April 26, 1927. 1,626,057

F. B. VAUGHN ET AL

WELL PRODUCTION APPARATUS

Filed Jan. 29, 1925

2 Sheets-Sheet 1

Fig. 1.

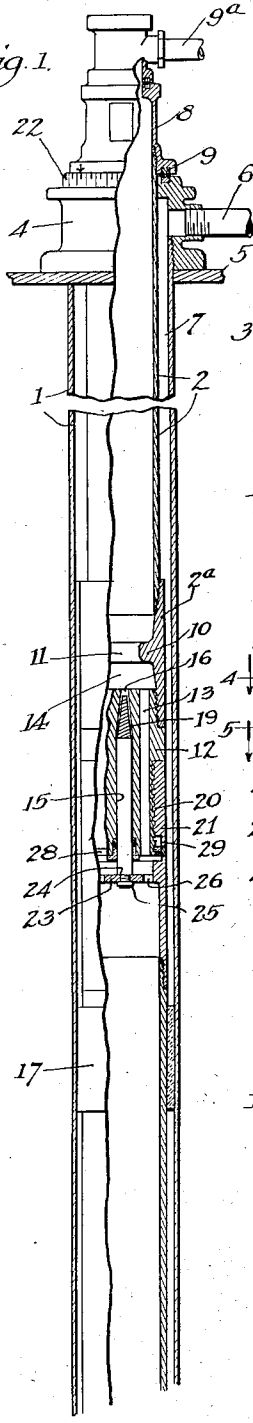


Fig. 2.

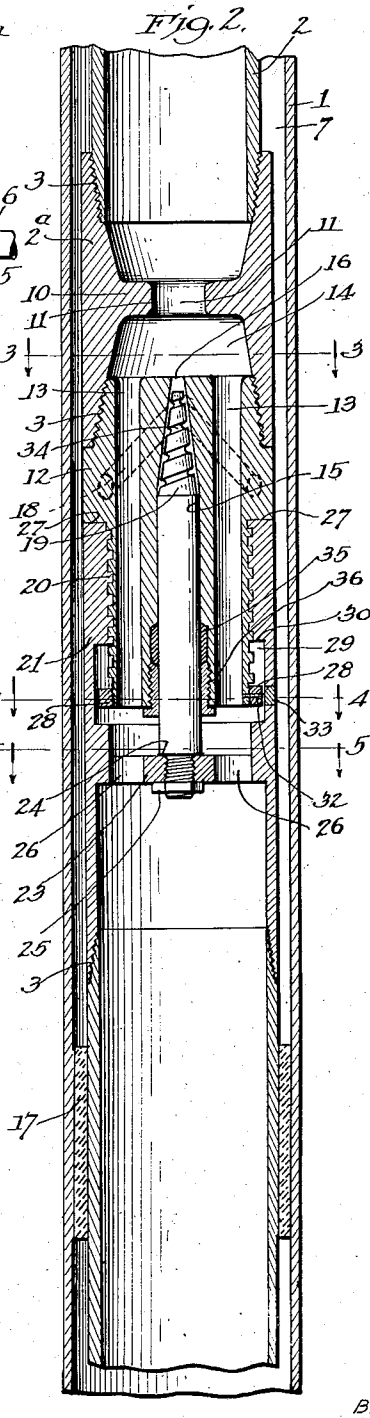


Fig. 3.

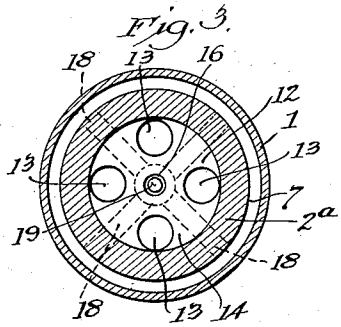


Fig. 4.

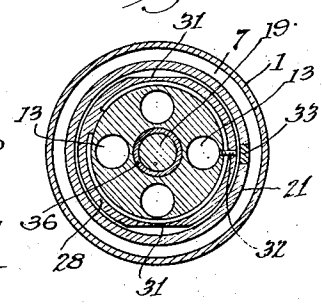
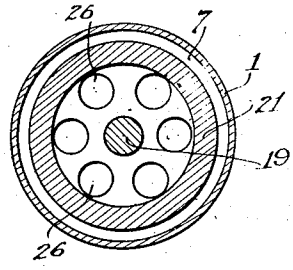


Fig. 5.



