April 7, 1942. A. BOYNTON 2,278,420

WEIGHT ACTUATED FLOWING DEVICE

Filed Dec. 8, 1939 2 Sheets-Sheet 1

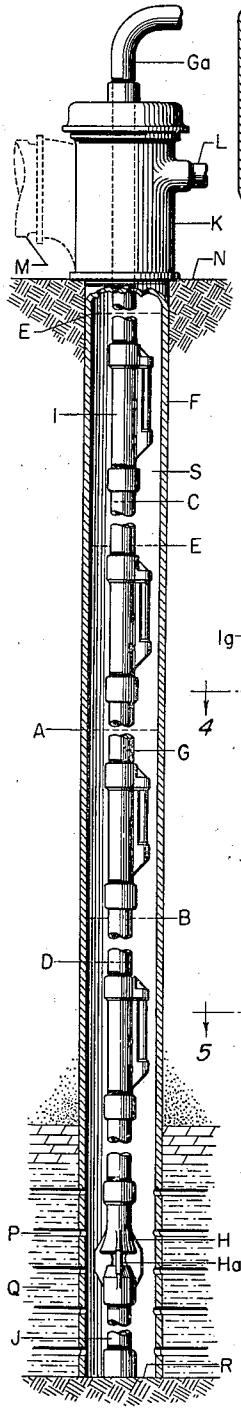


Fig. 1.

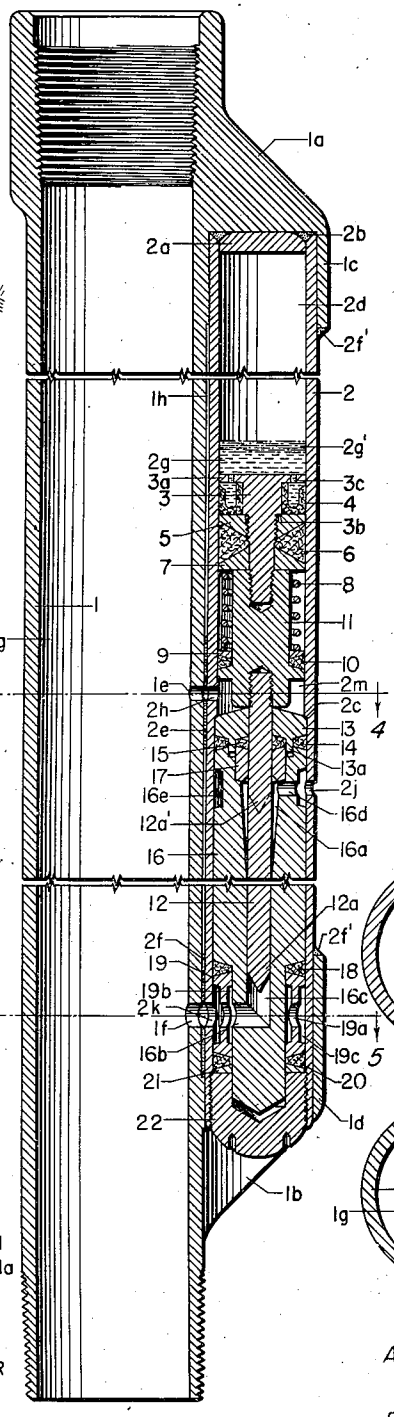


Fig. 2.

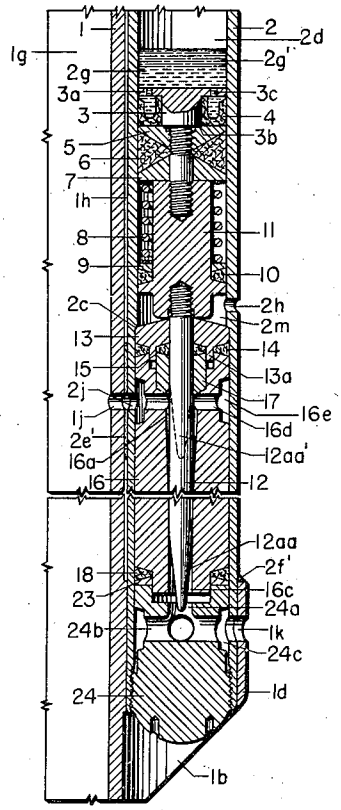


Fig. 3.

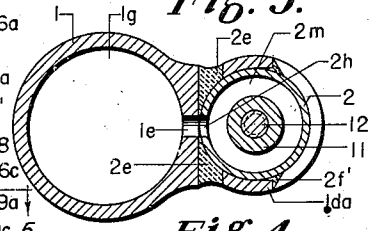


Fig. 4.

