to rotate. Loosen the installation and shipping screw to release the brake. EXTREME CAUTION should be exercised to stay clear of the cranks to prevent serious personal injury.

(2) With the cranks in a safe position, (see note 1) engage the positive stop pawl on the drum.

(3) Attach the brake control lever assembly to the base.

(4) The brake comes from the factory adjusted but may require final adjustment with the brake lever installed. Loosen the installation and shipping screw to release the brake. Adjust the position of both brake shoes with the adjusting nuts until the lining just clears the drum at the top and bottom. The spring release on the trunnion should pull the lining away from the drum near the trunnion. Trunnion position may be changed if necessary to increase this clearance. Loosen the cap screws attaching the trunnion to the bearing carrier. Engage the brake using the installation screw and move the trunnion away from the brake until adaquate clearance is obtained. Retighten cap screws.

(5) Attach the brake cable cover to the base near the brake lever using the "U" bolt provided.

(6) Disengage the brake, move the brake control lever to the maximum forward position, and position the yoke on the end of the brake cable so that it can be pinned to the brake control lever.

(7) Now engage the brake using the brake control lever. Full engagement should occur with several notches of the ratchet on the brake assembly still remaining to compensate for subsequent lining wear and cable stretch. Further adjustment to meet this condition may be made by repositioning the cable yoke on the brake control lever end. Care should be taken when adjusting the yoke not to cause the brake cable to overtravel internally in the cable cover. Should this occur, move both yokes the same amount in opposite directions.

(8) Recheck brake lining clearance after all adjustments are complete.

(9) The brake installation and shipping screw should be screwed out flush with the bottom of the lever and locked with the jam nut.

(10) Check brake drum key for proper tightness.

(11) Subsequent lining clearance adjustment for wear should be made only after stopping the cranks in a safe position and engaging the positive stop pawl.

(12) Disengage the positive stop pawl before attempting to start the unit. The brake should be engaged using the brake control lever when engaging or disengaging the positive stop pawl to prevent accidental drum rotation.

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

RATING CHART

UNIT	Polish Rod Load Class, Lbs.	Stroke Length, Inches	Piston Dia., Inches	Walking Beam Size	Wireline Hanger Dia. & Centers	*Floating Hub Sheave Sizes, P.D. Inches	Bearings			
							Crank Pin	Equal-izer	Samson Post	Air Tank
A-2560D-470-240	47,000	240-200	14½	36 x 16½ @ 245#	1⅜" x 16"	68" (16D)	OT	E32	P19	334
A-1824D-470-240	"	"	"	"	"	40, 46, 51, 55, 68 (11D)	"	E26	"	"
A-1824D-427-216	42,700	216-190-162	"	33 x 15¾ @ 201#	"	"	"	"	"	"
A-1824D-427-192	"	192-168-144	"	"	"	"	"	"	"	"
A-1280D-470-240	47,000	240-200	"	36 x 16½ @ 245#	"	40, 46, 51, 55, 68 (10D)	"	"	"	"
A-1280D-427-216	42,700	216-190-162	"	33 x 15¾ @ 201#	"	"	"	"	"	"
A-1280D-427-192	"	192-168-144	"	"	"	"	"	"	"	"
A-1280D-305-168	30,500	168-141-118	13	27 x 14 @ 161#	"	"	"	"	"	232
A-912D-470-240	47,000	240-200	14½	36 x 16½ @ 245#	"	28, 34, 40, 46, 51 (8D)	"	"	"	334
A-912D-427-216	42,700	216-190-162	"	33 x 15¾ @ 201#	"	"	"	"	"	"
A-912D-427-192	"	192-168-144	"	"	"	"	"	"	"	"
A-912D-305-168	30,500	168-141-118	13	27 x 12 @ 146#	"	28, 34, 40, 46, 51, (7D)	"	"	"	232
A-912D-427-144	42,700	144-120-100	"	27 x 14 @ 161#	"	"	"	"	"	"
A-640D-305-168	30,500	168-141-118	"	27 x 12 @ 146#	"	28, 34, 40, 46, 51, (6D)	"	"	"	"
A-640D-427-144	42,700	144-120-100	"	27 x 14 @ 161#	"	"	"	"	"	"
A-640D-305-144	30,500	"	12	27⅜ x 12¾ @ 146#	1¼" x 12"	"	"	"	P18	326
A-640D-365-120	36,500	120-100-86	"	"	"	"	"	"	"	"
A-456D-305-144	30,500	144-120-100	"	"	"	28,34,40,46,51(6D or 8C)	"	"	"	"
A-456D-365-120	36,500	120-100-86	"	"	"	"	"	"	"	"
A-456D-256-120	25,600	120-104-90	11	24 x 12¾ @ 104#	"	"	"	"	"	324
A-320D-256-120	"	"	"	"	"	25, 30, 36, 42, 47¼ (6C or 5D)	2T	E22	"	"
A-320D-305-100	30,500	100-86-74	"	"	"	"	"	"	"	"
A-228D-173-100	17,300	"	10	21 x 12 @ 101#	1⅛" x 12"	24¼, 30, 36, 41¼ (5C or 4D)	"	"	P17	322
A-228D-246-86	24,600	86-74-64	"	"	"	"	"	"	"	"
A-160D-200-74	20,000	74-64-54	"	18¼ x 11 @ 76#	"	24¼, 29¼, 33¼, 38 (4C or 3D)	3TA	E19	P16	"
A-114D-173-64	17,300	64-54	8	16 x 8½ @ 67#	1" x 9"	19¼,24,29¼,33¼, (3C)	"	E18	"	318

