Selecting Gas Lift Equipment for Various Types of Wells

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FACTORS TO CONSIDER IN CHOOSING EQUIPMENT

In selecting gas lift equipment, there are several factors which must be given careful consideration. As each field has individual and distinct characteristics which make it different from others, these factors should be considered in the following sequences:

A. Type of well.
B. Problems of producing the well and the over-all production cost.
C. Problems to be considered in installation, work-over, and work-over cost.
D. Over-all cost of gas lift equipment and work-over on a two-year basis.

Type of Well

The type of well must be given first consideration, taking into account the following:

Is it a high or low productivity well? This is usually determined by past production performance. If the total fluid production exceeds 300 barrels and the well is capable of producing this amount or more, it is a safe rule that it will produce it more efficiently by continuous flow.

In the design of any gas lift installation, the spacing of the valves is of primary importance. It is first necessary to locate the most efficient point of injection for the desired rate of flow, with the available lift gas pressure, volume and wellhead back pressure taken into account. There are several methods used by oil companies and gas lift companies to locate the point of injection. Some are more exacting than others, but accuracy depends on the available information on the well. It is necessary that the following data be accurate in order to permit proper calculations for installing gas lift equipment:

1. Static bottom hole pressure.
2. Available operating gas pressure and volume.
3. Static fluid level.
4. Depth to producing zone.
5. Total fluid production desired.
6. Productivity index.
7. Size of tubing and casing.
8. Percentage of water, specific gravity and rate of increase.
9. Rate of decline of bottom hole pressure.
10. Separator pressure and estimated back pressure at wellhead.
11. Oil gravity.
12. Size and length of flowline with approximate number of sharp bends.
13. Sand, paraffin, scale and corrosive potentialities of well.
14. Bottom hole temperature and estimated wellhead temperature at normal rate of flow.
15. Formation gas gravity and lift gas gravity.
16. Formation gas-oil ratio.

If most of this information can be obtained before an installation is made, the type of gas lift, as well as the proper valve spacing, can be readily determined, taking into consideration the future conditions of the well as well as the present conditions.

The type of installation must be considered, such as dual completion, single completion, chamber installation, open-hole installation or casing flow. Each is different in that the problems of one may not apply to another.

Problems Of Producing The Well And The Over-All Production Cost

Producing the greatest amount of oil in the most efficient manner is the primary concern of all operators. With a properly designed gas lift installation in the well, it becomes the problem of the production men to produce it efficiently. Proper regulation of the injection gas is the principal concern, either in continuous flow or intermittent lift.

Correct application of continuous flow requires an understanding of the basic theory underlying it. To efficiently constant flow, a well has to have a high P.I. (productivity index) and a high enough bottom hole pressure to maintain a high static fluid level. By aerating the fluid column through controlled constant injection at the deepest point that the lift gas pressure will permit, the bottom hole pressure of the fluid column will be lessened to a point where it will be less than the formation static bottom hole pressure. When this condition exists, the well will flow. With this method, it is possible to flow tremendous quantities of fluid. In fields which are producing from the Ellenberger, Hendrick Reef lime, or other water-drive formations, water encroachment is a major problem in that the increasing percentage of water to oil requires more total fluid production. This can be produced more efficiently by continuous flow.

The limiting factors of efficient continuous flow are the extent to which the flowing gradient of the fluid can be lightened with efficient gas fluid ratios and the resulting friction caused by the increased velocity of the fluid. Excessive back pressure should be avoided as it works directly against the lift pressure.

Two Types of Continuous Flow

There are two types of continuous flow. One is used as a well purger, as in the case of a well that will flow but will log up with water and die if gas is not injected into the flow tube. A small size choke is installed in the gas injection line at the wellhead along with a controller with a pressure element. The pressure element of the controller is connected to the tubing and set so that a drop in tubing pressure below normal will cause the controller to inject gas into the well until the tubing pressure returns to normal. There is sometimes danger of overproducing a well of this type so that it may be necessary to choke the flow at the wellhead to control it. This is one of the few instances where a surface choke in a flowline is desirable in gas lift.

The other type of continuous flow is constant injection and is generally used in wells producing a large percentage of water where it is necessary to produce large volumes of fluid in order to produce oil allowable. In this type of well, injecting the proper volume of gas into the flow tube at the efficient point of injection is of utmost importance. The use of gas lift valves with fixed orifices makes it a problem to regulate the proper volume of gas; however, there is a valve which operates as an expanding or contracting orifice which will inject the same volume of gas into the flow tube as the surface gas injection choke is flowing into the annulus. This makes it possible to efficiently regulate the gas volume to produce the well in the most efficient manner. In this type of well, a surface flowline choke should never be used except in rare instances.

