This invention relates to improved fluid well valves in the nature of an automatically operable fluid controlled balanced valve for use in fluid wells of the gas, oil and water variety.

The purpose of the invention is to provide an automatic valve structure which is an improvement on the type of valve illustrated and claimed in Patent 1,840,694 granted to me under date of January 12, 1932.

As pointed out in the description of the aforementioned patent it is common practice in well construction to provide surface or external means for injecting gas, air, or fluid under pressure into the well tubing to start the flow of fluid from said well and thereafter to serve at desired intervals, to stimulate continuous flow of the well fluid when the same fails to develop sufficient natural nurture or force to flow of its own accord.

In the specific embodiments of valves herein illustrated the principal improvement resides in the construction of the valve body containing two valves operating as a unit of an automatically operable balanced valve, which unit is supported in the tubing and which unit is constructed so that so long as the balanced valve is closed the fluid emanating from the well has developed sufficient force to flow under its own power, said balanced valve serving also to permit outside pressure to enter the well automatically and at requisite intervals when the well fluid fails to flow under its own natural pressure.

Broadly stated an essential distinction between the valve herein described and claimed and that set forth in the previous patent is that the improved valve is such in construction as to provide for a flow of fluid through the casing as well as through the tubing, together with a velocity control in the automatic balanced valves when flowing through the casing.

Many other more specific and structural features of the invention will be pointed out at the concluding portion of the description.

In the accompanying drawings wherein like numerals are employed to designate like parts throughout the same:

Figure 1 is a longitudinal sectional view through the casing and tubing showing two of the automatic valves installed at vertically spaced points.

Figure 2 is an enlarged close up sectional and elevational view disclosing the construction of the improved valve as it is supported in the tubing.

Figure 3 is a horizontal section on the line 3—3 of Figure 2.

Figure 4 is a longitudinal section through the valve seat equipped body of the valve.

Figure 5 is a horizontal section on the line 5—5 of Figure 2.

Figure 6 is a detail view of the gravity opened pressure closed duplex valve unit per se.

Figure 7 is a detail view of a valve adjusting bushing.

Figure 8 is a detail sectional view of a modified type of check valve equipped valve body supporting member.

Figure 9 is a cross section on the line 9—9 of Figure 8.

Referring now to the drawings by detail reference characters it will be observed in Figure 1 the casing is distinguished by the numeral 10 a tubing by the numeral 11. The valves are generally denoted by the numeral 12 and each valve is the same in construction and the description of one will suffice for both.

Referring now to Figure 2 it will be seen that the valve body comprises an open ended tube 13 of appropriate length having a sleeve 14 fitted in the upper end and a similar sleeve 15 fitted in the intermediate portion suitably secured in place. These sleeves constitute valve seats. The lower end of the tubular body is internally screw threaded as indicated at 16 to accommodate the screw threaded valve adjusting bushing 19. The bushing serves to regulate the sensitivity of operation of the valve unit. The valve unit comprises an elongated rod 17 having upper and lower valve members 18 and 19 (19 being a reverse seating valve; which seats against the adjusting bushing 30 when in the adjusting position, thus eliminating the flow of gas downward through bushing 30, countercurrent to the flow of the fluid up the tubing, the result being a triple-seated valve) with the respective seats 14 and 15. The lower end of the rod extends down through the bushing where it is screw threaded as at 20 to accommodate the pressure operated head 21.

Tapped into the diametrically opposite screw threaded holes 22 and 23 of the valve body are the supporting members 24 attached to a wall of the tubing 11 as seen in Figure 2. These members are of tubular form to serve as fluid intakes or outlet-lets for conducting the gas into or from the space between the casing and tubing into and through the improved well. Adjacent the bushing and adjacent the lower end of the valve casing I provide additional fluid passages or ports 25, 26 which serve as gas in-lets or out-lets in and through the improved valve.

Directing attention to Figure 8 it will be observed that it is desirable under certain conditions to provide either one or both of the tubular
supporting members 24 with a pressure controlled supplemental check valve assembly which comprises longitudinally spaced stop 26 and 27 on the side valve disk 28. The disk is provided with circumferentially spaced notches 29 which define gas orifices or ports.