* Standard Sheave Sizes Shown are Floating Hub Sheaves for Clutch Driven Compressors; Largest Size Shown is Maximum Available. For Electric Motor Driven Compressors, Use Solid Type Reducer Sheave as Shown in Crank Balance Unit Specifications.

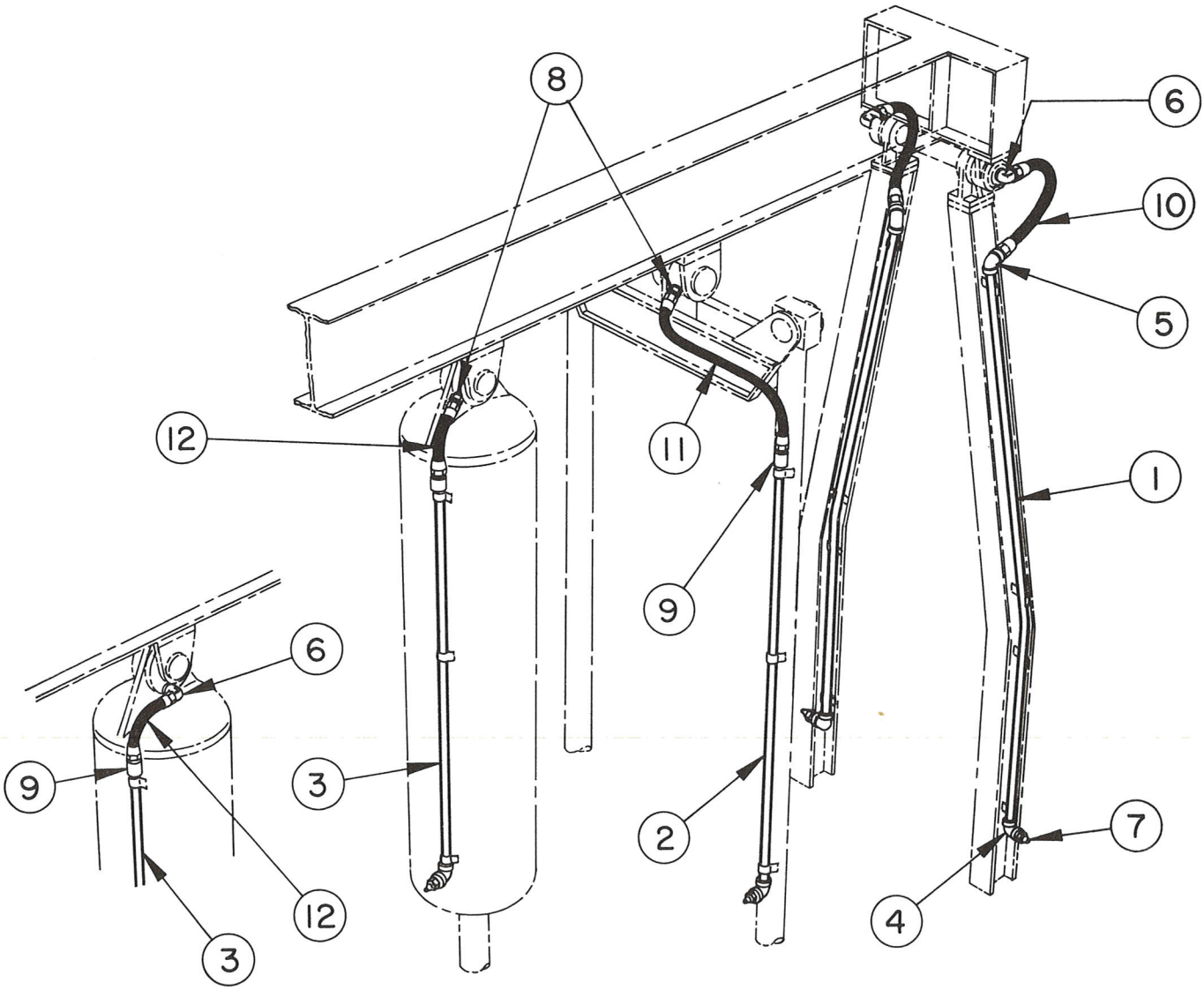
COUNTERBALANCE DATA

Effective Counterbalance In Pounds Based On Average Pressure

UNIT	*Average Pressure, PSIG											
	150	175	200	225	250	275	300	325	350	375	400	410
A-2560D-470-240 A-1824D-470-240 A-1280D-470-240 A-912D-470-240	.....	2,870	5,740	8,610	11,480	14,350	17,220	20,090	22,960	25,830	28,700	29,850
A-1824D-427-216 A-1280D-427-216 A-912D-427-216	920	3,220	5,520	7,820	10,120	12,420	14,720	17,020	19,320	21,620	23,920	24,830
A-1824D-427-192 A-1280D-427-192 A-912D-427-192	3,905	6,475	9,045	11,615	14,185	16,755	19,325	21,895	24,465	27,035	29,605	30,635
A-1280D-305-168 A-912D-305-168 A-640D-305-168	2,810	4,700	6,585	8,475	10,365	12,250	14,140	16,030	17,915	19,805	21,695	22,450