<u>Intermittent Lift</u>

Wells which fall in the classifications of high P.I. low bottom hole pressure, low P.I. high bottom hole pressure, or low P.I. low bottom hole pressure cannot be produced efficiently by continuous flow. As a large percentage of secondary producers fall in this category, there has been a great deal of development in this type of lift, which is known as "intermittent" or "slug" lift.

In an installation of this type, a string of pressure controlled valves is installed. These operate in much the same manner as back pressure regulators. The method of installation is such that each consecutive valve is slightly lower in pressure than the valve above it. A pressure increment of 20 or 25 psi is generally used between valves. The lowest pressured valve which will pass gas into the fluid column is the valve located

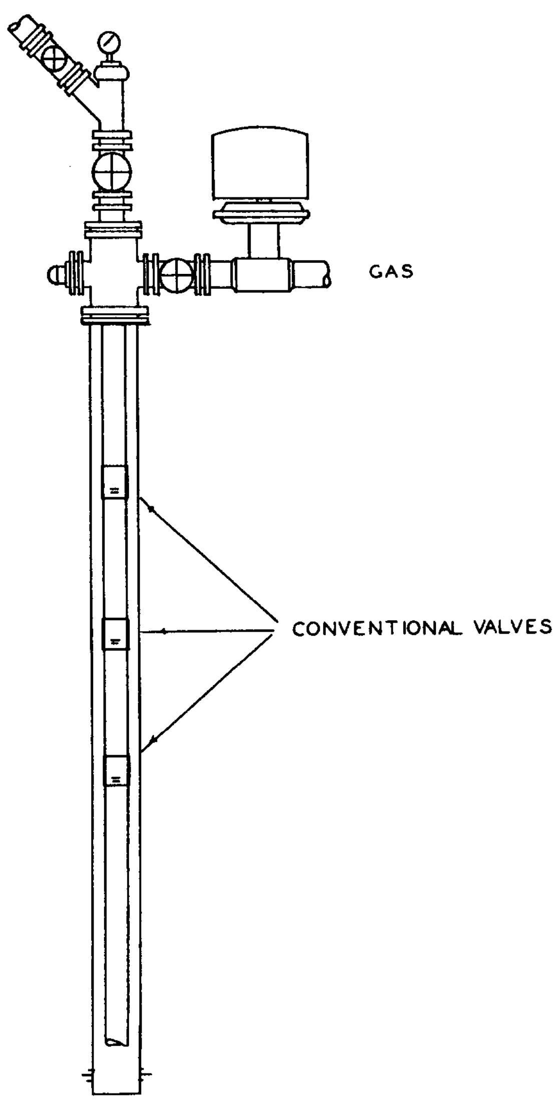


Fig. 1 STANDARD VALVE OPEN INSTALLATION

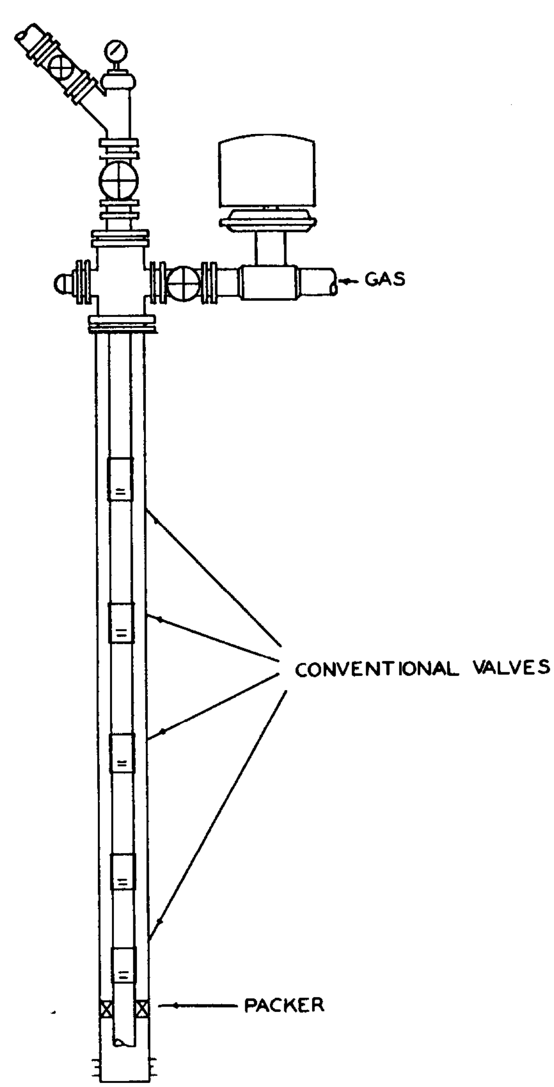


Fig. 2 STANDARD VALVE SEMI-CLOSED INSTALLATION

below, and nearest, the top of the working fluid level. This valve opens when the annular pressure exceeds the set pressure of the valve. Through expansion and displacement by the gas, the fluid head above the point of injection is lifted in a piston-like slug with sufficient velocity to fully clear it through the educator tube.