INVENTORS.
Fred B. Vaughn
Idris Thomas

BY R. W. Smith

ATTORNEY.

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Fig. 6.

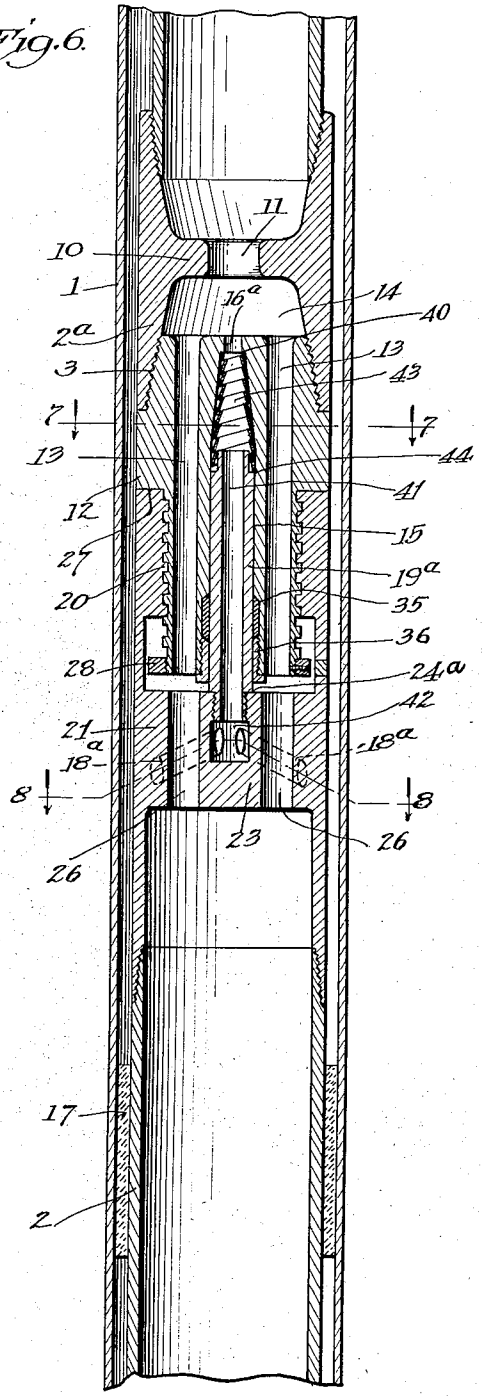


Fig. 7.

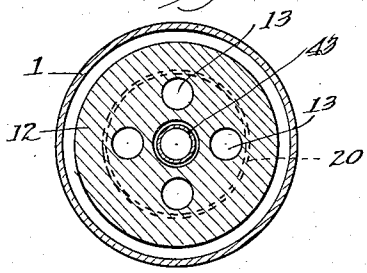


Fig. 8.

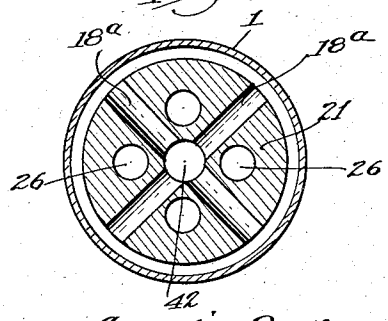
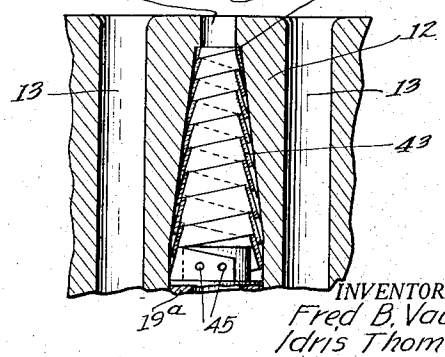


Fig. 9.



