April 6, 1954 K. KELLEY ET AL 2,674,202

STAGE LIFT APPARATUS FOR WELLS

Filed May 12, 1952

Fig. 1.

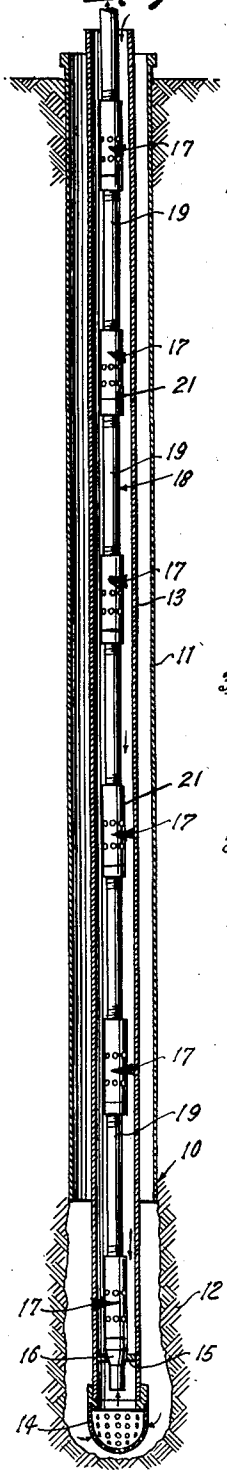


Fig. 2.

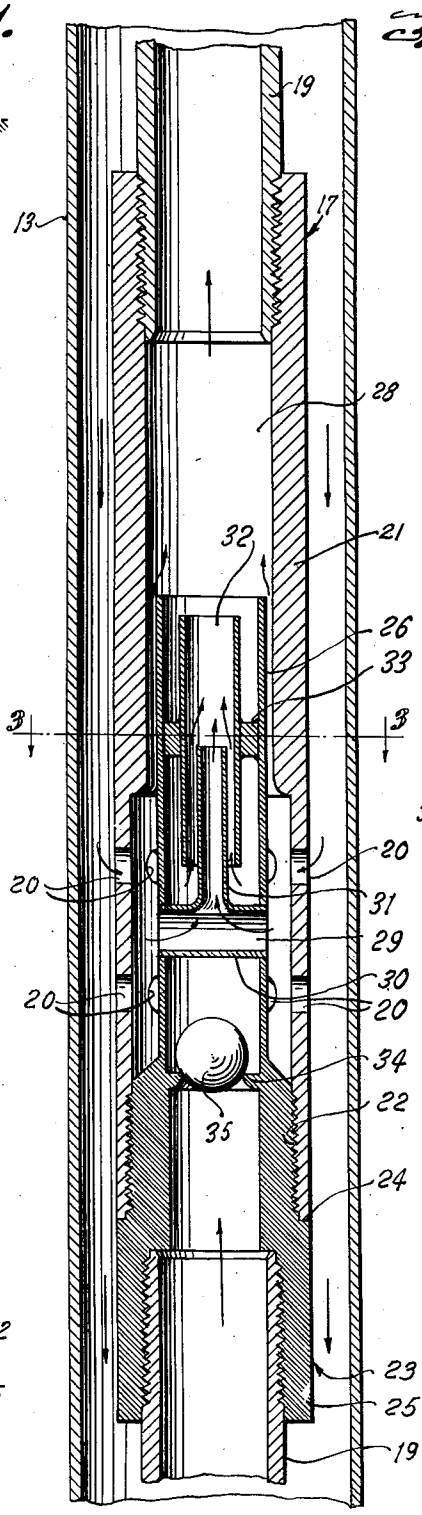


Fig. 3.