A-912D-427-144 A-640D-427-144	5,240	7,420	9,605	11,785	13,970	16,150	18,335	20,515	22,700	24,880	27,065	27,935
A-640D-305-144 A-456D-305-144	3,520	5,125	6,725	8,330	9,935	11,540	13,145	14,745	16,350	17,955	19,560	20,200
A-640D-365-120 A-456D-365-120	4,725	6,630	8,535	10,440	12,345	14,250	16,155	18,060	19,965	21,870	23,775	24,535
A-456D-256-120 A-320D-256-120	4,035	5,415	6,795	8,175	9,560	10,940	12,320	13,700	15,085	16,465	17,845	18,400
A-320D-305-100	4,855	6,495	8,135	9,775	11,415	13,055	14,695	16,335	17,975	19,615	21,255	21,910
A-228D-173-100	2,925	4,060	5,195	6,335	7,470	8,610	9,745	10,885	12,020	13,160	14,295	14,750
A-228D-246-86	4,045	5,355	6,670	7,980	9,295	10,605	11,920	13,230	14,545	15,855	17,170	17,695
A-160D-200-74	4,410	5,680	6,945	8,215	9,480	10,750	12,015	13,285	14,550	15,820	17,085	17,595
A-114D-173-64	2,760	3,550	4,345	5,135	5,930	6,720	7,515	8,305	9,100	9,890	10,685	11,000

* Pressure Shown is Average Pressure Between Maximum and Minimum and Occurs at Approximately Beam Horizontal Position. For Counterbalance at Other Pressures Use Direct Interpolation.