INVENTORS.
Fred B. Vaughn.
Idris Thomas.

BY R. W. Smith.

ATTORNEY.

Patented Apr. 26, 1927. 1,626,057

UNITED STATES PATENT OFFICE.

FRED B. VAUGHN, OF MAYWOOD, AND IDRIS THOMAS, OF WHITTIER, CALIFORNIA.

WELL-PRODUCTION APPARATUS.

Application filed January 29, 1925. Serial No. 5,464. REISSUED

This invention relates to the production of oil and the like from a well, by discharging a jet of gaseous fluid under pressure upwardly into the column of liquid standing in the well, in order to elevate the column of liquid for discharge thereof at the ground level.

It is the object of the invention to regulate the jet in accordance with variations in the pressure of the flow in the well in order to obtain maximum production; and to provide a control for the regulating means located at the ground level, so that the jet submerged in the column of liquid in the well, may be readily adjusted without pulling the well tubing.

It is a still further object of the invention to provide a jet of maximum efficiency by arranging the same for spiral discharge into the column of liquid in the well.

It is a still further object of the invention to regulate the submerged jet by rotating the portion of the string of well tubing which extends upwardly therefrom to the ground level, said upper portion of the string of tubing resting upon the well casing with anti-frictional means preferably provided between the parts so that the string of tubing may be readily turned.

The invention will be readily understood from the following description of the accompanying drawings, in which:

Fig. 1 is a vertical section through the bore of a well, showing the improved jet mechanism.

Fig. 2 is a vertical section through the jet.

Figs. 3, 4, and 5 are transverse sections on the lines 3—3, 4—4, and 5—5 of Fig. 2.

Fig. 6 is a view similar to Fig. 2 showing a modified form of the invention.

Figs. 7 and 8 are transverse sections on the lines 7—7 and 8—8 of Fig. 6.

Fig. 9 is a vertical section through the nozzle shown in Fig. 6.

The invention is illustrated in connection with a usual oil well construction including well casing 1 and a string of tubing 2 extending downwardly therethrough with the lengths of tubing connected by usual threaded means 3. A head 4 is mounted on the well casing at the derrick floor 5, and a pipe 6 communicates with the head for discharge into the annular space 7 between the casing and tubing.

The tubing 2 projects upwardly through head 4, and a collar 8 is fixed on the tubing so as to rest upon the head and thus support the string of tubing in the well casing. Anti-frictional means shown as ball bearings 9, are provided between collar 8 and head 4 to permit ready rotation of the collar so as to turn the string of tubing in the well casing for a purpose to be hereinafter described.

The column of oil elevated through the string of tubing is discharged through collar 8 into a pipe line 9^a leading to suitable storage means.

Oil enters the string of tubing in the well in usual manner (not shown), and stands therein at the level of the oil in the bore of the well; and a jet for elevating the oil in the tubing is mounted therein at any desired point below the normal oil level.

As an instance of this arrangement, a length of the well tubing shown at 2^a is provided with an interior shoulder 10 forming a restricted central orifice 11 for the passage of oil upwardly therethrough. A plug 12 is fixed to the lower end of tubing 2^a by a threaded connection 3, so as to space the plug a short distance below orifice 11 and thus form an oil reservoir 14 between the latter and the plug. The plug is provided with longitudinal bores 13 for the passage of oil, and the parts are positioned in the well so that the normal level of the oil is above orifice 11, thereby filling the reservoir 14 and submerging the plug 12.

The plug 12 forms a jet at its upper end discharging into reservoir 14, so as to elevate the column of oil in the tubing 2 for discharge thereof through pipe line 9^a. The jet is illustrated as comprising a central bore 15 in plug 12, tapering at its upper end to a restricted orifice through which a gaseous fluid under pressure is discharged into reservoir 14.

The gaseous fluid is preferably dry gas recovered from the flow from the well in usual manner, and forced downwardly through the annular space 7 by a compressor (not shown) connected to pipe 6. The annular space is closed below the jet mechanism by a usual packer 17 between the tubing and casing of the well, and the compressor maintains the gaseous fluid in the annular space at the necessary pressure to elevate the column of oil in the well tubing.