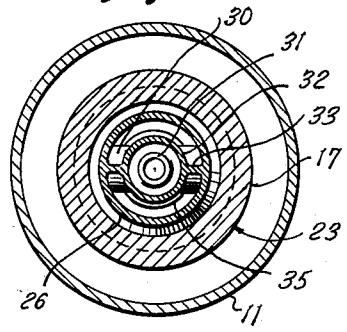
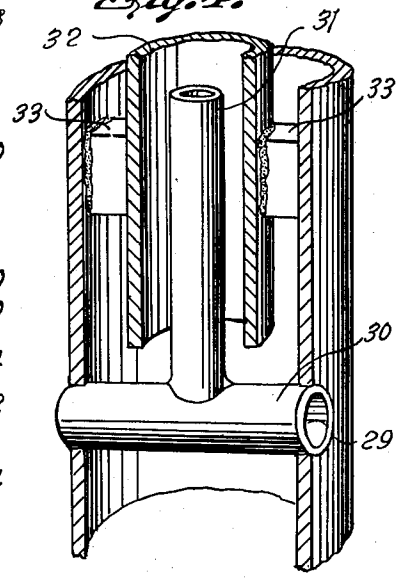


Fig. 4.



KORK KELLEY
ALLEINE KELLEY
INVENTORS

BY

ATTORNEY

Patented Apr. 6, 1954

2,674,202

UNITED STATES PATENT OFFICE

2,674,202

STAGE LIFT APPARATUS FOR WELLS

Kork Kelley and Alleine Kelley, Venice, Calif.

Application May 12, 1952, Serial No. 287,386

6 Claims. (Cl. 103—260)

1

This invention relates to well equipment and more particularly to a pump and a pump system for lifting fluids from wells.

Jet or Venturi type pumps, insofar as is known to us, are used to lift well fluids only from shallow wells whose depths do not exceed two or three hundred feet since their effectiveness is limited by the turbulence created by the restrictions placed in the passage or "throat" of the pump to increase at a particular point in the passage the velocity of the power fluid passing through the pump. Moreover, a plurality of such conventional jet or Venturi pumps cannot be employed efficiently in series to lift well or production fluid from great depths since each of the pumps would have to have a pump of such cross-sectional area as to allow fluid discharged from lower pumps in the system to pass upward without causing back pressure to be set up which would slow down the velocity of the fluid passing through the lower pumps and thus destroy the Venturi effect in the lower pumps. It is desirable, therefore, to provide a jet pump in which the turbulence is held to a minimum. It is also desirable to provide a jet pump, a plurality of which can be connected in series in a production string to lift well fluid from great depths.

Accordingly, it is an object of the invention to provide a new and improved pump.

It is another object of the invention to provide a new and improved pump of the jet type.

It is still another object of the invention to provide a new and improved pump of the jet type for lifting well fluids.

It is a further object of the invention to provide a new and improved pump of the jet type in which the turbulence of the fluids is reduced to a minimum.

It is a still further object of the invention to provide a new and improved pump system for lifting fluids from wells.

It is a still further object of the invention to provide a new and improved pump system employing a plurality of pumps connected in series for lifting fluids from wells.

For a better understanding of the invention, reference may be had to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing,

Figure 1 is a vertical sectional view of a well showing the pump system of the invention in place for lifting fluids from the well to the surface;

Figure 2 is an enlarged vertical sectional view of one of the pumps of the pump system shown in Figure 1;

Figure 3 is a sectional view taken on the line 3—3 of Figure 2; and

2

Figure 4 is a fragmentary view of a portion of the pump shown in Figures 2 and 3, with some parts broken away.

Referring now to the drawing, the reference character 10 designates a well having the usual casing 11 extending from the surface to the well fluid producing formation 12. A tubing string 13, shown as a single tubing but which is ordinarily composed of a plurality of sections, extends from the surface to the bottom of the well and is provided at its lower end with a strainer 14. A seating shoe or sealing device 15 is secured in the tubular string adjacent its lower end to seal between the tubing string and the frustoconical surface or shoulder 16 of the lowermost pump of a series of pumps 17 connected in series in a production string 18 through which well fluid is pumped from the bottom of the well to the surface. The pumps 17 are connected between adjacent sections 19 of the production string 18.

