

PERMIAN

PUMPING UNITS

Beam Pumping Unit Installation, Operation and Maintenance Manual

C456D-305-144

Tim Snelson's Pumping Unit Service Inc

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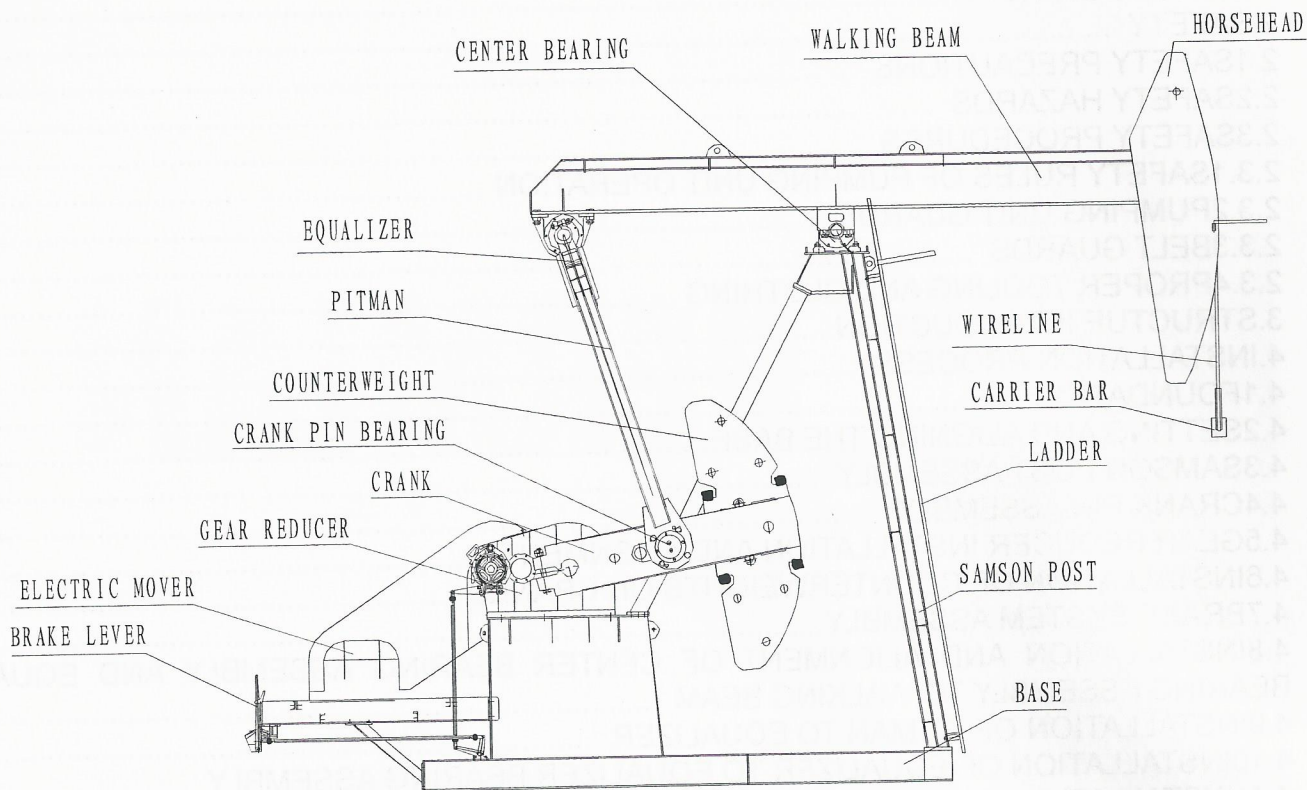
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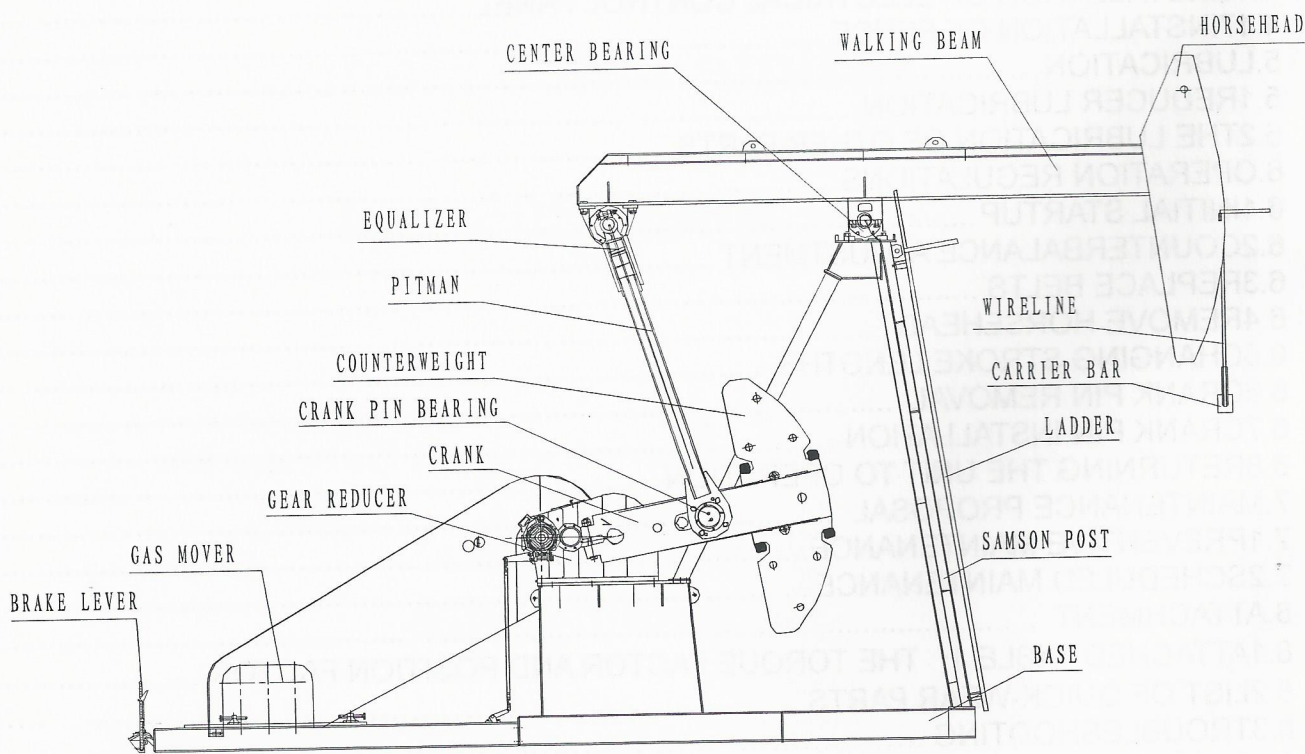
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Pumping Unit Terminology



PUMPING UNIT WITH ELECTRIC MOTOR



PUMPING UNIT WITH GAS MOTOR

1.Introduction

Permian Conventional Walking Beam Pumping Unit is conventional in name only. It is a symmetrical rear mounted geometry Class I Lever System possessing crank counterbalance, and is designed for operation in anticlockwise directional rotation of the cranks upon user requirements. All individual components of the unit and the unit as a whole represent the very best engineering design, manufacturing, quality control. Within applicable load and torque ratings combined with adequate maintenance, your Permian Pumping Unit will perform many years of dependable service. The Permian Pumping Unit has been designed to uncompromising standards and exceed API (American Petroleum Institute) standard requirements for beam pumping unit design.

2. Safety

2.1 Safety Precautions

Before proceeding with the erection, operation, or maintenance of a pumping unit, it is essential that compliance of all applicable federal, state, and local safety laws be strictly observed.

All mechanical sucker rod pumping units have large and heavy rotating parts; therefore it is imperative that all personnel involved in the erection, operation, and maintenance of pumping units use extreme care 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 may start moving from the effect of gravity. All personnel should stay clear of the cranks and counterweights or other elements which may start moving.

All electrical labor must be performed by a qualified electrician, especially on pumping units that utilize electric motors, automatic timers, or other related electrical devices. The electrical components should be regularly inspected and maintained in a safe operating condition by a qualified electrician,

2.2 Safety Hazards

Permian strongly discourages the installation or maintenance of pumping units during thunderstorms or other types of inclement weather.

Times of particular peril from rotating or moving parts occur during unit erection, stroke change, counterbalance changes, and while obtaining dynamometer cards. When it is necessary to perform maintenance or work around the unit, be certain that the prime mover can not be started and that the cranks are blocked to prevent rotation.

Be aware of all power line positions prior to beginning installation or maintenance on or around the pumping unit. Your operation must be organized to avoid all contact with power lines. Failure to heed this warning could result in severe bodily injury or death to personnel.

**STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE
RAISE POSITION DO NOT RELY ON THE BRAKE!**

2.3 Safety Procedures

It is essential to prevent any rotation of the cranks for the purpose of service or maintenance of any kind. Never enter the crank sweep area for maintenance.

2.3.1 Safety Rules of Pumping Unit Operation

To ensure the pumping units normal running and personal safety, the users must obey the following rules:

- a. The pumping units near the city, village and the pasture must install the defending fence:
 - b. Lubrication, inspection or adjusting the transmitting belts are strictly forbidden when the pumping units are still running or not completely stop:
 - c. The user must shutdown the power before braking the pumping units. After the power is shutdown, the crank can still slowly run. Before the cranks completely stop, the user can brake it to the position he needs. Don't quick-brake the pumping units;
 - d. For safety, the user must reliably brake the units or fasten the cranks to safe position before checking the pumping units or repairing the well:
 - e. The user must loosen the brake system before starting the motor:
 - f. When separating the carrier bar and polished rod, the user should fasten the polished rod on the well mouth with the clamp and suspend the carrier bar on the Horsehead;
 - g. The user must equip fire extinguisher when maintenance;
 - h. Don't change the device without our permission;
 - i. Make sure that foundation meets the technical requirements;
 - j. The users should install, use and maintain the pumping units according to the maintenance manual.
-

2.3.2 Pumping Unit Guards

Never operate your pumping unit without the appropriate guards in position. The purpose of guarding is to provide a safety fence between the moving components of the

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pumping unit and the personnel that are familiar with the operation of the unit. When pumping units are operated within the domain of the general public it is imperative to place the pumping unit with guards in a totally enclosed area with locked access, thus preventing entry from unauthorized personnel. Failure to comply with this warning may result in severe injury or death to personnel. Various federal, state, and local agencies may require specific models of guarding, consequently the user is wholly responsible for the choosing of the precise guarding required. It is essential that all personnel comply with the respective federal, state, and local safety laws when operating their pumping units. Additional information on guarding your pumping unit may be found in API specification RP11ER.

2.3.3 Belt Guards

Belt guards are furnished as standard equipment with each Permian pumping unit unless specifically ordered without one. They are designed to protect the user from exposed sheaves and belts.

2.3.4 Proper Tooling and Clothing

Always use the proper tools in the manner they were intended to be utilized for your job. When working in elevated areas, a safety belt or man basket is recommended to further reduce the possibility of accidents caused by falls.

The preferred clothing when working in or around pumping units is hard hat, safety glasses, safety shoes, and close fitting clothing without jewelry.

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3. Structure

3.1 Pumping Units:

The structure of C456D-305-144 Conventional Pumping Units is shown in Fig.1. The power is transmitted through C-belt from motor pulley to drive shaft of double-reduction reducer, and then outputs from crank shaft to drive crank, pitman, walking beam and horsehead, finally, it makes carrier bar move up and down. Then the crude oil will be successfully pumped to the surface from the oil reservoir.

The whole pumping units consists of carrier bar assembly, horsehead assembly, walking beam assembly, center bearing assembly, equalizer assembly, pitman assembly, crank assembly, reducer assembly, base assembly, Sampson post assembly, brake assembly, electric motor or gas motor assembly, lubrication pipeline and so on.