The maximum number of complete cycles that may take place in a twenty-four hour period depends on the depth of the working fluid level and the rate of fill into the well bore from the producing formation to establish a number of heads that produce the greatest volume of oil with the least gas-oil ratio. Sufficient time is required for the fluid head to travel to the surface, unload into the separator, exhaust the gas behind the fluid head, and still leave time for the well fluid to build up again to its efficient fluid level. A good rule of thumb of 100 psi of lift gas pressure per thousand feet of lift with a minimum total pressure of 250 psi can usually be followed with efficient results to depths ranging to 4,000 feet. Experience has proved that a pressure of 500 psi is sufficient at depths from 4,000 to 6,000 feet, 600 psi at 6,000 to 8,000 feet and 700 to 1,000 psi for depths to 12,000 feet.

Large Ported Valves

Large ported valves that give controlled gas injection are the most efficient in producing low volume gas lift wells. These operate by injecting a large volume of gas quickly under the fluid head and maintaining sufficient pressure to lift it in a piston-like slug to the surface with a minimum amount of gas. Slippage must be held to a minimum in intermittent lift. The gas must act as a solid piston under the fluid head, keeping it moving together at all times. The instant this fluid is permitted to slow down, a portion of the fluid falls back into the hole. It is most important, therefore, to have a gas lift valve that has a port area large enough to maintain sufficient pressure and volume under the fluid head all the way to the surface.

The regulation of gas injection in intermittent flow is more difficult than in continuous flow. It requires constant gaging over at least a twenty-four hour period, keeping a record of time adjustment both in cycle and injection. At least four different settings should be made in order to find the most efficient time adjustment.