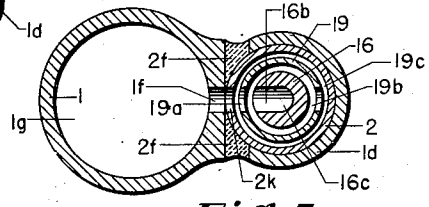


Fig. 5.

ALEXANDER BOYNTON,
INVENTOR,
BY Jesse P. Stone
Lester B. Clark
ATTORNEYS.

April 7, 1942. A. BOYNTON 2,278,420

WEIGHT ACTUATED FLOWING DEVICE

Filed Dec. 8, 1939 2 Sheets-Sheet 2

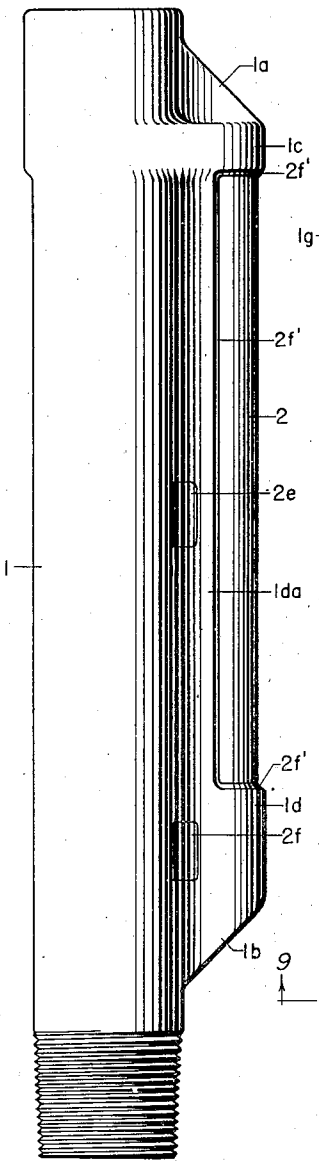


Fig. 6.

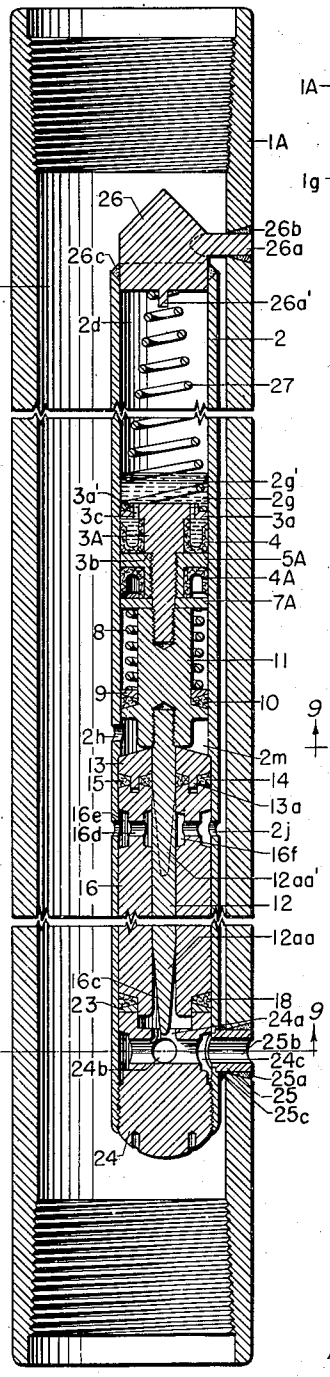


Fig. 7.