Power fluid is pumped from the surface down between the tubing string 13 and the production string 18 and enters into the pumps 17 through the port holes 20 in the tubular jackets 21 of the pumps. The power fluid is prevented from passing into the well by the seating shoe 15 which forms a fluidtight seal between the lowermost pump 17 and the tubing string 13. The power fluid is under relatively high pressure and flows with relatively high velocity through the pumps 17 thereby drawing well fluid through the strainer 14 and up through the production string 18.

The tubular jacket 21 of each of the pumps 17 is internally threaded at both of its ends. The externally threaded lower end of a section 19 of the production string is engaged in the upper threaded end of the tubular jacket while the lower threaded end of the jacket receives the externally threaded reduced section 22 of a mandrel 23, the lower end of the jacket abutting the annular shoulder 24 of the mandrel. The lower end 25 of the mandrel is internally threaded to receive the upper externally threaded end of a lower section 19 of the production string.

An outer sleeve 26, which may be integral with the mandrel, extends upwardly from the mandrel past the internal shoulder 27 of the jacket 21 and into the reduced portion 28 of the central bore of the jacket.

The outer sleeve 26 is provided with a pair of diametrically opposed lateral holes 29 through which power fluid may pass into a transverse conduit 30 whose opposite ends are secured to the outer sleeve 26 by welding or in any other suitable manner. A jet sleeve 31 extends upwardly from the transverse conduit into an inner sleeve 32 which is held in position and is secured to the outer sleeve 26 by webs 33. It will be noted that the upper end of the jet sleeve 31 is

disposed intermediate the ends of the inner sleeve 32 and that the upper end of the inner sleeve is disposed below the upper end of the outer sleeve. It will also be noted that the jacket and the sleeves are disposed concentrically with respect to the central longitudinal axis of the jacket and that each sleeve is spaced from the other sleeves so that fluids may pass through the cylindrical passages between the sleeves and between the outer sleeve and the jacket.

The mandrel 23 is provided with an inner annular flange 34 which serves as a seat for a ball check valve 35.

The operation of each pump 17 will now be explained. The power fluid pumped from the surface down between the tubing string 13 and the production string enters into the tubular jacket 21 through the port holes 20 and passes through the lateral holes 29 in the outer sleeve 26 into the transverse conduit 30. From the transverse conduit, the power liquid flows upwardly through the jet sleeve and into the inner sleeve 32. The power fluid jetting from the jet sleeve creates a pressure differential with the inner sleeve between the upper and lower portions thereof which tends to move fluid upwardly in the cylindrical space between the jet and inner sleeve from the lower portion of the outer sleeve 26. This pressure differential also tends to move the ball check valve 35 upwardly as the well fluid is moved upwardly by the pressure differential so that well fluid is allowed to move upwardly from a lower section 19 of the production string 18 through the mandrel 23 and into the outer sleeve 26.

A mixture of power fluid and well fluid is thus caused to flow upwardly from the upper end of the inner sleeve 32. This flow of the mixture tends to set up a pressure differential within the outer sleeve 26 between its ends which also tends to cause well fluid to flow upwardly in the cylindrical space between the outer and inner sleeves.

Power fluid also flows upwardly in the pump jacket 21 in the cylindrical space between the outer sleeve 26 and the jacket. This upward flow of the power fluid also tends to create a pressure differential in the outer sleeve 26 between its upper and lower end which also tends to move well fluid upwardly through the outer sleeve. It will now be seen that in each pump 17, a central rod-shaped stream of power fluid jets upwardly from the jet sleeve 31 and an outer cylindrical stream of power fluid which is concentric with the central rod-shaped stream jets upwardly from the cylindrical space between the outer sleeve 26 and the jacket, both streams tending to create pressure differentials which move fluid from the lower end of the outer sleeve upwardly to the upper section 19 connected to the upper end of the jacket.

A very important function of the cylindrical stream of power fluid is to reduce the turbulence which would otherwise occur above the upper end of the outer sleeve 26 if only the central rod-shaped stream of power fluid were present. In effect, the well fluid is carried between two upwardly moving streams which prevent the extreme turbulence found in conventional jet or Venturi pumps.