It will be noted that the bore in the stop 27 is such that when the disk is pressed against said part 27 the valve is closed while when the disk is against the ring stop 26 the valve is open. In other words the depths of the notches 29 is such that when the disk bears against the ring 26 said notches form restricted passages for the gas under pressure.

By comparing the structure herein illustrated with that depicted in Patent 1,840,694 previously mentioned the following structural differences and advantages will be noted. The end-caps have been dispensed with and in their place the upper valve seat acts as the valve stem guide and the lower cap has been replaced with an adjustable bushing, but inserted and threaded on the inside, instead of the outside. This bushing is of major importance as an adjustable setting on the valve, whereby the valve can be set to close off when flowing fluid up the casing at any desired pressure, ranging from ten pounds to six hundred.

Also, in the old valve the end-cap served the purpose of attachment to the tubing walls, for suspending the valves. This attachment, is not needed and, therefore, only the eighth-inch nipples that serve as inlet and outlet ports on the valve, both in the original and in the present one, act as the supporting members.

Moreover, although the valve body and stem are essentially the same, the original body was separable, but is now made in one piece, and the seats, instead of cast as a part of the original body, are now press in, however, in their same relative positions and for the same purpose and same method of operation. Instead of using a flat valve, we are now using what is known as a parabolic, or pear shaped, valve, and patent should cover the use of both types, inasmuch as their operation is identical.

The improved valve is capable of flowing a wide variety of liquids, oil or mixture thereof, up either string of pipe the casing or the tubing.

The valve has the ability, when admitting gas down the tubing through the valve openings in the valve and out through the nipples into the casing string to automatically close off by the velocity of the gas through the valve ports, but actually controlled by the reduction of pressure of the fluid in the casing exerted on the valve when lifted by the admission of gas, which lessening of pressure increases the velocity of gas through the valve, and together with the proper adjustment of the adjusting nut will close off in any set pressure. The valve has the ability to, and will, remain in this closed position, once closed, until either the pressure has been removed from the tube or inlet string, or until the fluid rises in the casing up to point to where the pressure of the fluid exerted against any valve in the string equals the gas pressure in the tubing, when the valve automatically reopens and thereby acts as a self-intermitter as well as a positive shut-off, kick-off valve. Other valves may have the ability to close off by velocity control although built of different character. Our specific claim here is to the ability of the valve without the use of springs, diaphragms, or other mechanics to both close off and reopen by the weight of the fluid acting as an intermitter. The claim to the ability of the valve to control the volume of gas passing through the valve before it shuts off by the regulation of the valve nut is an original and exclusive feature.

An additional point which was not made in the original application, is that the bushing 17 at the bottom of the valve body 30, which replaces the old end-cap, is adjustable to the extent that when tightened upward to its greatest extent it will automatically close the valve with an extremely low pressure and velocity, sometimes as little pressure as ten pounds. On the other hand, when loosened or unscrewed towards the bottom, the valve will stay open and resist closing, even under an extremely high pressure and velocity, to an extent of a maximum of six hundred pounds.

Any range of pressure from ten to six hundred pounds can be had by the adjustment of this bushing between these two upper and lower limits, the pressure referred to herein in the inlet pressure or pressure applied to the tubing. The result of this adjustment is that each valve in a series of valves installed in the tubing can thus be set to suit the operator, by the proper regulation of the inlet pressure.

An additional exclusive feature claimed is that after any or all valves have been closed (subsequent to a flow) any or all of the valves will act as an intermitter, in that when the fluid from 105 the bottom of the well nippies that serve as inlet and outlet ports on the valve, both in the original and in the present one, act as the supporting members.

Moreover, although the valve body and stem are essentially the same, the original body was separable, but is now made in one piece, and the seats, instead of cast as a part of the original body, are now press in, however, in their same relative positions and for the same purpose and same method of operation. Instead of using a flat valve, we are now using what is known as a parabolic, or pear shaped, valve, and patent should cover the use of both types, inasmuch as their operation is identical.

The improved valve is capable of flowing a wide variety of liquids, oil or mixture thereof, up either string of pipe the casing or the tubing.

