Dec. 17, 1929. F. W. LAKE 1,740,106

CENTRALIZED HEADER SYSTEM FOR GAS AND AIR LIFT OPERATIONS

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Fig. 1.

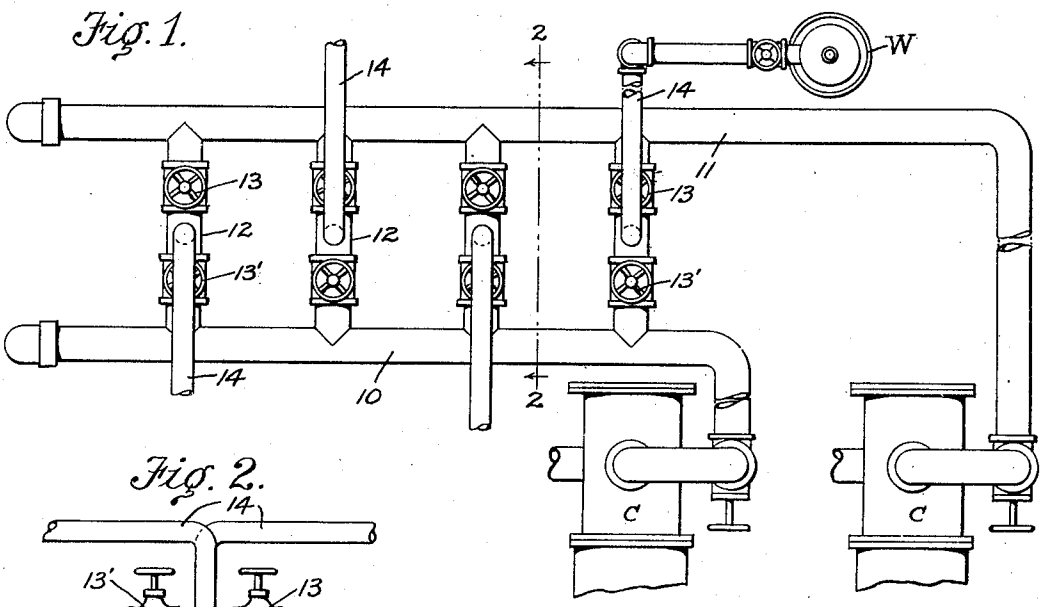
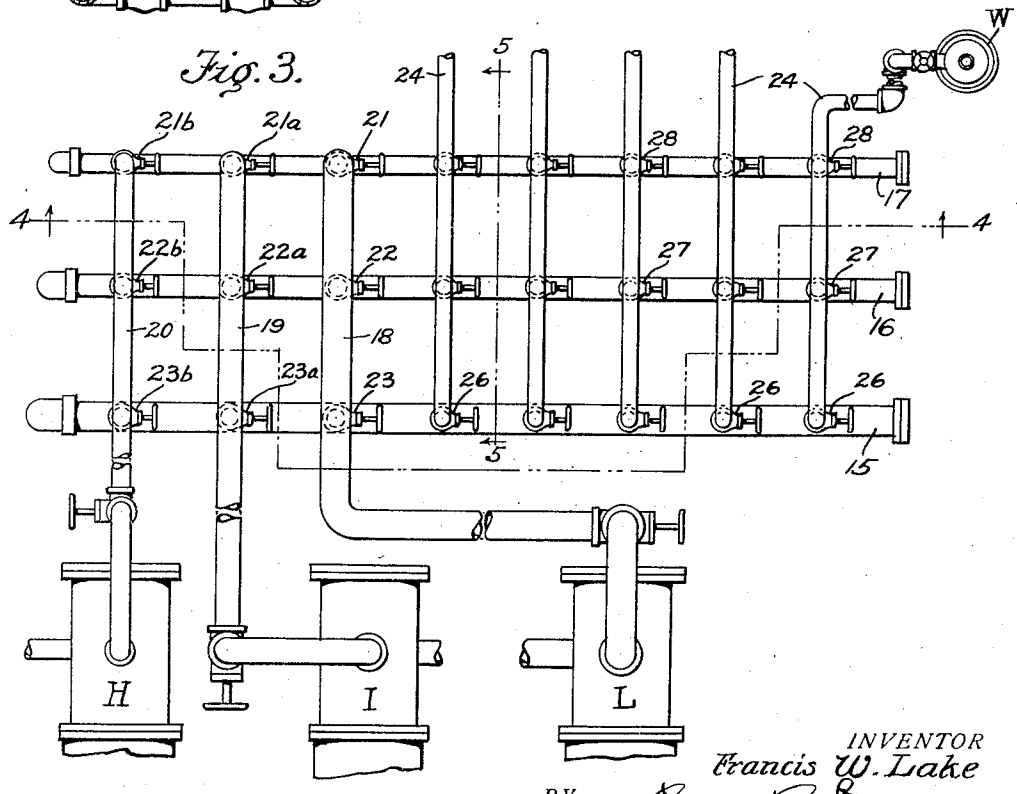


Fig. 2.