The inner sleeve 32 also tends to decrease or minimize turbulence since the upper end of the jet sleeve is disposed intermediate its ends, the portion of the inner sleeve above the jet sleeve serving as a guide to direct upwardly the flow of the mixture of power and well fluids. The use of the inner sleeve also minimizes the obstructions in the pump to upward flow of fluid since if the inner sleeve were not present, the jet sleeve would have to be of greater diameter so that cylindrical space between the jet sleeve and the outer sleeve would not be so great that the central rod-shaped stream jetting upwardly from the jet sleeve would not create a sufficient pressure differential between the upper and lower ends of the outer sleeve. The use of the inner sleeve permits the use of a jet sleeve of relatively small diameter and the combined obstruction of the outer sleeve caused by both the jet sleeve and the inner sleeve is not as great as would be the obstruction of a jet sleeve of the necessarily greater diameter needed if the inner sleeve were not provided.

Each of the pumps 17 functions in the above described manner except that only the lowermost pump draws pure well fluid through its mandrel 23, since each upper pump draws a mixture of power and well fluids delivered to its mandrel 23, the mixture acquiring an increasingly greater proportion of power fluid as it moves upwardly through each pump 17. The pump system employs a plurality of the pumps 17, spaced as desired along the production string, to lift the well fluid from even extremely deep wells to the surface. The pumps 17 being connected in series in the production string, the pump system functions to lift the well fluids in stages to the surface. The ball check valves 35 prevent downward flow of fluid in the production string.

It will be seen now that a new and improved pump has been provided which employs a central rod-shaped stream and a cylindrical stream of power fluid formed by a jet sleeve 31, an outer sleeve 26 and a tubular jacket 21 to create a pressure differential to move fluid through the outer sleeve. Moreover, it will be seen that an inner sleeve 32 has been provided between the jet sleeve and the outer sleeve which minimizes the turbulence in the fluids flowing through the pump and which also permits the use of a jet sleeve 31 of relatively small diameter. Furthermore, it will be seen that a single tubular string 13 may be employed to deliver power fluid simultaneously to a plurality of the pumps 17 connected in series in a production string 18 disposed in the tubular string 13.

It will be apparent that many changes and modifications can be made in the described and illustrated pump and pump system without departing from the invention and it is intended, therefore, in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A pump comprising a tubular jacket having a central bore and a lateral aperture for admitting power fluid into said central bore; a first sleeve having a central bore disposed in said tubular jacket means between said first sleeve and said jacket below said lateral aperture for preventing downward flow of power fluid therebetween; a jet sleeve extending into said first sleeve, said sleeves and said jacket being concentrically aligned; means communicating with said central bore of said jacket and the lower end of said jet sleeve for admitting power fluid from said central bore of said jacket to said jet sleeve, said sleeves being spaced from said jacket and from one another whereby power fluid flowing into said central bore of said jacket through said aperture may flow into and upwardly through said jet sleeve and upwardly between said jacket and said first sleeve to produce a rod-shaped stream

and a cylindrical-shaped stream for creating a pressure differential in the central bore of said first sleeve.

2. A pump comprising a tubular jacket having a central bore and lateral ports for admitting power fluid into said central bore; a first sleeve having a central bore disposed in said tubular jacket; a second sleeve disposed in said first sleeve; a jet sleeve extending into said second sleeve, said sleeves and said jacket being concentrically aligned means between said first sleeve and said jacket below said lateral ports for preventing downward flow of power fluid therebetween; means communicating with the jet sleeve and said central bore for admitting power fluid from said central bore of said jacket to the lower end of said jet sleeve, said sleeves being spaced from said jacket and from one another whereby power fluid flowing into said central bore of said jacket may flow into and upwardly through said jet sleeve and upwardly between said jacket and said first sleeve to produce a rod-shaped stream and a cylindrical-shaped stream for creating a pressure differential in the central bore of said first sleeve.