The valve has the ability, when admitting gas down the tubing through the valve openings in the valve and out through the nipples into the casing string to automatically close off by the velocity of the gas through the valve ports, but actually controlled by the reduction of pressure of the fluid in the casing exerted on the valve when lifted by the admission of gas, which lessening of pressure increases the velocity of gas through the valve, and together with the proper adjustment of the adjusting nut will close off in any set pressure. The valve has the ability to, and will, remain in this closed position, once closed, until either the pressure has been removed from the tube or inlet string, or until the fluid rises in the casing up to point to where the pressure of the fluid exerted against any valve in the string equals the gas pressure in the tubing, when the valve automatically reopens and thereby acts as a self-intermitter as well as a positive shut-off, kick-off valve. Other valves may have the ability to close off by velocity control although built of different character. Our specific claim here is to the ability of the valve without the use of springs, diaphragms, or other mechanics to both close off and reopen by the weight of the fluid acting as an intermitter. The claim to the ability
the open position, automatically re-establishing the flow by the injection of gas.

When pressure is delivered through tubing 11 for discharging liquid through the space between casing 10 and tubing 11 the gas or air being introduced down the inner pipe or tubing 11 encounters the valve suspended in the tubing. Gas enters the valve around the valve stem 17, passes through port 14, passes through port 25 and exerts pressure on the lower valve by entering around the lower end of the valve stem through bushing 30. The higher the pressure existing in the tubing, the greater will be the velocity of the gas going into the valve at the above mentioned points, and discharging through ports 23 and 22 into the casing, or outer pipe 10. When sufficient velocity is attained the valve stem will raise towards its closed position.

Due to the velocity and as soon as lower valve is partially lifted off of the top of bushing 30, it also acts as a lower seal for the bottom of outer valve, the escape of gas through the bushing 30 striking upon lower side of valve 19 drives this valve to its upper or closed position. The adjustment of the bushing 30 in or out of the valve body brings the valve in or farther away as the case may be, from valve seat 15, any pressure desired can be made to close the valve.

In explanation of this action, so long as fluid existing in the outer pipe exerting a weight downwardly through valve port 23 and into the valve stem proper, velocity at nominal pressures will remain too low for the valve to close, but as soon as the fluid in the outer pipe is blown out of the hole, this downward pressure is relieved, no fluid being left in the pipe and the loss of this weight automatically increases the velocity of the gas from the valve into the outer pipe, which: as stated before, causes the valve to be both pulled by a vacuum and pushed upward by the increased velocity of the gas through the port around the stem in bushing 30.

It is thought that the description taken in connection with the drawings will enable a clear understanding of the invention to be had. Therefore, a more lengthy description is thought unnecessary.

While the preferred embodiment of the invention has been shown and described, it is to be understood that minor changes coming within the field of invention claimed may be resorted to if desired.

Having thus described my invention, what I claim as new is:

1. An automatic fluid well valve of the class described comprising an open ended tubular body provided with valve seats, means for supporting said body in the well tubing, a valve unit comprising a longer seal or bottom for outer valve, extending through the opposite ends of said body and provided with valve elements coacting with said seats, said rod being provided on its lower end with a head against which the well fluids act in simultaneously closing said valve elements, and means for regulating the sensitivity of operation of the valve elements.

2. An automatic fluid well valve of the class described comprising a tubular body provided with internal valve seats, said body being internally screw threaded at its lower end and provided above said end with fluid ports, a valve adjusting bushing threaded into said lower end of the body, sleeves fitted into the intermediate and upper end portion of the body and constituting valve seats, a rod slidable through the bushing and sleeves and provided with valve elements coacting with said sleeves, a pressure head secured to the lower protruding end of the rod, and supporting members for suspending the valve body in the well tubing.

3. An automatic fluid well valve of the class described comprising a tubular body provided with internal valve seats, said body being internally screw threaded at its lower end and provided above said end with fluid ports, a valve adjusting bushing threaded into said lower end of the body, sleeves fitted into the intermediate and upper end portion of the body and constituting valve seats, a rod slidable through the bushing and sleeves and provided with valve elements coacting with said sleeves, a pressure head secured to the lower protruding end of the rod, and supporting members for suspending the valve body in the well tubing, supporting members being in the form of tubular nipples affording communication between the valve body and the space between the tubing and surrounding casing whereby to permit gas or air under pressure to be passed through the valve by either by way of the tubing, or by way of the space between the tubing and casing.