Fig. 3.



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Fig. 4.

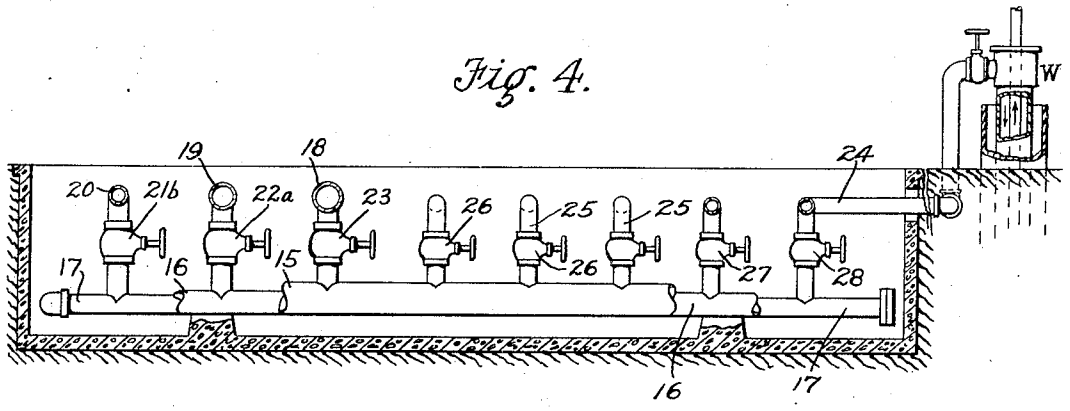


Fig. 5.

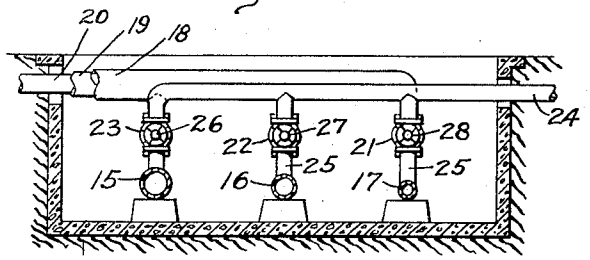


Fig. 6.

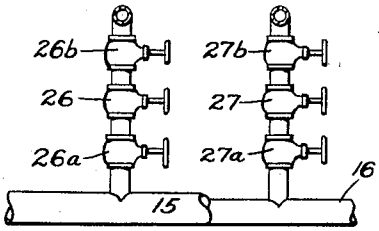
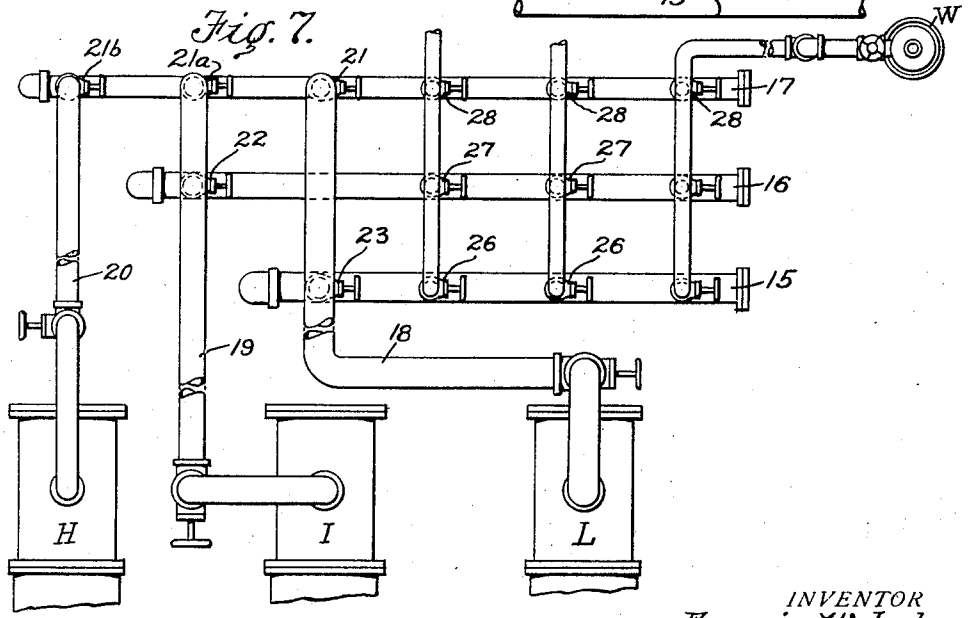


Fig. 7.



