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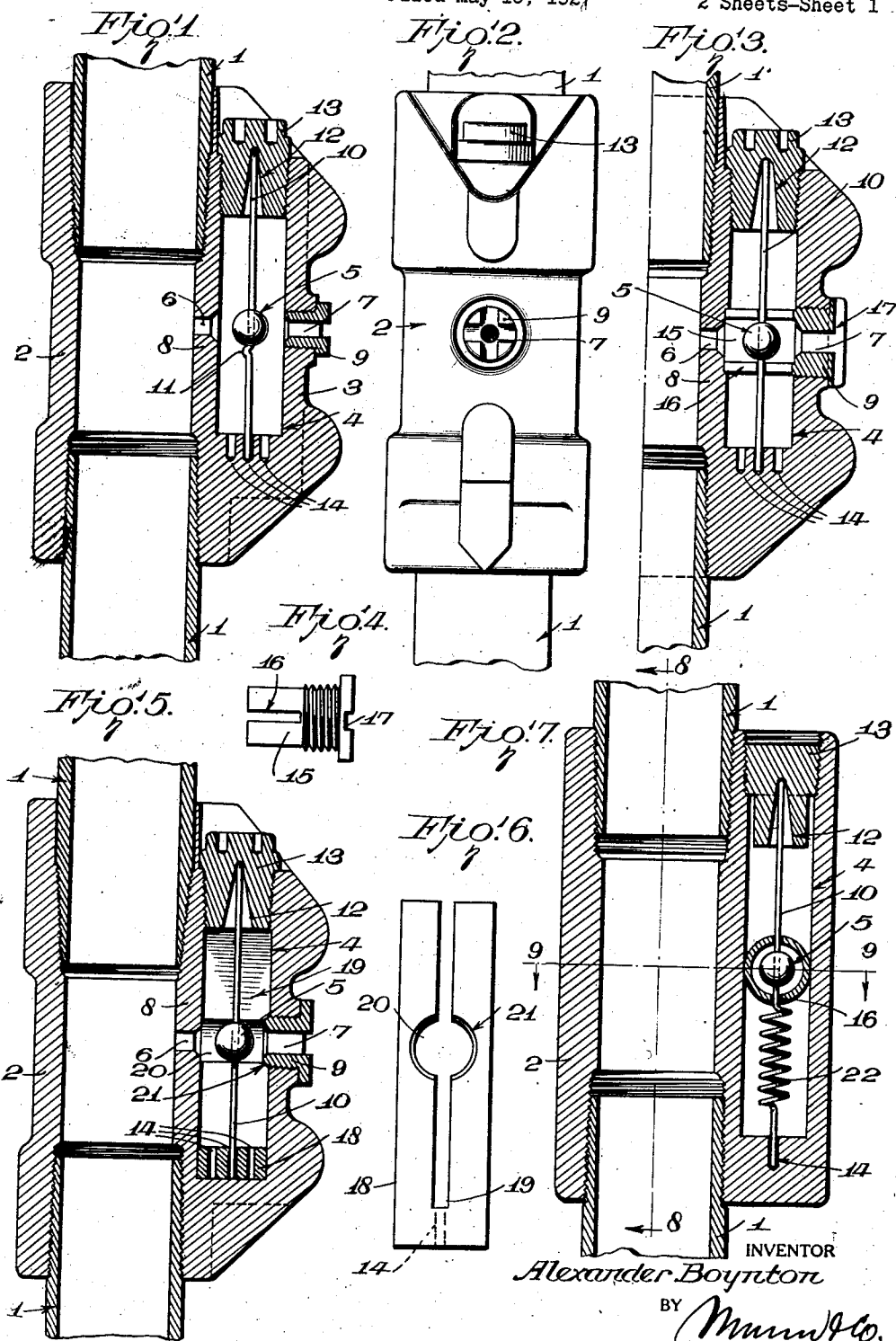
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AUTOMATIC STAGE LIFT FLOWING APPARATUS FOR WELLS