GROUND OILING SYSTEM
LUFKIN AIR BALANCED UNITS



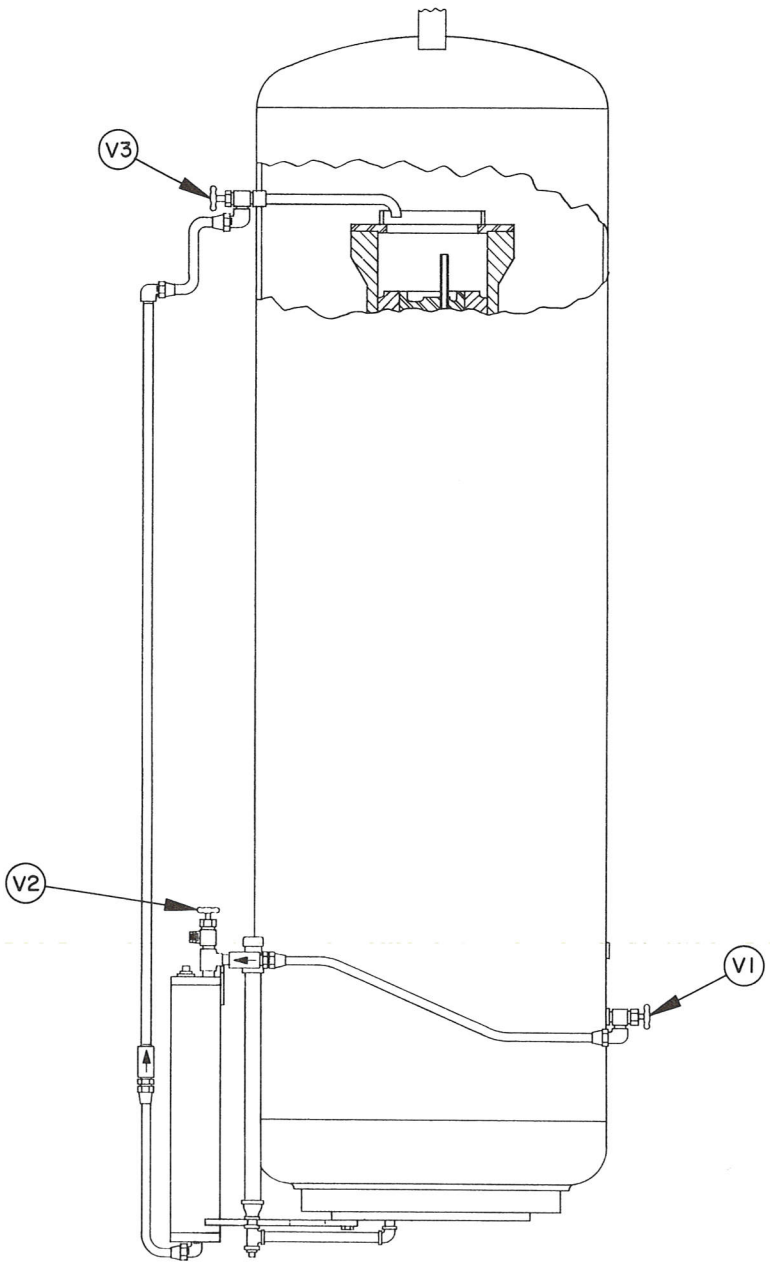
UNIT	Item No. 1 (2 - Req'd.) 1/4 Pipe Part No.	Lgth.	Item No. 2 (1 - Req'd.) 1/4 Pipe Part No.	Lgth.	Item No. 3 (1 - Req'd.) 1/4 Pipe Part No.	Lgth.	Item No. 6 Ell 90° 1/4 x 1/8 Part No.	Qty.	Item No. 8 Half Union 1/4 x 1/8 Part No.	Qty.	Item No. 10 (2 Req'd.) Samson Post Flexible Hose Part No.	Lgth.	Item No. 11 (1 - Req'd.) Equalizer Flexible Hose Part No.	Lgth.	Item No. 12 (1 - Req'd.) Air Tank Flexible Hose Part No.	Lgth.
A-114D-173-64	JM20801	8'-0"	JM69670	68"	JM16036	6'-6"	N911153	2	N911103	2	JP69511	21"	JP73085	40"	JP69513	14-1/2"
A-160D-200-74	JM20801	8'-0"	JM69670	68"	JM16036	6'-6"	N911153	2	N911103	2	JP69511	21"	JP73085	40"	JP69513	14-1/2"
A-228D-246-86	JM69581	9'-1-1/2"	JM16036	6'-6"	JM15904	7'2-1/2"	N911153	2	N911103	2	JP69511	21"	JP72966	50"	JP69513	14-1/2"
A-228D-173-100	JM69581	9'-1-1/2"	JM16036	6'-6"	JM15904	7'-2-1/2	N911153	2	N911103	2	JP69511	21"	JP72966	50"	JP69513	14-1/2"
A-320D-305-100	JM69674	9'-10"	JM69576	7'-4-3/4"	JM20801	8'-0"	N911153	2	N911103	2	JP69511	21"	JP72965	54"	JP69511	21"
A-320D-256-120	JM69574	11'-10"	JM69673	9'6"	JM20801	8'-0"	N911153	2	N911103	2	JP69511	21"	JP72965	54"	JP69511	21"
A-456D-256-120	JM69574	11'-10"	JM69673	9'-6"	JM20801	8'-0"	N911153	2	N911103	2	JP69511	21"	JP72965	54"	JP69511	21"
A-456D-365-120	JM69574	11'-10"	JM69673	9'-6"	JM69673	9'-6"	N911153	2	N911103	2	JP69511	21"	JP72965	54"	JP69511	21"
A-456D-305-144	JM20805	14'-6"	JM72968	11'-0"	JM69673	9'-6"	N911153	2	N911103	2	JP69511	21"	JP72965	54"	JP69511	21"
A-640D-365-120	JM69574	11'-10"	JM69673	9'-6"	JM69673	9'-6"	N911153	2	N911103	2	JP69511	21"	JP72965	54"	JP69511	21"
A-640D-305-144	JM20805	14'-6"	JM72968	11'-0"	JM69673	9'-6"	N911153	2	N911103	2	JP69511	21"	JP72965	54"	JP69511	21"