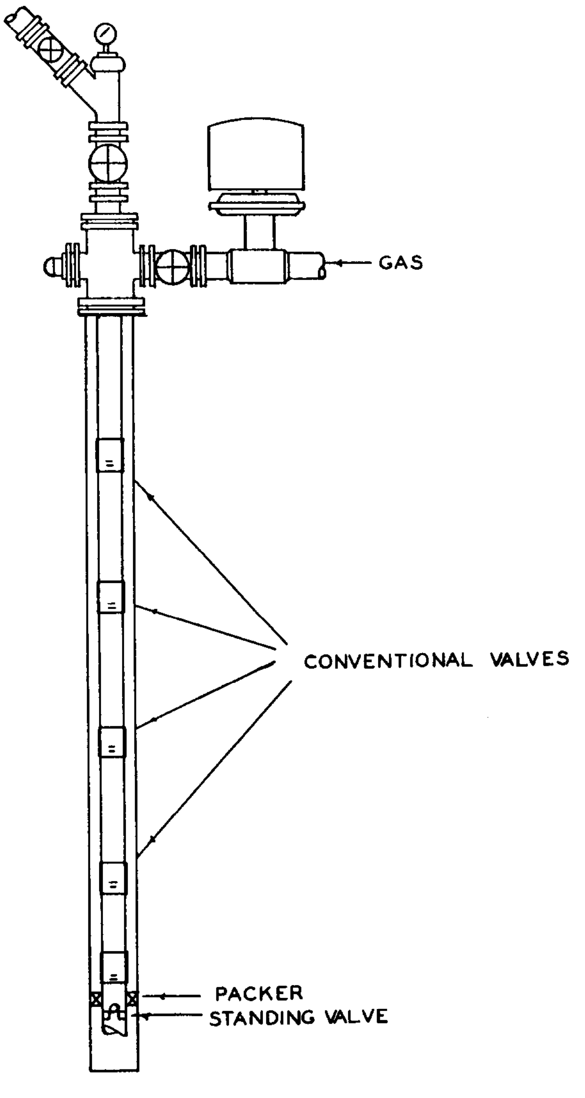


Fig. 3 STANDARD VALVE CLOSED INSTALLATION

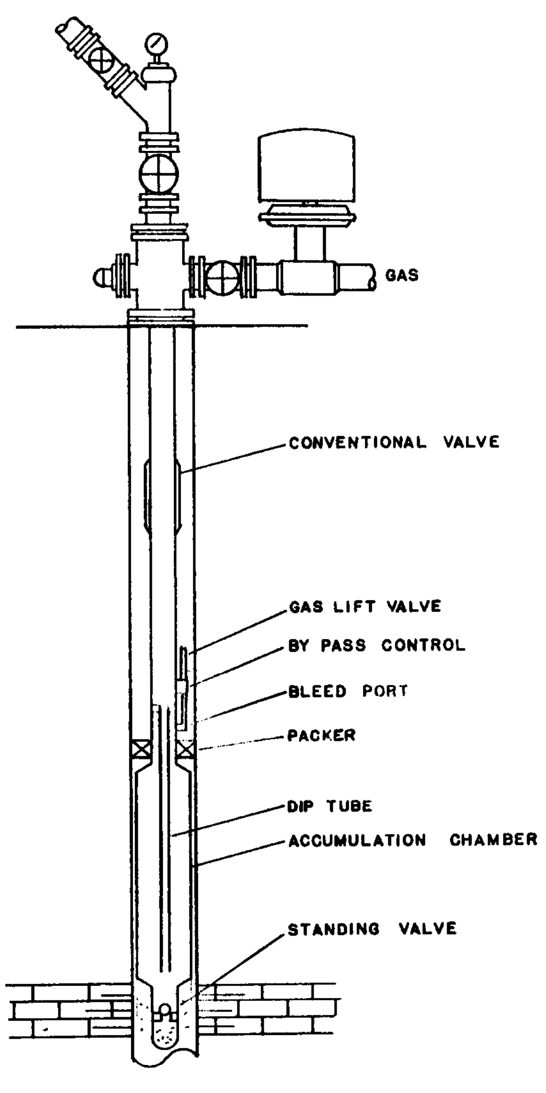


Fig. 4 BY PASS ACCUMULATION CHAMBER INSTALLATION

In this type of lift, any restriction such as paraffin, chokes, bends and long flowlines should be avoided. It is necessary to have ample pressure and volume in order to minimize slippage.

The gas lift valves should be large-ported, balanced in respect to opening and closing pressures, which are approximately the same, and should not have an uncontrolled period after the valve opens in which it cannot be closed until it reaches a much lower pressure. With the balanced gas lift valve, there is complete control of the gas volume injected into the tubing, which results in the recovery of a maximum fluid head with a minimum of gas.

Lift Gas

Lift gas source and recovery of lift gas are vitally important in efficient gas lift. The demand and ready market for natural gas has increased the use of compressors; as a result, this has increased the use of gas lift for artificial lift production. The gas is compressed and used to lift the wells that will not flow. Formation gas is recovered along with the injected gas, and the surplus is sold. In order to do this, a supply of make-up gas is necessary.

It is also necessary to minimize leaks and carefully regulate the injection of gas in the gas lift wells. Inefficient regulation increases the horsepower demand on compressors and limits the number of wells that might be lifted efficiently. Lift gas storage volume is sometimes a problem that can be partially solved by utilizing the annular space in pumping wells or an abandoned well. It is necessary that gas injection lines, suction lines and flowlines be of sufficient capacity to meet present and future demands.

Closed Rotative Systems

Closed rotative gas lift systems offer simple, low operating cost means of producing oil wells to depletion. Most wells will produce enough formation gas to operate the compressor's prime movers and to make up for normal leakage that occurs in the system. There will be less upkeep of machinery and fewer man hours required to care for a gas lift system than in other means of artificial lift. The surface equipment cost is small in comparison with other lift methods. It consists of intermitters or chokes and gas lines to the wells.

Compressor plants can be purchased as package units, and it has been found in most cases that it is better to use smaller units, and add them as needed, than to buy one large unit. The reason is that the full horsepower requirements of the smaller units can be used, whereas if a large unit is bought to handle present and future needs, it will operate for a long period without approaching its full capacity. There is also the problem of "down" time. With a large unit, all production is off; in the use of smaller units, only a percentage of the wells are off.

Problems To Be Considered In Installation, Work-Over, And Work-Over Cost:

There are many problems to be considered in the installation and work-over of gas lift equipment. With the introduction of retrievable gas lift equipment and the prospect of many new advancements now being developed, there will be occasions where it will be more desirable to use than conventional equipment; however, conventional equipment definitely has its place. These valves have been improved through new design. They now are concentric, full opening, and have O.D.'s of collar dimensions. They have tensile strength greater than N-80 tubing and will withstand pressures in excess of 6,000 psi without damage. Their operation is versatile.

A simple surface charge will convert the type of lift from continuous flow to intermittent lift, or vice-versa. As the cost of conventional equipment is approximately one-half of the cost of retrievable, it is in most cases economically feasible to use it. A well that is easily pulled may have the valves changed at less cost to the operator than the same well with wire line valves, with the advantage of being able to clean out the perforations and check the tubing and packer along with the valves.

In wells where rig cost is expensive or where it is practicable to permanently complete, retrievable equipment has many advantages. In dual completions where work-over has many hazards, it is necessary to install equipment that can easily be removed. It is a good policy to be able to rotate at least the short string. If gas lift is to be used for both zones, the long string may be equipped with retrievable valves; however, the short string should have full open tubing and have an O.D. no larger than the collars, the reason being that in case the tubing becomes stuck, it can be rotated to back off. This can only be done with conventional full opening, collar O.D. gas lift valves.

