Selection of Equipment for Multiple Completion Rod Pumping Wells

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INTRODUCTION

There have been many papers presented and many discussions about producing multiple completion wells. In fact, two papers were presented last year at the 5th Annual Short Course. We do not intend to cover the entire field of pumping multiple completion wells but must, of necessity, review some of the past history and accomplishments in this field.

Dually completed wells first came into being during the early 1940's for two reasons:

1. Shortage of steel (tubular goods)
2. Increased demand and price of oil

Dual completions of that day served their purpose and they also disclosed many complex problems to their operators. At that time, there were no specialized tools and practices for dual completions. The early tools were modifications of accepted tools and practices for standard single completions. Cementing techniques, while acceptable for single completions, were found to be unsatisfactory for duals as they allowed the producing pays to commingle. Imperfect packer seals were another common cause of failure.

The poor record of the early dual completions caused a great decline in interest in duals. In the late 1940's, some felt that they would never again attempt to dually complete oil wells. However, during this time, many oil companies, manufacturers, and service companies continued to explore this field, making use of the new materials and scientific facts and minds developed during the war.

New cementing techniques and materials were developed; new synthetics which were far superior to those available in 1942 or 1943 were tried successfully as packing elements. New methods of perforating casing and formations were developed, based on wartime discoveries in explosives; new metals and alloys became available; many eager young men were anxious to try the new and relatively unexplored fields in oil.

There were many new developments during the late 1940's and some were not economically sound or necessary at that time. However, one of the sound developments was the use of tandem oil well pumps actuated by a single sucker rod string. The first installation was made by the Sun Oil Company in the Sun Garcia Field in South Texas. There were many problems and failures connected with this try and the effort was abandoned in favor of two separate wells. Many still believed this method of pumping to be practical, however, and renewed emphasis was placed on this type recovery. In the early 1950's many of the problems were solved and by 1951 the dually completed pumping well was on its way to full acceptance.

We cannot give credit to tools and men alone for this acceptance as a large part of the credit must go to the old bear - ECONOMICS - . As economics was the major reason for the first duals, it is still the largest reason for today's dual, triple and quadruple completions. We, as suppliers, are constantly faced with the problem of supplying you, as producers, with better and cheaper tools or methods to help you to produce more efficiently, thereby enabling you to buy more, to produce more, to buy more, etc.

It's like the bicycle tire - "There ain't no end to it." Still it is a problem of economics and one which I am certain will be with us and with our childrens' children.

Today we want to attempt to bring to your attention some of the developments in the field of pumping multiple completed wells. Let me remind you, though, that well conditions will dictate the type of equipment to be used. All the methods we will discuss cannot be used in every instance; each method will have distinct advantages and disadvantages. Also, bear in mind that you cannot get something for nothing. In other words, you cannot secure a dual well for the same price as a single well. It will be cheaper than two single wells as drilling costs and casing for the second well will be saved, but you will pay more for completion and equipment initially, as well as higher remedial or workover costs.

It is not our intention to give, at this time, the factors involved in sizing the surface equipment for the various types of rod pumping for multi-completion wells. We will only state that you must consider sucker rods and units with sufficient capacity to handle the two fluid loads of tandem pumps in dual pumping.

Perhaps some of the methods we will discuss will be attractive to you and may help you to find an economical application to your particular problem.

VARIOUS METHODS

Two Pumping Unit Method

Casing and Tubing Program

a. 7 inch casing with two 2-inch tubing strings
b. 5-1/2 inch casing with two 1-3/4 inch OD special tubing strings or 2-1/16 inch OD flush joint
c. 5-1/2 inch casing with two 1-1/2 inch OD tubing strings

2. Advantages

a. Extreme flexibility, enabling the operator to vary speed and stroke independently; also, making it possible to shut in one zone while producing the other
b. Simple subsurface equipment. Most manufacturers of subsurface pumps have slim hole pumps for the small diameter tubing
c. Standard equipment which is well understood by pumpers and other operating personnel