In the form of the invention illustrated in Figs. 1 to 5, the gaseous fluid is discharged through the restricted orifice of bore 15 which forms a nozzle 16. The gaseous fluid is sup-

plied to the bore 15 through radial bores 18 in plug 12, the bores 18 communicating at their outer ends with annular space 7, and inclining upwardly toward their inner ends which open into the tapering upper end of bore 15 adjacent discharge nozzle 16.

The discharge of the gaseous fluid through the restricted orifice of the jet is adjusted from the derrick floor without the necessity of pulling the tubing from the well. For this purpose a needle valve 19 is mounted in bore 15 with its tapering end extending through the tapering end of the bore, so that vertical adjustment of plug 12 relative to the needle valve will vary the discharge through nozzle 16.

The plug 12 may be vertically adjusted by means of a threaded connection 20 between the exterior of the lower portion of said plug and the interior of the upper portion of a barrel 21 forming the next lower length of the string of tubing 2. Barrel 21 is fixed to the lower portion of the string of tubing in the well by a threaded connection 3, and packing 17 is adapted to hold said barrel and the lower portion of the string of tubing against rotation in the well casing, while the upper portion of the string of tubing and the plug 12 connected thereto are adapted to be turned in the well casing, so as to vertically adjust the plug through threaded connection 20.

The needle valve 19 is mounted on the stationary barrel 21, so that vertical adjustment of plug 12 relative to said barrel will vary the discharge through orifice 16 of the jet, and the plug and upper portion of the string of tubing connected thereto, are rotated for vertically adjusting the plug, by turning collar 8 at the derrick floor. Graduations 22 cooperate with collar 8 to indicate the vertical adjustment of plug 12, and the connection 20 is of relatively coarse threads so that the plug may be appreciably vertically adjusted by relatively slight turning of the collar.

The mounting for needle valve 19 on the stationary barrel, may comprise a transverse partition 23 in said barrel in spaced relation below plug 12, with the lower end of the needle valve stem threaded through said partition, and a shoulder 24 on the valve stem clamped against the partition by a nut 25 threaded on the lower end of the valve stem.

Longitudinal bores 26 for the free passage of oil, extend through partition 23, the spacing of said partition below plug 12 providing an unobstructed passageway irrespective of the alinement of bores 13 and 26.

In order to limit the vertical adjustment of plug 12 relative to barrel 21, a shoulder 27 on the plug is adapted to abut against the upper end of the barrel so as to prevent wedging of the needle valve in bore 15 when the plug is lowered; and a collar 28 threaded on the lower end of plug 12 is received in an annular groove 29 in barrel 21, so as to abut against a shoulder 30 at the top of said groove and thus prevent disengagement of threaded connection 20 when the plug is elevated.

The parts are assembled with collar 28 removed from plug 12, and in order to permit insertion of said collar in the groove 29, opposite sides of the collar may be cut away as shown at 31, so that by tilting the collar to vertical position with its cut away sides parallel to the bore of barrel 21, the collar may be inserted in the barrel and then turned back to horizontal position in groove 29.

Plug 12 is then threaded into barrel 21 so that final rotation of said plug will thread the same into collar 28; and the parts are preferably fixed in assembled relation by a screw 32 threaded through the collar and into the plug, the screw being placed in position through an aperture in barrel 21 which may be subsequently closed by welding or the like as shown at 33.

In order to obtain maximum efficiency of the jet discharging into the column of oil in the well tubing, the tapering end of needle valve 19 may be spirally grooved as shown at 34, so as to form a whirling jet.

A leak-proof joint is preferably provided between the stem of needle valve 19 and the lower end of the bore 15, by means of a stuffing box comprising annular packing 35 and a follower 36.

In Figs. 6 to 9 we have shown a modified means for adjusting the discharge of gaseous fluid through the nozzle formed in plug 12. In this construction the tapering end of the central bore 15 terminates in a nozzle 16^a forming a shoulder 40 at the upper end of the bore. A stem 19^a having a bore 41 extending therethrough is slidable in the non-tapering portion of bore 15, and is threaded into a central recess 42 formed in partition 23, with a shoulder 24^a of the stem abutting against the partition so as to space the end of the stem from the base of recess 42.