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UNITED STATES PATENT OFFICE

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CENTRALIZED HEADER SYSTEM FOR GAS AND AIR LIFT OPERATIONS

Application filed July 18, 1927. Serial No. 206,682.

This invention relates to gas and air lift methods for recovering liquids from wells and it is particularly designed for the removal of petroleum from deep wells where a plurality of gas or air pressures is required for operating a number of such wells.

Gas lift consists in forcing gas under pressure down through either the well casing or a tube depending therein and known as the flow tube, and flowing the oil up through the other in an atomized condition, produced by the passage of large volumes of the gas under the lower end of the flow tube.

It has been found in practicing gas lift that a higher pressure is nearly always required for starting a well to flowing than the highest normal operating pressure, and that after the initiation of flow has been brought about, normal flow may be continued by dropping down to a lower pressure than the starting pressure. This is due to the fact that in initiating gas lift, it is necessary to remove a considerable head of oil which always accumulates in the well hole, and due to the fact that a relatively high pressure is required either to push the oil up through the flow tube until the gas flows under the end of the tube, or to depress the oil level by forcing the oil body back into the sands until the end of the tube is uncovered. Then, when gas circulation has once been established, a much lower pressure may then be used to continue gas lift. Also, it usually happens that different normal operating pressures are required for normally flowing different wells, thus making it necessary to provide not only an additional pressure for starting, but also a plurality of pressures for continuing flow of the wells.

If any attempt be made to use the high starting pressure for continuing gas lift, it is necessary to throttle the pressure down to the required value. But the pressure waste consequent upon such throttling, together with the extra cost to provide high pressure equipment for all purposes, and the excessive repair requirements of the throttling valves, represent a large economic loss. Even where lower pressures are additionally provided as proposed by this invention, the throttling required for close pressure control, also requires occasional valve repair.

Therefore, one object of this invention is to make it convenient to shift from one pressure to another in flowing wells by gas lift. Another object of the invention is to provide a centralized control which preferably may be managed by a single attendant and whereby many wells may be operated from a central point employing but a single compressor plant in which are located such compressors as may be required for the system. A further object of the invention is to make it possible to apply any one of the various pressures to any one of a plurality of headers to avoid shutting down an entire series of wells in the event that a valve controlling one well should become damaged and require replacement or repair.

Briefly stated, the invention comprises employing a high pressure to start a well to flowing by gas or air lift, and then switching the well over to a lower pressure to continue the flow for normal production. The structural phase of the invention comprises in its broadest aspect, a plurality of headers adapted to receive air or gas under different pressures, these headers being interconnected by a plurality of gas circulating lines through the medium of valved connections whereby each line may receive pressure from any header. The invention also comprises a plurality of pressure manifolds interconnected with the headers through the medium of connections also controlled by valves which connections may be of such number that any header may receive gas under different pressures from different manifolds upon proper manipulation of the respective valves. This arrangement of manifolds, headers and connections to the circulating lines makes possible such a grouping of the various valves that all of said valves may be readily attended by a single operator.

It is to be understood that the number of headers will depend upon the number of pressures it may be economical to employ. Two instances of two and three pressures respectively are illustrated so that any person

skilled in the art may adapt this invention to more pressure stages if found desirable.

In the accompanying drawings wherein certain embodiments of the invention are disclosed by way of illustration:

Fig. 1 is a plan view of two headers interconnected with a plurality of gas circulating lines leading to oil wells;

Fig. 2 is a cross section taken along line 2—2 of Fig. 1;

Fig. 3 is a plan view of a modification wherein each of three headers is connected with each of three pressure manifolds and with each of several circulating lines;

Fig. 4 is a longitudinal sectional elevation taken along line 4—4 of Fig. 3;

Fig. 5 is a cross section taken along line 5—5 of Fig. 3;

Fig. 6 is a similar view showing a fragment of a modification wherein a plurality of valves is used in each connection for the gas circulating lines; and

Fig. 7 shows a modified arrangement of connections between the manifolds and headers.