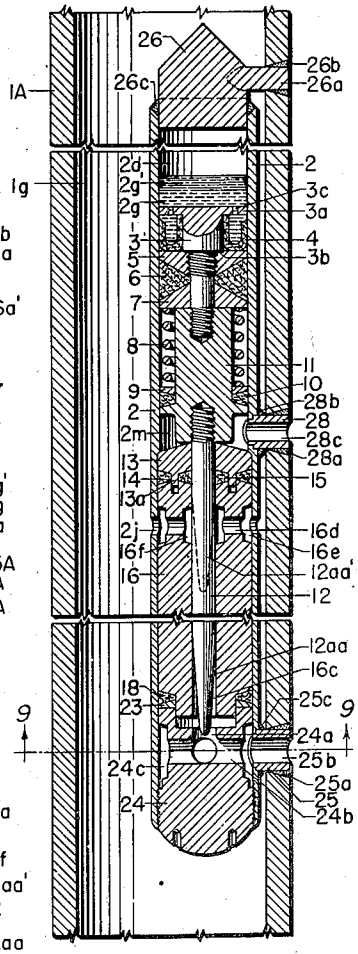


Fig. 8

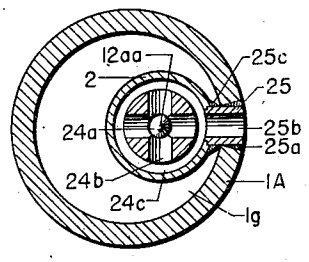


Fig. 9

ALEXANDER BOYNTON,
INVENTOR,

BY Jesse R. Stone
Lester B. Clark

ATTORNEYS.

Patented Apr. 7, 1942 2,278,420

UNITED STATES PATENT OFFICE

2,278,420

WEIGHT ACTUATED FLOWING DEVICE

Alexander Boynton, San Antonio, Tex.

Application December 8, 1939, Serial No. 308,313

6 Claims. (Cl. 137—111)

My invention relates to stage lift flowing devices for wells employing aeration as the eduction means.

The principal object is to start wells at comparatively low pressures and to flow them by stages at comparatively low pressures and low gas-oil ratios.

Other objects are: (1) to employ the weight of the well liquid to open the valve; (2) to employ a relatively powerful force in operating a comparatively small valve; (3) to provide a valve mechanism which can be adjusted to operate at different forces by changing only the value of a contained pressure fluid which will manifest only slight urge to escape while subjected to great pressures from without; and (4) to automatically regulate the inflow of pressure fluid to the well liquid according to the load by means of a valve mechanism wherein the valve is withdrawn from the path of abrasives during the flowing operation; all of which will clearly appear from mechanism described in this specification and illustrated in the accompanying drawings, in which:

Fig. 1 is an installation plan of the devices in a well.

Fig. 2 is a longitudinal section of the preferred embodiment of the invention for tubing flow.

Fig. 3 is a partial longitudinal section of a modified form of the device illustrated in Fig. 2 adapted for casing flow.

Fig. 4 is a cross section on the line 4—4 of Fig. 2.

Fig. 5 is a cross section on the line 5—5 of Fig. 2.

Fig. 6 is a side view of the device shown in Fig. 2.

Fig. 7 is a longitudinal section of the second modified form of the invention, being adapted for tubing flow.

Fig. 8 is a partial longitudinal section of a third modified form, being adapted for casing flow.

Fig. 9 is a cross section on the line 9—9, Figs. 8 and 9.

Similar characters are employed to refer to similar parts throughout the several views.

In all forms of this invention, the expansive force of pressure fluid confined within the chamber 2*d* constitutes the valve closing force; while the pressure of the well liquid upstanding in the eduction tube, acting upon the nether side of the movable piston assembly, composed of the parts 3 to 12, both inclusive, Figs. 2, 3, 7 and 8, constitutes the valve opening force.

In Fig. 2, the body 1, which may be a steel casting adapted to be threadedly connected into the tubing G, Fig. 1, has the passage 1*g* of the same size and in alignment with the tubing passage. The upper shell 1*c* of the body 1 is formed below the upper sloping surface 1*a*. The lower shell 1*d*, having the lower sloping end 1*b*, is aligned with the upper shell 1*c*, both shells being adapted to closely receive the tube 2 parallel with the body 1, the slight clearance 1*h* between the body and the tube being for manufacturing convenience.

The parallel ribs 1*da*, Figs. 4 and 6, having side openings for the solders or welds 2*e* and 2*f* as shown in Figs. 4, 5, and 6, are formed with a trough between them adapted to receive the tube 2 for slightly more than half of its diameter. This tube, having its upper end hermetically closed by the plug 2*a* and the weld 2*b*, may be secured within the shells 1*c* and 1*d*, by the solder or welds 2*e*, Figs. 4 and 6, and 2*f*, Figs. 5 and 6, and by the additional solder or weld 2*f'* Fig. 6 if desired.

The lateral opening 1*e* in the body 1 and the lateral opening 2*h* in the shell, communicating with the chamber 2*m*, are in alignment and sealed against leakage through the marginal clearance 1*h* between the members 1 and 2 by the weld or solder 2*e*, Fig. 4. The lateral opening 1*f* in the body 1 and the lateral opening 2*k* in the tube 2 are aligned similarly and likewise made leakproof by the weld or solder 2*f*, Fig. 5. The lateral opening 2*k* has communication with the bore 16*c* via the lateral openings 19*a*, the annular spaces 19*b* and 19*c*, and the lateral opening 16*b*.