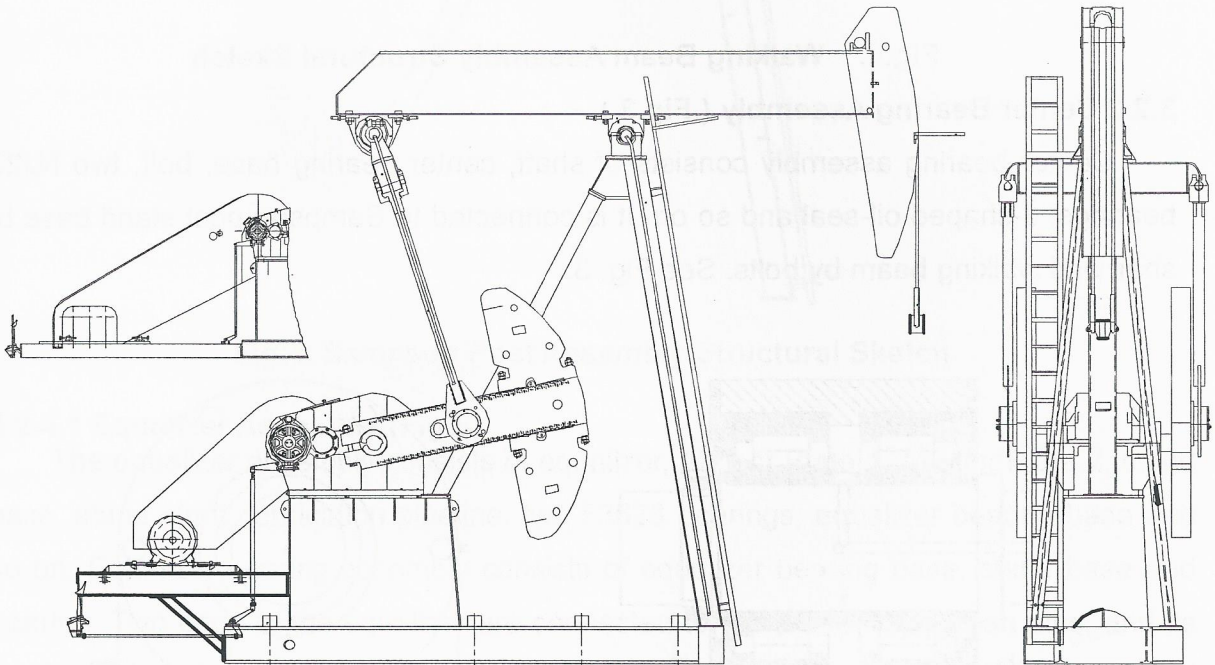


Fig.1: Pumping Units Structural Sketch

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3.2 Components List of Pumping Units

3.2.1 Walking Beam Assembly (Fig.2)

Walking beam assembly is welded with steel-plate. The front of walking beam is connected to horsehead, the rear to equalizer bearing base and the center is connected to Sampson post by the center bearing base. Four adjusting bolts are used for micro adjusting the walking beam back and forth to make sure the polished rod center aligns accurately the wellhead center, which can avoid abrasion of polished rod and other destroy because of horsehead eccentricity.

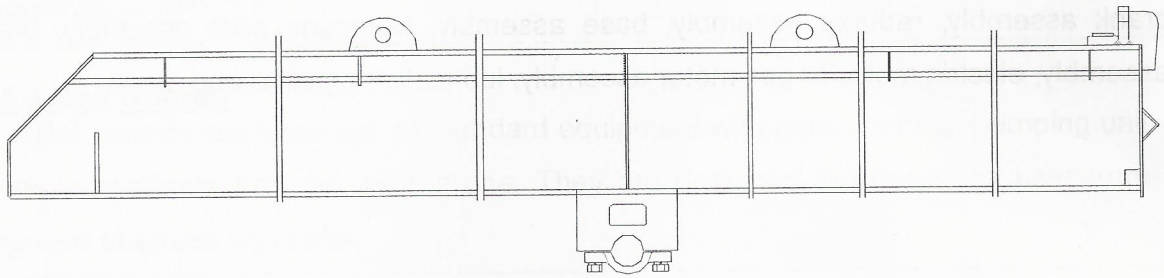


Fig.2: Walking Beam Assembly Structural Sketch

3.2.2 Center Bearing Assembly (Fig.3)

Center bearing assembly consists of shaft, center bearing base, bolt, two NJ2332 bearings, J-shaped oil-seal and so on. It is connected to Sampson post stand base by a shaft and walking beam by bolts. See Fig. 3:

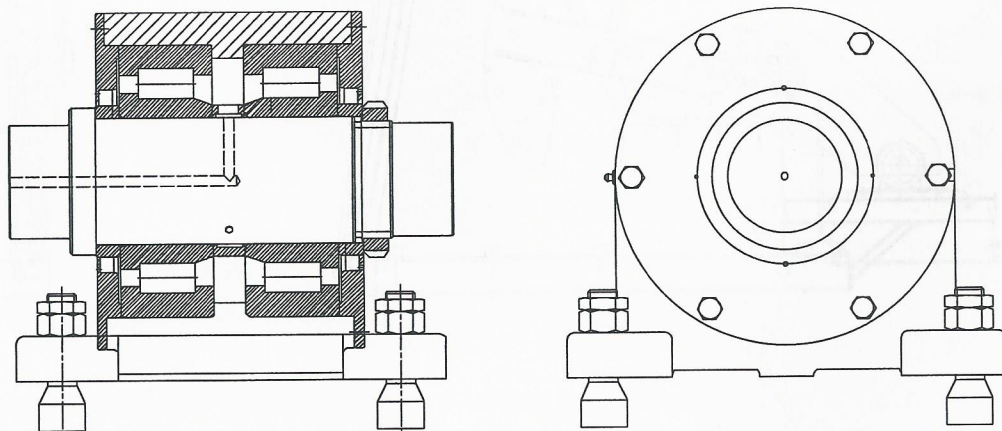


Fig.3: Center Bearing Assembly Structural Sketch

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3.2.3 Sampson Post Assembly (Fig.4)

Sampson post assembly consists of front leg, rear leg, ladder and stand base and so on. The tower-shaped Sampson post, made of shape-steel, is equipped with a ladder on the front leg for installation and maintenance, and its top is connected to the walking beam by the stand base and the center bearing assembly, and its bottom to the base of pumping units with the bolts.

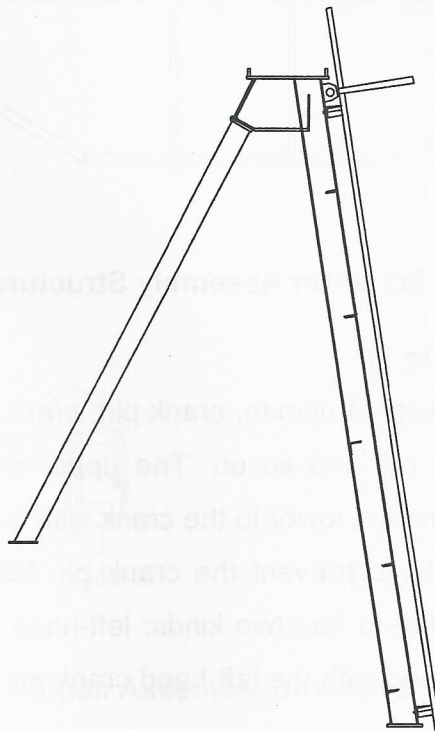


Fig.4: Sampson Post Assembly Structural Sketch

3.2.4.1 Equalizer Assembly (Fig.5)

The equalizer assembly consists of equalizer, Anchor Plate 1, Anchor Plate 2, stand base, stand shaft, lubrication pipeline, two 53628 bearings, equalizer bearing base and so on. Equalizer bearing assembly consists of equalizer bearing base, stand base and bearing. Two ends of the equalizer are connected to two pitmen by pitman pins, and its top to walking beam by the equalizer bearing base and bolts. As two tiers centripetal roller bearing are installed in the equalizer bearing base, which can micro compensate the error of manufacturing and installation. In addition we can micro adjust the position of equalizer bearing base to ensure that pumping units can work normally. See Fig 5:

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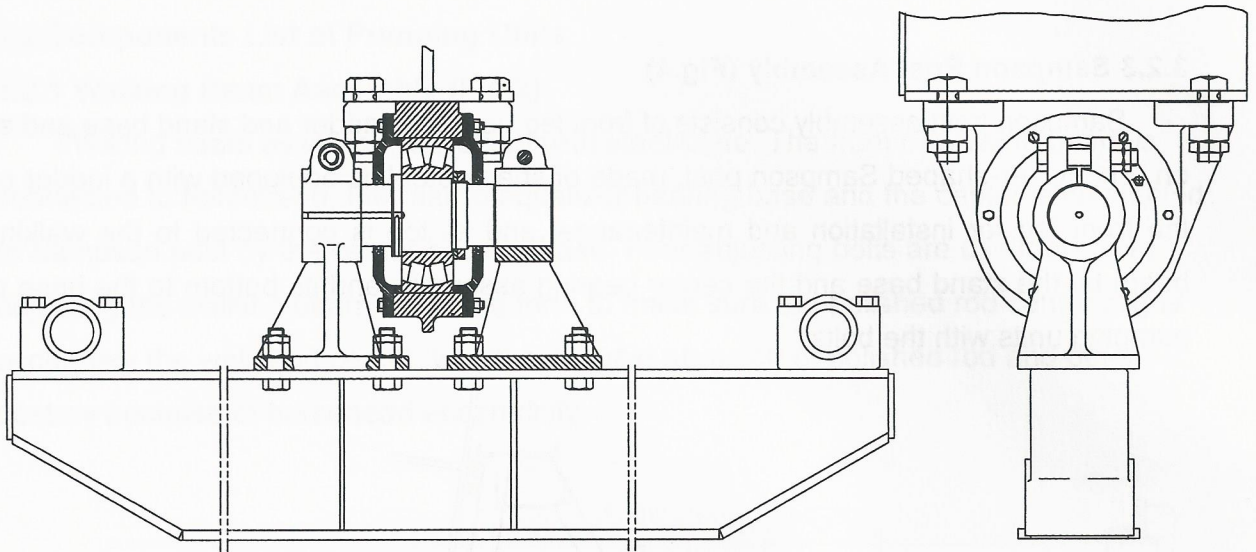


Fig.5: Equalizer Assembly Structural Sketch

3.2.4 Pitman Assembly (Fig.7)

Pitman assembly consists of pitman, crank pin, crank pin bearing base, taper bush, bearing, left & right crank pin and so on. The upper end of pitman is connected to equalizer with pitman pin and the lower to the crank with crank pins. The big end of crank pin is milled to be quadrate to prevent the crank pin from rotating and the nuts from loosening. The crank pin thread has two kinds: left-hand thread and right-hand thread, which is respectively equipped with the left-hand crank pin and right-hand crank pin. See Fig.7:

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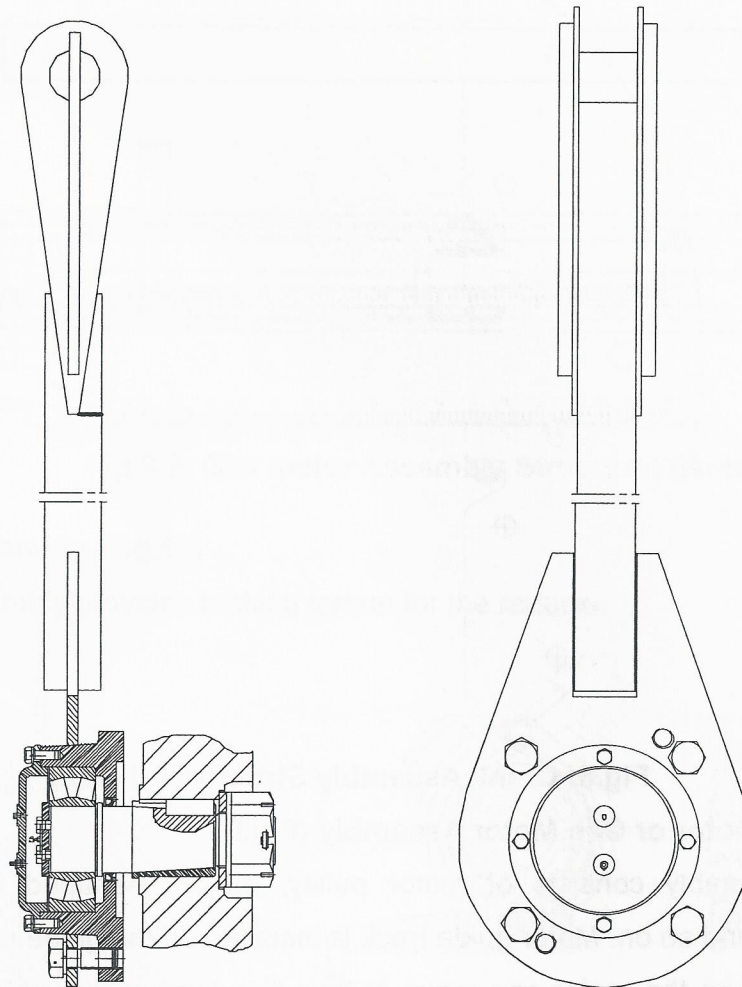


Fig.7: Pitman Assembly Structural Sketch

3.2.6 Crank Assembly (Fig.8)

Crank assembly is composed of crank, counterweight and locking block and so on, which is used for balancing the torque caused by polished rod load. Two cranks are symmetrically connected to the output shaft of reducer with wedge keys and fastening bolts to transmit the torque. There are three holes in the crank that are used to adjust the stroke length of pumping units, which can adapt to different well status.