In the simplest form, the invention comprises a pair of headers as shown in Figures 1 and 2, wherein header 10 normally carries a lower pressure and header 11 a high pressure, furnished respectively by the compressors "C". Between these headers a plurality of connections 12 are provided, each connection having a pair of valves 13 and 13′, and from each connection at a point between said valves a circulating line 14 extends for the purpose of conducting the gas or air to a well. By opening valve 13′ and closing valve 13 low pressure gas or air may be conducted to the respective well, and by reversing the adjustments high pressure may be conducted to the well.

However, with the above construction if one of the valves should become damaged, it will be necessary to shut down the entire series of wells working under the respective pressure. This difficulty has been overcome by employing a preferred form of construction which is applicable for most uses and is shown in Figures 3, 4 and 5, wherein the manifold for each of the required pressures is connected with each of a plurality of headers by means of a valved connection whereby any of the pressures may be transmitted to any header. In this form there is shown a header 15 for low pressure, a header 16 for intermediate pressure and a header 17 for high pressure, each of said headers being adapted to receive compressed gas or air from any one of a corresponding number of low, intermediate and high pressure manifolds, 18, 19 and 20 supplied by compressors L, I and H, and respectively controlled by a series of valves of which the valves 21, 21ª and 21ᵇ are located in connections leading to the high pressure header 17, valves 22, 22ª and 22ᵇ are provided in connections leading to the intermediate pressure header 16, and valves 23, 23ª and 23ᵇ are provided in connections leading to the low pressure header 15. Circulating lines 24 leading to wells W are interconnected with the headers by means of risers 25 in which are provided valves 26 controlling passage of gas from header 15, valves 27 controlling passage from header 16, and valves 28 controlling passage from header 17.

Under normal operating conditions two pressures are employed, namely the low pressure for flowing a low pressure series of wells, and a higher or intermediate pressure for flowing another series of wells, requiring a higher flowing pressure, the two headers 15 and 16 being employed for this purpose. The third header 17 is provided as a reserve and also for the purpose of starting those wells which initially require a third or high pressure to establish flow; these last uses, however, are of infrequent occurrence so that the header 17 is usually available for whatever purpose desired. If three pressures were required normally, a fourth header would necessarily be added in order to retain the reserve header 17. In any event, there are always as many headers as normal operating pressures, plus an additional header for reserve use which use includes starting up wells, all of these headers being interconnected with the pressure manifolds and circulating lines by means of connections having valves as above indicated. With such construction it will readily be seen that any header may receive any of the pressures supplied by manifolds 18, 19 and 20, upon proper manipulation of the various valves 21, 21ª, 21ᵇ and 22, 22ª, 22ᵇ and 23, 23ª and 23ᵇ. Obviously, any pressure may be applied to any well by proper manipulation of the various valves 26, 27 and 28.

In employing this system for the operation of a well W, when said well is to be started up and the highest available pressure is required for this purpose, high pressure in the manifold 20 is applied to the header 17 by opening the valve 21ᵇ, and by also opening the valve 28 in the respective circulating line 24 such high pressure is conducted to the well until the well begins to flow. Assuming that the header 16 is under intermediate pressure from the manifold 19 and that the header 15 is under low pressure from the manifold 18, either the valve 27 or 26 leading to said respective circulating line 24 will then be opened to supply to the well either the intermediate or low pressure according to which of these pressures is required to continue normal well flow, and the corresponding valve 28 will be closed to cut off the high pressure which, now that flow has been started, is no longer required.

In the event that one of the valves to the circulating lines 24, for example, the valve 27,

should become damaged thereby making it necessary to repair the same, the shutting down of all of the other wells in the series operating upon the same header pressure may be avoided by transferring said pressure to the reserve header 17. In this case, the high pressure will be cut off from said header 17, the valve 21^a thereto from the manifold 19 will be opened, the valves 28 to the respective wells will be opened, the valves 27 thereto will be closed and the valve 22^a then will be closed, whereby the intermediate pressure from manifold 19 will now be made to pass to the respective wells by way of header 17.

The modification indicated in the Figure 6 also may be employed to avoid shutting down the rest of a series of wells when it is necessary to repair a control valve, and at the same time this form makes it possible to avoid transferring pressures for the unaffected wells from one header to another. In this case, the valves 26 and 27 are the control valves and the valves 26^a, 27^a, and 26^b, 27^b, are cut off valves employed to isolate the damaged control valve. With this valve arrangement, pressure in the respective header is not disturbed when a control valve therefrom is to be repaired, since such pressure is cut off from escape merely by closing the corresponding valve 26^a or 27^a. This structure also makes it possible to avoid shutting down the affected well. To accomplish this, the same pressure may also be transmitted to the high pressure manifold 17 and then passed by way of the respective valve 28 to the respective circulating line 24, the escape of pressure through the damaged valve 26 or 27 being avoided by closing the corresponding cut-off valve 26^b or 27^b. This modification thus makes it possible to repair a valve without interfering with the operation of any well including that well which said valve normally controls.