The weld or solder 2*f'* may be employed to more firmly secure and complete the engagement between the shells 1*c* and 1*d* and the tube 2. The lateral opening 2*j* is opposite the annular recess 16*e* which recess has communication with the lateral openings 16*d*, the annular tapered space 16*a*, and the central bore 16*c*.

The piston base 11 has threaded engagement over the lower end of the assembling rod 3 and over the upper end of the valve rod 12 which rod is closely slidable within the packing 15, the gland bushing 17, and the central bore 16*c*. The member 3 has an annular flange 3*a* with the openings 3*c* adapted to transmit pressure from the chamber 2*d* to within the U cup 4 and expand it against the tube 2. This cup may be of leather or any other tough, pliable substance; and may be of any other suitable form, such as a ring or series of rings which may be metallic or a combination of alternating metal and fabric. The annular shoulder 3*b* engages the gland ring 5 at proper distance from the flange 3*a* to posi-

tion the cup 4 exactly between the members 3a and 5, as appears in Figs. 2, 3, 7, and 8. The packing 6, engaged between the gland rings 5 and 7 and the packing 10, engaged between the gland ring 9 and the upper surface of the annular flange proximate the lower end of the member 11, are adapted to be compressed and urged against the tube 2 by the force of the coiled spring 8, installed under some compression and having free clearance over the member 11; it being understood that the gland ring 7 is slidable over the rod 3, and that the gland ring 9, likewise is slidable over the member 11.

The packings 6 and 10 are for the purpose of reinforcing the U cup or packing 4 in preventing any leakage out of the chamber 2d.

The members 3 to 12, both inclusive, constitute the movable piston assembly, each member thereof being closely slidable within the bore of the tube 2, excepting the spring 8, which has free clearance within that tube and also excepting the valve rod 12, which is closely slidable within the bore 16c.

The diameter of the movable piston may be such as one to one and one-half inches, while the valve rod 12 may have a diameter such as ⅜ to ½ inch. This ratio between the diameters of the valve rod and the piston will cause the valve to be actuated by much greater force, resulting in more positive action than if the valve were actuated by a force acting upon the same area as that of the valve, as is now the common practice.

A valve positioning member 13, having the central tubular appendage 13a adapted to separate the packings 14 and 15, and to be received within an annular recess within the upper end of the member 16, may be pressed into the tube 2 and landed upon the slight annular shoulder 2c. The lower end of the member 11 lands centrally upon the upper end of the member 13. This contact limits the downward travel of the valve rod 12, as is apparent.

The packing 14 is adapted to engage closely with the tube 2, and the packing 15 is adapted to engage closely with the rod 12, by the force of the plug 22, having threaded engagement within the lower extremity of the tube 2. This force is transmitted to the packing 15 by the gland 17 urged upwardly by an annular shoulder within the member 16 immediately over the annular space within the tapered bore 16a. The packing 18, engaged between the member 16 and the upper end of the gland sleeve 19, and the packing 20, engaged between the lower end of the member 19 and the gland ring 21, are adapted to receive and transmit the force of the plug 22 to both packings 14 and 15. It will be understood that the members 19 and 21 are slidable within the tube 2 and over the lower extension of the member 16, around the lower end of which the tubular portion of the plug 22 has slight clearance.

The packing 18 prevents any leakage of pressure fluid out of the annular chamber 16e between the tube 2 and the member 16. The packing 20 prevents pressure fluid in the annular space S, Fig. 1, from entering the device between the tube 2 and the plug 22, the gland ring 21, and the lower enlarged end of the member 19, as is apparent in Fig. 2. The packings 14 and 15 prevent the upward escape of pressure fluid out of the annular space 16e between the member 13 and the tube 2.

The chamber 2d will be assumed to contain pressure fluid, such as compressed air or other gas, under the assumed pressure of 10 pounds per square inch. The lower end of this chamber may contain a liquid lubricant 2g such as neat's foot oil or glycerine, which will condition and preserve the U cup or packing under it, and a chemical substance 2g', such as sulphur dioxide casinghead gasoline, carbon tetrachloride, ether, etc., adapted to give off gas at and below the pressure of ten pounds per square inch, in order to hold a constant pressure in the chamber 2d. The valves in all forms of the device are closed normally by the resilient force of the pressure fluid in the chamber 2d, as appears in Figs. 2, 3, 7, and 8.

