Modern Tools For Well Servicing

By S. E. CORRY
Franks Division, Cabot Shops, Inc.
Tulsa, Okla.

As late as 1940, the method of pulling rods and tubing utilizing a horse-drawn single line over an A-frame mounted on wagon wheels, was in common use in shallow areas. For those who are not acquainted with this early operation we have provided an illustration to point out basically the simplicity of performance which has become a major part of our industry. One of the next steps in the progress of providing portable equipment to cover larger areas, was the Rumley tractor unit. This equipment served the Oklahoma, Eastland and the East Texas fields in the early stages. Following the Rumley tractor was the application of the servicing hoist to a relative fast moving truck which could take advantage of the highways to go from one area to another.

The truck mounted unit soon began to carry its own portable pipe mast which started the controversy over the economy of leaving a permanent servicing derrick over the well. For a long period of time, the pipe or pole mast has been made to pull only 25-ft. rods in doubles and 30-ft. tubing in singles. There have been a number of pipe masts made in recent years which handled the 30-ft. tubing in doubles, stacking the tubing in a board provided on the mast. The derrick type portable mast as developed in 1937, was first used in the Texas field. This derrick type mast was mounted with the servicing hoist on a suitable truck and could provide a structure which was strong enough to do heavy requirements with a minimum amount of rig-up and with a maximum safety factor.

The truck mounted servicing unit with either the pipe mast or with the portable derrick type mast was provided with power either from the truck motor or from an individual engine behind the cab. For larger requirements, highway weight laws forced the issue of eliminating as much weight as possible and thus found favor with the unit utilizing one motor for the power plant. In some areas the weight problem became critical to the point of providing squipment that was trailer mounted with portable derricks so that the towing tractor would provide extra axles under the gross load and making the equipment either legal or permissible to the Highway Department. An effort has come forth to overcome the bulk and the awkwardness of handling the trailer type equipment for servicing operations, and from this requirement has grown the modern self-propelled drive-in unit.

Most manufacturers have followed the pattern of providing a selection of self-propelled units for the medium to deep servicing requirements. One of the latest attempts to provide servicing equipment for deepest requirements yet providing a minimum of weight, is the development under way utilizing the lighter alloys. A 96-ft. all aluminum alloy derrick has now been in operation on a drive-in unit since November, 1954. This derrick has been inspected every three months and although it has had severe usage, it has proven that from a structural standpoint, it is very practical to make the derrick structure from this material.

However, the cost of such equipment in most areas prohibits the contractors from owning and operating it, unless the demand provides a hourly rate to justify initial cost. The manufacturing of the aluminum structure now under way, shows some improvement in manufacturing cost; however, such costs are still the main drawback to the full presentation to the industry of the lighter alloy eqquipment. Such costs have been approximately one and one-half times that of similar structures made from steel alloys. Present day economies, both from company-owned equipment and from the prices paid to contractors, apparently will not allow a field acceptance of some new developments now being offered. It is not a hopeless picture, however, and basic economies will balance the situation.

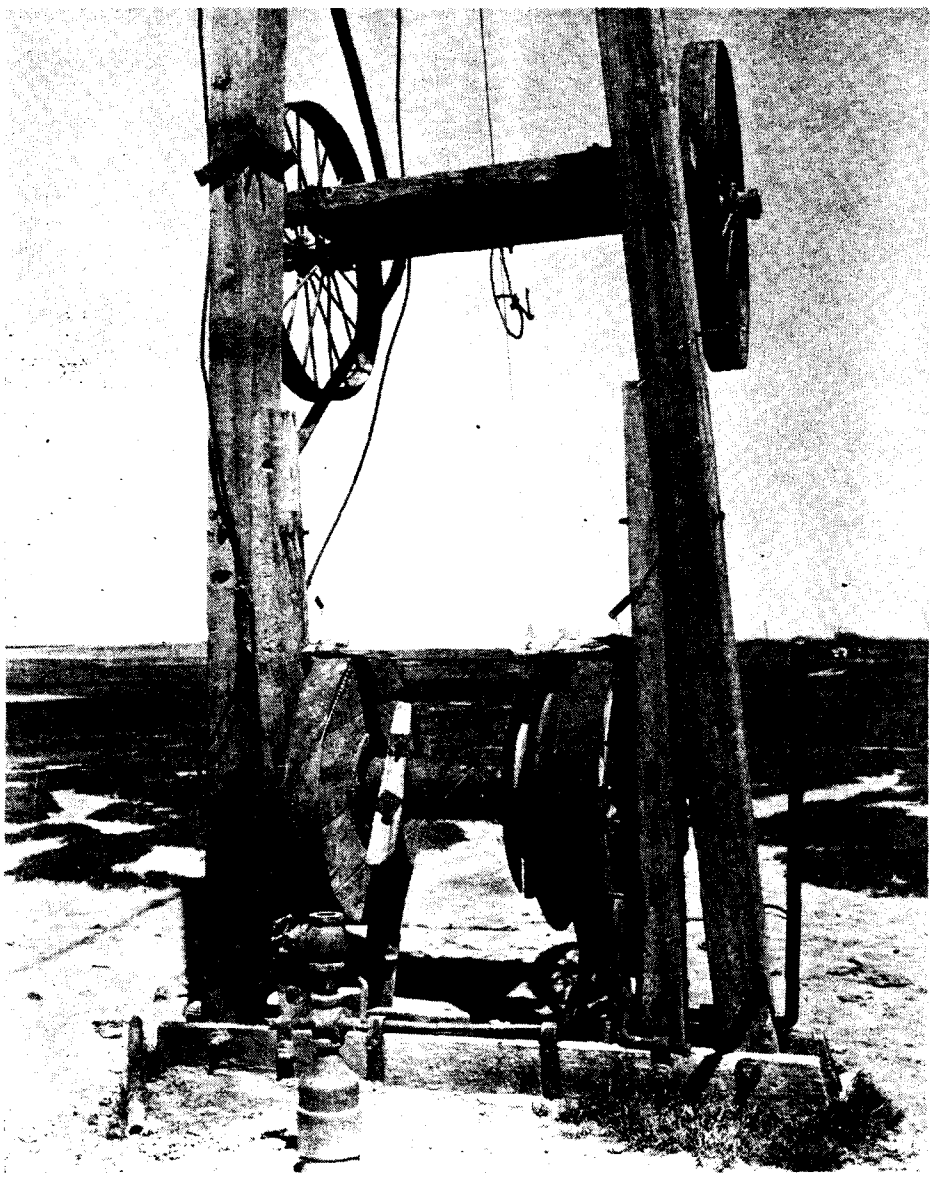


Figure 1

Operational Maintenance

This discussion has been pointed

From the time an oilwell is completed and turned into the tank, whether a flowing well or pumping well, all future operations to the well would fall under the general term of well servicing. Often the term servicing basically pertains to rod and tubing or swabbing work and the term workover covers the heavier operations to a completed well, such as the removal of old casing, perforating jobs, and the various fracturing operations.

A rod and tubing basically consists of a carrying frame, either skid type, truck or trailer; the power plant; a drawworks; and a portable pipe mast or derrick mast.

Although many drawworks clutches in operation are still of the jaw clutch type, the greater percentage of manufacturers' servicing units today are using the friction clutch in the end of drum for final application of power to