The modification shown in Figure 7 dispenses with a number of the connections between the manifolds and the headers. In this instance, all of the manifolds are connected with high pressure header 17, whereby any pressure may be conducted to any one of the wells by way of the valves 28. But the high pressure manifold 20 is not connected with any other header, nor is the intermediate pressure manifold 19 connected with the low pressure header 15. Likewise, the low pressure manifold 18 is not connected with intermediate pressure header 16. This construction not only eliminates about half of the connections and their valves between the headers and manifolds, but it still makes it possible to apply any one of the pressures to any well.

With the above described arrangement of headers, manifolds and risers, it is possible to so dispose the lines leading to the wells and the lines leading from the compressors that meters, recorders and gauges for the respective lines may be grouped together at some convenient point and yet be spaced somewhat from said headers, if desired. In this manner, it is possible not only for an attendant to have ready access to all valves and connections but it is also possible for a single attendant to easily observe the relative conditions of all the various wells as represented by the grouped meters, recorders and gauges. Thus control may be accurately maintained at all times and supervision becomes simple. The present connection and arrangement has resulted in materially improving gas lift operation and in simplifying the method of handling the wells. In the past when additional pressures were required, as for example, for starting a new well or operating a few wells which require a higher pressure than normal, it became necessary to hook up auxiliary units, or to employ large compressors with sufficient capacity to start the well and then throttle the pressure down for normal flow, thus causing an enormous waste due to the fact that a large quantity of gas was compressed to a high pressure and then throttled down to a low pressure. Also, if the valve for controlling a certain well gave out as above indicated it became necessary to shut down the entire series operating under the given pressure. But with the structure herein disclosed as many pressures may be carried as desired and any one of these pressures may be transmitted to any one of the headers, and thence to any one or all of the wells.

The above disclosures are to be considered not as limiting but as merely illustrative, and many variations of the invention may be made within the scope of the following claims.

I claim:

1. In gas lift apparatus, a plurality of headers, means to supply gas under different pressures to said headers respectively, a plurality of connections leading from each header, a plurality of wells, and circulating lines leading to certain of said wells from points in said connections.

2. In gas or air lift apparatus, a plurality of headers, means to supply gas under different pressures to said headers, a plurality of wells, and a plurality of valved circulating lines interconnecting said headers and leading to said wells.

3. In gas lift apparatus, a plurality of centralized headers adapted to carry different pressures, a plurality of connections leading from each header, a gas line leading from each connection, and a plurality of pressure manifolds leading to each header and provided with a valve control for each header and means for supplying gas, under different pressures, to said manifold.

4. In gas lift apparatus for oil wells, a plurality of headers adapted to carry differ-

ent pressures, a plurality of pressure manifolds, a valved connection between each manifold and each header whereby each header may be placed under any one of the different pressures as desired, a plurality of circulating lines, a plurality of wells, each line being adapted to lead to a wall, and a valve connection between each line and each header whereby the pressure in any one of the headers may be conducted to the respective well.

5. In gas lift apparatus for oil wells, a plurality of headers adapted to carry different pressures, a plurality of pressure manifolds, each manifold being connected with a header and at least one of said manifolds being connected with a plurality of said headers, a plurality of circulating lines, each line being adapted to lead to a well, and a valved connection between each line and each header whereby the pressure in any one of the headers may be conducted to any well.

6. In gas lift apparatus for oil wells, a plurality of headers each of which is adapted to carry a different pressure, a plurality of pressure manifolds, interconnections between said manifolds and headers, valves controlling said interconnections, a plurality of circulating lines adapted to lead to wells, connections between each of said lines and said headers, and valves in the last mentioned connections.

7. Gas lift apparatus for oil wells comprising a plurality of headers adapted to receive gas under different pressures, a plurality of circulating lines leading to a plurality of wells and a valved connection between each line and certain of said headers, one of said lines being connected with all of said headers.

8. Gas lift apparatus for oil wells comprising a plurality of headers adapted to receive gas under different pressures, a plurality of circulating lines, a plurality of wells to which said lines lead, and a valved connection between each line and each header.

Signed at Los Angeles, in the county of Los Angeles, and State of California, this 12th day of July, A. D. 1927.

FRANCIS W. LAKE.