If it be assumed that the chamber 2d is five inches long and has within it air or gas under ten pounds per square inch of pressure, then every time that pressure is doubled within the chamber 2m under the piston assembly, the piston will rise one-half the distance which was between the liquid and the top plate before the pressure was doubled. It follows that at twenty pounds in the chamber 2m, the distance between the chemical substance 2g' and the top plate will be two and one-half inches. At forty pounds under the piston this distance will be one and one-quarter inches; and so on, until, at great pressures, the distance between the chemical 2g' and the top plate ultimately will become very slight. The length of the chamber 2d is such that the tapered lower end of the valve rod 12 will never be raised within the packing 14.

Unlike the valve action in differential devices, this device will have more valves open as the upstanding liquid column is lengthened by increasing the pressure fluid value to embrace more devices within the upstanding column. The value of the pressure fluid, therefore, will effect increasingly the rate of liquid expulsion as the pressure fluid force is increased.

It is also apparent that different devices may be adjusted to open their valves at different forces by merely changing the value of the pressure field within the chamber 2d, or by providing the spring 27, as in Fig. 7.

The devices 1 illustrated in Fig. 2 will be considered installed at intervals of 150 to 300 feet in the tubing G, Fig. 1, the casinghead K, proximately above the ground surface N, being employed to form a hermetic seal between the casing F and the tubing G suspended centrally of the annular space S. The nipple H, having lateral openings Ha, may be employed to connect the tubing to the anchor string J extending to the bottom of the well R.

The extension line Ga may extend to a flow tank. The pipeline L will be assumed to be connected with a source of pressure fluid, and the discharge line M for casing flow will be considered closed during the tubing flow. The gun perforations P admit the contents of the producing formation Q into the well.

The expulsion of liquid from the well will be understood to result from the expansion of pressure fluid discharged through the devices shown in Figs. 2, 3, 7 and 8 into the upstanding column of well fluid.

In flowing the well through the tubing G as an eduction conduit, the tubing, preferably will be of larger diameter in the upper regions of the well than that employed below. The well liquid will be assumed to be standing in both the tubing and the casing at the level indicated at A when pressure fluid is turned out of the line L into the annular space S. The liquid level in the annu-

lar space S will be depressed by this pressure fluid to the level B, while the well liquid will rise in the tubing to C where the upstanding column in the tubing will balance against the force of the pressure fluid within the space S.

Pressure fluid will be discharged into the upstanding liquid column by the device next to its base in the following manner: Well liquid in the tubing will enter the chamber 2*m* via the openings in registration 1*e* and 2*h* and exert pressure under the movable valve assembly further to compress the air or gas within the chamber 2*d*, until, at the assumed pressure of 200 pounds per square inch within the chamber 2*m*, the air or gas within the chamber 2*d* will be compressed until the chemical 2*g'* will closely approach the plate 2*a*. In this position of the movable assembly, the lower end 12*a* of the valve rod 12 will rise within the bore 16*c* and the tapered bore 16*a* to the place indicated at 12*a'*.

Pressure fluid from the annular space S then will enter the upstanding liquid column in the tubing through the device, the path of this travel being via the opening 2*j*, the annular recess 16*e*, the lateral opening 16*d*, the tapered bore 16*a*, the straight central bore 16*c*, the lateral opening 16*b*, the inner annular space 19*b*, the openings 19*a*, the outer annular space 19*c*, and the openings in registration 2*k* and 1*f*, in the order named.

The packings 14 and 15 are for the evident purpose of preventing any of the pressure fluid from leaking by the member 13 into the chamber 2*m* and escaping thence into the tubing, instead of taking the proper path above stated.

It is apparent that the valve rod 12, by reason of its close sliding fit within the untapered central bore, 16*c*, will close that bore and not permit any flow of pressure fluid into the upstanding liquid column in the tubing until the lower end 12*a* of this rod is raised to within the tapered bore 16*a*. This bore, which enlarges toward the top, manifestly, will admit progressively more pressure fluid through the device as the upstanding liquid column elongates and consequently exerts more pressure under the piston assembly, due to increasing pressure within the annular space S.

The flow of pressure fluid between the valve rod 12 and the tapered bore 16*a* can be made automatically self-adjusting in proportion to the load by properly varying the diameter and taper of the tapered bore 16*a*. This bore may have its diameter increased more rapidly from the bottom upward by forming it into a trumpet shape. Such a bore, of course, would provide for a slower increase of the pressure fluid flow as the rod 12 rises than would result from a straight taper of this bore. Under some well conditions, such a flared taper of the bore 16*a* will be found desirable.