3. Disadvantages

a. Greater cost of equipment
   1. 2 units - 2 tubing strings

FIG. 1

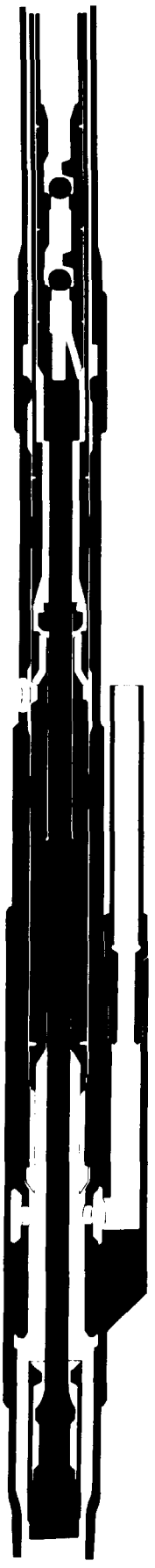


FIG. 2

FIG. 3

2 rod strings - or 3 of each for triple completions

b. Increased hazards of fishing jobs, both pipe and rods
c. Limitation of volume
d. Limitation of depth

One unit with two horseheads and one unit with two carrier bars

1. Advantages

a. Simplified equipment only

2. Disadvantages

a. Inflexible, both zones operate at same speed and stroke
b. Both zones must be continuously pumped unless willing to go to considerable trouble and expense to unhook one well and re-counterbalance
c. Extra large equipment required for 2 rod string
d. Increased hazards of fishing, both rods and tubing
e. Limitations of depth and volume

Simultaneous or Tandem Dual or Triple Pumps

A. Single tubing string with two packers - (Fig. 1)

1. Advantages

a. Cheapest of dual installations
b. Reduced fishing hazards
c. Able to use larger bore pumps and tubing

2. Disadvantages

a. Must use casing annulus for lower zone fluid production. If this zone is corrosive, casing damage may result
b. Increased hazards of commingling as more seals are required
c. Limits packer design as only one can be mechanically set
d. Unable to vent either zone
e. Cannot successfully treat or inhibit either zone

B. Parallel Strings - (Fig. 2)

1. Advantages

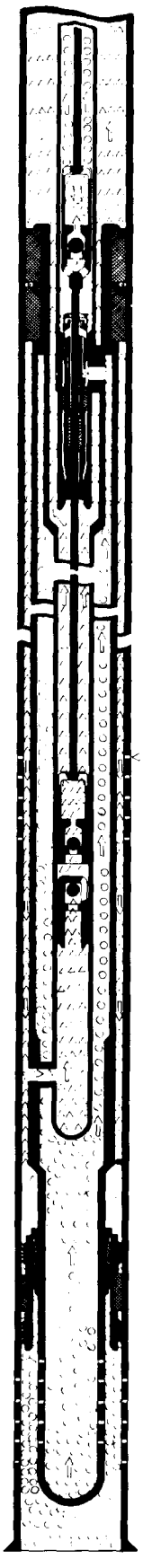
a. Vent and/or inhibit upper zone at will
b. Eliminate upper packer

2. Disadvantages

a. Higher in cost than one string two packers
b. Increased hazards of fishing
c. Some limitation of volume due to size of pumps and tubing

The above advantages apply to both clamped and independently run parallel strings; however, the independently run short string can be pulled without disturbing the pumps, rod, or long string, if desired. This may become necessary in the event of extreme sand or paraffin condition.

B-1. Triple Strings - (Fig. 3)