The crank has guide groove on its top and bottom and the calibration on the crank is to correctly adjust the barycenter position of counterweight. The counterweights are fixed on the crank with locking block and fastening bolts.

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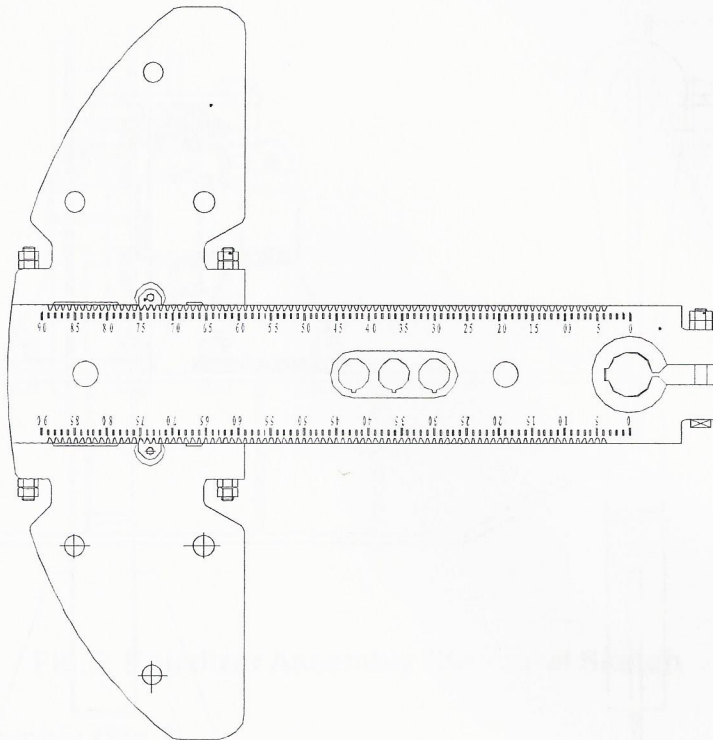


Fig.8: Crank Assembly Structural Sketch

3.2.7 Electric Motor or Gas Motor Assembly (Fig.9)

Motor Assembly consists of motor pulley, motor, T-shaped bolts, guide track, adjusting bolts and so on. Motor guide track is installed on the guide rail of pumping units base, making sure the motor can move in four directions to adjust its position and the strain stress of V-belt. The pulley is connected to the motor with the taper bush, which can make the different diameter pulleys be easily exchanged to get different stroke frequency. See Fig. 9.1, Fig. 9.2.

Gas motor assembly consists of gas motor, guide track, adjusting bolts,fastening base and so on.

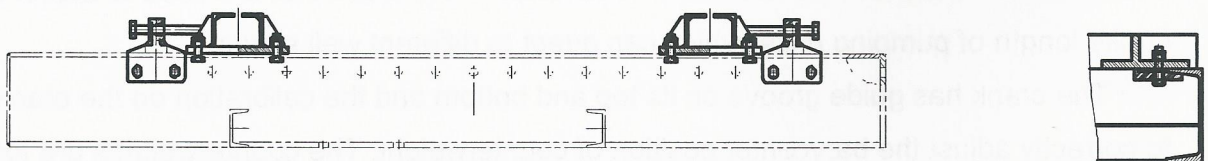


Fig.9.1: Electric motor Assembly Structural Sketch

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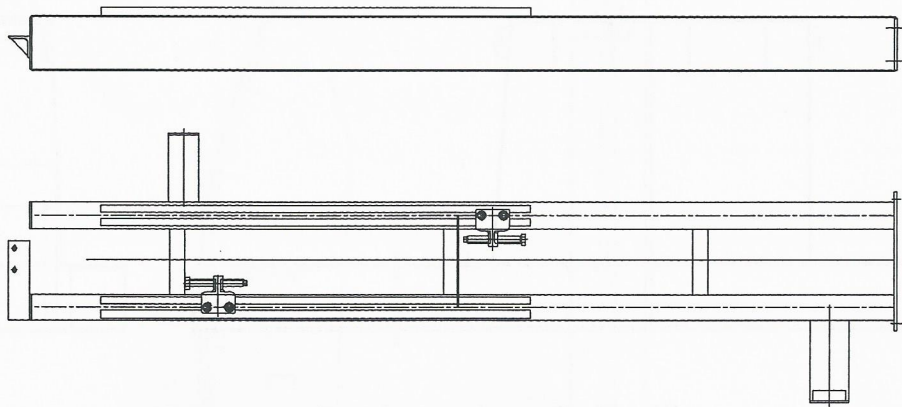


Fig.9.2: Gas motor Assembly Structural Sketch

3.2.8 Brake Assembly (Fig.10)

Brake assembly provides braking torque for the reducer.

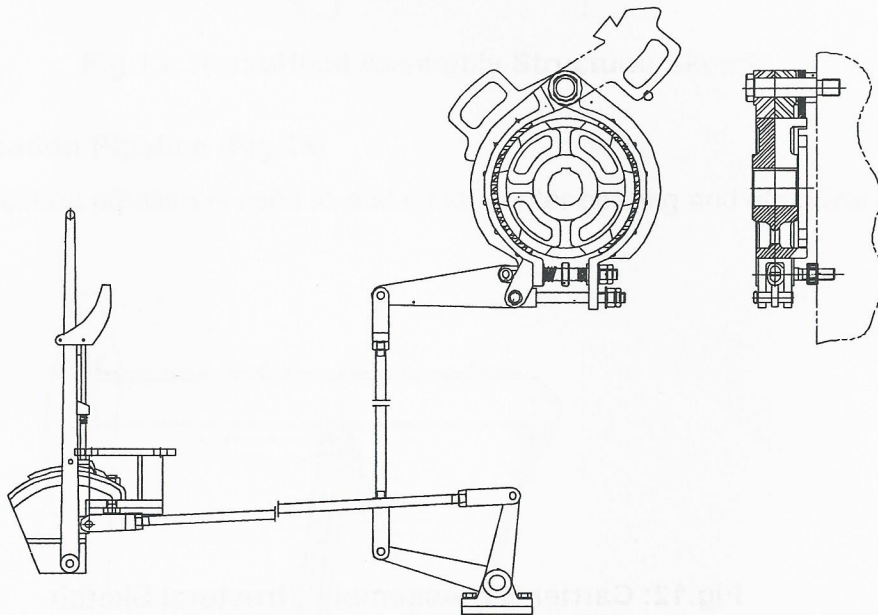


Fig.10: Brake Assembly Structural Sketch

3.2.9 Base Assembly (Fig.11)

Base assembly is welded with shape steel and steel plate. The front is used for installing Sampson post, reducer support in the center for installing the reducer and the rear for installing motor device and brake device. There is a mark of walking beam centerline vertical projection on the front end surface of base, which is used to redress base to oil well centerline and redress Sampson post and walking beam to base.

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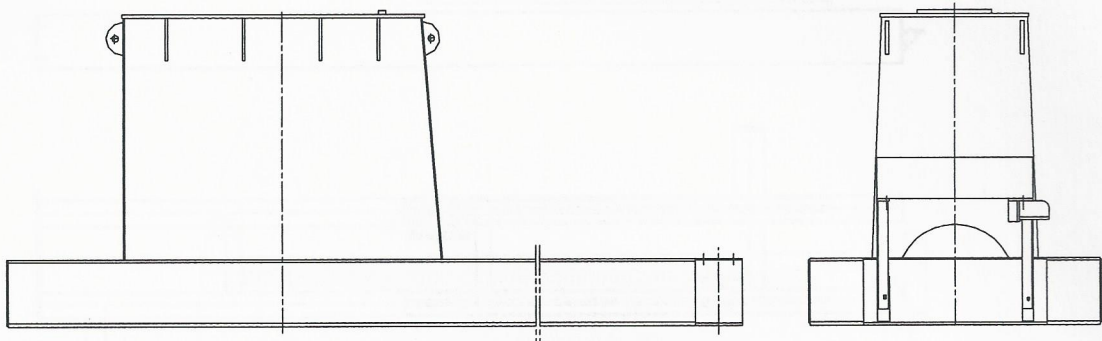


Fig.11: Base Assembly Structural Sketch

3.2.10 Carrier Bar Assembly (Fig.12)

Carrier bar assembly is the connecting part of horsehead and polished rod, which is mainly composed of ox noddle body, Slip Block, Keep off Block and so on.

Fig.12: Carrier Bar Assembly Structural Sketch

3.2.11 Horsehead Assembly (Fig.13)

Horsehead is welded with steel plate. When workovering the oil well, the users should firstly draw out the safety bar, screw off the adjusting bolts, then it can be lifted to an safety place away from the well, which make it easy to workover the oil well.

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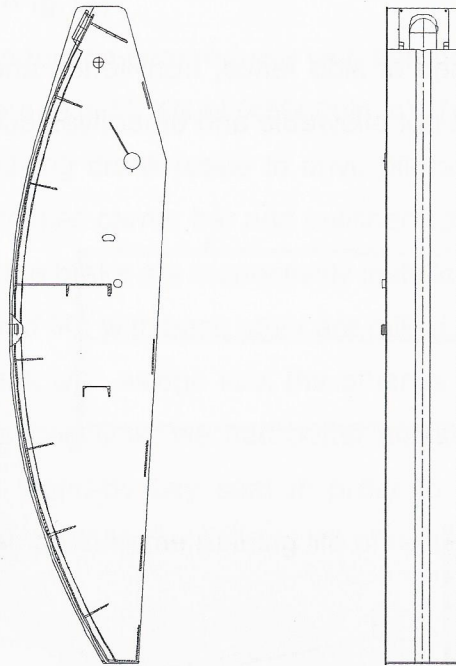


Fig.13: HorseHead Assembly Structural Sketch

3.2.12 Lubrication Pipeline (Fig.14)

The lubrication pipeline is used to add oil for center bearing and equalizer bearing on the ground.

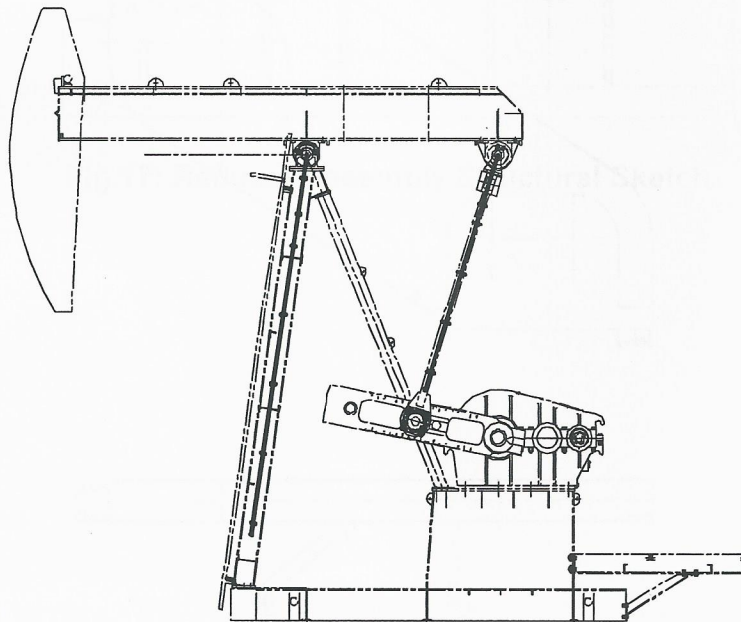


Fig.14: Lubrication Pipeline Structural Sketch

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3.2.13 Fence (Fig.15)

The fence is composed of side fence, front fence and rear fence etc.. It is used to prevent the person who is not allowable and other livestock from contacting the pumping unit.