The openings governing the admission of pressure fluid through the devices may be, by way of example, such as the equivalent of a circular opening of from ⅛ to ¼ inch diameter.

It is apparent that all devices at or below the level where the liquid in the tubing exerts the assumed pressure of 200 pounds per square inch will be wide open, and that the valves in the devices at higher levels will be closed or closing, according to the pressure of the upstanding column at each such device.

The air or gas within the chamber 2*d*, while not compressed by well liquid, is assumed, as stated, to be ten pounds per square inch, that pressure being considered ample to close the valve completely by landing the member 11 upon the member 13 at all times when there is no liquid pressure opposite the device in the tubing G. This chamber pressure of ten pounds per square inch is also considered ample to act upon the U cup or packing 4 through the openings 3*c* for the purpose of expanding the same against the tube 2 and thereby retaining the pressure fluid within the chamber 2*d* during times when the device is inoperative.

The lubricant 2*g* will further tend to prevent the escape of the pressure fluid within the chamber 2*d* by keeping the U cup 4 lubricated and at the same time interposing a liquid barrier between the cup and the gaseous pressure fluid, within the chamber 2*d*, said lubricant being less apt to escape by the cup than the gas above it.

It is known that gas will be gradually absorbed by well liquid coming in contact with it. The lubricant 2*g* interposed between the well liquid and the chemical 2*g'* and the gas in the chamber 2*d* will prevent such absorption in the event that well liquid should permeate the U cup or packing 4.

If, in the course of time, some of the pressure fluid within the chamber 2*d* should escape, the chemical 2*g'* will give off enough gas to hold the value of the pressure fluid in the chamber 2*d* constant at not less than ten pounds, it being the property of this chemical to give off gas at pressures of less than ten pounds compression and to retain its gas at higher pressures.

The high pressures frequently obtaining within oil wells, especially deep ones, will not cause intrusion of well gas within the chamber 2*d*, because the pressures obtaining within and without this chamber will always be within ten pounds of each other. With the assumed normal ten pounds of pressure within the chamber 2*d* and no pressure within the chamber 2*m* beneath the piston assembly, then if the pressure in the chamber 2*m* be increased to 10,000 pounds, the pressure within the chamber 2*d* will be 10,010 pounds, a sustained differential of 10 pounds.

It is apparent that there are only two forces which control the operation of the valve rod 12. The expansive force of the gas within the chamber 2*d* is constantly urging this valve rod to its valve closing position within the bore 16*c* when the lower end of the rod 12 will be at 12*a*; while the pressure of the upstanding column of well liquid acting under the movable assembly is constantly tending to lift the movable assembly until, at a pre-determined force exerted by the upstanding column, the lower end of the rod 12 will move to the open position of the valve at 12*a'*.

It should be further observed that, unlike all devices operated by the differential, the pressure fluid never contacts the valve operating means in the device but works by indirection only in causing the upstanding column, the force of which controls the valve movements.

The force exerted by the upstanding column is variable, depending upon the place in this column where it is exerted, while the force within the chamber 2*d* varies in the same manner. The only constant force is the pressure fluid placed within the chamber 2*d* when the device is assembled.

In Figs. 2 and 7 it is apparent that the rod 12 will act as a check valve to prevent drainage out of the tubing back through the device at conclusion of the flowing operation.

In Fig. 3, which illustrates the adaptation of the device in Fig. 2 to casing flow through the annular space S, it will be understood that these

devices may be installed as in Fig. 1. The tubing G now becomes the induction tube for pressure fluid and the casing becomes the eduction tube for the well liquid. The tubing now may be smaller than that employed for tubing flow, and, preferably, should be all of one size.

To flow the well through the casing, the pressure fluid pipe line L will be removed and replaced by a plug in the casing head and the flow line M will be open. The well liquid in both the casing and the tubing will be assumed to be standing at the level A. Pressure fluid of proper value now will be admitted into the tubing G through the line G*a*. The liquid in the tubing will become depressed to D and will rise in the annular space S in balance against the pressure fluid in the tubing, resulting in the upstanding liquid column in the casing extending from D to E. The device next above the base of the upstanding column at D in the space S will be open and all devices will function as previously explained for the tubing flow, except that the force actuating the movable piston assembly will enter the tube **2** through the opening **2***h*, now communicating with the upstanding liquid column in the casing, and the pressure fluid will pass through the device into the tubing via the lateral openings **1***j*, **2***j*, the annular space **16***e*, the lateral opening **16***d*, the central tapered bore **16***a*, the central straight bore **16***c*, the central bore **24***a*, the lateral openings **24***b*, the annular recess **24***c*, and the lateral opening **1***k* through the lower shell **1***d* and the tube **2**, in the order named.