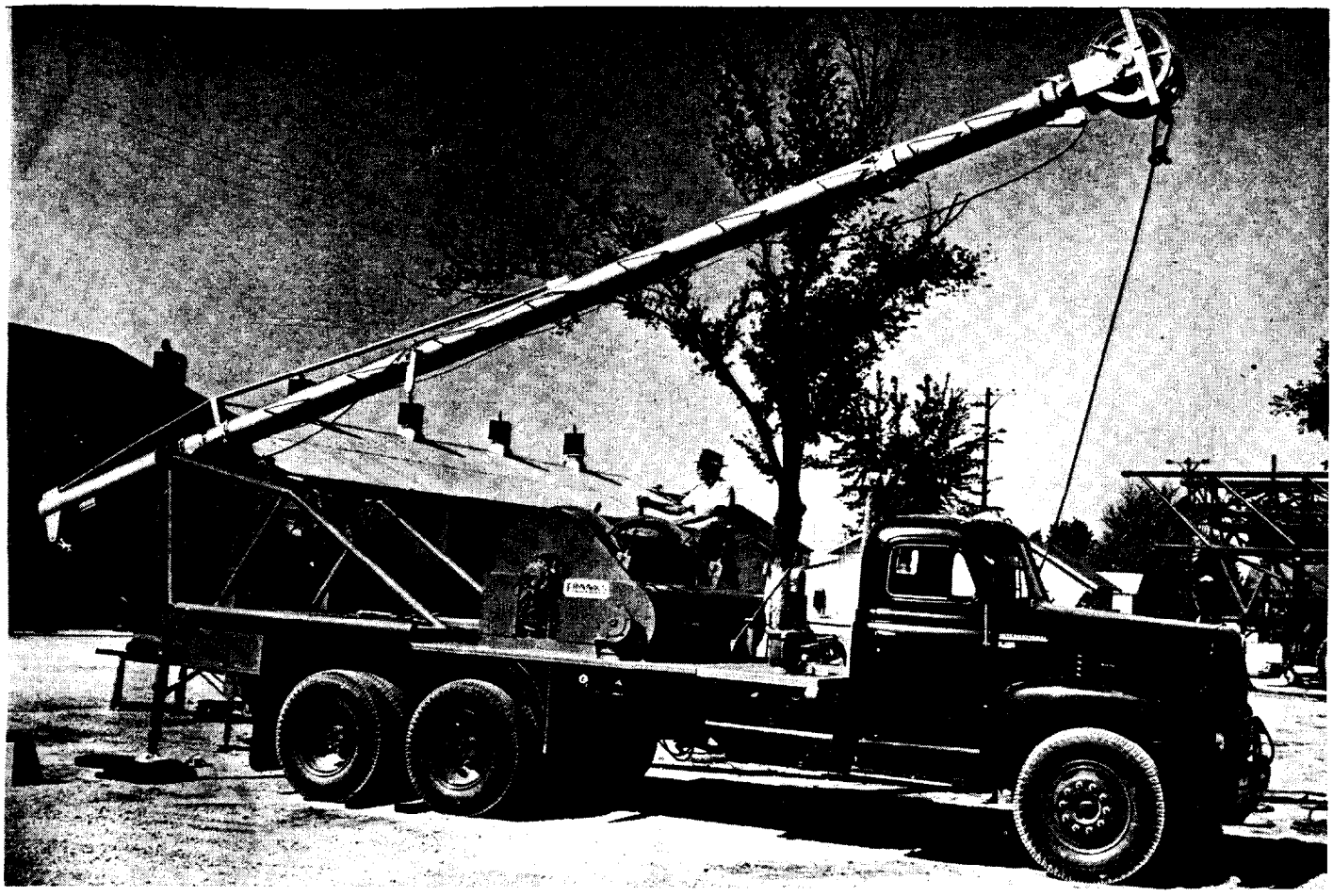


Figure 2

the hoisting line. The trend to the use of a torque convertor in addition to regular transmission, has been noted in late material research data. Brakes on the drawworks must be of sufficient capacity to absorb the energy of the mass of tubing being lowered into the well at a very rapid rate. Roughly, the braking horse power required is approximately five times that of the hoisting power.

Swabbing practices require sizes for drums that will have the strength and capacity to spool long lines. Under normal swabbing loads the pressure applied to the drum has a loading in the direction to spread the flanges; consequently, sufficient ribbing must be provided to resist this condition. To prevent excessive line speeds while running the swab into the well large brake areas are required to provide sufficient cooling since the brakes are in contact for retarding drum speed a larger part of the time. The actual static loading of the brakes has but little consequence but the heating problem must be considered. Many units used for swabbing are combined with the regular rod and tubing unit with a double drum so that the overall unit utility may be more economical when making the original purchase.

Considering workover units which range to all depths, the general conception considers both the rotary workover and the cable tool workover unit. Most requirements call for workover units to be on the maxi-