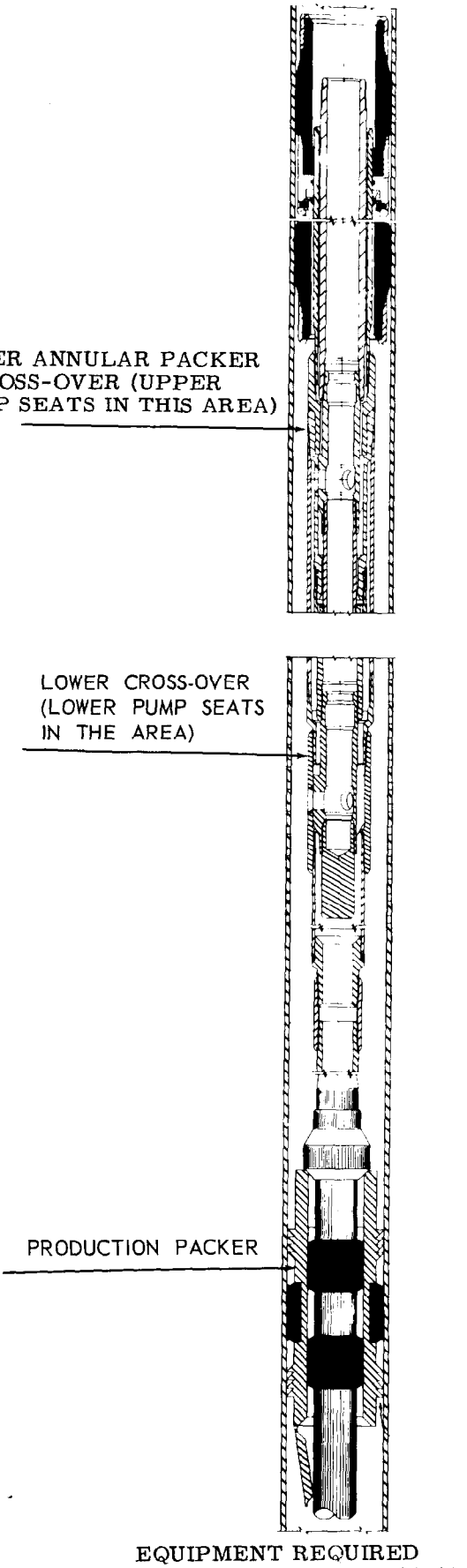
Key:

Upper zone fluid

Lower zone fluid

Direction flow

SCHEMATIC DIAGRAM OF DOUBLE CROSS-OVER ASSEMBLY SHOWING FLUID FLOW.



EQUIPMENT REQUIRED FOR DOUBLE CROSS-OVER INSTALLATION

FIG. 4

In this type of operation, when used for rod pumping dual wells, the third string is used to vent and/or inhibit the lower zone. Inside 5-1/2 inch casing this third string must be clamped to the long string and generally the three strings are clamped together. In 7 inch casing where two strings of 2 inch tubing are used, the lower segment of the macaroni string is clamped to the main string from the packer to the crossover. The upper or longer segment is run independently inside the short 2 inch string and landed in the receptacle provided in the crossover tool, thereby giving complete independent access to the lower zone.

The sole advantage of this is the ability to treat or vent the lower zone at will. The disadvantages are:

a. Increased fishing hazards
b. More tubing to handle
c. Special vent type packer for zone separation

c. Triple simultaneous rod pumping

In this operation three zones are produced with three pumps actuated by a single pumping unit and one sucker rod string, part of which must be hollow rods. The lower packer is set to separate the bottom and middle zones and the crossover installed approximately 100 feet above this packer. A second vent type packer for middle and upper zone separation is then installed with macaroni tubing clamped to the main string between the crossover and the vent packer. The third zone is then introduced into a "watermelon" or "pickle" which is placed in the upper segment of the long string. The middle zone fluid is bypassed through this tool and the upper zone fluid is then pumped through hollow rods to the surface.

1. Advantages

   a. Three producing zones can be pumped at relatively low equipment cost.

2. Disadvantages

   a. Requires two packers plus two tubing strings
   b. Volume limitations by size of pumps and tubing
   c. Inability to treat or vent any but the upper zone
   d. Fishing extremely hazardous and difficult.

D. Double Crossovers - (Fig. 4)

This equipment is designed to permit dual pumping of wells which have an extremely heavy lower zone and a very light upper zone. It can also be used where parallel strings are not wanted or where the lower zone fluid is extremely corrosive and it is desirable to keep it away from the casing. In order to prevent pounding fluid in the light zone and to allow the use of a stripper or small bore pump to handle the low producing upperzone, the upper zone fluid is not permitted to enter the crossover at its normal point; it is