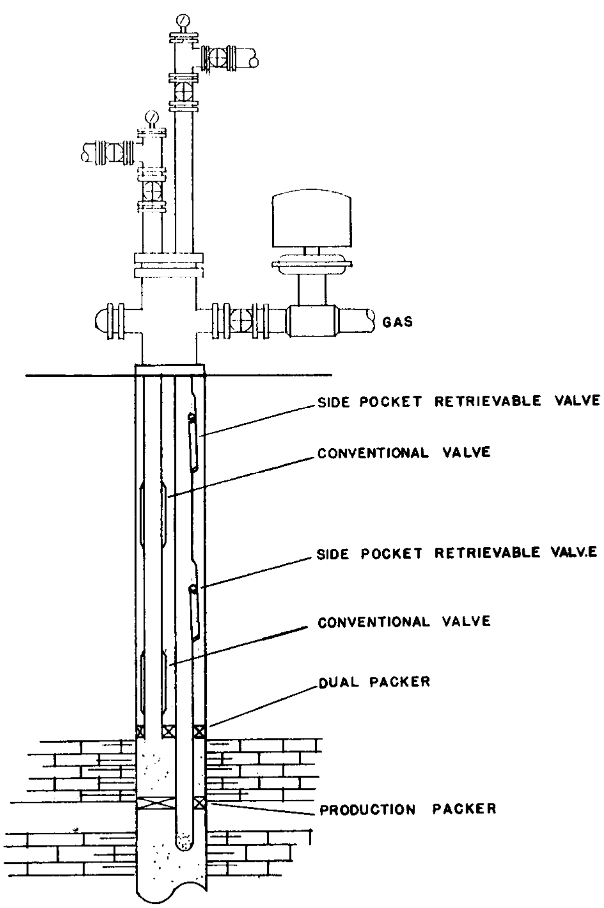


Fig. 5 DUAL COMPLETION

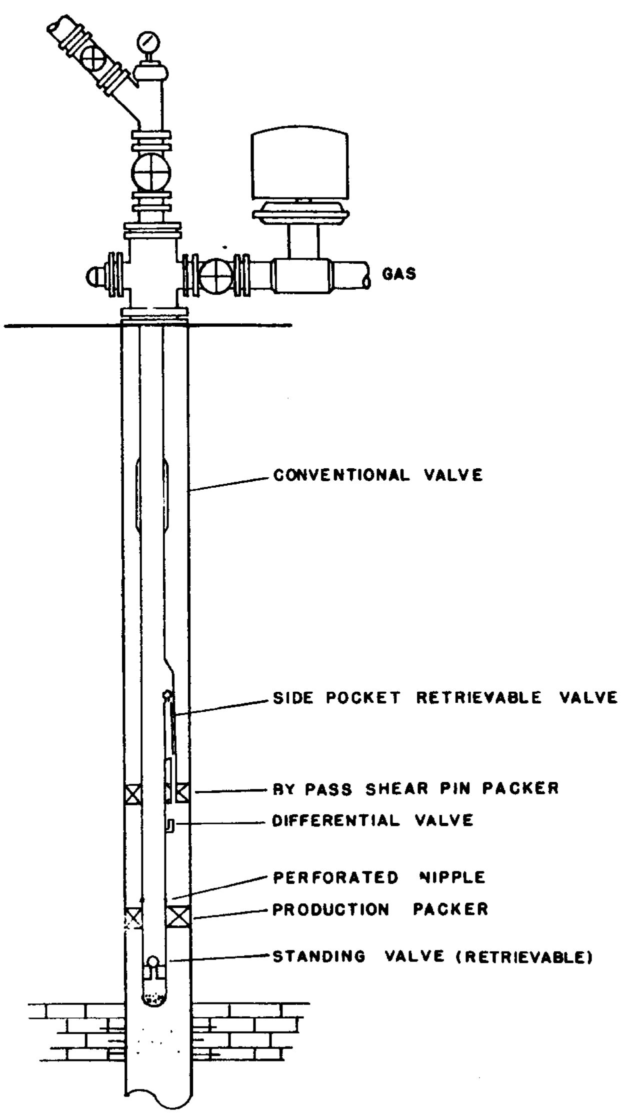


Fig. 6 RETRIEVABLE DUAL PACKER CHAMBER INSTALLATION

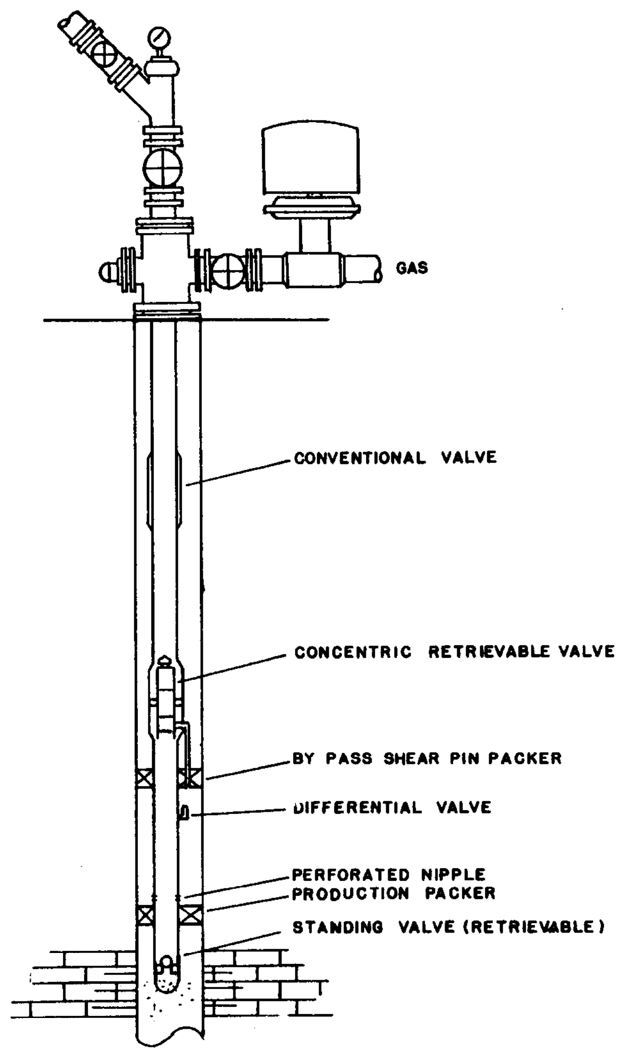


Fig. 7 CONCENTRIC RETRIEVABLE DUAL PACKER CHAMBER INSTALLATION

Chamber Installation

In chamber installation design, many methods have been used. It is good to keep in mind that the tubing should be full opening if possible in order to have a wire line retrievable standing valve. A retrievable operating gas lift valve is desirable in many cases; however, a conventional valve is also applicable, and may be used to a better advantage than a retrievable in many instances.

In selecting a valve for chamber installations, careful consideration should be given to the valve. A valve with an uncontrolled "spread" would be undesirable, as the conditions in most chamber installations would be such that the separator pressure would be the only pressure effective on the stem area of the valve; as a result, the valve would have its greatest "spread" between opening and closing, and a great deal more gas would be used than necessary on these small volume wells. A balanced valve with a large port permits controlled gas injection and is ideal for this type of well.

Over-All Cost Of Gas Lift Equipment And Work-Over On A Two Year Basis:

It is generally a good policy to use a two year period as a basis for estimating the length of time a string of gas lift valves will remain in service. The conditions affecting the removal of gas lift valves are many. They range from a plug back and producing from a new zone, fracturing the formation, valve repair, gravel packing, well repair, dual completion of a well that was a single completion, and countless others. For this reason, the initial cost of the gas lift equipment, the repair cost, and the frequency of changing the valves either due to repair, or to change from one type of lift to another, are factors that must be carefully considered by the operator.

Comparison of conventional gas lift valves and rig cost versus wire line truck cost and the added cost of wire line valves must be considered. Careful consideration must also be given to the possibility of having a "fishing" job. It is always good practice to have