A-640D-427-144	JM20805	14'-6"	JM72968	11'-0"	JM72968	11'-0"	N911153	3	N911103	1	JP69511	21"	JP72965	54"	JP72969	26"
A-640D-305-168	JM70792	16'-6"	JM69579	13'-6"	JM72968	11'-0"	N911153	2	N911103	2	JP69511	21"	JP72965	54"	JP72969	26"
A-912D-427-144	JM20805	14'-6"	JM72968	11'-0"	JM72968	11'-0"	N911153	3	N911103	1	JP69511	21"	JP72965	54"	JP72969	26"
A-912D-305-168	JM70792	16'-6"	JM69579	13'-6"	JM72968	11'-0"	N911153	2	N911103	2	JP69511	21"	JP72965	54"	JP72969	26"
A-912D-427-192	JM72789	18'-4-1/2"	JM69579	13'-6"	JM69575	12'-7"	N911153	2	N911103	2	JP69511	21"	JP69489	66"	JP72969	26"
A-912D-427-216	JM86804	20'-10"	JM20806	16'-0"	JM86803	15'-1"	N911153	2	N911103	2	JP69511	21"	JP69489	66"	JP72969	26"
A-912D-470-240	JM72971	22'-2"	JM69566	17'-0"	JM20806	16'-0"	N911153	2	N911103	2	JP69511	21"	JP69489	66"	JP72969	26"
A-1280D-427-144	JM20805	14'-6"	JM72968	11'-0"	JM72968	11'-0"	N911153	3	N911103	1	JP69511	21"	JP69489	66"	JP72969	26"
A-1280D-305-168	JM70792	16'-6"	JM69579	13'-6"	JM72968	11'-0"	N911153	2	N911103	2	JP69511	21"	JP72965	54"	JP72969	26"
A-1280D-427-192	JM72789	18'-4-1/2"	JM69579	13'-6"	JM69575	12'-7"	N911153	2	N911103	2	JP69511	21"	JP69489	66"	JP72969	26"
A-1280D-427-216	JM86804	20'-10"	JM20806	16'-0"	JM86803	15'-1"	N911153	2	N911103	2	JP69511	21"	JP69489	66"	JP72969	26"
A-1280D-470-240	JM72971	22'-2	JM69566	17'-0"	JM20806	16'-0"	N911153	2	N911103	2	JP69511	21"	JP69489	66"	JP72969	26"
A-1824D-427-192	JM72789	18'-4-1/2"	JM69579	13'-6"	JM69575	12'-7"	N911153	2	N911103	2	JP69511	21"	JP69489	66"	JP72969	26"
A-1824D-427-216	JM86804	20'-10"	JM20806	16'-0"	JM86806	15'-1	N911153	2	N911103	2	JP69511	21"	JP69489	66"	JP72969	26"
A-1824D-470-240	JM72971	22'-2	JM69566	17'-0"	JM20806	16'-0"	N911153	2	N911103	2	JP69511	21"	JP69489	66"	JP72969	26"
A-2560D-470-240	JM72971	22'-2	JM69566	17'0"	JM20806	16'-0"	N911153	2	N911103	2	JP69511	21"	JP69490	70"	JP72969	26"