Filed May 19, 1927

2 Sheets-Sheet 1



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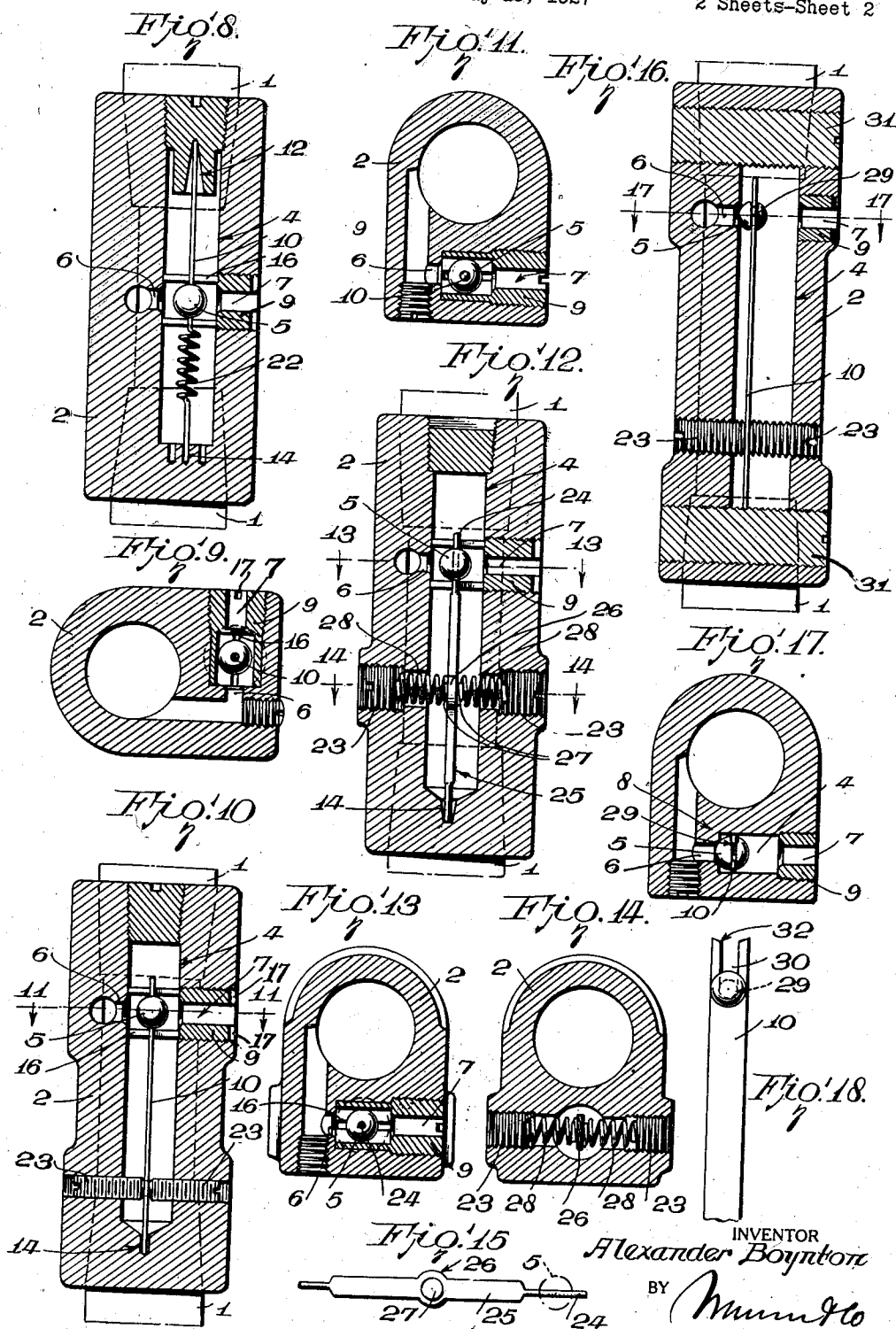
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UNITED STATES PATENT OFFICE

2,010,807

AUTOMATIC STAGE LIFT FLOWING
APPARATUS FOR WELLSAlexander Boynton, San Antonio, Tex., assignor
to Chas. A. Beatty, San Antonio, Tex.

Application May 19, 1927, Serial No. 192,717

13 Claims. (Cl. 137-111)

This invention relates to improvements in flowing apparatus for wells, and it consists of the constructions, combinations and arrangements herein described and claimed.

5 An object of the invention is to provide a flowing apparatus or device which depends for its operation upon the difference in gas or air pressure on the interior and exterior of the tubing string.

10 Another object of the invention is to provide a form of flowing device wherein the purpose of the invention is accomplished by means of a ball valve and resilient mounting therefor as distinguished from the valve-plunger in certain co-

15 pending applications. Other objects and advantages appear in the following specification, reference being had to the accompanying drawings, in which:—

20 Figure 1 is a central vertical section illustrating possibly the simplest form employing a ball valve, Fig. 2 is a front elevation thereof,

Fig. 3 is a detail section of a modification, Fig. 4 is a detail plan view of the slotted bush-

25 ing in Fig. 3, Fig. 5 is a central vertical section of a further modification,

Fig. 6 is a detail view of the valve cage plug or bushing of Fig. 5,

30 Fig. 7 is a central vertical section of a further modification of the flowing device,

Fig. 8 is a vertical section taken on the line 8-8 of Fig. 7,

35 Fig. 9 is a horizontal section taken on the line 9-9 of Fig. 7,

Fig. 10 is a vertical section of a further modification employing a ball-supporting spring of the vibratory type,

40 Fig. 11 is a horizontal section taken on the line 11-11 of Fig. 10,

Fig. 12 is a vertical section of a further modification employing a non-flexible pin as the support for the ball valve,

Fig. 13 is a horizontal section taken on the line 13-13 of Fig. 12,

45 Fig. 14 is a horizontal section taken on the line 14-14 of Fig. 12,

Fig. 15 is a detail elevation of the spring lever or non-flexible pin,

50 Fig. 16 is a vertical section of a further modification employing a flat spring as the support for the ball valve,

Fig. 17 is a horizontal section taken on the line 17-17 of Fig. 16,

55 Fig. 18 is a front elevation of the flat spring and ball.

This invention is an improvement on the automatic stage lift flowing apparatus, disclosed in Letters Patent 1,926,030 of September 12, 1933 to Alexander Boynton and is a correlative to another Patent 1,926,031 of September 12, 1933 also to Alexander Boynton. The latter patent employs a plunger for carrying out the purpose of the invention, as, in fact, does also the first patent mentioned, whereas the present application discloses the use of a ball valve, variously mounted, for controlling the flow of pressure fluid from one side to the other of a string of tubing.