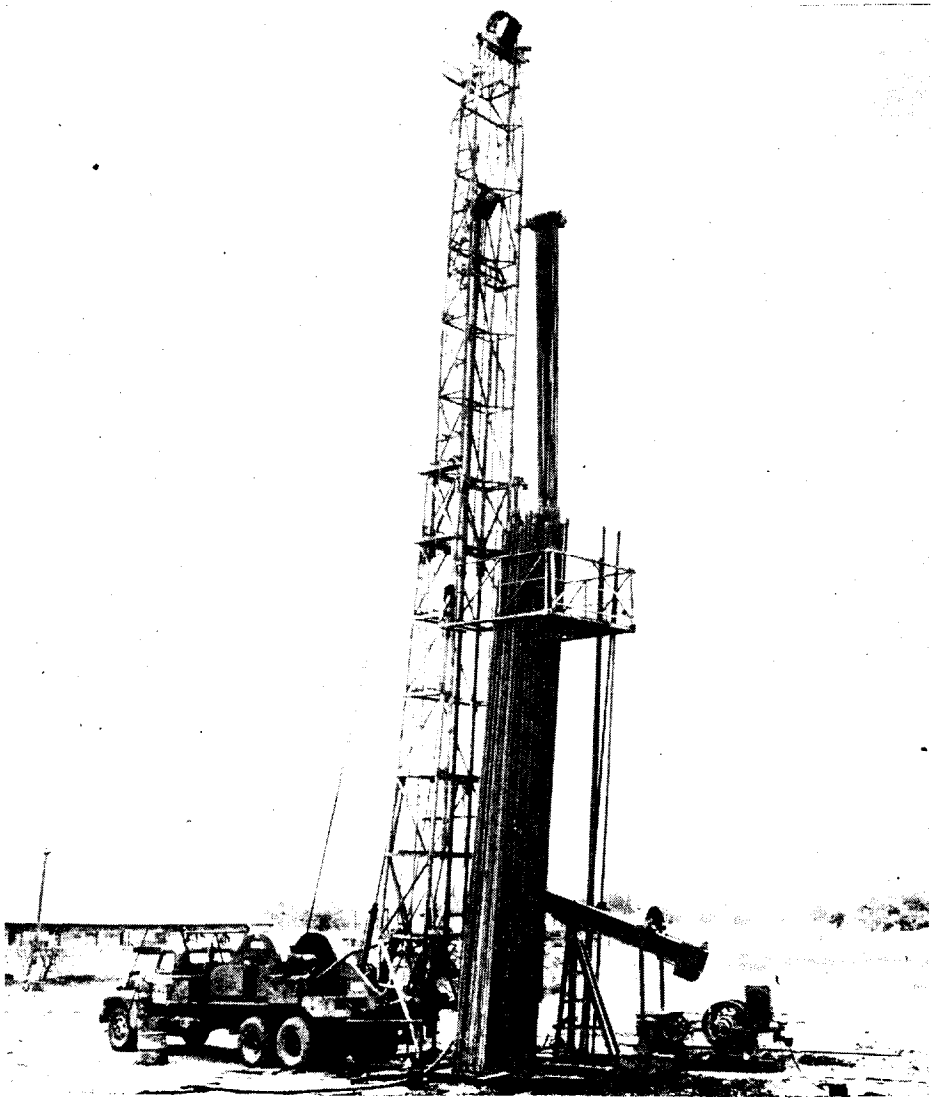


Figure 3

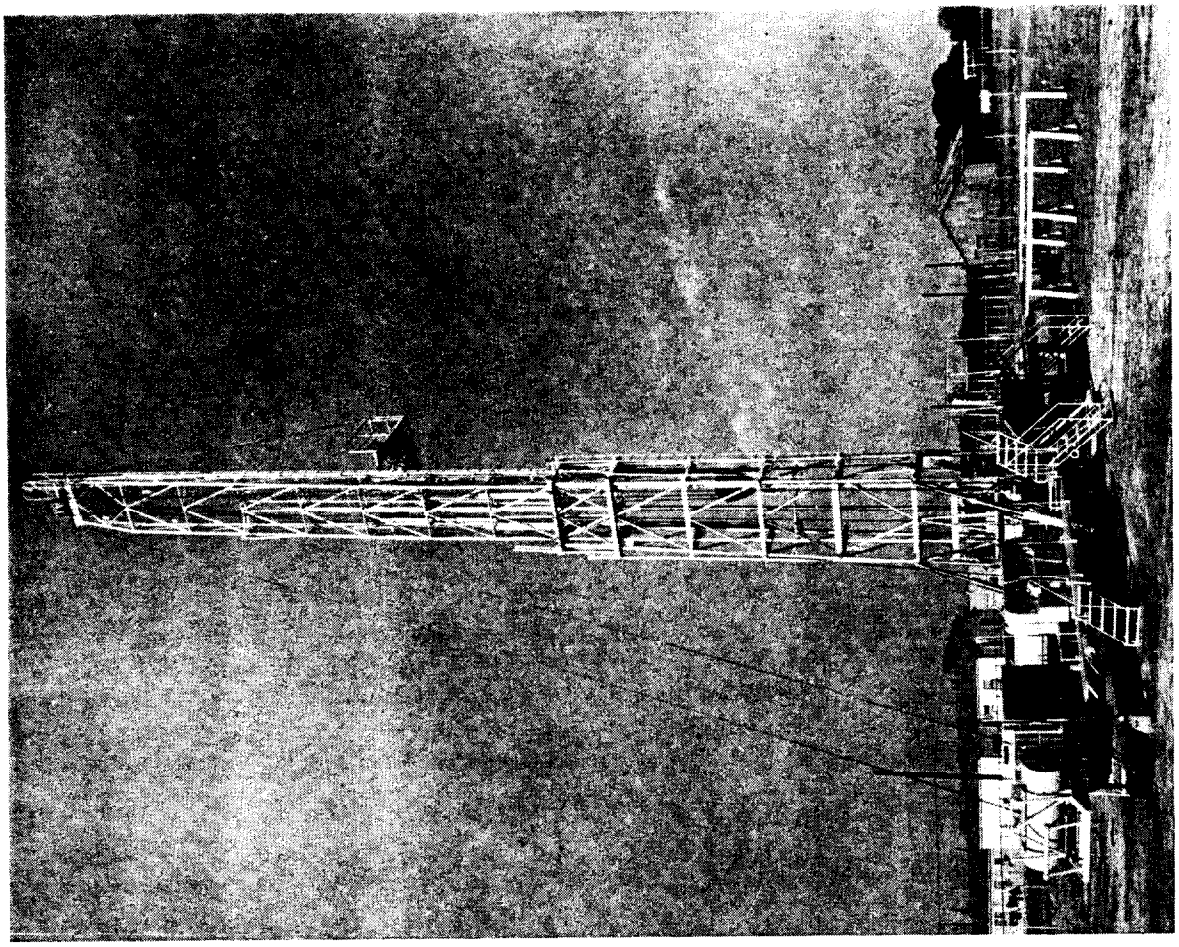


Figure 5

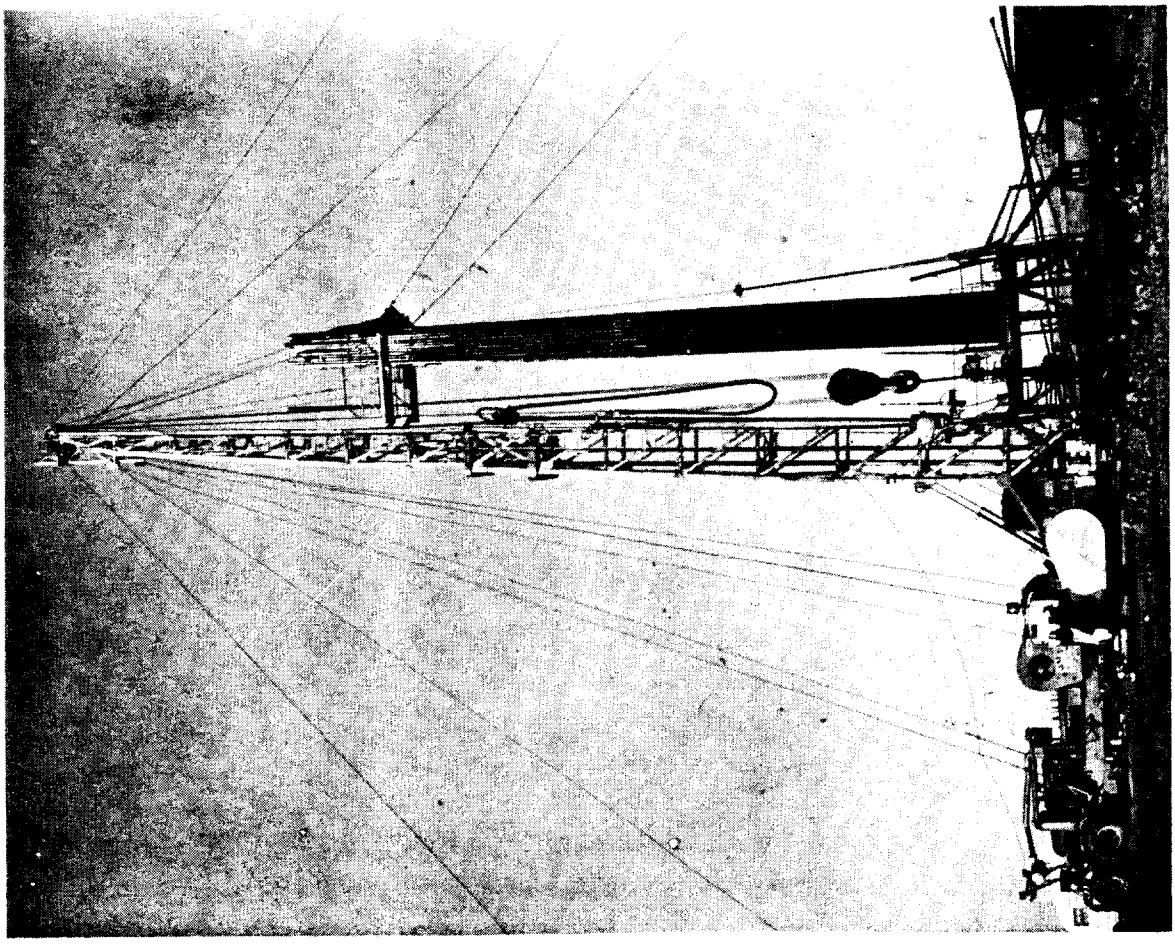


Figure 4

mum side of power available and drawworks and derrick capacities. Some areas having field conditions with high pressures involved, require blowout preventers and high substructure for rotary floor operation.

The workover areas requiring cable tool operation normally use the pipe mast structure and a large part have been trailer mounted. These cable tool units generally are three drum construction so as to eliminate the requirement for changing out lines for each of the operations: The bailing line, drilling line, and casing line.

Well servicing eqquipment as usually operated, is either owned by the producer or by a contractor and the