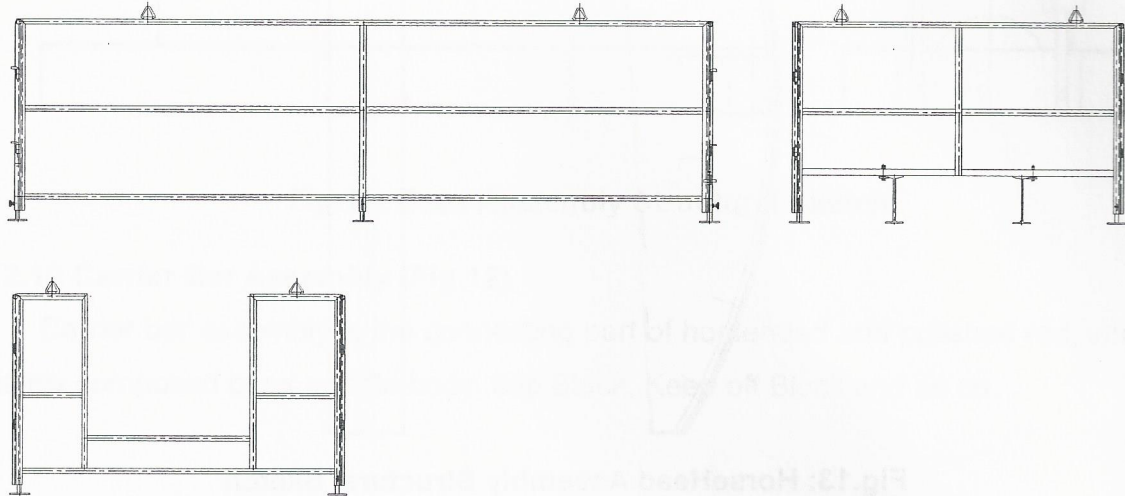


Fig.15: Fence Structural Sketch

3.2.14 Belt Cover (Fig.16)

Belt guards are designed to protect the user from exposed sheaves and belts.

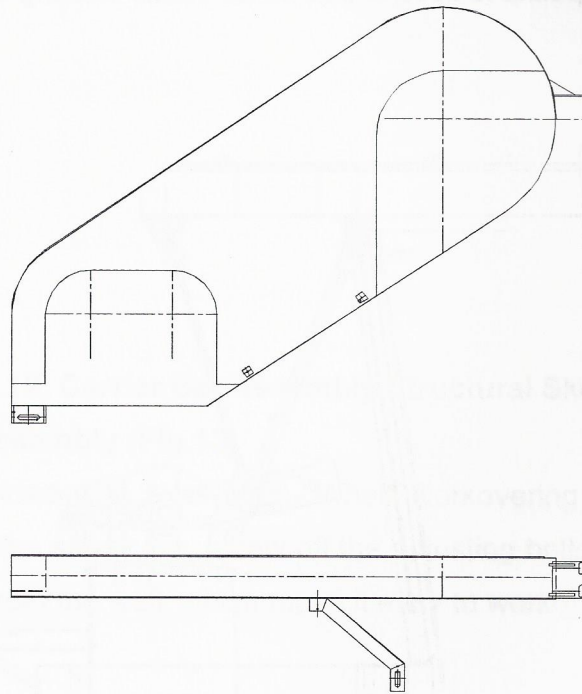


Fig.16: Belt Cover Structural Sketch

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3.2.15 Reducer Assembly (Fig.17)

The reducer is double reduction gear reducer with herringbone gears (double helical gear), and its rated output torque is 53 KN.M (456000lb.in). The reducer is directly driven by the motor with V-belt, making crank rotate to drive pitman, equalizer, walking beam and horsehead, and then it makes carrier bar and polished rod move up and down.

The bigger sheave and the brake are respectively installed on the two ends of driving shaft. Two key seats angulated 90° with each other are milled on two ends of driven shaft, one is connected to the crank with wedge key, the other is used to stand-by. After the pumping units working for a long time, we had better disassemble the crank and then install it to match with the stand-by key seat in order to put the max. load on the less-wearing tooth, which can prolong the running life of reducer gears. See Fig.14

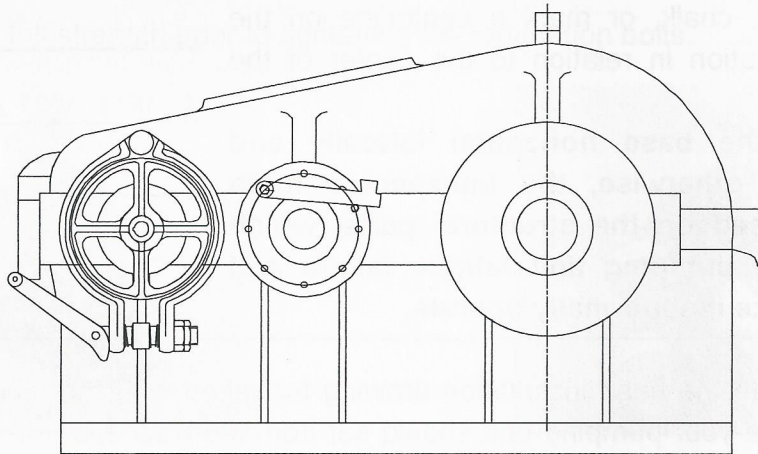


Fig.17: Reducer Assembly Structural Sketch

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4.INSTALLATION PROCESS

4.1 FOUNDATION

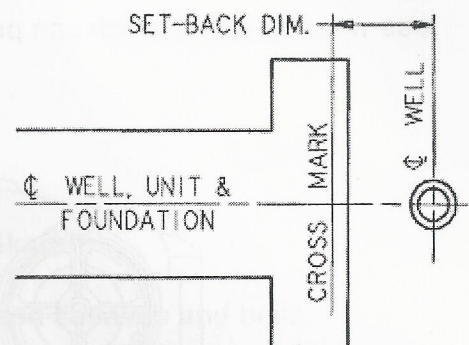
The foundation should be positioned in accordance with a foundation plan only. A copy of this plan is shipped with the unit. This foundation plan shows the hold down bolt location in relation to the well head, bolt and anchor nut sizes and number. No attempt is made on the foundation plan to prescribe the shape, depth nor characteristics of the foundation. The contractor must supply this information based on their knowledge of and experience with the soil conditions as they exist at the well site and assume full responsibility for the quality of the foundation. Foundation tie down bolts must be hammered tight after concrete has set up and pumping unit base alignment is complete.

4.2 SETTING AND ALIGNING THE BASE

Review the safety section of this manual prior to beginning erection of the pumping unit.

Step 1: Scribe, chalk, or mark a centerline on the preferred foundation in relation to the center of the wellhead.

Note: make the base horizontal laterally and longitudinally, otherwise, the unexpected force will be produced on the structural parts, which may make the pumping unit fatigue failure and eventually make it abnormally operate.



Step 2: Refer to the base installation drawing furnished with the unit to determine the specific distance your pumping unit should set from the wellhead. Measure the distance from the wellhead and mark a line that intersects with the centerline.

Step 3: Lift the main pumping unit structure into position over the foundation. Position the front edge of the base on the intersecting line made in Step 2. Be certain to align the center marks on the front and rear of the base with the centerline on the foundation.

CAUTION: Always stay clear of the base to avoid serious injury or death in the event that the load shifts or drops. When working on the gearbox, do not rely on the brakes, stay clear of the crank at all times.



STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE RAISE POSITION DO NOT RELY ON THE BRAKE!

Step 4: Measure the distance from the wellhead to each corner of the front cross member. The distance must be equal. If they are not equal, reposition the unit until the two distances are equivalent. Re-examine the distance from the center of the wellhead to the centerline on the front cross member to insure it has remained unchanged.



Step 5: Place a level on the base beams to determine if the pumping unit is setting level. Level the unit as the foundation requires. Tighten the base tie down bolts, as required for your specific base arrangement. If utilizing anchor bolts or grout-, allow a sufficient period of time to attain full strength prior to tightening the foundation bolts.



4.3 SAMSON POST ASSEMBLY

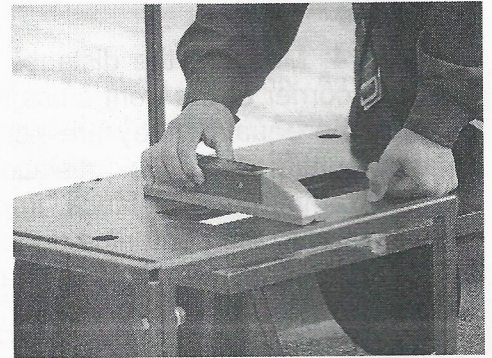
Caution: when assemble the Sampson post, the persons are forbidden under any load

Step 1: clean the contacting surface of connecting plate between the front leg and rear leg. Put the front leg on the ground. Hoist the rear leg with crane and align the bolt holes of connecting plate and tighten the bolts. Thread the lifting chain or cable between the support beams and around the top bracket to make the Sampson post vertical, which can install it on the base conveniently.



STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE RAISE POSITION DO NOT RELY ON THE BRAKE!

Step 2: Connect the front and rear leg to the base, insert the bolts from the lower direction, and can make it conveniently tighten the bolts. After checking its horizontality, the users should securely tighten all the bolts.



Step 3: Hoist the ladder of Sampson post and assemble it on the base with the bolts, and the bottom of ladder should be on the top of base. Position the ladder safety ring on the outside of the ladder rails at the top of the ladder and bolt securely, and its purpose is to supply a standing surface to the operators working around the center bearing.

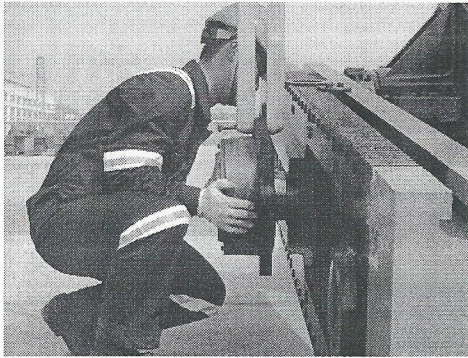
4.4 CRANK PIN ASSEMBLY

Step 1: Coat some certain lubricating grease on the crank pin hole, put the taper bush into the crank hole, and make its open align with the key seat of crank by hammering with the copper bar.



Step 2: Put the crank pin assembly with the key into the taper bush, and then put the flat washer from the tread end of crank pin, mount the pin nut and tight it with hammer, then mount the crank pin pressing plate and tighten it with bolts. Finally add some lubricating grease to the crank pin bearing with the grease gun.

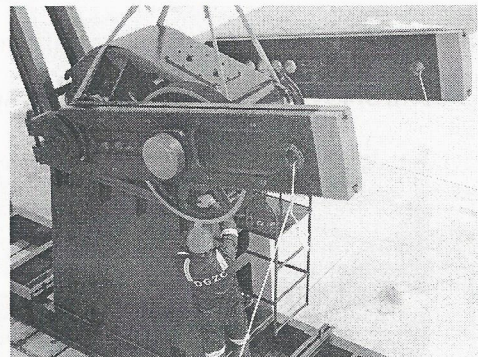
STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE RAISE POSITION DO NOT RELY ON THE BRAKE!



4.5 GEAR REDUCER INSTALLATION AND ALIGNMENT

DANGER: The reducer with cranks is an assembly that comprises heavy rotating components. All personnel must exercise extreme caution when lifting this assembly to insure that the cranks are locked to prevent rotation.

Step 1: To install the reducer on its sub-base, attach slings or chains to the reducer and both cranks for proper stabilization. Never allow the slings or chains to bear against the slow speed shaft oil seals or damage will result. Mark the centerline on top of the sub-base and bottom of gear reducer and utilize this line for initial alignment. Place the reducer on the sub-base and install the bolts, leave the bolts loose for alignment shifting.



Notice: adding the lubricating oil before assembling the gear reducer.

Step 2: Measure the distance from each end of the crank shaft to the alignment mark. Tighten all bolting on gear reducer and bolting on sub-base.

4.6 INSTALLATION OF COUNTERWEIGHTS ON CRANKS

Step 1: Firstly make the crank stay vertically and set the brake, and clean the contacting surface between the crank and counterweights.

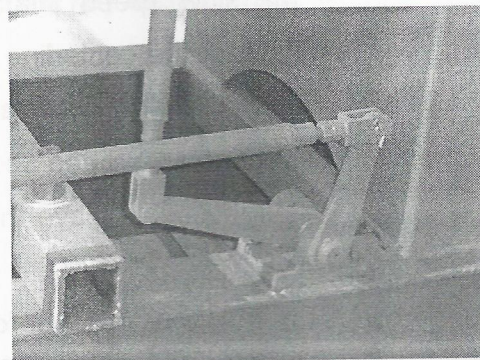
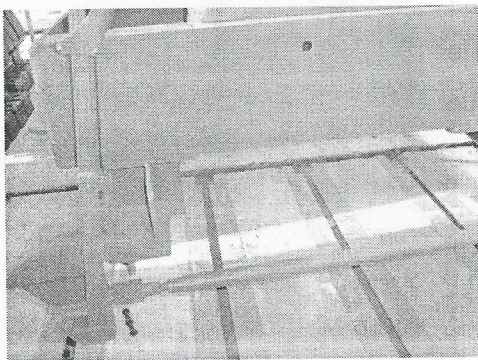
STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE RAISE POSITION DO NOT RELY ON THE BRAKE!