THE FOLLOWING PARTS ARE THE SAME ON ALL UNITS

Item No.	Quantity	Part No.	Description
4	4	N923002	Ell, 1/4 x 90°
5	2	N923102	Ell, 1/4 x 45°
7	4	JP14327	Alemite Fitting, 1/4"
9	2	N923302	Coupling, 1/4"

AIR CYLINDER LUBRICATION SYSTEM

LUFKIN AIR BALANCED UNITS



TO FILL OILER

1. CLOSE VALVE (V1)
2. OPEN VALVE (V2) TO BLEED AIR FROM OILER
3. REMOVE 1" OIL FILLER PLUG
4. FILL OILER WITH 4 QUARTS OF OIL
5. REPLACE 1" PLUG — CLOSE VALVE (V2)
6. OPEN VALVE (V1) AND START UNIT
7. ALLOW ABOUT 30 MINUTES FOR THE OIL TO PUMP TO THE TOP OF THE PISTON
8. CLOSE VALVE (V1) TO MINIMIZE POSSIBILITY OF LEAKS
9. REPEAT EACH MONTH

FOLLOW INSTRUCTIONS IN A-66 BULLETIN FOR ADDING OIL TO OIL RESERVOIR

XV. STARTING PROCEDURE WITH CLUTCH-DRIVEN COMPRESSOR

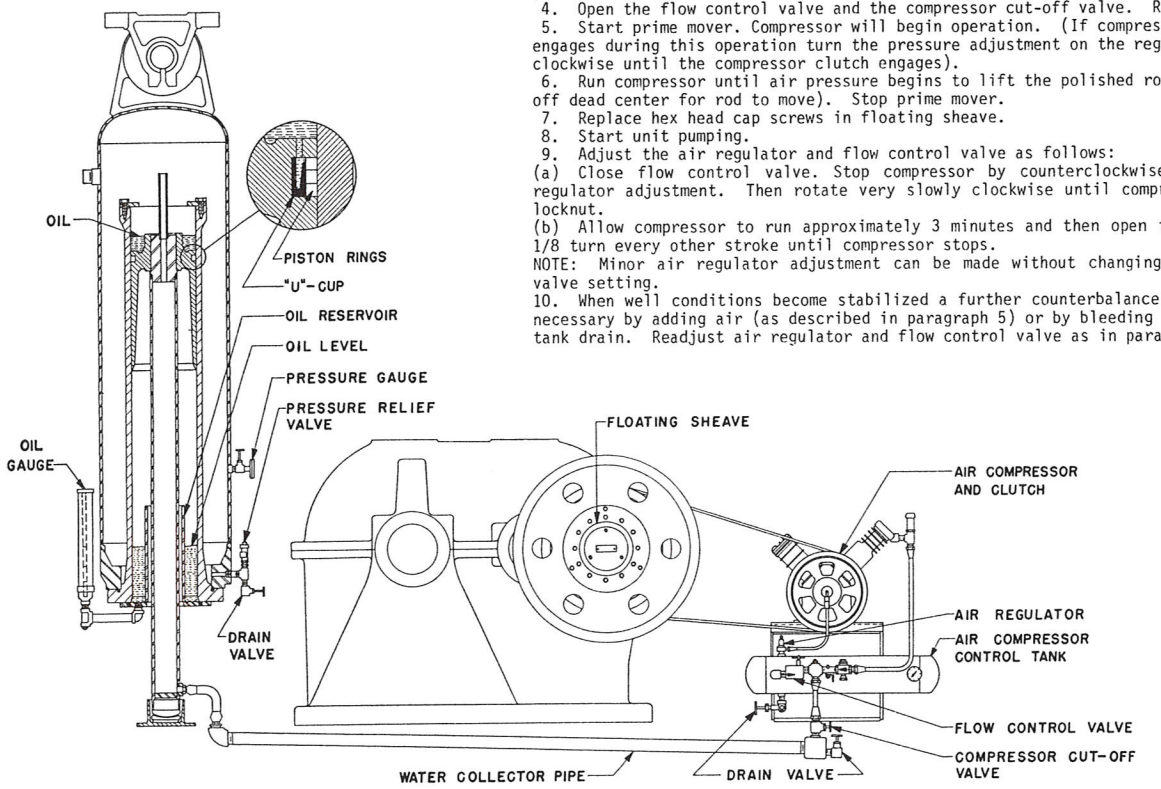
1. Make sure all bolts are thoroughly tightened - use hammer wrenches provided.
2. Follow all lubrication instructions on tags and name plates.