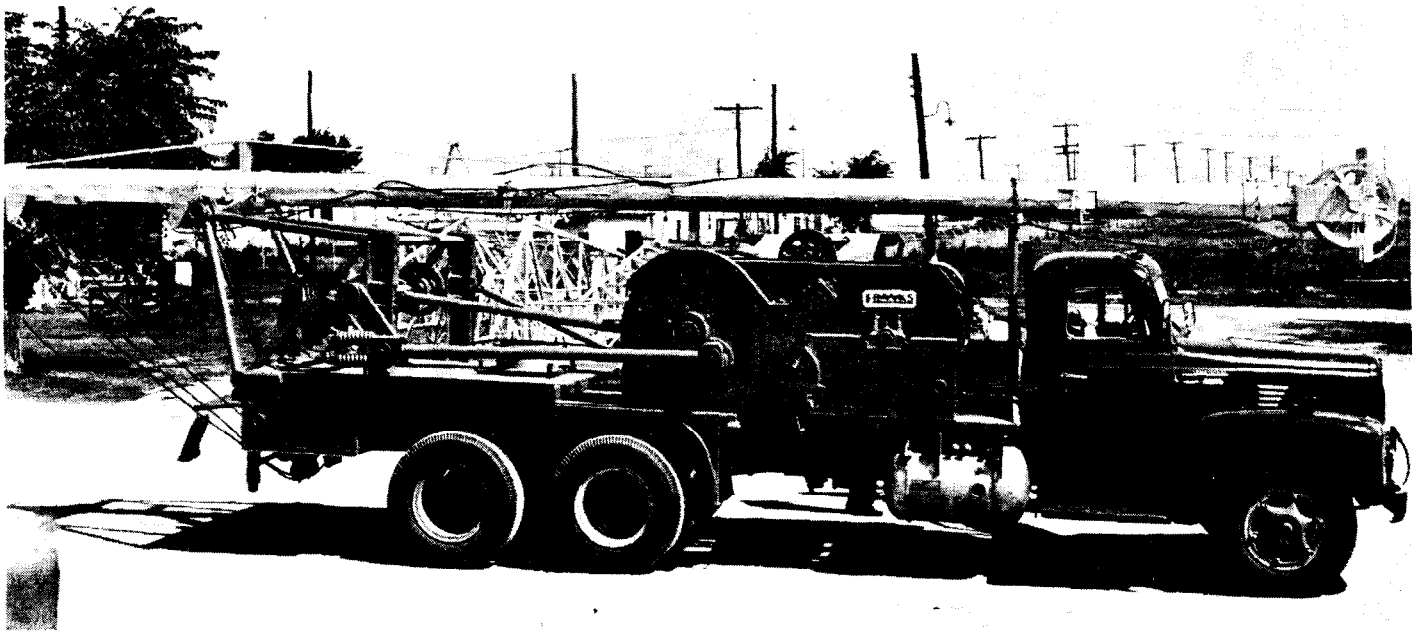


Figure 6

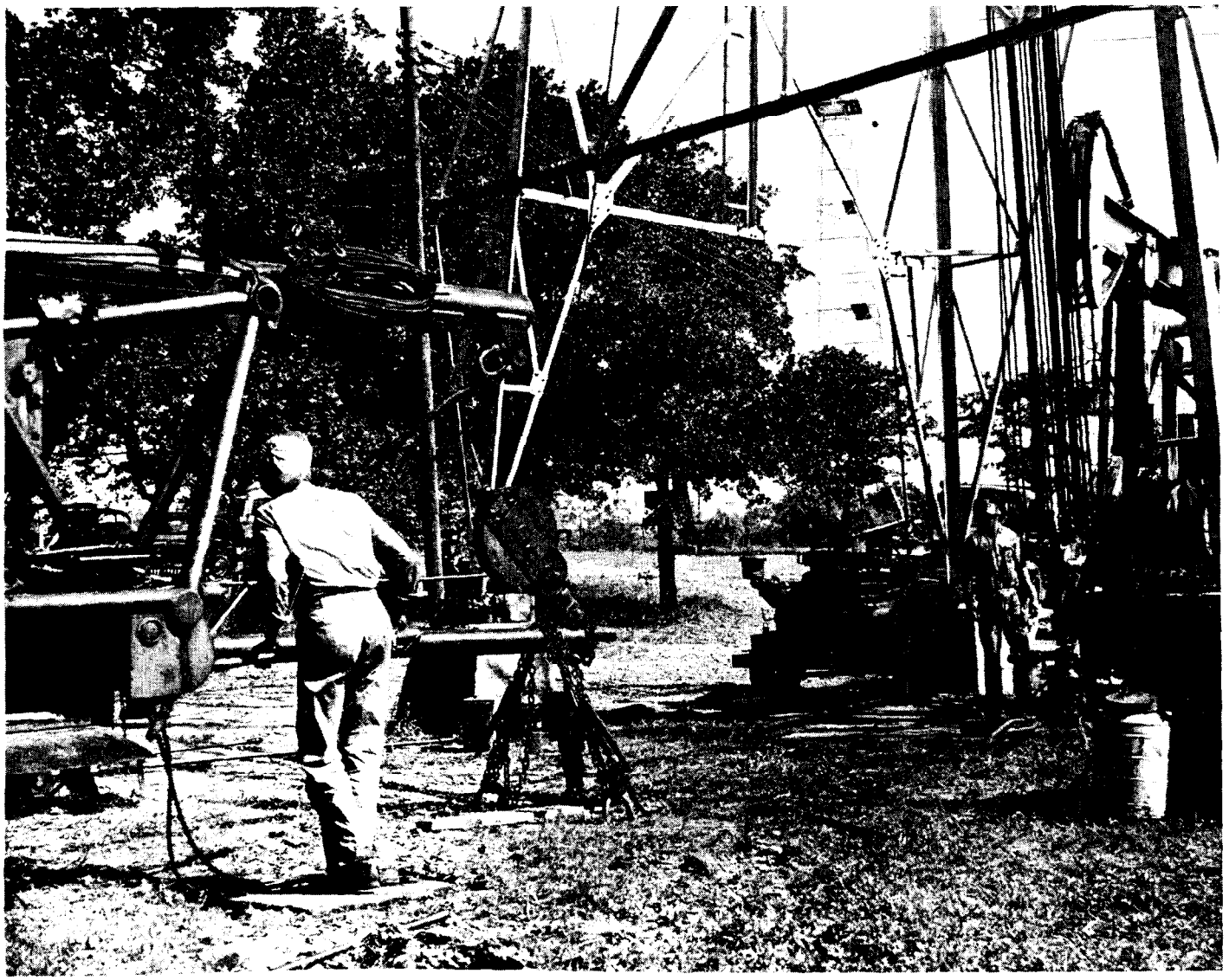


Figure 7

UNIT ECONOMY

POLE MAST - 65'	DERRICK - 60 - 69'	DERRICK - 84 - 102'
Laying tubing down in singles & rods in doubles	Standing tubing in singles & hanging rods in doubles	Standing tubing in doubles & hanging rods in thribbles

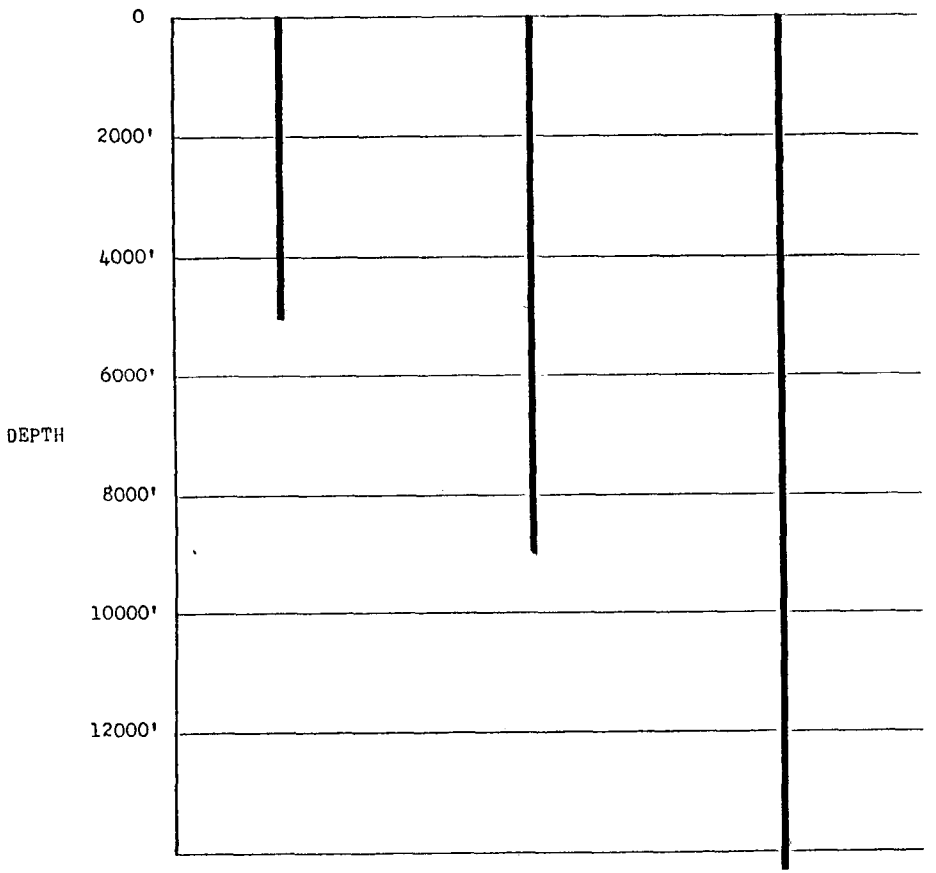
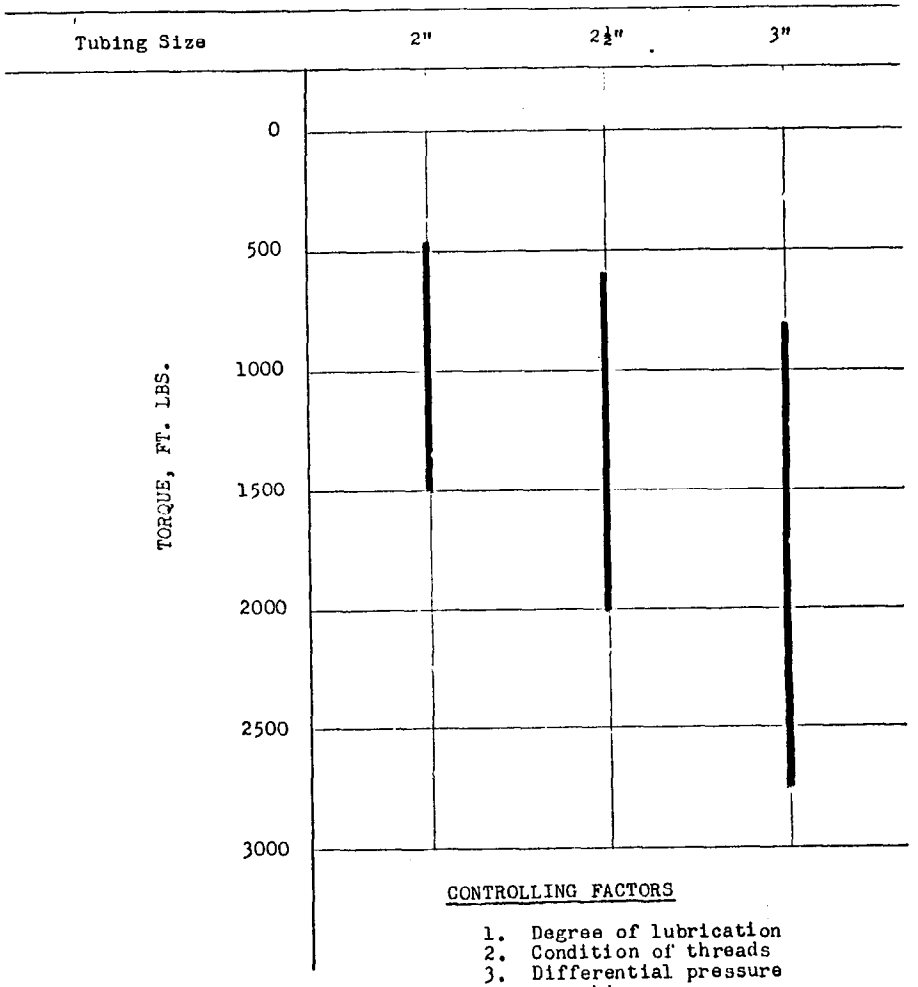