Step 2: Install the "T" bolts in the slot of the crank. Hoist the counterweights with the crane to make its contacting surface nearly vertical, and then slowly remove the counterweights and set it on the bolts. Install a flat washer, a standard nut and jam nut on each of the counterweight bolts and tighten securely. Repeat the installation procedure for each of the counterweights to be installed.



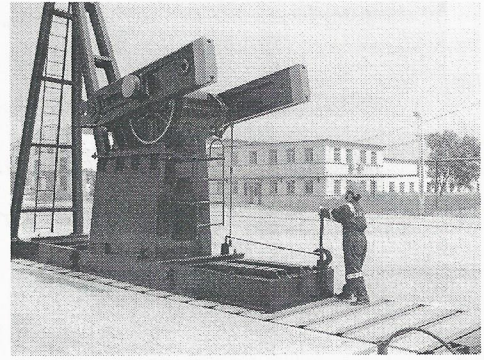
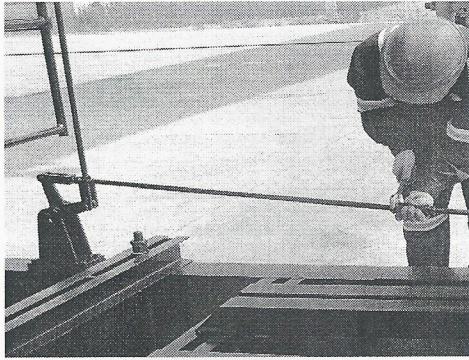
4.7BRAKE SYSTEM ASSEMBLY

Step 1: install the control level frame and stand base on the base with bolts. Connect one end of connecting yoke to the reducer cam with pin shaft and cotter pin, and connect the other end to the stand base. And then connect one end of horizontal drawbar yoke to the stand base with the pin shaft and cotter pin, and connect the other yoke to the brake control level of control level frame.



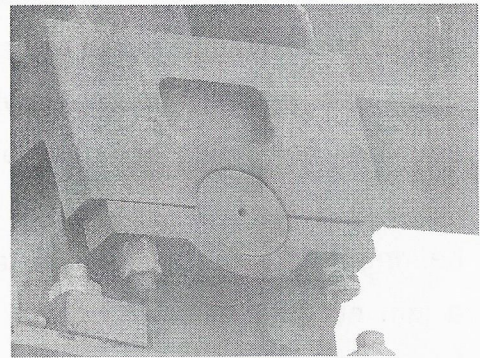
Step 2: Check whether the brake length is suitable. We can get the suitable brake length by adjusting the adjusting nuts of vertical and horizontal drawbar to change the drawbar length. And then tighten the locking nuts. Hoist the crank and take off the secure pawl from the groove of brake drum. And make the crank stay at vertical position by slowly loosening the brake, and finally set the brake.

STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE RAISE POSITION DO NOT RELY ON THE BRAKE!



4.8 INSTALLATION AND ALIGNMENT OF CENTER BEARING ASSEMBLY AND EQUALIZER BEARING ASSEMBLY TO WALKING BEAM

Step 1: Put the center bearing on the ground and make the contacting surface is down and level. Clean the surfaces between shaft and walking beam support base hole. Be sure these contacting surfaces are metal-to-metal. Position the beam over the center bearing, align the bolts holes and install the bolts and snug tighten.



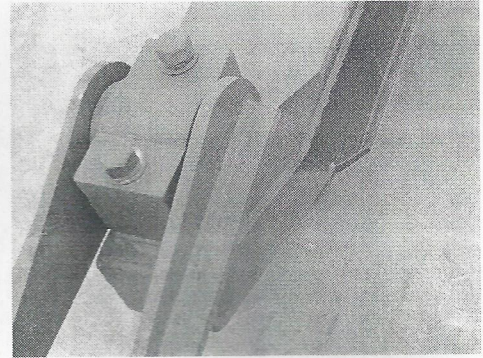
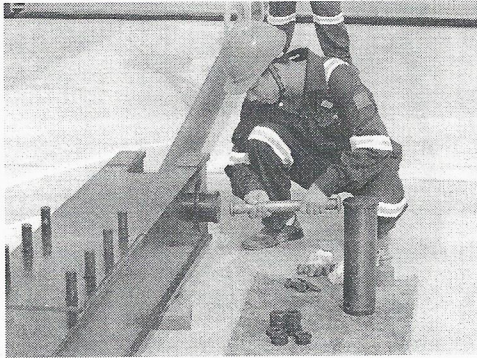
Step 2: Put two cuneal wood on two sides of equalizer bearing and make the contacting surface is up and level. Put the stand base on the ground. Lift walking beam and position on equalizer bearing, align the bolts holes, and install the bolts and tighten. Add the lubricating grease to the center bearing and equalizer bearing with grease gun.



4.9 INSTALLATION OF PITMAN TO EQUALIZER

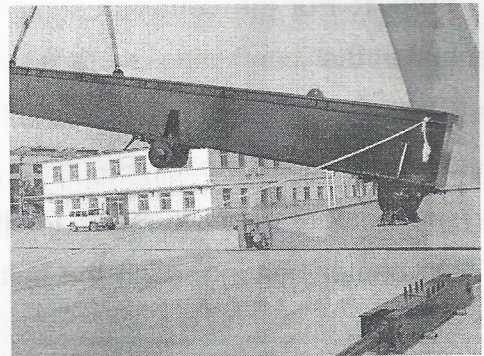
Hoist the equalizer , put the equalizer on the ground and let the pitman connecting base on the top. Coat the lubricating grease on the pitman connecting base hole. Hoist the pitman and align the pitman shaft with the pitman connecting base hole. Install the pitman connecting base cover, install and tighten bolts.

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4.10 INSTALLATION OF EQUALIZER TO EQUALIZER BEARING ASSEMBLY

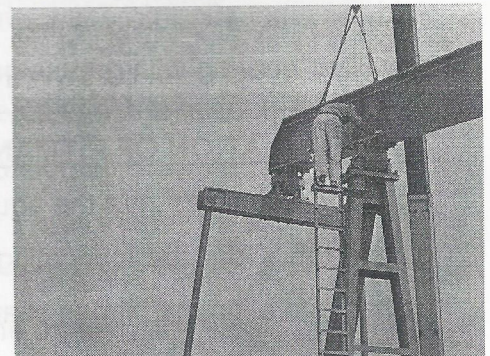
Lift the walking beam with equalizer bearing at a proper HEIGHT and move near the equalizer. Put down the walking beam slowly and align the equalizer bolt holes of equalizer bearing. So the equalizer bolts can traverse the holes of equalizer bearing. Tighten all bolts and install a second nut as a jam nut and hammer tighten. And connect the lubricating pipeline of the pitman to the adding-oil hole of equalizer bearing base.



4.11 INSTALLATION OF WALKING BEAM TO SAMPSON POST

Step 1: Disassemble the pressing block on the stand base of walking beam.

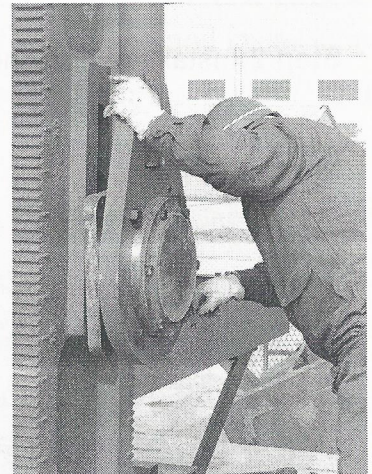
Step 2: Lift the walking beam over the Sampson post and make the shaft of center bearing align with the shaft holes of stand base. Put down the walking beam slowly and position the shaft into the shaft holes. Reinstall the pressing block and snug tighten the bolts. The bolts will be tightened later after pitman alignment is checked.



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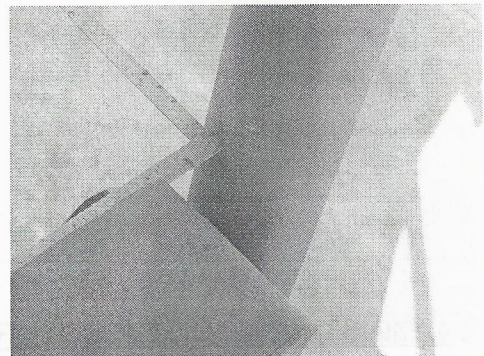
Step 3: Slowly hoist the walking beam rear part with the crane until the pitman lower connections are aligned with the bearing base of crank pins. Lead the pitman with the rope, which can prevent them from colliding with the crank pin or other parts. Clean the contacting surface. The pitman big ends should fit easily on the bearing base of crank pin.

Failure to properly align the pitman to the crankshaft may cause undue stresses on the structural components, which will shorten the life of pumping unit.



CAUTION: Do not hammer the pitman lower connection onto the crank pin bearing base, which could result in damaging to the crank pin.

Step 4: Using a tape, carefully measure the distance between the end of the crank shaft and the nearest part of the pitman on both sides of the reducer. The two distances should be approximately same. In the event the two distances are not same, rotate the walking beam by adjusting the adjusting bolts on the walking beam.

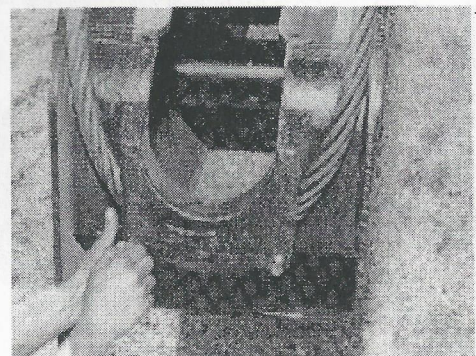


Hammer tighten the center bearing to the walking beam bolts.

Connect the lubricating pipeline of Sampson post to the filling-oil hole of center bearing base.

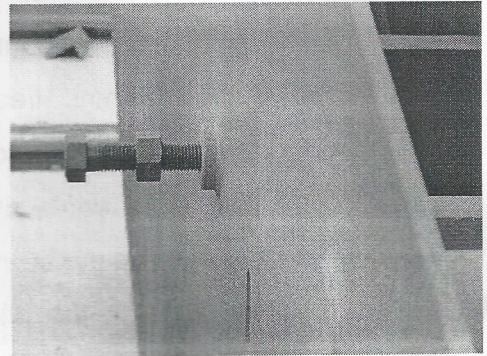
4.12INSTALLATION OF HORSEHEAD TO WALKING BEAM

Step 1: Put the wireline on the groove of horsehead and install the secure bolts. And connect the carrier bar to the wireline.



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Step 2: Install the horsehead adjusting bolts.

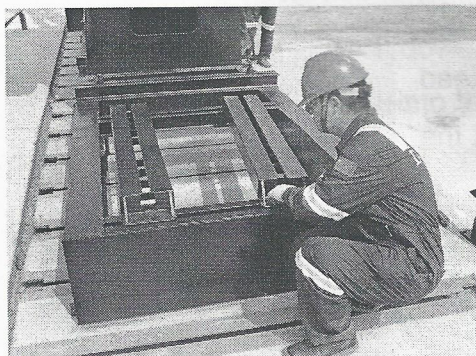


Step 3: Lift the horsehead into position and place the roll bar behind the flange on the walking beam. Install the safety flag through the horsehead and angle slot on the walking beam and tighten adjusting bolts. Install the safety bar.



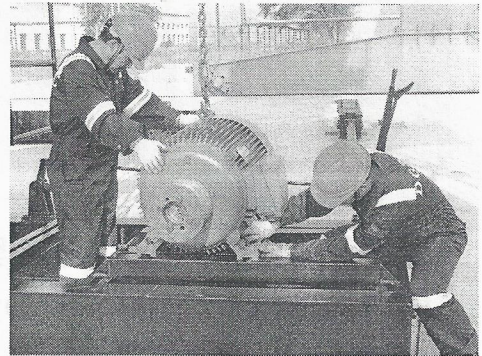
4.13 INSTALLATION OF MOTOR AND C-BELT

Step 1: Fasten the guide track of motor on the base with T-bolts and snug tighten the bolts. And install the key on the key-seat of motor shaft. Assemble the motor taper bush on the motor shaft by hammering with copper bar, and then install the motor pulley on the motor taper bush, finally tighten the fixing bolts.