3. Remove the six hex head cap screws in floating sheave on the gear reducer; add grease as instructed on floating sheave lubrication tag.
4. Open the flow control valve and the compressor cut-off valve. Release unit brake.
5. Start prime mover. Compressor will begin operation. (If compressor clutch disengages during this operation turn the pressure adjustment on the regulator valve clockwise until the compressor clutch engages).
6. Run compressor until air pressure begins to lift the polished rod. (Cranks must be off dead center for rod to move). Stop prime mover.
7. Replace hex head cap screws in floating sheave.
8. Start unit pumping.
9. Adjust the air regulator and flow control valve as follows:

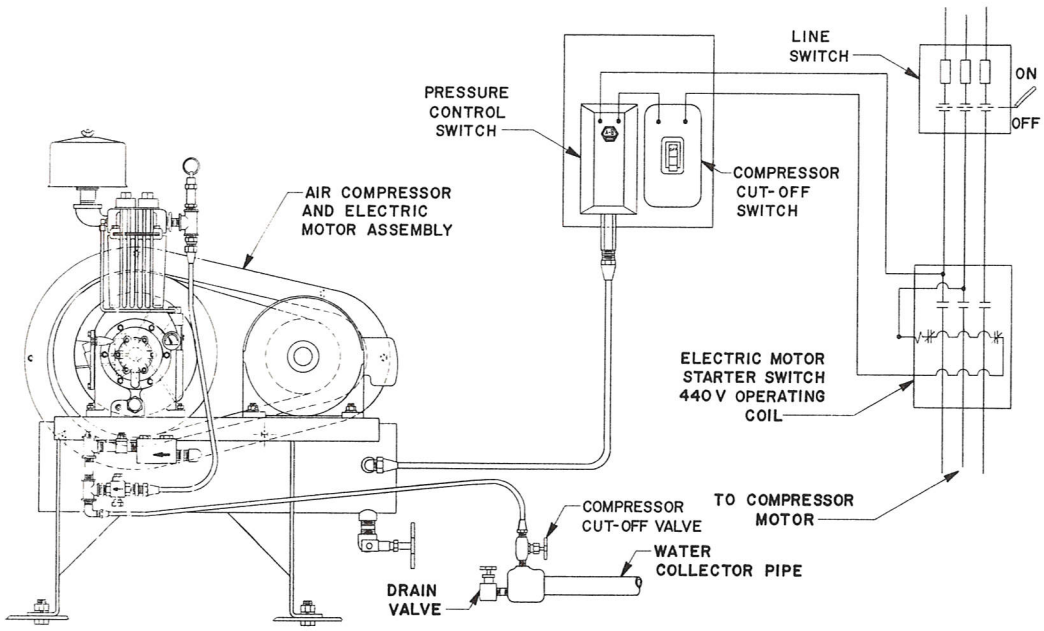
(a) Close flow control valve. Stop compressor by counterclockwise rotation of air regulator adjustment. Then rotate very slowly clockwise until compressor starts. Set locknut.