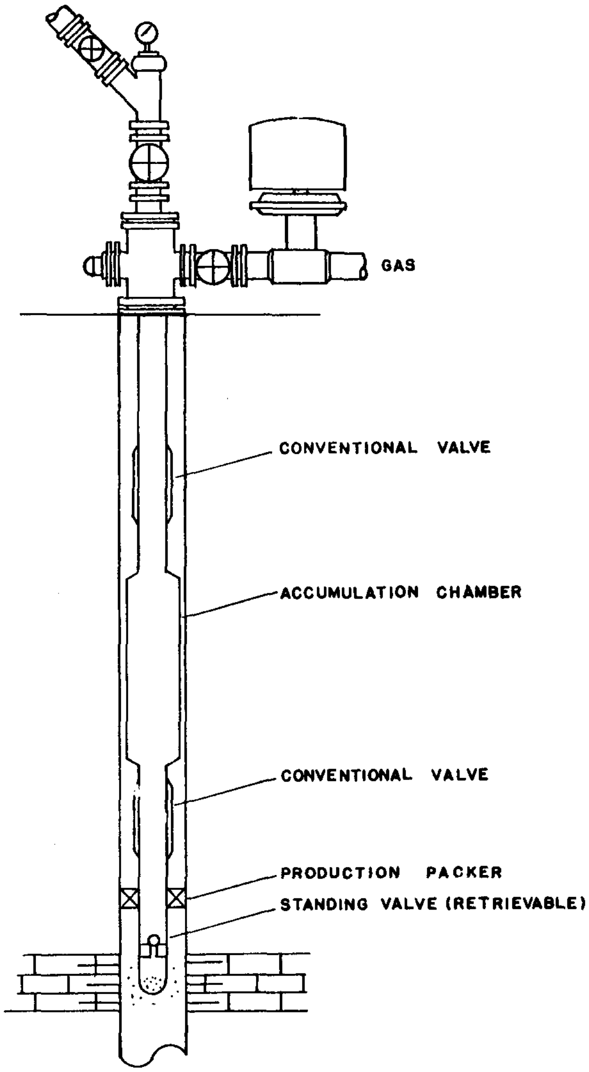


Fig. 8 SINGLE PACKER ACCUMULATION CHAMBER INSTALLATION

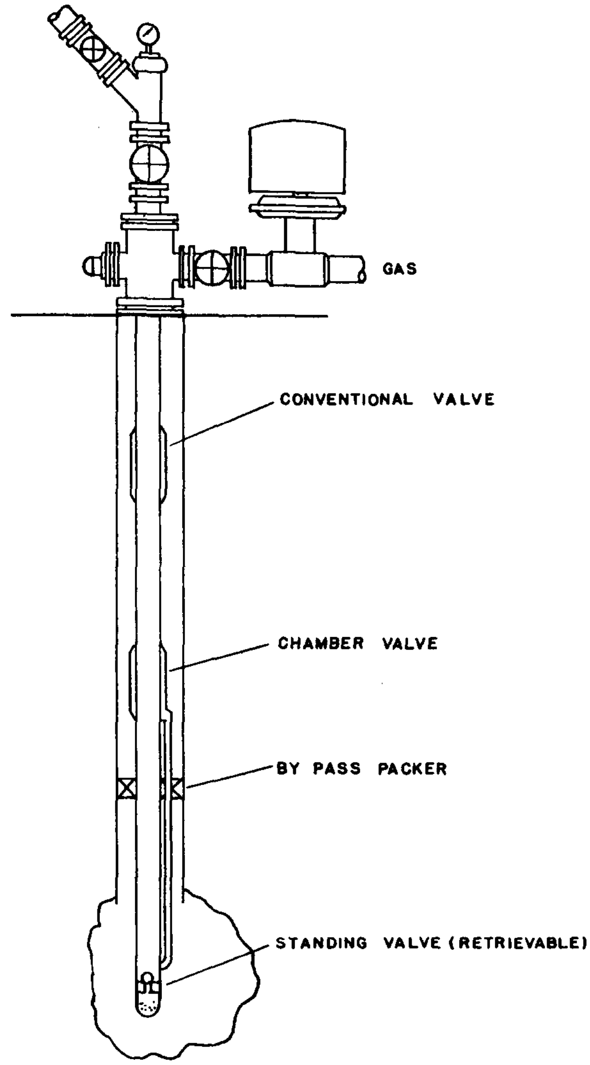


Fig. 9 OPEN HOLE DIP TUBE INSTALLATION

equipment in a well that can be rotated in order to back off, and that has a tensile strength equal to or greater than the tubing. The necessity of washing over, or inside, the gas lift valves, and the heavy jarring or pulling that is many times necessary, makes the selection of gas lift equipment important.

It is difficult to thoroughly cover this subject in such a brief paper, but the main points of interest have been mentioned and may bring to mind others that are related.