The lower end of the valve rod **12***aa* in Fig. 3 is shown tapered farther than the end **12***a* in Fig. 2 in order to co-act with the tapered bore **16***a* so as to admit more pressure fluid to pass through this bore in the upper position of the valve rod indicated at **12***aa'* than would pass if the end were tapered for a shorter distance. This arrangement provides that more pressure fluid will pass through the device during casing flow, which requires more gas, than will pass through it during tubing flow.

The gland ring **23** in Fig. 3 transmits the force of the plug **24** to the packing **18** for the evident purpose of preventing leakage of pressure fluid from the annular recess **16***e* into the opening **24***b* between the tube **2** and the member **16**.

It will be understood that the slight marginal opening between the members **1** and **2** in Fig. 3, at and around the aligned openings **1***j* and **2***j*, is hermetically closed by a weld **2***e'* similar to the weld **2***e* in Fig. 4. The weld **2***f* in Fig. 5 is omitted as unnecessary in Fig. 3.

The construction and operation of the device in Fig. 3 except as otherwise stated, will be understood as being the same as in Fig. 2.

In the second modified form, adapted for tubing flow illustrated in Fig. 7, the tube **2** is secured within the coupling body **1A** by having the boss **26***a*, integral with the plug **26**, secured to the body by the weld **26***b*. The tube **2** is further secured to the body **1A** by the nipple **25**, and by the welds **25***a* and **25***c*.

The upper end of the tube **2** is shown hermetically closed by the plug **26** and the weld **26***c*. The annular space **16***f* corresponds in purpose to the tapered bore **16***a* in Figs. 2 and 3.

The coiled spring **27**, installed under some compression, has its upper end of reduced diameter engaged over the pin-like boss or extension **26***a'* integral with and depending centrally from the plug **26**. The lower end of this tapered spring is engaged over a slight upstanding extension **3***a'* above the flange **3***a* of the member **3A**. The spring **27** is thus centrally held from contacting and possibly scoring the tube **2**. The U cup or packing **4A**, having its outer surface engaged with the tube **2**, is otherwise housed by the cup housing ring **7A** and the gland housing sleeve **5A**, having threaded connection over the member **3A**.

This form of the invention will be installed and operated as was explained in connection with Fig. 2. The pressure of well liquid in the upstanding column in the tubing enters the chamber **2***m* through the lateral opening **2***h* and raises the piston assembly with the connected valve rod **12** until, at a pre-determined pressure, the valve rod extremity **12***aa* will rise to its dotted position at **12***aa'*. The path of pressure fluid into the upstanding liquid column in the tubing then will be via the lateral opening **2***j*, the annular recess **16***e*, the lateral openings **16***d*, the annular space **16***f*, the central bore **16***c*, the central bore **24***a*, the lateral openings **24***b*, the annular recess **24***c*, and the opening **25***b*, in the order named.

The spring **27** serves to increase the resistance to upward movement of the movable piston assembly, while the U cup or packing **4A** will expand and prevent fluid from without from intruding into the chamber **2***d* if this spring, at any time, should offer enough resistance to invite such intrusion. To prevent this, the expansive force of the spring **27** should never exceed the expansive force of the pressure fluid confined within the chamber **2***d*. Manifestly, the pressure fluid within the chamber **2***d*, aided by the spring **27**, will cause the valve rod **12** to rise and open the pressure fluid passage through the bore **16***c* at greater well fluid pressure than would be required to open the passage if the spring were not employed.

The tapered lower end **12***aa* of the valve rod is adapted to govern the inflow of pressure fluid by its varying clearances within the lower end of the annular space **1***f*. These clearances, manifestly, increase progressively as the rod **12** rises after its tapered end enters the lower end of the chamber **16***f*.

Otherwise than stated, the action of the device illustrated in Fig. 7 is so similar in construction and operation to the mechanism in Fig. 2, as to require no further explanation.