3. A pump comprising a tubular jacket having a first portion providing a large central bore and a second portion providing a small central bore; a lateral aperture in said first portion for admitting power fluid into said large central bore; a first sleeve in said tubular jacket having a central bore and extending from said first portion into said second portion; means between said first sleeve and said first portion below said lateral aperture to prevent downward flow of power fluid between the first sleeve and the jacket; a jet sleeve disposed in said first sleeve, said sleeves and said jacket being concentrically aligned; means communicating with said jet sleeve and said large central bore for admitting power fluid from said large central bore to the lower end of said jet sleeve, said sleeves being spaced from said jacket and from one another whereby power fluid flowing into said large central bore of said jacket may flow into and upwardly through said jet sleeve and upwardly between said jacket and said first sleeve to produce a rod-shaped stream and a cylindrical shaped stream for creating a pressure differential in the central bore of said first sleeve.

4. A pump comprising a tubular jacket having a first portion providing a large central bore and a second portion providing a small central bore; a lateral aperture in said first portion for admitting power fluid into said large central bore; a first sleeve in said tubular jacket having a central bore and extending from said first portion into said second portion; means between said first sleeve and said first portion below said aperture to prevent downward flow of power fluid between said first sleeve and said jacket; an inner sleeve disposed in said first sleeve; a jet sleeve extending into said inner sleeve, said sleeves and said jacket being concentrically aligned, the upper end of said inner sleeve being spaced vertically between the upper ends of said first sleeve and said jet sleeve; means communicating with said jet sleeve and said large central bore for admitting power fluid from said large central bore to said jet sleeve, said sleeves being spaced from said jacket and from one another whereby power fluid flowing into said large central bore of said jacket may flow into and upwardly through said jet sleeve and upwardly between said jacket and said first sleeve to produce a rod-shaped stream and a cylindrical shaped stream for creating a pressure differential in the central bore of said first sleeve.

5. A pump comprising a tubular jacket having a first portion providing a large central bore and a second portion providing a small central bore; a lateral aperture in said first portion for admitting power fluid into said large central bore; a first sleeve in said tubular jacket having a central bore and extending from said first portion into said second portion; means between said first sleeve and said first portion and below said aperture to prevent downward flow of power fluid between said first sleeve and said jacket; an inner sleeve disposed in said first sleeve; a jet sleeve extending into said inner sleeve and having its outlet end disposed intermediate the ends of said inner sleeve, said sleeves and said jacket being concentrically aligned; means communicating with said jet sleeve and said large central bore for admitting power fluid from said large central bore to said jet sleeve, said sleeves being spaced from said jacket and from one another whereby power fluid flowing into said large central bore of said jacket may flow into and upwardly through said jet sleeve and upwardly between said jacket and said first sleeve to produce a rod-shaped stream and a cylindrical shaped stream flowing for creating a pressure differential in the central bore of said first sleeve.

6. A pump comprising a tubular jacket having a first portion providing a large central bore and a second portion providing a small central bore; a lateral aperture in said first portion for admitting power fluid into said large central bore; a first sleeve in said tubular jacket having a central bore and extending from said first portion into said second portion; means between said first sleeve and said first portion to prevent downward flow of power fluid between said first sleeve and said jacket; an inner sleeve disposed in said first sleeve intermediate the ends thereof; a jet sleeve extending into said inner sleeve and having its outlet end disposed intermediate the ends of said inner sleeve, said sleeves and said jacket being concentrically aligned; means communicating with said jet sleeve and said large central bore for admitting power fluid from said central portion to said jet sleeve, said sleeves being spaced from said jacket and from one another whereby power fluid flowing into said large central bore of said jacket may flow into and upwardly through said jet sleeve and upwardly between said jacket and said first sleeve to produce a rod-shaped stream and a cylindrical shaped stream for creating a pressure differential in the central bore of said first sleeve.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
425,624	O'Neil	Apr. 15, 1890
1,547,194	Arbon	July 28, 1925
1,729,794	Newnham	Oct. 1, 1929
1,763,030	Wolfe	June 10, 1930
1,784,242	Melton	Dec. 9, 1930