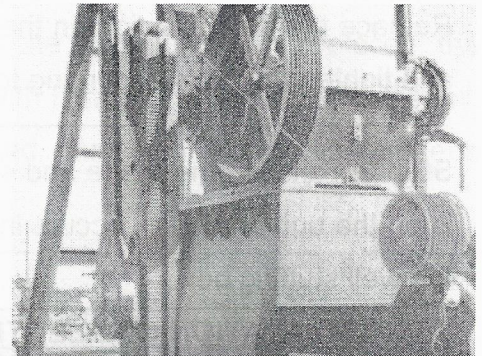


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Step 2: Put the C-belt on the reducer sheave. Hoist the motor with crane and install it on the guide track with T-bolts. And the T-bolts should be inserted from the bottom, and finally snug tighten them.

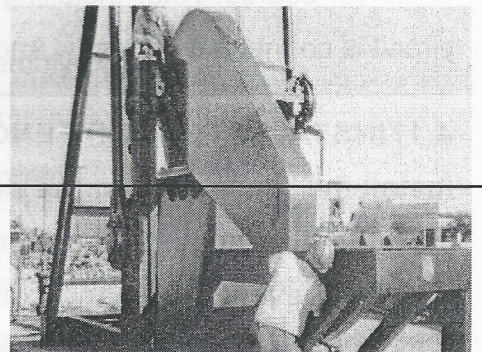


Step 3: Make sure the motor pulley and the reducer sheave on the same horizontal plane by checking with a string. And tighten the connecting bolts of motor guide track and base. The tensile stress of motor pulley can be suitably adjusted by adjusting the motor jackscrew. The tensile stress of all the new C-belts should be rechecked after operating 24hours.



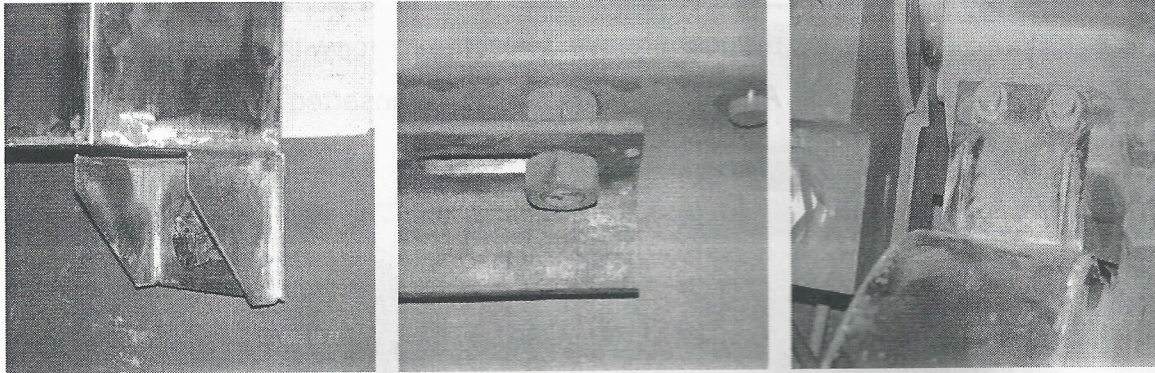
4.14INSTALLATION OF BELT GUARD

Step 1: Raise the belt guard and position it over the sheaves.



Step 2: Insert the bolt in the slotted bracket at the gear reducer. Position the upright support and install the bolt. Adjust the clearance between the belt guard and sheaves by raising the belt guard and tightening the bolts in the slotted brackets. Make certain that there is adequate clearance between the belt guard and the rotating cranks and then securely tighten the bolts.

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4.15 INSTALLATION OF CARRIER BAR TO WELLHEAD

Step 1: Hold the carrier bar away from the polished rod with a rope or chain. From above the horsehead, slowly lift the polished rod with a crane the stroke length. Remove the gate from the carrier bar and position the slot in the carrier bar around the polished rod. Replace the gate and tighten the bolts. Install the polished rod clamp over the carrier bar and tighten the bolts according to the clamp manufacturer's torque recommendations.

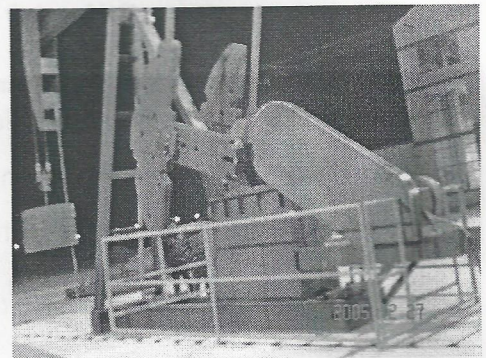
Step 2: Release the brake and slowly let the load down with the crane until the well load is on the unit and slack occurs in the chains. Reset the brake. Remove the rod clamp on the well stuffing box.

4.16 INSTALLATION OF ELECTRICAL CONTROL PANEL

Install the electrical control panel on the suitable position, and connect it to the motor and electrical source. After installing, the users should carefully check and make sure the circuit is connected correctly. And the electrical control panel should be earthed.

4.17 INSTALLATION OF FENCE

Install the fence around the pumping unit. Be care the distances from the crank and counterweight, prevent crank and counterweight from hitting the fence, fasten the fence.

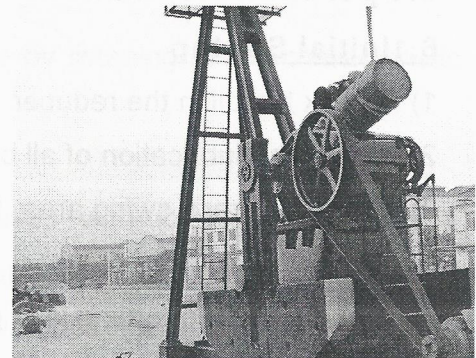


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5.Lubrication

5.1 Reducer Lubrication

Remove the inspection cover from the gear reducer housing and fill with oil until the oil level is even with the top drain plug. Replace the cover, insuring that the gasket is not damaged to prevent contamination of the oil.



The recommending model of lubricating oil:

In summer: U.S.A SAE 90EP; In winter: U.S.A SAE 80EP. Oil Capacity of 456D Reducer is 412 L.

The filling period of lubricating oil:

Replace the lubricating oil each 6 months for the gear reducer lubrication. It can be immediately replaced at the special conditions. When the lubricating oil is replaced, the gears and bearings in the reducer must be cleaned with light oil, for example, diesel oil. All garbage in the oil groove must be completely cleaned, don't clean them with kerosene or gasoline.

5.2 The Lubrication of Other Parts

The lubrication of other parts mainly include the following points:

- a. Center bearing: on the Sampson post leg;
- b. Equalizer bearing: on one side of pitman;
- c. Crank pin bearing: Outside the Crank pin assembly cover;
- d. Pitman pin: On top of the pitman small aspect;
- e. Motor bearing: At the front and rear covers of motor.
- f. Brake control lever: At the 1st pin.

The bearing assembly should be filled with the lubricating grease before ex-factory. But we would like to advice the users should check the lubricating conditions of bearing assembly before starting the pumping unit. Fill the suitable lubricating grease into the bearings with the grease gun until the grease flows out from the overflow valve of the bearing cover. Pay attention to fill the lubricating grease slowly in order to prevent the oil-seal from being damaged.

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6.Operation Regulations

6.1Initial Startup

- 1) Check the oil in the reducer.
- 2) Check the lubrication of all bearing assemblies.
- 3) Clear the crank swing area. Remove all tools or other obstructions left on the unit and foundation.
- 4) Make sure all guarding is in place.
- 5) Disengage the positive-stop brake lock out.

Rotation Direction

The Permian conventional pumping unit rotates counter-clockwise, and the wellhead is in the right-hand direction. The two crank pins have two kinds of threads: left-hand thread and right-hand thread.

Initial Crank Rotation

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

6.2Counterbalance Adjustment

Determining the Required Counterbalance

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

1) Polished Rod Dynamometer

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

2) Ammeter

A clip on ammeter may be used to compare the upstroke and downstroke current on electrically powered units. When the counterbalance is adjusted so that the current peaks are equal, the unit will be roughly in balance. In the normal conditions, the max.

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current difference can't exceed 15% of the max. current.

3) Sound of the Prime Mover

An approximate estimation of balance can be made by listening to the characteristic sound of the prime mover as it drives the unit.

4) Belt Tension

Belt tension and subsequent belt stretch increases with load. This causes a proportional amount of slack in the belts on the side opposite the direction of rotation of the prime mover. A visual inspection of the belt sag on upstroke or downstroke can be used to estimate counterbalance.

5) It can also be evaluated according to the well conditions.

Determine the max. balance torque:

The max. balance torque of new pumping units can be got from the following formula, which is also applicable to the same model pumping units under the same well conditions:

$$M_B = SL (54Dg^2 + D_p^2)/2 \quad \text{KN.m}$$

Where S=stroke length, m

L=Depth of the surface pump, m

D_g=Diameter of sucker rod, m

D_p=Diameter of the pump, m

Determine the position of counterweights:

According to the provided example, take four counterweights of pumping units. And the distance between the barycenter of counterweight and the output shaft of reducer is supposed to be x. then,

$$X=(M_B.M_Q)/4G \quad (\text{m})$$

Where M_B =Max. balance torque

M_Q =Torque produced by two cranks, KN. M

For C456D-305-144 model pumping units

$$M_Q = 36.7 \text{ kN.m}$$

G=Weight of counterweights, KN

For C456D-305-144 model (electric motor) pumping units G=14kN

For C456D-305-144 model (gas motor) pumping units G=18kN

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The adjusting method of counterweights position:

During the pumping units running, the balance torque has to be adjusted according to the working conditions. Max. balance torque adjustment is mainly realized by changing the distance "x" between the barycenter of the counterweights and rotating center of the cranks. The balance torque will be increased if the cranks are moved outside, decreased if cranks are moved inside. According to "The Adjusting Position Sketch of Counterweight", it can confirm the distance X.

Rotate the unit and apply the brake so that the crank is slightly downhill in the direction that the weights are to be moved. Set the brake, engage the brake lockout bolt or pawl, and secure the cranks against rotation. Loosen the counterweight bolts just enough to allow the weights to be moved. Use the pinion adjusting wrench to move the weights to the desired position. It is important to note that larger weights may have to be moved with the aid of a crane or a pry bar. The weight on the crank may be moved in a similar manner. After positioning the weights in the desired location, tighten the counterweight bolts utilizing recommended levels of tightness, and add a second nut for a jam nut.

counterbalance data sheet 1

Stroke (in)		144	126	107
TF(in)at90 degree		1.7417	1.5251	1.3035
Cranks only(lb)		4745	5419	6340
Effective counterbalance two main weights at crank position shown (Include cranks)	10"	5631	6431	7525
	20"	6532	7459	8727
	30"	7432	8487	9930
	40"	8332	9515	11133
	50"	9232	10544	12336
	60"	10133	11572	13539
	70"	11033	12600	14742
	Max	11483	13114	15343
Effective counterbalance four main weights at crank position shown (Include cranks)	10"	6517	7443	8708
	20"	8318	9443	11114
	30"	10118	11555	13520
	40"	11919	13612	15926
	50"	13719	15668	18331
	60"	15520	17724	20137
	70"	17320	19780	23143
	Max	18200	20808	24646

Note: The counterweight is 3086 lbs now.

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counterbalance date sheet 2

Stroke (in)		144	126	107
TF(in)at90 degree		1.7417	1.5251	1.3035
Crank only(lb)		4745	5419	6340
Effective counterbalance two main weights at crank position shown (Include cranks)	10"	5948	6793	7947
	20"	7170	8188	9580
	30"	8391	9583	11212
	40"	9613	10978	12845
	50"	10835	12374	14477
	60"	12056	13769	16110
	70"	13278	15164	17742
	Max	14500	16559	19374
Effective counterbalance four main weights at crank position shown (Include cranks)	10"	7150	8166	9554
	20"	9594	10956	12819
	30"	12037	13747	16084
	40"	14481	16537	19349
	50"	16924	19328	22614
	60"	19368	22118	25878
	70"	21811	24909	29143
	Max	24254	27699	32408

Note: The counterweight is 3968 lbs now.

counterbalance date sheet 3

Stroke (in)		144	126	107
TF(in)at90 degree		1.7417	1.5251	1.3035
Crank only(lb)		4745	5419	6340
Effective counterbalance two main weights at crank position shown (Include cranks)	10"	6074	6937	8117
	20"	7425	8479	9921
	30"	8775	10021	11725
	40"	10125	11563	13529
	50"	11476	13106	15334
	60"	12826	14648	17138
	70"	14176	16190	18942
	Max	15527	17732	20746
Effective counterbalance four main weights at crank position shown (Include cranks)	10"	7404	8455	9892
	20"	10104	11539	13501
	30"	12805	14623	17109
	40"	15505	17708	20718
	50"	18206	20792	24326
	60"	20907	23876	27935
	70"	23607	26960	31543
	Max	26308	30044	35152

Note: The counterweight is 4630 lbs now.