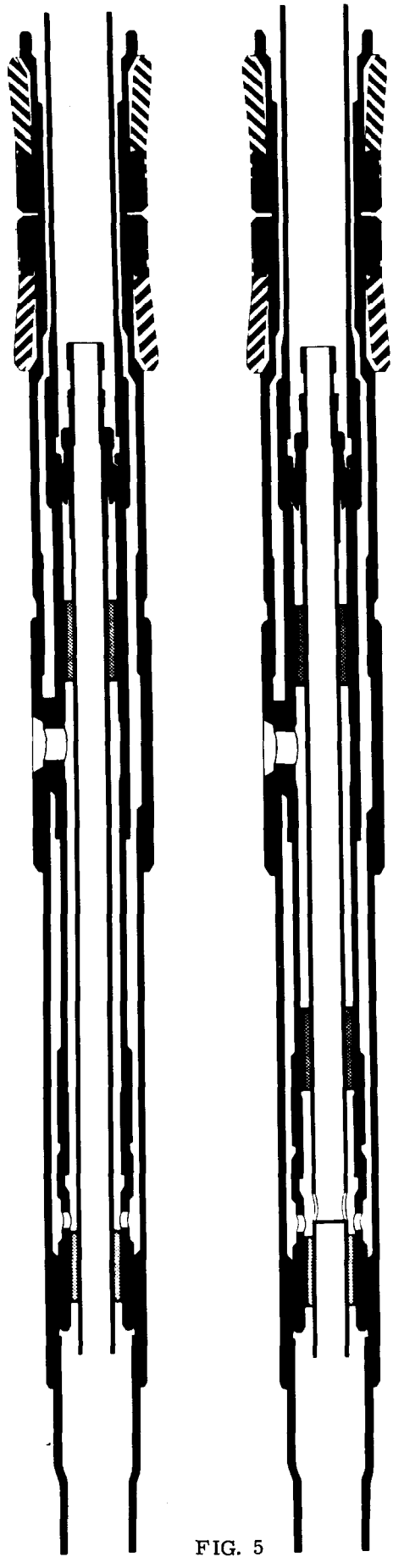


FIG. 5

introduced below the crossover and above the production packer. It is then handled as though it were the lower zone production and crossed at the crossover tool. The lower or heavy zone is brought into the crossover at the normal entry port for the upper zone and then handled as though it were the upper zone fluid.

1. Advantages

   a. Control of corrosive fluids
   b. Able to handle two widely different producing zones

2. Disadvantages

   a. Bulky and more complex down-hole equipment
   b. Increased hazard in fishing jobs

E. Hollow sucker rods have been used in several wells to control corrosive fluids from the upper zone as well as to inhibit or treat the upper formation.

1. Advantages

   a. Able to effectively prevent corrosive fluids from contacting the casing
   b. Elimination of upper packer and parallel string
   c. Reduced cost

2. Disadvantages

   a. Limited in depth and volume on both zones

Some Recent Developments

F. Some recent developments in pumping multiple completion wells are:

1. Use of spring loaded traveling valves to regulate production from either or both zones.
2. Gas re-entry by the use of special tools. Gas is taken from the tubing below the lower pump by means of a bypass production packer or a vent tube below the lower pump seat and then reintroduced above the lower pump, either directly into the tubing string or into the parallel string or casing annulus at the crossover.
3. Dual pumping in slim hole completions requires the use of two packers as there is insufficient room for parallel strings of effective size within 4-1/2 inch or smaller casing. The same advantages and disadvantages of a two packer installation in 5-1/2 inch or 7 inch casing are inherent in the smaller tools.
4. Simplified upper pump standing valve which is attached to the upper pump and is a true standing valve, operating around the lower polished rod. In this design it is possible to retrieve the standing valve with the rod string and no special holddown or releasing equipment is required. See Fig. 2
5. Increased flexibility of wire line retrievable chokes or separation sleeves which enable the operator to use either tubing string for either produced fluid or to block one zone completely and use both strings for the other zone. These new tools give the operator greater access to either zone for treating, plus the ability to swab