Chart 1

MAKE-UP TORQUE FOR TUBING

Thread Seal Joints



CONTROLLING FACTORS

1. Degree of lubrication
2. Condition of threads
3. Differential pressure on tubing
4. Length of tubing string

Chart 2

operating personnel can view the well servicing equipment problems from two angles. First, the operation of the equipment which you own, and second, selection of a contractor who has equipment to suit your requirements.

In the first instance, you have likely been called upon to recommend equipment required for your area. In this case, further discussions of this paper will provide you with some of the answers to your questions.

In the event that you are called upon to make recommendations for purchase of equipment, you will wish to consider the many points brought about in the same manner that you would select a contractor unit to work for you. Selecting a balanced unit to obtain efficiency, safety, speed, and eliminate crew member fatigue, requires a knowledge of the variations in field conditions.

First, we must consider the unit rating as given by the manufacturer against the well depth and tubing size. Normally, these points would cover all that would need to be considered for an application; however, there are exceptions. For inustance, the Texas Company in the Buckeye, New Mexico area, had paraffin problems that increased the hoisting requirements well beyond that of considering the weight of the tubing string only. This means that a drawworks with larger power, and larger clutch capacity is required to handle this operation. A standard unit applied to this application would have larger brakes than would normally be required. Another example is in the Forsan area at Big Spring. Many shallow wells use strings of 3" tubing. Most well servicing units are rated on the capacity of 2 1/2" wet string tubing. In this case, the weight of the larger tubing would require both increased clutch and brake capacity, over nominal manufacturing ratings. In the Iraan area, extreme conditions exist in the reverse direction. In this case, the well pressures require that the derrick be so rigged that the tubing is snubbed to prevent it from blowing out of the well as valve changes are required, and the tubing is required to be pushed back into the well for completion of the operation. In this condition very small brakes are required although normally standard equipment would be furnished.

Considering the above examples, a balanced unit for well servicing must consider the following items:

1. The well depth. Complete load of wet string is maximum working condition.

2. The power required for hoisting at a safe, economical, operating speed with matching clutches and brakes rated for this capacity.

3. The tubing line, block, hooks, and elevators in proportion for speed and efficiency.

4. The Pole masts or portable derricks selected to handle the proposed load.

Chart 1 shows theoretical depths for economic handling of tubing in singles as a laydown operation; tubing pulled in singles and stacked: and tubing pulled in doubles stacked.

The permanent derrick for well servicing still exists at all depths in many areas. Permanent derricks, because of tax and maintenance costs, are being removed and the portable equipment taking its place. However, we must consider a servicing unit for such basic operation. For permanent derrick use it consists of drawworks and power plant. The permanent derrick is rigged with a false derrick line which is used to pull the tubing line over the crown and make the string-up without a man climbing the derrick. Such units are provided with rolling tail board, stinger, and anchor provisions.

Rod hangers of chain or finger type are provided with a permanent rod board in the derrick. Rod hanging equipment is usually removed after each operation.

The pipe or pole mast unit is basically the same unit as described above except that it carries its own mast which remains strung up at all times. Such eqquipment can be provided with attachments to allow it to work under permanent derricks where mixed field conditions exist. Varying field conditions determine the economies of where to consider a pole mast unit or where to consider the portable derrick unit. For example, in California with well depths from 7,000-12,000 feet, the portable derrick type mast has been used practically exclusively for several years. In West Texas, the same depth wells with identical conditions are economically using truck mounted units with 10x13x65' single pole masts. There are economic problems involved with investments and importance of speeding operations which determine the type of equipment that the industry in general is buying.

The portable derrick well servicing unit provides speed, safety, and operational economy, but with higher initial investment. From Chart 1, previously referred to , you can see in the range of approximately 5,000' the derrick to pull tubing in singles should be considered. In depths below 9,000', the derrick with capacity to handle tubing in doubles should be considered. The performance of crew members as a team, contribute to a large degree as to whether or not a pipe mast unit operates as efficiently as a derrick unit.