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6.3 Replace Belts

- a. Prepare special spanner, crowbar, new belts.
- b. Stop pumping unit, set the brake.
- c. Loosen the adjusting bolts and the T- bolts. Move the motor forward until the belts are loosen, remove old belts and install new belts. Tighten the adjusting bolts and assure that the inside faces of pulley and sheave are coplanar, and check the tension by slapping the belts in the middle of the span. The C-belts should be elastically.
- d. Disengage the brake, start the pumping unit, check whether the operation is normal.

6.4 Remove Horsehead

Danger: Do not stand under any part of the load.

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

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

With the wellhead to the right, stop the unit with the cranks in about the eight o'clock position and set the brake. Engage the secure pawl. Lockout all energy sources.

Attach chains to the cranks. Using the crane, remove the slack from the chains. Remove the pawl and disengage the brake. Slowly lift the cranks until the walking beam is in a near level position. Reset the brake, engage the pawl and chain the drum.

In order to release the wellhead load, a polished-rod clamp should be placed on the stuffing box and fixed firmly. And disassemble the carrier bar from the polished rod.

Insert a long rope or chain through the carrier bar and put the gate back into the carrier bar. Be sure the rope or chain is long enough to hold the carrier bar without lifting a person off the ground.

Tie the chain on the horsehead, screw out the adjusting bolts from two sides of horsehead, until it is horizontal with the side plate of horsehead, and then disassemble the secure pin. Pull out the carrier bar away from the polished rod, and slowly lift the horsehead from the walking beam. Put the horsehead on the ground far from the operating area. Release the brake slowly to make the cranks rotate to the 6 o'clock position. Then engage the secure drum to prevent the pumping unit from running.

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Notice: the users must wear the safety belt when working in the high-altitude.

6.5 Changing Stroke Lengths

Locate the cranks at approximately the 2 o'clock position and set the brake. Place a polished-rod clamp at the stuffing box and tighten according to the clamp manufacturer's recommendations. Using the prime mover or a crane-lift, relocate the cranks to the 12 o'clock position and set the brake.

You may now disconnect the carrier bar from the polished rod.

Insert a long chain through the carrier bar and install the gate back into the carrier bar. Hold the end of the chain and pull the carrier bar away from the polished rod while slowly releasing the brake and letting the cranks down to the 4 o'clock position.

Make sure that the motor disconnects with the power and engage the secure pawl.

6.6 Crank Pin Removal

Remove the pressing plate of crank pin and fixed bolts, hammer the crank pin with hammer to loosen it, and then remove the crank pin nut.

Drive out the crank pin using a drive nut and tools above. 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. If a drive nut is not available, it is recommended that the hammer hit as squarely on the end of the pin as possible to prevent surface damage. Once the pin becomes loose, do not remove it from the hole. Remove the drive nut and install the original nut three or four threads deep. This procedure should also be used on the opposite crank pin.

Check the crank pin clearance in the hole and adjust come-a-longs accordingly so that when the pins are removed they will not fall nor pull up in a sudden motion. Remove the nuts and pull the crank pins out of the crank holes. The pitman side members will support the crank pin bearing assemblies until the pin is installed into another hole. It is recommended that rust preventive be applied to the crank pin bore after the pin is removed.

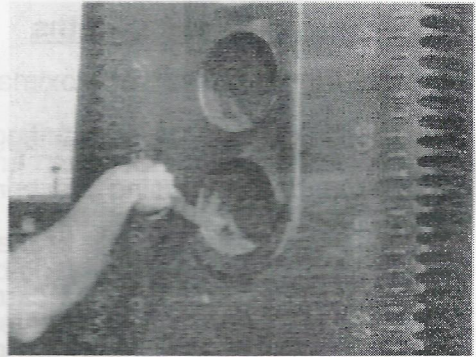
6.7 Crank Pin Installation

Step 1: Use a safe solvent to clean the crank pin, crank pin hole, and the surface of the crank that the nut will seat against. Remove all paint, burrs and other foreign matter from

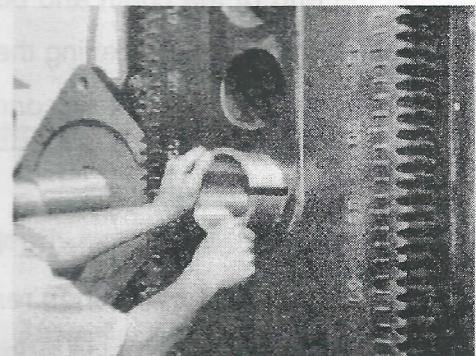
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these areas. Always inspect the crank pin and hole surfaces for rust or wear, as these conditions may indicate that the crank pin was loose.

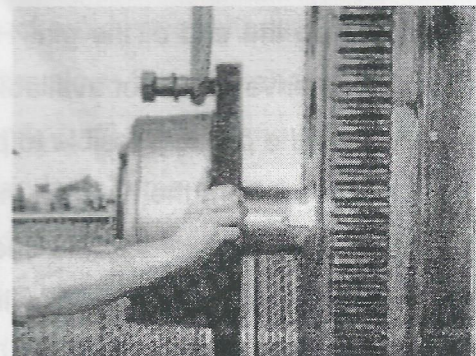
Use a spot bluing to check the contact between the pins and the new holes. The contacting surface should not less than 85%.



Step 2: Adjust come-a-longs to line up the crank pins with the proper holes for the stroke length desired. Apply a light coat of oil on the tapered pin, threads and crank pin hole. All excess oil should be wiped off with a clean cloth prior to inserting the crank pin high alloy bushing into the crank hole.



Step 3: Install the crank pin bearing assembly.



Step 4: Using a sledge hammer on the wrench, turn the nut two cotter pin notches past the hole in the pin and line up the hole in the pin with the third cotter pin notch. Install the cotter pin. Never back the nut off to insert the cotter pin. If you have turned the nut too far, remove the crank pin and repeat all of the installation procedures.

6.8 Returning the Unit to Operation

With the brake engaged, remove the come-a-longs, unchain the drum and disengage

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the lock out bolt or pawl. Reinstall the crank guard panels.

Hold the carrier bar away from the polished rod with the chain and slowly release the brake to let the cranks go to the bottom. Engage the prime mover (or crane) to slowly reposition the cranks at 12 o'clock while holding the carrier bar away from the polished rod. Remove the chain from the carrier bar and attach the carrier bar to the polished rod-, please note that the bottom hole pump spacing will need to be checked and the polished rod clamp may have to be repositioned to accommodate the new stroke length.

Slowly release the brake to transfer the well load back to the carrier bar. Make certain that the load is not on the polished rod clamp at the stuffing box. If necessary, use the prime mover to lift the load. Remove the polished rod clamp at the stuffing box that was used to clamp off the well load.

It is important to note that after a stroke length change, the counterbalance should be checked and the weights repositioned for the proper balance.

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7.Maintenance Recommendations

7.1PREVENTIVE MAINTENANCE

Preventive maintenance is essential to promote safety, prolong unit life, and to prevent expensive failures. Many items can be checked by visual inspection and by listening for unusual noises. It is recommended that the unit should be checked upon each visit to the location.

The following visual inspections are recommended before approaching the pumping unit:

- (1) Visually inspect both crank pins for tightness;
- (2) Visually inspect the counterweights for tightness to the crank;
- (3) Visually inspect the center bearing to insure it has not worked loose;
- (4) Visually inspect the vertical alignment of the unit with the well;
- (5) Visually inspect the distance between the pitman-side members and the cranks on each side of the unit;
- (6) Visually inspect the wireline to insure it is properly tracking on the horsehead. Also look for broken strands of wire fraying from the wireline;
- (7) Visually inspect the level of the foundation for an uneven position causing alignment shifts;
- (8) Visually inspect the unit for loose or missing bolting. Loose bolts will eventually fail in fatigue and are responsible for the majority of pumping unit failures;

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

7.2SCHEDULED MAINTENANCE

There are several items that should be checked on a regular interval to assist in extending the life of your pumping unit.

Monthly

Gear Reducer

The reducer oil level should be checked. Loss of oil from the reducer is usually caused by seal leakage at the shafts or leakage at the parting line of the housing. If the oil level is low, remove the inspection cover and add oil to the proper level.

Structural Bearings

**STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE
RAISE POSITION DO NOT RELY ON THE BRAKE!**

Visually inspect the structural bearings for oil seal leaks. This would include the crank pin, equalizer, and center bearing assemblies. Grease fittings are located at ground level, and if needed, the grease should be pumped in slowly to avoid pushing out the oil seals.

Quarterly

Belts & Sheaves

Belt alignment and tension should be checked and adjusted to prolong belt life. Under normal utilization belts will stretch and wear. It is recommended that new belts be retightened after the first 24 hours of operation. Also check the sheaves for wear, chips or cracks.

Brake & Drum

The 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.

Inspect the brake drum for cracks around the hub and key area. Also look at the brake lock out bolt or pawl for damage.

Bi-Annually

Gear Reducer

It is recommended that an oil sample be taken every six months to determine condition of the oil. If you determine that you have any of the following conditions in the lubricant, check with a qualified vendor regarding replacement:

- (1) An acid or singed odor indicates oxidation of the oil to the degree that it should be replaced.
- (2) If sludge is observed in the used sample, the oil should be replaced or filtered to remove the sludge. This condition is prevalent if the lubricant has not been changed for a long period of time.
- (3) If water exists in the used sample, the water should be completely drained from the reducer. Water presence in oil can be detected by placing a drop or two on a heated metal surface. Subsequent bubbling will occur with as little as 0.1 % of water present in the oil. If there is greater than 0.2% water by volume, an oil change is recommended.

Wire line

Visually inspect the wireline for wire fraying. A rusty wireline should be cleaned and coated with a wireline lubricant as specified on page

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Bolting

Check all bolts. Retighten as recommended in the Supplement. Loose bolting will eventually fail.

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8.Attachment

8.1Attached Table 1: The Torque Factor and Position Factor

C456D-305-144 Pumping Unit

Crank Rotating Angle θ	S=144	R=1190	S=126	R=1035	S=107	R=880
	Torque Factor IF (m)	Position Factor PR%	Torque Factor IF(m)	Position Factor PR%	Torque Factor IF(m)	Position Factor PR%
0	-0.1069	0.0632	-0.0681	0.0356	-0.0403	0.0181
15	0.5525	1.6338	0.4769	1.7171	0.4002	1.7783
30	1.1761	7.8389	0.9854	7.8039	0.8075	7.7298
45	1.6422	17.9857	1.3721	17.6363	1.1228	17.2536
60	1.8744	30.6353	1.5828	29.9511	1.3081	29.2398
75	1.8840	44.1142	1.6194	43.2663	1.3602	42.3744
90	1.7420	57.0740	1.5255	56.3080	1.3038	55.4609
105	1.5233	68.7133	1.3534	68.2198	1.1734	67.6076
120	1.2763	78.6767	1.1417	78.5290	0.9977	78.2399
135	1.0207	86.8481	0.9099	87.0016	0.7941	87.0105
150	0.7565	93.1757	0.6619	93.4966	0.5696	93.6878
165	0.4711	97.5587	0.3925	97.8631	0.3241	98.0707
180	0.1469	99.7845	0.0930	99.8884	0.0560	99.9455
195	-0.2289	99.5246	-0.2398	99.3044	-0.2326	99.0964
210	-0.6488	96.4211	-0.5954	95.8672	-0.5304	95.3695
225	-1.0725	90.2850	-0.9441	89.4993	-0.8157	88.7734
240	-1.4396	81.3013	-1.2458	80.4213	-1.0606	79.5651
255	-1.7023	70.0581	-1.4658	69.1732	-1.2402	68.2662
270	-1.8415	57.3823	-1.5853	56.5172	-1.3379	55.6028
285	-1.8574	44.1576	-1.5985	43.3123	-1.3459	42.4189
300	-1.7538	31.2461	-1.5045	30.4404	-1.2610	29.6098
315	-1.5302	19.4958	-1.3024	18.7885	-1.0824	18.0876
330	-1.1809	9.7789	-0.9909	9.2549	-0.8121	8.7611
345	-0.7025	3.0059	-0.5734	2.7341	-0.4581	2.4949
360	-0.1081	0.0646	-0.0690	0.0366	-0.0411	0.0188

S—Stroke Length (in)

R— Crank Radius (mm) , Regarding the 12 o'clock position of crank as 0 degree, face the pumping unit, the wellhead is in the right, and the clockwise rotating angle;

TF-- Torque Factor (m)

PR— the percent of "the polished rod counting from the lower dead point" to "the stroke length".

STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE RAISE POSITION DO NOT RELY ON THE BRAKE!

8.2 List of Quick-Wear Parts

List of Bearings

Attached Table 2: Bearings

Item	C456D-305-144			
	Bearing Type	Overall Dimension		
		Inside Diameter × Outside Diameter × Width (mm)		Qty.
Center Bearing	42630	150 × 320 × 108		2
Equalizer Bearing	3630	150 × 320 × 108		1
Crank Pin Bearing	53622	110 × 240 × 80		2
Reducer	Input Shaft	NU2322	110 × 240 × 80	2
	Center Shaft	NU2326	130 × 280 × 93	2
	Output Shaft	3544	220 × 400 × 108	2

List of Sealing Parts

Attached Table 3: Sealing Parts

Item	C456D-305-144	
	Name and Specification	Qty
Equalizer Bearing Assembly	Spring Seal PD130*160*15	2
Walking Beam Stand Base Assembly	Spring Seal PD 180*220*15	2
Crank Pin Bearing Base	Spring Seal PD 110*140*12	2

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8.3 Troubleshooting

Table 4: Common Trouble and Troubleshooting

No.	Troubles	Appearance	Causes	Troubleshooting
1	The whole pumping units loses its stability	Some parts displace	<ol style="list-style-type: none"> 1. Foundation isn't firm. 2. Installation is incorrect. 3. Bolts between reducer and base, Sampson post and base, become loose. 	<ol style="list-style-type: none"> 1. Correct according to the drawings. 2. Check and correctly install. 3. Tighten all the connecting bolts and periodically check their tightness.
2	The whole pumping units swings	Sampson post swings	<ol style="list-style-type: none"> 1. Stroke length is too long, or load on polished rod is too heavy. 2. Pumping units is out of balance. 	<ol style="list-style-type: none"> 1. Determine its running requirements according to the recommended technical specifications. 2. Check and rebalance the units.
3	Crank pin is loose	Crank pin is loose	<ol style="list-style-type: none"> 1. Connection of pitman and crank pin is incorrect. 2. Crank pin is loose. 	<ol style="list-style-type: none"> 1. Adjust the installing position of pitman and crank pin. 2. Tighten the locking nuts.
4	Friction is in the pitman and crank (counterbalance weights)	Periodically knock	Walking beam is incorrectly installed, or the units are incorrectly adjusted, or the key is loose.	Determine the center of the units. Adjust walking beam till its center coincides with the longitudinal centerlines of the units. Tighten the slope key with a copper bar.
5	Equalizer bearings are loose	Bearing base is displaced	Bolts are loose	Tighten bolts.
6	Connection of sucker rod to the horse head is loose	Crank shocks	<ol style="list-style-type: none"> 1. Crank locking bolts are loose. 2. Key way of shaft or key is out of work. 	<ol style="list-style-type: none"> 1. Tighten crank locking bolts. 2. Turn crank 90°. Replace key or keyway.

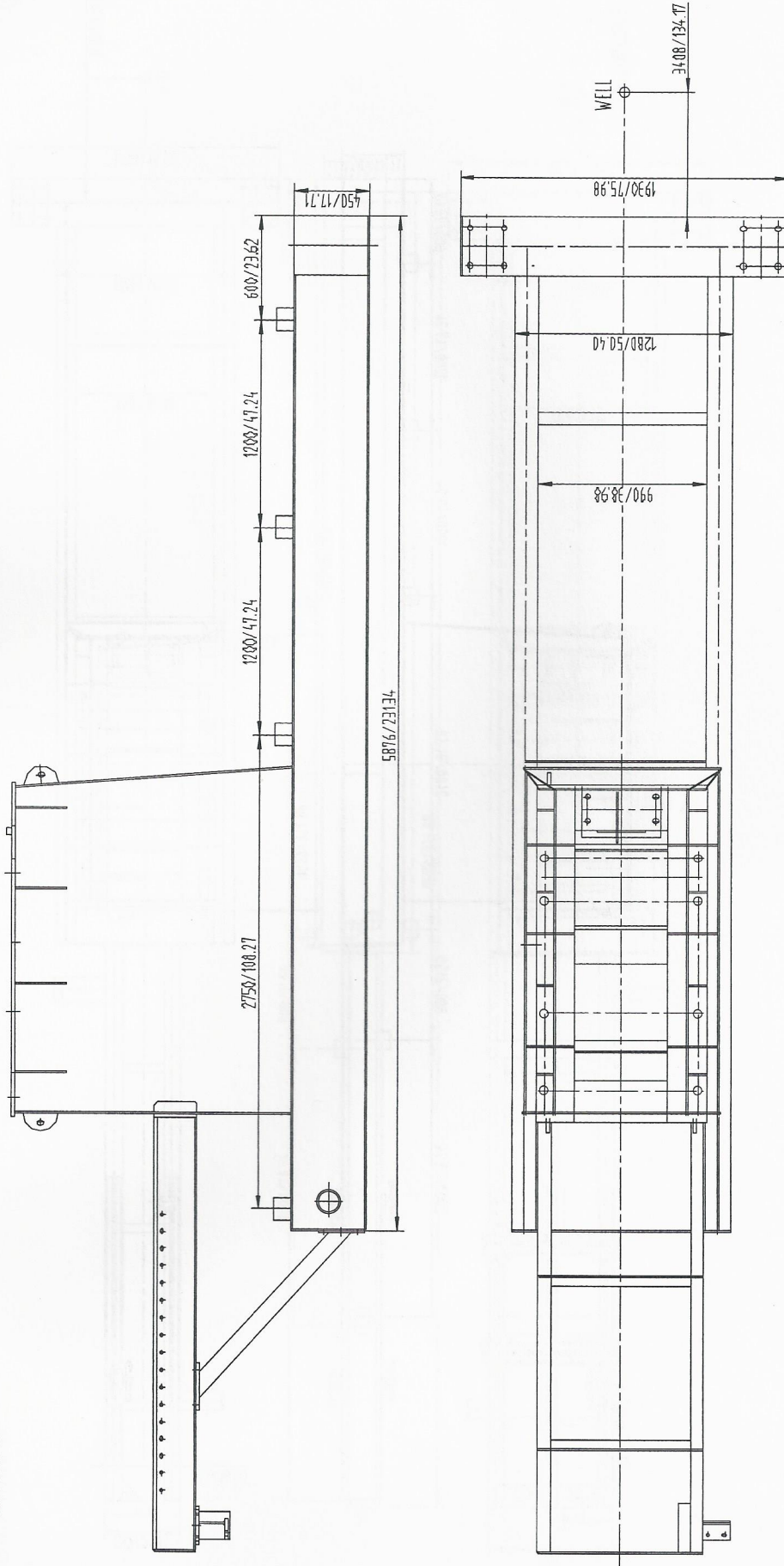
STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE RAISE POSITION DO NOT RELY ON THE BRAKE!

No.	Troubles	Appearance	Causes	Troubleshooting
7	Connections of sucker rod to the horse-head is loose.	Polished rod and wire line on carrier bar slides	1. Slip and polished rod are not matched. 2. Teeth of slip is worn-out.	1. Use suitable slip.
8	Lubricating temperature is over 50°C while the reducer is in operation.	The housing of the reducer is too hot.	1. Oil level of the reducer is too low. 2. Oil level is too high. 3. Due to unbalance of the pumping units, reducer is overloaded.	1. Add lubrication oil up to the height of screw. 2. Drain excessive oil to lower the level to height of screw. 3. Rebalance the units or change heavy-duty pumping units.
9	There is abnormal sound during operation of the reducer.	Sounds are not even, and there are some knocks. The units shocks periodically.	Load of reducer is not uniform during upstroke and down-stroke.	Rebalance the pumping units.
10	Oil leakage.	Oil appears on the reducer and the parts around it.	1. Too much oil in reducer. 2. Oil return passage is blocked. 3. The oil seal ring is worn-out	1. Drain excessive oil to lower the level to the specified mark. 2. Make the return passage through. 3. Tighten the bolts, or replace oil-sealing ring
11	Bearings are abnormal in rotation.	The bearings are too hot and there are sounds periodically.	1. Oil passage is blocked. 2. Axial clearance of output shaft is too small.	1. Make the oil passage unlocked. 2. Adjust the axial clearance.
12	Clearance of matching gears of reducer is too large.	There are periodical knocks inside the reducer.	1. Gear teeth are worn-out or keys are loose. 2. The reducer is overloaded.	1. Replace the parts. 2. Operate according to technical specifications. 3. Check and balance the pumping units.

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8.4Base Installation Drawing

UNIT: mm/in

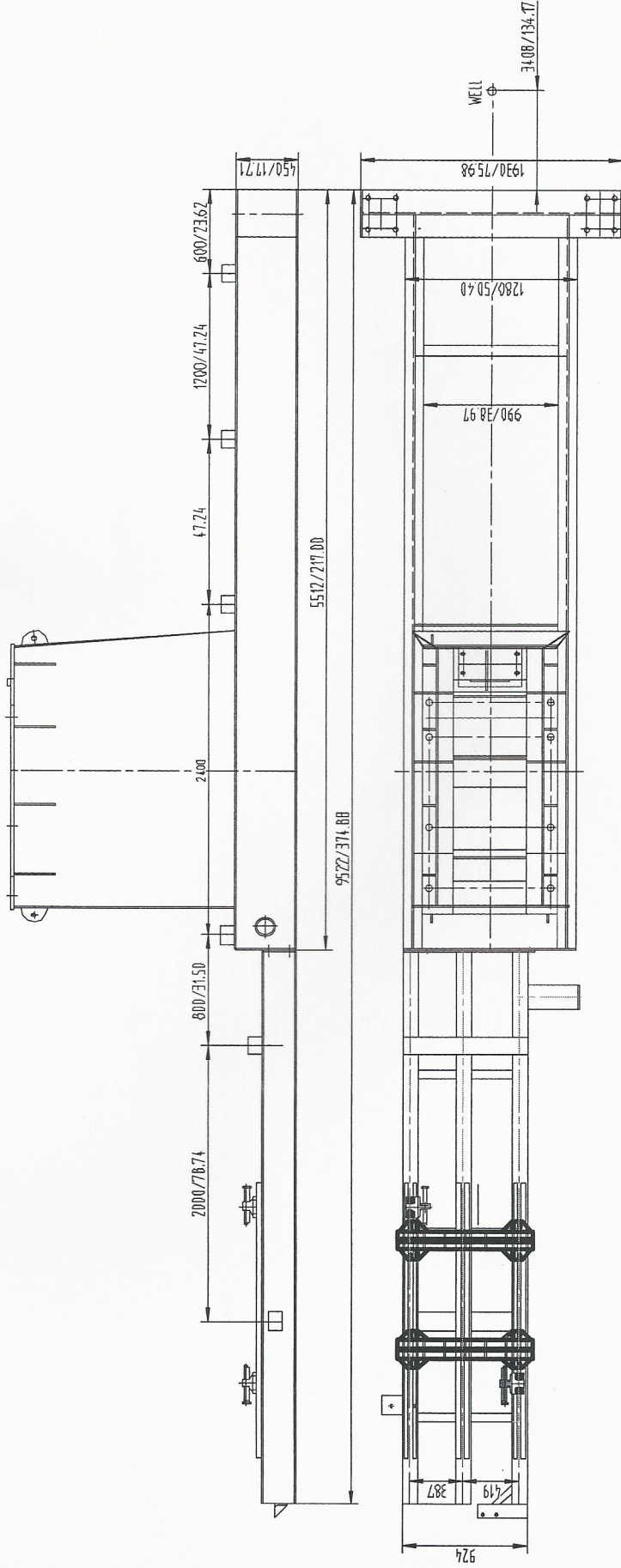


C456D-305-144PUMPING UNIT WITH ELECTRIC MOTOR

STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE RAISE POSITION DO NOT RELY ON THE BRAKE!

C456D-305-144PUMPING UNIT WITH GAS MOTOR

Unit: mm/in



C456D-305-144 PUMPING UNIT WITH ELECTRIC AND GAS MOTOR

STAY CLEAR OF THE CRANK AT ALL TIMES! WHEN THE CRANK IS IN THE RAISE POSITION DO NOT RELY ON THE BRAKE!