4. An automatic valve of the class described comprising an open ended tubular body internally screw threaded at its lower end and provided adjacent said screw threaded end with circumferentially spaced gas ports, said valve body being provided intermediate its ends with diametrically opposite screw threaded holes, tubular supporting members threaded into said hole at their inner ends, and connected at their outer ends to the well tubing, a valve adjusting bushing threaded into the lower end of said body, sleeves fitted into the upper and intermediate portions of the body and constituting valve seats, a rod slidable through the bushing and sleeves and provided with valve elements coacting with said seats, a pressure head on the lower end of the rod, one or more of said nipples being provided with a check valve.

5. An automatic fluid well valve comprising a hollow valve casing, at least one supporting member mounted on the valve casing constituting a passage from the interior of the valve casing, a check valve mounted in at least one of the supporting members for controlling the passage, said valve casing formed with communication means establishing an additional passage from the interior of the casing, a pair of valve seats mounted in the additional passage of the valve casing one to each side of the first mentioned passage, a gravitating valve rod mounted in the valve casing and carrying valve elements for controlling both of said passages, a portion of the valve rod depending below the valve casing, a head connected with the depending portion of the valve rod, and an adjustable member carried by the casing and coacting with the valve means for controlling the sensitivity of operation of the valve elements.

6. An automatic fluid well valve adapted to be supported in communication with the interior of an inner well tubing comprising a valve passage and a second passage registering with the through passage, at least one valve seat in the through passage on the opposite sides of the second passage, a check valve in the second passage, a movable valve rod in the through passage carrying valve elements coacting with the valve seats, a portion of the
valve rod depending below the valve casing, a pressure head connected with the depending portion of the valve rod, adjustable means carried by the valve casing and cooperable with the valve rod for regulating the sensitivity of operation of the valve elements, and means connected with the valve casing whereby the valve casing is supported in communication with the interior of said tubing.

7. An automatic fluid well valve comprising a valve casing having at least one passage through the valve casing, a valve for controlling the passage mounted in the interior of the valve casing, a portion of the valve depending below the valve casing, a head connected with the depending portion of the valve, and an adjustable means carried by the casing and cooperable with the valve to regulate the sensitivity of operation of the valve.

8. In combination with a well characterized by an outer casing and an inner tubing spaced from the outer casing, at least one valve casing connected with the inner tubing in registration with the interior thereof, communication means establishing a passage through the valve casing from the inner tubing to the space between the outer casing and inner tubing, a valve in the valve casing for controlling the passage and having a depending portion projecting below the valve casing, a head connected with the depending valve portion, and means carried by the valve casing and cooperable with the valve for regulating the sensitivity of operation of the valve.

9. In combination with a well characterized by an outer casing and an inner tubing spaced from the outer casing, at least one hollow valve casing disposed in the inner tubing, a pair of valve seats in each of the hollow valve casings, communication means located between the valve seats establishing a passage from the interior of the valve casing to the space between the outer well casing and inner tubing, a check valve in said communication means for controlling the passage, additional communication means establishing a passage from the interior of the valve casing to the interior of the inner tubing, a valve rod mounted for reciprocation in the valve casing and carrying valve elementscoacting with the valve seats for controlling both of the passages, a portion of the valve rod depending below the valve casing, a head carried by the depending portion of the valve rod, and adjustable means carried by the lower portion of the valve casing and cooperable with the valve rod to regulate the sensitivity of operation of the valve elements.

10. In combination with a well characterized by an outer casing and an inner tubing spaced from the outer casing, a plurality of hollow valve casings each one of which is disposed in the inner tubing in the path of the well fluid being lifted in the inner tubing, said valve casings also disposed in the inner tubing in vertical spaced relation to one another, a pair of valve seats in each of the valve casings, at least one supporting member for controlling the passage, each valve casing formed with a communication means for establishing an additional passage from the interior of the valve casing to the interior of the inner tubing, a pair of valve seats carried by the interior of each valve casing one to each side of the first mentioned passage, a valve rod mounted for reciprocation in each valve casing and carrying valve elementscoacting with the valve seats for controlling both of said passages in each valve casing, a portion of the valve rod depending below each valve casing, a head carried by the depending portion of the valve rod against which impinges the well fluid being lifted for closing both passages in each valve casing, and adjustable means carried by the lower portion of each valve casing and cooperable with the valve rod to regulate the sensitivity of operation of the valve elements.

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