Radial bores 18^a, in lieu of the bores 18 previously described, extend through partition 23 between the longitudinal bores 26, and open at their outer ends to the annular space 7 above packer 17. The inner ends of bores 18^a incline upwardly and open into recess 42 below stem 19^a, so that the gaseous fluid under pressure in space 7 is discharged upwardly through the bore 41 of the stem.

A spring strip coiled to form a hollow spring cone, is mounted in the tapering end of bore 15, with its upper end abutting against shoulder 40 and its lower end extending around and secured to a neck at the end of stem 19^a as shown at 45. The cone thus forms a nozzle tapering to a restricted orifice at its upper end, and adapted for

discharge of the gaseous fluid from bore 41 through the nozzle 16ª, and into the reservoir 14 for elevating the column of oil in the tubing as previously described.

The discharge orifice of cone 43 is adjusted by vertical movement of plug 12, which is raised and lowered by rotation of collar 8 as previously described. When the plug 12 is at its upper limit of movement the discharge orifice of the cone is expanded to its full size as determined by the bore 15, and when the plug is lowered the spring cone is longitudinally contracted so as to restrict the discharge orifice of the same. The discharge of gaseous fluid through the jet and into the column of oil in the well tubing is thus adjusted from the derrick floor without the necessity of pulling the well tubing.

We claim:

1. A well construction including tubing in the bore of the well, a jet submerged in the liquid in the lower portion of said tubing and adapted for elevation of said liquid by discharge of fluid under pressure through a restricted orifice and into said liquid, and means for adjusting said orifice of the submerged jet by turning said tubing at the top of the well.

2. A well construction including casing in the bore of the well, tubing in said casing rotatably supported thereby, a jet submerged in the liquid in the lower portion of said tubing, means for forcing fluid downwardly between said casing and tubing and thence upwardly through a restricted orifice of said jet and into said liquid, and means for adjusting said orifice of the submerged jet by turning the tubing relative to the casing.

3. A well construction including tubing in the bore of the well, a plug fixed to said tubing and forming a nozzle submerged in the liquid in the tubing, means for forcing fluid through said nozzle and into the liquid for elevating said liquid in the tubing, a valve cooperating with said nozzle and fixed to the portion of the tubing below said plug, and means for rotating the plug and the portion of the tubing above the same relative to said valve and the portion of the tubing below the plug, said relative rotation moving the nozzle and valve relative to one another so as to adjust the discharge orifice of said nozzle.

4. A well construction including well casing, tubing in said casing radially spaced therefrom, a section of said tubing having an interior annular shoulder forming a restricted central opening, a lower section of said tubing forming a plug extending across the tubing, said plug being spaced slightly below said shoulder and having a central bore and a longitudinal opening extending therethrough, the upper end of said central bore tapering to a restricted discharge orifice, and said central bore having a transverse bore communicating therewith and opening to the annular space between the well casing and tubing.

5. A well construction including well tubing, a plug forming a section of said tubing and extending across the same, said plug being connected to the portion of the string of tubing which extends upwardly therefrom and having threaded engagement with the string of tubing depending therefrom so that turning of the upper portion of the string of tubing will raise and lower the plug relative to the lower portion of the string of tubing, said plug having a central bore and a longitudinal opening extending therethrough, the upper end of said central bore tapering to a restricted discharge orifice, said central bore having a transverse bore communicating therewith and opening through the well tubing, a stem fixed to the lower portion of the string of tubing and extending into the central bore so as to close the lower end thereof, and valvular means associated with said stem and mounted in the tapering end of the central bore so that raising and lowering of said plug will regulate the discharge orifice of the central bore.

6. A well construction including tubing adapted to extend into the liquid in a well, a jet having means for spirally discharging a fluid into the tubing below the liquid level, and a restriction in the bore of the tubing below the liquid level and spaced slightly above the jet.

In testimony whereof we have affixed our signatures to this specification.

FRED B. VAUGHN.
IDRIS THOMAS.