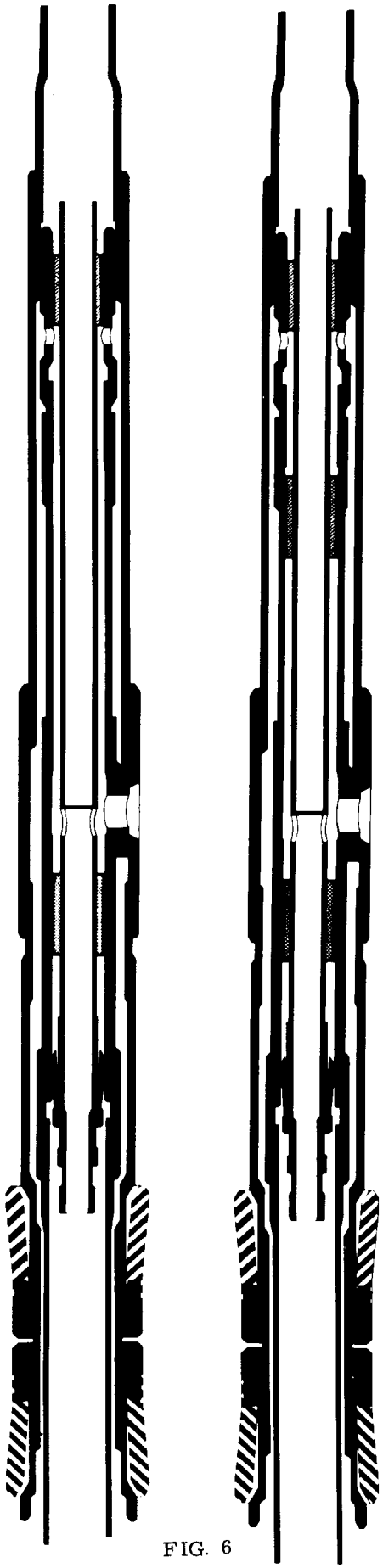


FIG. 6

either zone and produce one zone fluid through both strings. This is especially desirable in cleanup work or to kick off a zone which will continue to flow while the other must be pumped. Other wire line retrievable chokes are available to enable the operator to take packer leakage tests by applying pressure to the secondary string or casing annulus. See Fig.'s 5, 6, and 7

SUMMARY

It may be said that while simultaneous rod pumping of multiple completed wells still presents some complex problems, there is a wide variety of equipment available which will enable many operators to make commercial wells from producing zones that were once considered uneconomical.

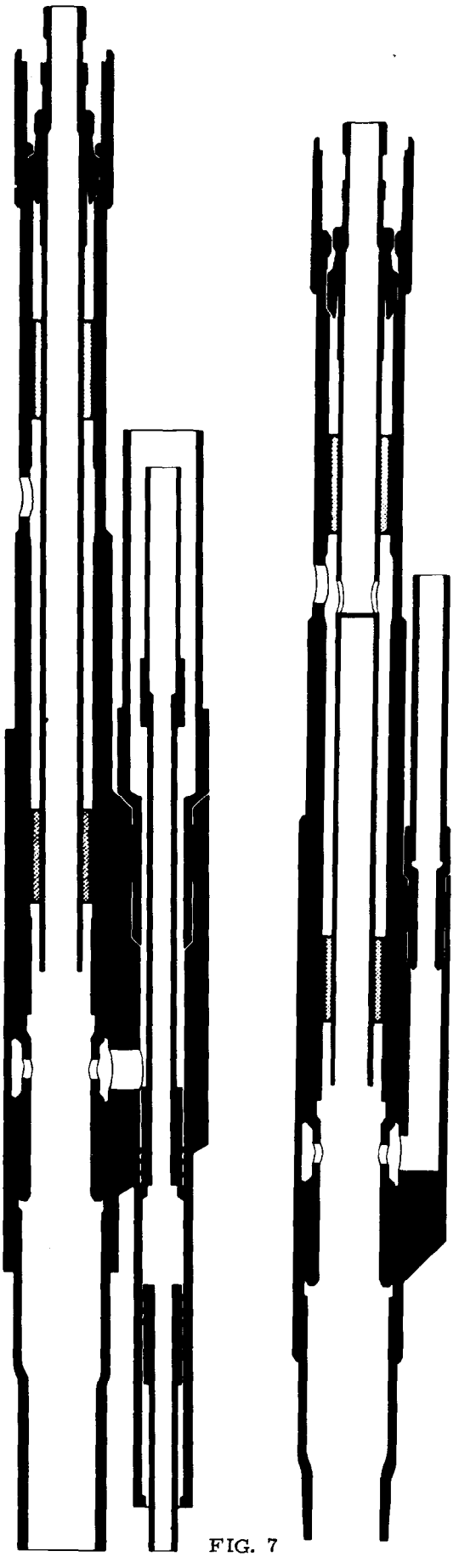


FIG. 7