In Fig. 8, the construction shown in Fig. 7 for tubing flow is adapted to casing flow, this adaptation being mainly accomplished by substituting the opening **28***c* in Fig. 8 for the opening **2***h* in Fig. 7. To accomplish this slight change, the short nipple **28** is secured within the shell of the tube **2** by the weld **28***b*, and secured within the body **1A** by the weld **28***a*. The coiled spring **27**, the U cup **4A**, and the boss **26***a'* are omitted in Fig. 8, resulting in the movable valve assembly being identical with that shown in Fig. 3.

In Fig. 8, the path of the pressure fluid out of the tubing and into the casing is via the lateral opening **2***j*, the annular recess **16***e*, the lateral openings **16***d*, the annular space **16***f*, the central bores **16***c* and **24***a*, the lateral openings **24***b*, the annular recess **24***c*, and the opening **25***b*, in the order named.

Otherwise than stated, the device illustrated in Fig. 8 is the same in construction and operation as the mechanism in Fig. 7.

In all forms of this invention, except in Fig. 7,

the movable piston assembly between the pressure fluid within the chamber 2*d* and the upstanding well liquid in the eduction tube may be said to constitute a pneumatic scale adapted to weigh the load and admit lifting energy in proportion thereto. In Fig. 7 the scale, of course, becomes a combination pneumatic and spring weighing force.

It is apparent that extremely low starting and operating pressures may be employed, because the upstanding column of any given length may be charged with pressure fluid at any desired distance from its top or base by changing the value of the pressure fluid within the chamber 2*d*, by changing the length of the rod 12, by changing the length of the tapered bore 16*a* in Figs. 2 and 3, by changing the length of the annular space 16*f* in Figs. 7 and 8, or by employing a spring such as the one indicated at 27 in Fig. 7. Shortening the rods 12 will hasten the valve opening, and vice versa. Lengthening the tapered bore 16*a* and the annular space 16*f* will, likewise, hasten the valve opening, and vice versa.

The invention as herein illustrated and described is manifestly subject to many changes in construction and arrangement of parts which will remain within the scope and purpose of the stated objects and appended claims.

What is claimed is:

1. Well flowing apparatus including a tubular valve body, a passage through the wall of said body, a valve in said passage, a cylindrical chamber in alignment with said valve and closed at its upper end, a piston in said chamber and attached to the valve, a lubricant in the bottom of said chamber above the piston, and a compressible fluid in the chamber above said fluid, there being a passage to the interior of the chamber below the piston.

2. Well flowing apparatus including a tubular valve body, a passage through the wall of said body, a valve in said passage, a cylindrical chamber closed at its upper end, a piston in said chamber and attached to the valve, a lubricant in the bottom of said chamber above the piston, and a substance in the chamber adapted to maintain a minimum constant pneumatic pressure therein, there being a passage to the interior of the chamber below the piston.

3. Well flowing apparatus including a valve body, a passage through the wall of said body, a valve in said passage, a sealed chamber containing liquid in alinement with the valve and closed at its upper end, a piston in said chamber and attached to said valve, a valve positioning member in the chamber below the piston, and means for admitting pressure fluid between said member and the piston whereby the valve is lifted against the pressure exerted by fluid entrapped in the chamber above the piston.

4. Well flowing apparatus including a valve body, a passage through the wall of said body, a chamber in the wall of the body, a piston in said chamber, a valve positioning member in the chamber below said piston, a compressible fluid under pressure in the chamber above said piston, means for admitting pressure fluid to the nether side of said piston and to said passage, a downwardly converging bore in said passage below the piston, and a valve member in said bore and movable with said piston to control the flow of pressure fluid through the passage.

5. Well flowing apparatus including a valve body, a passage through the wall of said body, a chamber in the wall of the body, said chamber being closed at its upper end, a piston in said chamber, a valve positioning member for said piston adapted to limit the downward position of the piston, a compressible fluid within the chamber above the piston, a passage from the interior of the body tube to the nether side of the piston, a central bore in the chamber below the piston, there being an enlargement in the bore intermediate its ends, said enlargement constituting a portion of said passage, and a tapered valve attached to the piston and movable in said bore to control the flow of fluid through the passage.

6. A well flowing device comprising a valve body having a chamber in the wall thereof, a piston in said chamber in spaced relation with the upper end thereof, a compressible fluid in the chamber above the piston and at a predetermined pressure when the piston is in its lowermost position, there being a passage to the interior of the chamber beneath the piston, a central bore in the chamber below the piston, a valve member attached to said piston and extending into said bore, and passages in the wall of the chamber from the opposite ends of said bore to the interior and exterior of the valve body.

ALEXANDER BOYNTON.