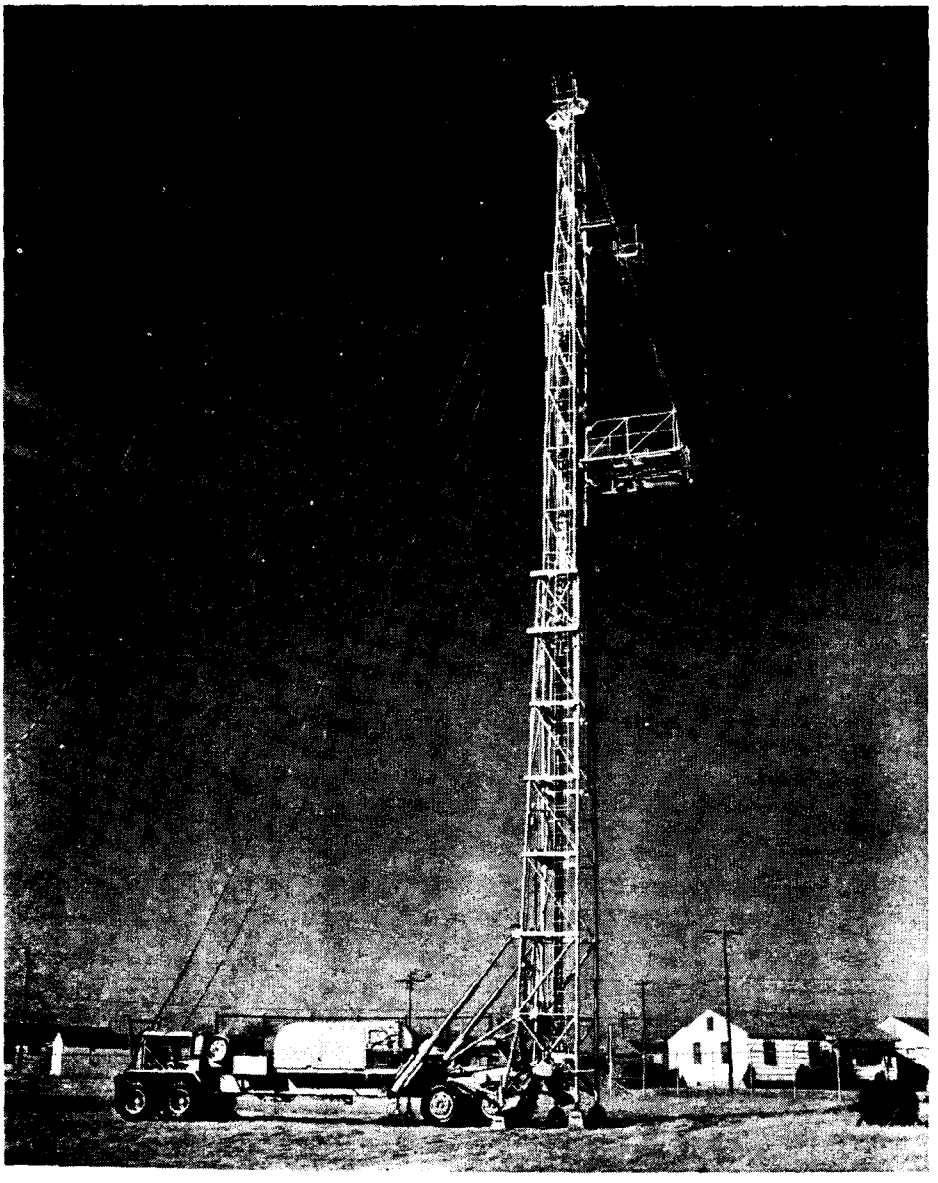


Figure 8

Should the crews be eqqual (which condition seldom exists due to labor and management conditions), then a standard is possible to measure equipment efficiency. Considering the speed of the portable derrick servicing unit, the elimination of guylines to the ground is possible and outriggers provide lateral stability. Portable derricks with a deep section provide the torsional rigidity necessary for this type of operation. Shallow derrick sections are very flexible and consequently have reduced safety factors. Most portable derricks are provided with air operated rod transfers and portable rod fingers. There is no climbing in the derrick required for rig-up.

There are many things that enter into the economy of well servicing. Basically, eight items cover points that must be considered for selecting contractor equipment or for operating company-owned equipment. They are as follows:

1. Moving costs, involving trucking bills, highway permits, road preparation and pay out of rolling stock.

2. Rig-up time at the well again involves extra trucks or labor.

3. Well preparation costs include such items as foundation, cellars, well connections, etc.

4. The time the well is off production affects the total lease production or the total income.

5. State allowables may provide time for remedial operations and effect the economy.

6. Safety programs for machinery and men affect insurance costs.

7. Labor costs of both company labor with insurance and benefits, and contractor labor affects quality of the work performed as well as direct cost of the operation.

8. The cost of related servicing equipment which must be rented to coordinate with the well servicing unit and its operation is important. The above factors are pointed out so that they may be considered for the overall justification.

Up to this point we have been considering the basic machinery for hoisting the rod and tubing string. The work to perform this operation has not been considered as manual since the first wells were drilled. The manual labor operations consist of the breaking and making of rod boxes and tubing joints. For many years this operation was done by main strength and akwardness with hand tools, which included the sledge hammer. The development of the air operated tubing tong and air rod wrenches was the first major step to remove manual and time consuming labor from the servicing operation. In addition, the efficiency of properly tightened joints was greatly increased and much waste and damaged tubing and rods were eliminated. In some instances, the manfacturers of power tongs have changed over to the use of hydraulic power so as to coordinate with other accessories that may be a basic part of the servicing unit. Hydraulic power can provide quieter operation, higher torque and better speed control than the earlier tongs powered by air motors. The enclosed chart, No. 2, shows the torque when making up the various sizes of tubing as recommended by several major oil companies. The size of the hydraulic motor is 20 - 24 gallon per minute at 2,000 lb. at 1200 R.P.M. maximum.

The next accessory developed to save labor was the air operated tubing slips. The controls for these slips are operated by the unit operator who then has complete control of the hand-