(b) Allow compressor to run approximately 3 minutes and then open flow control valve 1/8 turn every other stroke until compressor stops.

NOTE: Minor air regulator adjustment can be made without changing the flow control valve setting.

10. When well conditions become stabilized a further counterbalance adjustment may be necessary by adding air (as described in paragraph 5) or by bleeding off air at the air tank drain. Readjust air regulator and flow control valve as in paragraph 9.





XV. (Continued) STARTING PROCEDURE WITH ELECTRIC MOTOR DRIVEN COMPRESSOR

1. Make sure all bolts are thoroughly tightened -- use hammer wrenches provided.
2. Follow all lubrication instructions on tags and name plates.
3. Open the compressor cut-off valve and release unit brake.
4. Close line switch and start compressor motor by closing compressor safety switch located inside pressure switch box.
5. Increase the pressure switch cut-off setting until the air pressure begins to lift the polished rod. (Cranks must be off dead center for rods to move).
6. Start the pumping unit.
7. Set the differential pressure, beginning at near zero PSI, to a pressure just above the point where the compressor stops cutting in and out with each stroke of the unit. This differential pressure setting is usually 6 to 12 PSI. With the correct differential setting the compressor will run about 3 to 5 minutes before stopping.
8. Make a final counterbalance adjustment when well conditions become stable. Add air pressure by increasing the cut-out pressure setting. Lower air pressure by decreasing the cut-out pressure setting and bleeding off air at the water collector pipe drain valve. Readjust the differential pressure setting if necessary.

XV. (Continued) STARTING PROCEDURE WITH ELECTRIC MOTOR DRIVEN COMPRESSOR WITH MURPHY AIR CONTROL SYSTEM

1. Make sure all bolts are thoroughly tightened - use hammer wrenches provided.

2. Follow all lubrication instructions on tags and name plate.

3. Open the compressor cut off valve and pulsation dampener valve and release the unit brake.

4. Close the line switch and rotate the low pressure contact clockwise until it makes contact with the gage printer. Rotate the high pressure contact clockwise away from the gage pointer.

5. Allow the compressor to run until the air pressure begins to lift the rods. (Cranks must be off dead center for rods to move.) Move the high pressure contact so that it touches the pointer to stop the compressor.

6. Start the unit.

7. Add air to the system if required by starting the compressor or bleed air from the system through the water collector drain valve.

8. When desired counterbalance pressure is reached, rotate both contacts away from the pointer. Observe the amount the pointer swings with the pulsation dampener valve full open. Now close the valve slowly until the pointer swing is reduced to one half of full swing.

9. Move both contacts to just outside the swing of the pointer and adjustment is complete.

10. Make a final counterbalance adjustment when well conditions have stabilized. Add air by turning the left contact clockwise until it contacts the pointer to start the compressor. Decrease air pressure by opening the drain valve at the water collector pipe. Reset both contact just outside the swing of the pointer to complete the adjustment.