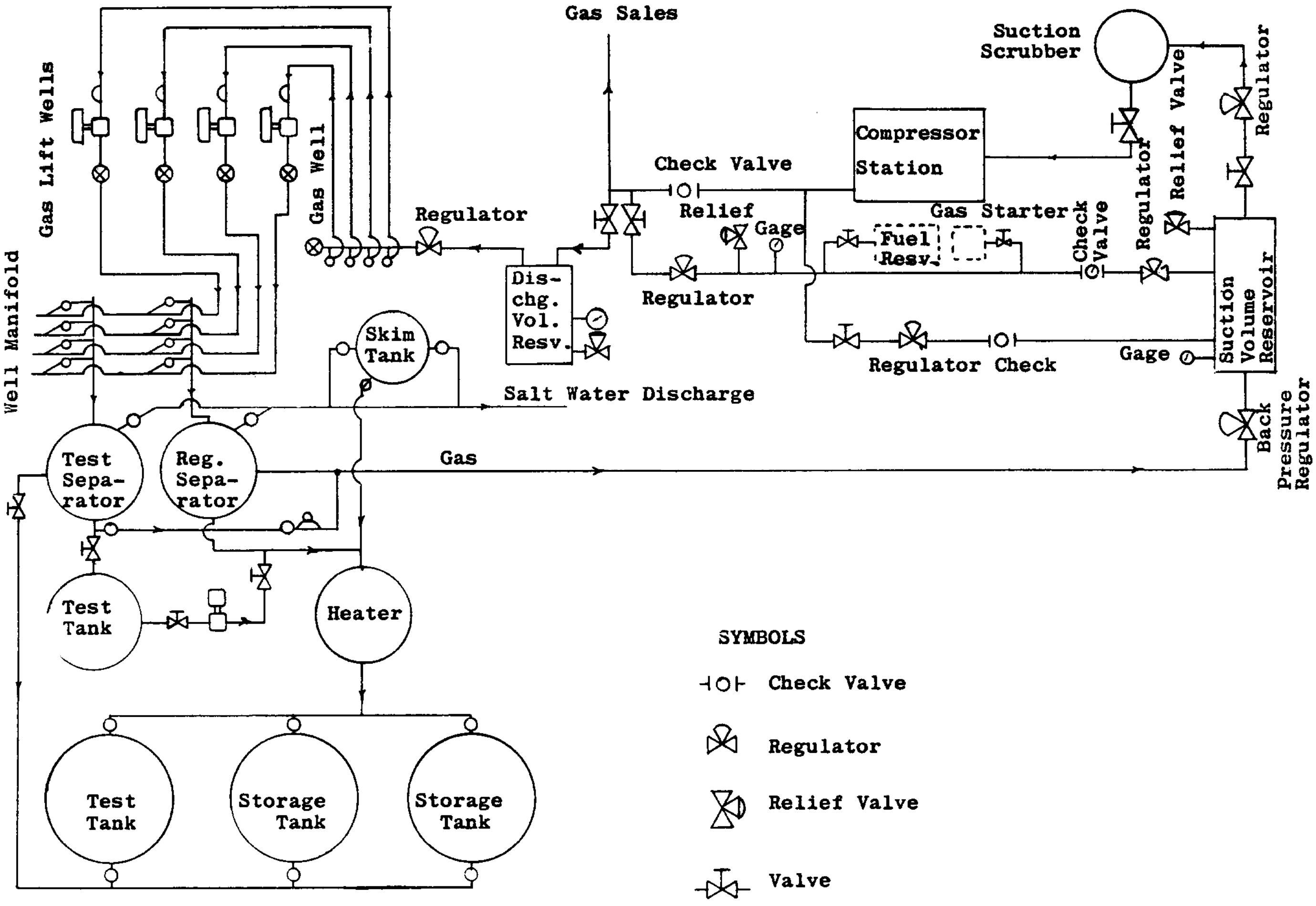
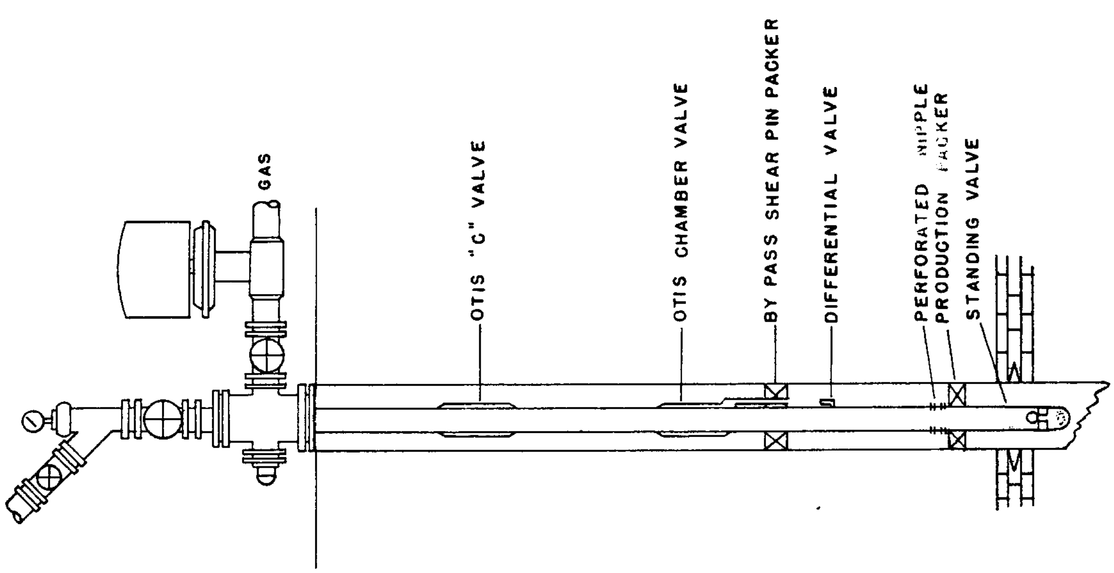


Fig. 10



STANDARD DUAL PACKER CHAMBER INSTALLATION

Fig. 11