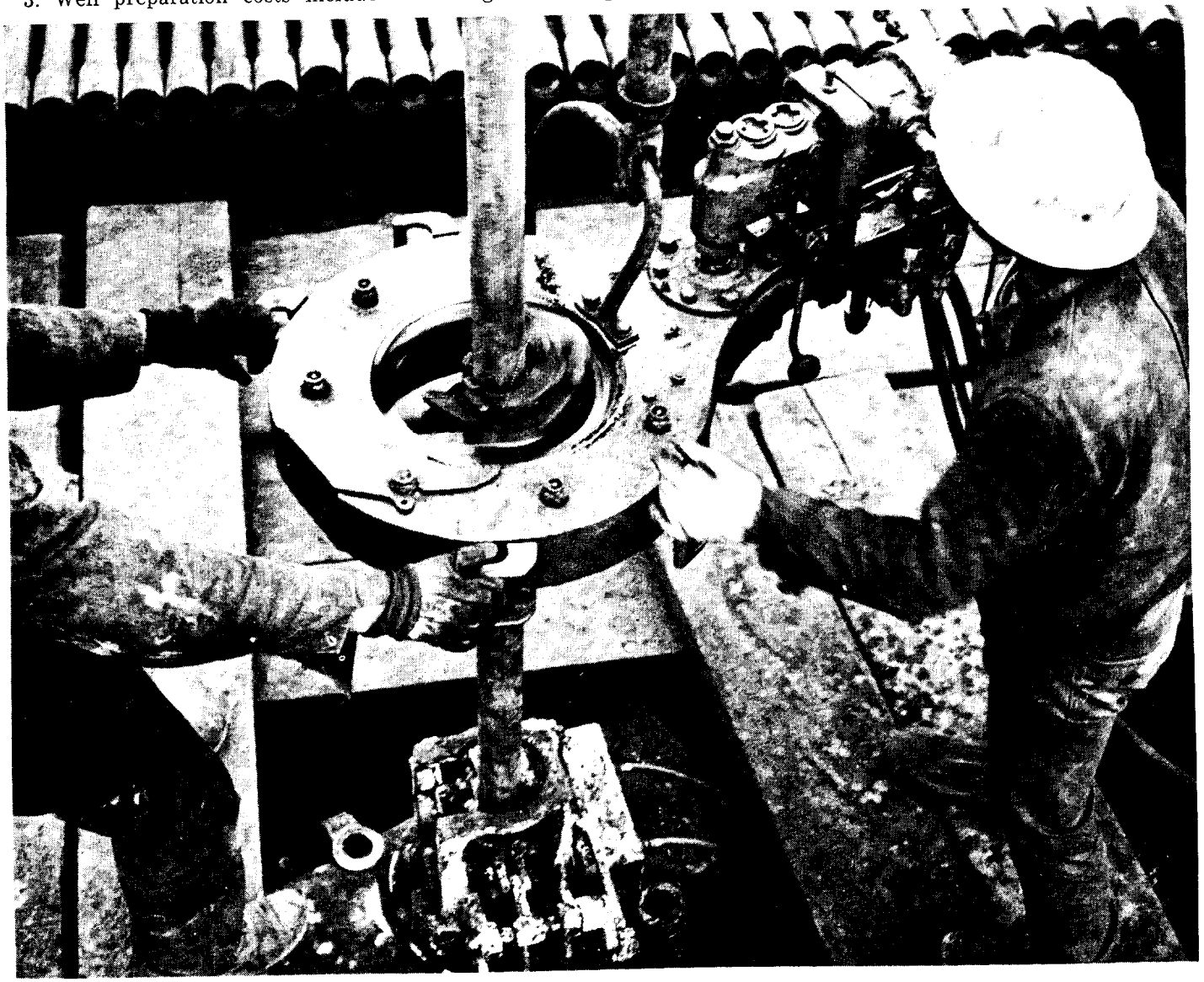


Figure 9

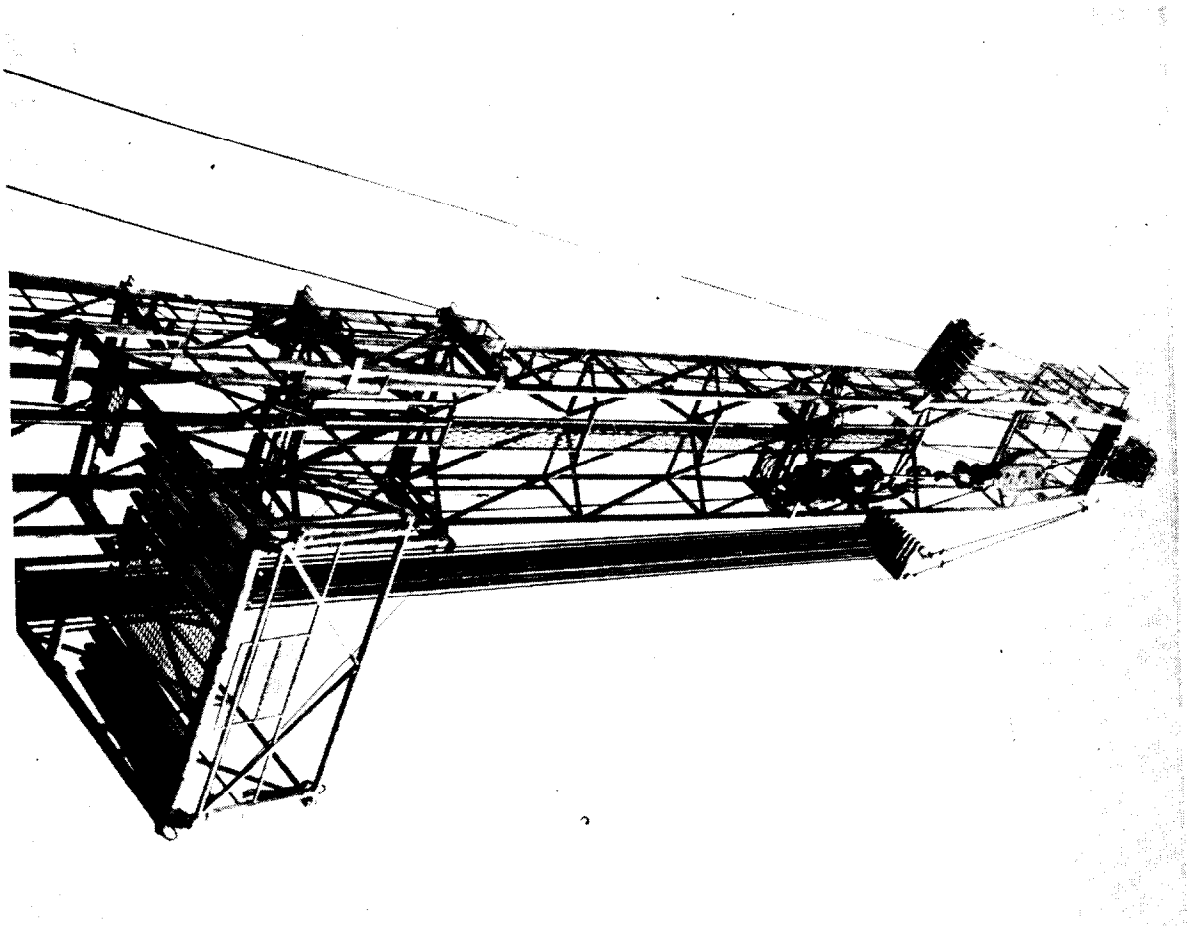


Figure 10

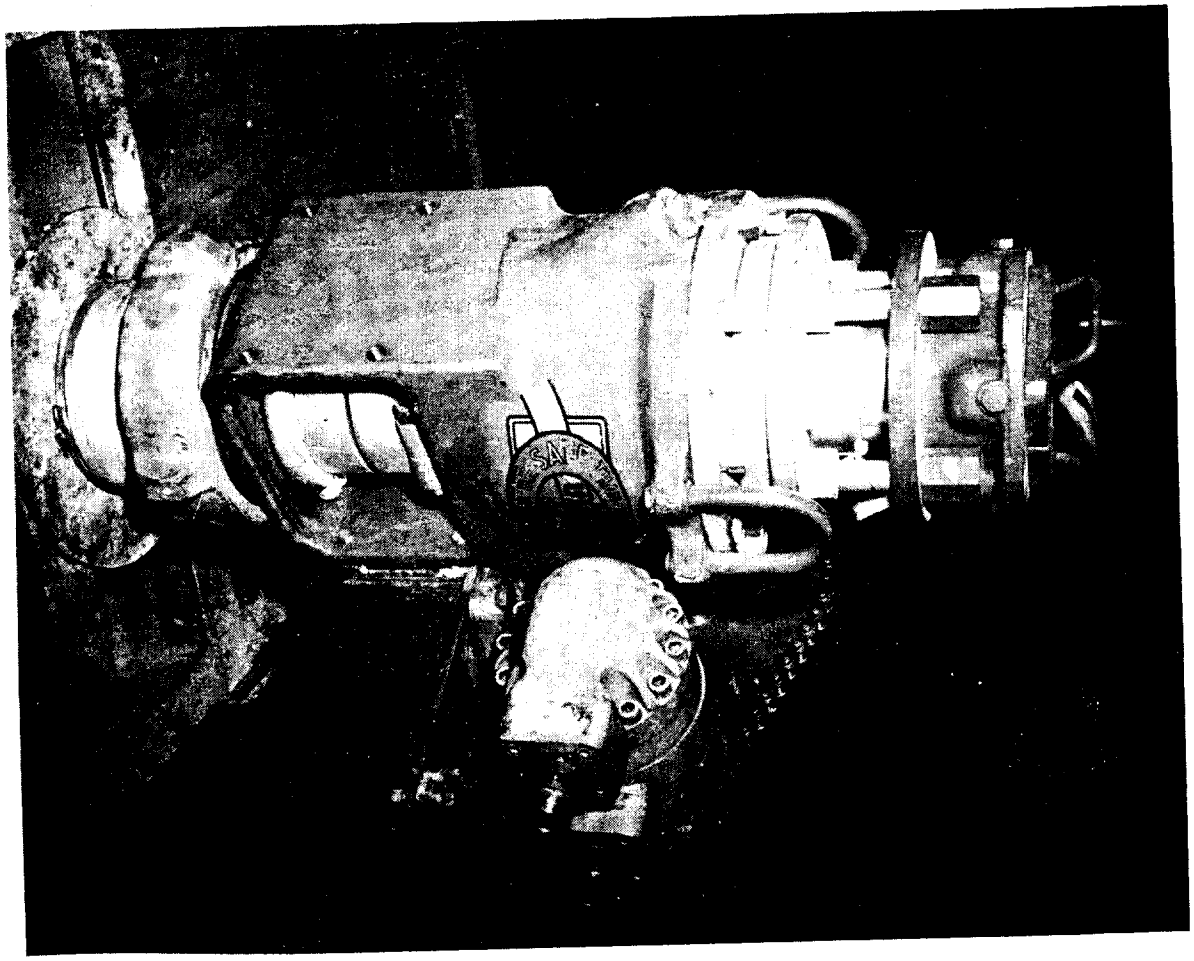


Figure 11

ling of pipe. The air slips require very small quantities of air supply and can be hooked into the normal servicing unit supply system without the necessity of increasing its capacity. The air slips as made by several manufacturers are becoming very popular and provide for better over all efficiency.

One of the most efficient time savers developed for handling sucker rods is the air lift rod transfer which is mounted in the portable derrick. This transfer, powered by an air cylinder, allows the man on the rod platform to free the block or rod weight to start its next trip while the floor man breaks out the connection. As the floorman hooks on the elevator, the rod man uses the air rod lift transfer to place the rod in the finger board. You can see in this manner that the traveling block or pickle is practically in constant motion which provides the most efficient rod handling method. By using this procedure, crews have been stopwatched at running rods into the well at the rate of five double stands per minute, or a return rate of 250' per minute. Again, the effici-

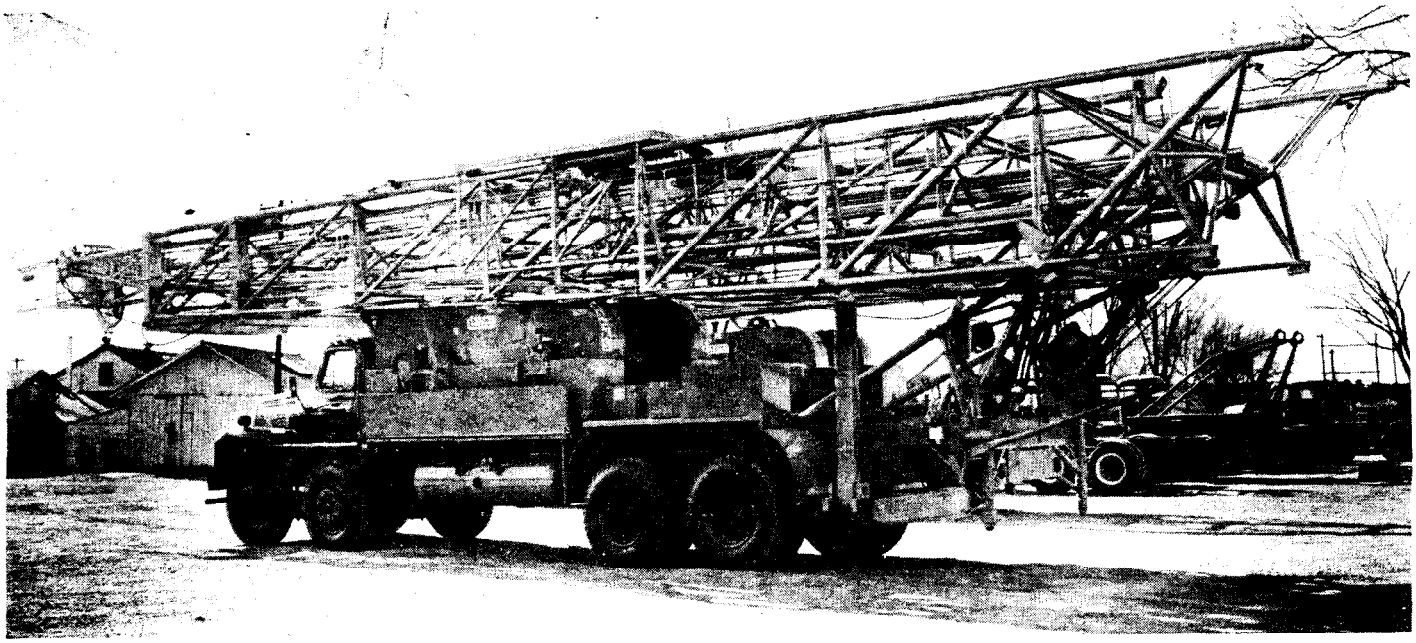


Figure 12

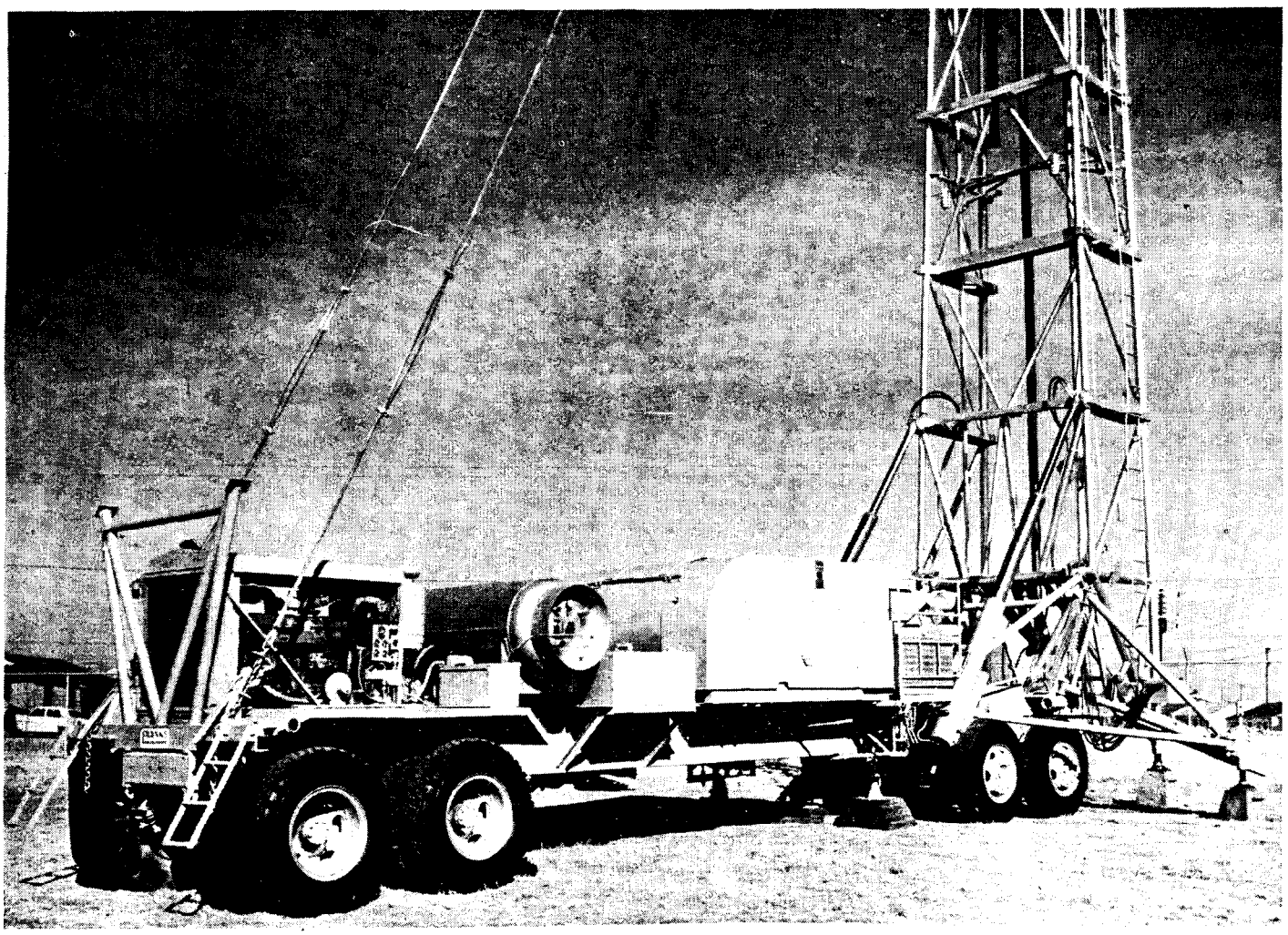


Figure 13

ency of the crew members often determine the limitations of the application of modern well servicing equipment.

Too often, use of these tools is limited by the hourly rate assigned for their pay out. For example, a set of air tongs complete with trailer and air supply is approximately $5,500.

The contractor rates vary for the use of tongs and are in addition to the regular unit rates. For the investment made by the owner, the pay out rate is not only relatively slow, but is reducing the overall number of hours the servicing unit is on location which cuts the total job cost. We hasten to recognize that the equipment that can definitely reduce overall job cost will be popular; but whether the servicing unit is company-owned or contractor-owned, it must show a profit to the owner.

In addition to rod and tubing accessories as considered above, workover accessories require additional equipment to increase the utility of the basic machine. There are three types of drives provided for rotaries. The conventional chain drive to the rotary table; a torque or propeller shaft direct drive, often requiring a reversing for conventional turning tables; and an independent powered rotary drive, set on a separate skid. A fourth development in rotary drives comes primarily for the use of the rotating Guiberson type head. This is a 2,000 PSI hydraulic system, utilizing a 46 gallon per minute pump with an identical fluid motor mounted on the rotating head. Such a drive has a torque control offering maximum protection to the tubing when it is used as a drill string. Under this classification also comes the power swivel, with much less capacity than the hydraulic head drive.

In cable tool workover operations the auxiliary spudder attachment provides the drilling motion for the long line for drilling out cement plugs and deepening operations.

Substructures or elevated platforms provide for varying field requirements largely based on the use of blowout preventer equipment. Substructures vary from the simple platform that has no tubing stacking space, to the elaborate trailer mounted substructure which includes drill pipe racks and telescoping walkways. With the trailer mounted substructure, space is provided to carry many of the wellhead tools and supplies so that they do not have to be handled other than during the workover operation.

Most industrial machinery is designed to operate in a level condition; however, the oilfields provide well servicing units with very challenging situations. Conditions found at the location vary from deep mud to elevated ant hills and steel substructures for pumping units. It has been found very efficient for company-owned equipment to prepare good roads to each well and to provide some form of leveling mat at the location. For normal pole mast use, it is advisable and safe practice to provide deadman for the guylines. Often stakes are driven for this purpose which consume considerable time and provide a chance for an accident.

In many cases, wells which require frequent servicing can efficiently justify a concrete mat on which the servicing equipment may operate with maximum safety. Contractor equipment is not normally provided with the fineries of this type of location preparation, and consequently, contractor maintenance costs are higher.

Considering all the basic servicing machines and their accessories, there are accepted and recommended practices of maintenance outlined by the manufacturers. To obtain maximum efficiency and utility from this equipment, it is very important that the recommendations be followed. Detailed replacement parts manuals are prepared for most equipment and are identified by the serial numbers assigned. Should the parts book for your equipment be misplaced, additional copies may be ordered at any time and in most cases, extra copies are maintained at the owner's Purchasing or Warehouseing office. In most of these manuals, lubrication and operation recommendations are listed. It would be good practice for you to check to see if parts and instruction manuals are available, and if not, order them from the manufacturer.

There are many refinements being designed into modern well servicing equipment which will give longer life and labor saving performance. As previously mentioned, the lighter alloys will definitely have their part to play in the future program. Pawer plants will be available at tremendous savings of weight, and new completion methods for wells may affect the overall picture. As the horsedrawn and powered servicing masts served our early shallow fields, present day equipment will be replaced as economic limits expand.