In this application, as is the case in the first patent, as well as in some of the forms of the invention in the second patent, the flowing device depends upon the difference in fluids (gas or air) pressure inside and outside of the tubing for operation. The principle employed in this and other applications is the imposition of fluid under pressure upon the liquid in a well or other container, causing a column of the liquid to rise in respect to a tubing string and to cause such operation of each of a succession of valves as to introduce a proper amount of the fluid into the column of liquid thereby to set it in motion and finally carry it to the top of the well.

The first application mentioned goes into considerable detail in explaining how the principle is carried out, and while the same principle appears in the present application, the particular mechanism employed is of a type different from any heretofore disclosed. Before describing this mechanism, the reader should be acquainted with the tubing and casing methods of raising the liquid.

35 In one instance the fluid under pressure is admitted to the well casing exteriorly of the tubing string. This causes the rising of a column of well liquid in the tubing string. In the other instance the pressure fluid is introduced into the tubing string and causes the rising of a column of well liquid in the casing. The well casing is not herein shown, but may be regarded as surrounding the tubing presently described.

Reference is had to Fig. 1. The short ends of tubing 1 are to be regarded as part of a tubing string extending into the liquid of a well, the bore of which the reader may suppose to be lined with a casing (not shown). Connected in the tubing string is a valve body 2. In practice, numerous valve bodies or flowing devices are incorporated in the tubing string, the manner of such incorporation being fully brought out in the first application mentioned.

A lateral enlargement 3 of the valve body has

a chamber 4 now known as the ball valve chamber, in that it serves as the housing for a ball valve element 5 which is capable of movement between opposite ports 6 and 7 according to the flow of pressure fluid. The port 6 is formed in the wall 8 intervening between the chamber 4 and the interior or conduit of the valve body, while the port 7 is formed in a bushing 9 screwed into the outer wall of the enlargement 3.

A straight, preferably round, length of spring wire 10 serves as a support for the ball valve, the latter being impaled by the support and held in registration with the ports 6 and 7 by an appropriate formation on the spring wire. The formation in this instance comprises a sharp bend 11. The extremities of the supporting spring wire may, or may not be pointed, as illustrated, and are received respectively in the conically formed bore 12 of a closure plug 13 and in any one of a series of recesses 14 in the bottom of the chamber 4. Spanner wrench holes in the top of the plug 13 provide means for screwing the plug in or out.

The reader will note that the conical formation of the bore 12 allows lateral movement of the supporting wire 10 in the region of the upper extremity thereof in order that the valve element 5 may assume the required seating position over the ports 6 and 7. The bore 12 is of considerable depth, the secondary purpose of such depth being that the upper end of the supporting wire may be inserted in the bore prior to screwing the plug 13 home, the operator having the assurance that the wire 10 will not move out of place during the screwing operation. Except for this provision, there would be no way of making sure that the upper end of the spring 10 enters the bore.

Desired adjustments of the ball valve 5 as to position in reference to the ports 6 and 7 are made by merely seating the lower end of the wire 10 in appropriate ones of the recesses 14. Three such adjustments are provided for in Fig. 1, but it is quite obvious that a wider range of adjustment may be had without varying the principle.

It is assumed that the reader is fairly well acquainted with the foregoing tubing and casing methods of flowing the well. With this understanding the reader will apprehend the capability of employing the form in Fig. 1 for either method. The seating effort is supplied by the entrance of the pressure fluid at one or the other of the two ports, the seating of the ball valve 5 depending upon the pressure differential inside and outside of the tubing string.

In Fig. 3, as in all subsequent modifications, such parts as correspond with the form in Fig. 1 are identified by similar reference numerals, without a repetition of the description. The improvement in Fig. 3 resides in the enlarging of the bushing 9 and providing it with a cylindrical projection 15 (Fig. 4) which houses the ball valve 5 thereby avoiding the necessity of bending the spring wire 10 for the purpose of keeping the ball valve in alinement with the ports as in Fig. 1 and which also adds draft to move the ball. In order to permit passage therethrough of the spring wire 10 as well as to allow for the lateral movement of the ball 5, the projection 15 is slit or slotted as at 16 (Fig. 4).

This slit or slot must, of course, always be in the vertical position so as to effect proper alinement with the spring 10. The screw-driver slot 17 is perfectly alined with the slot 16, the object being to enable the mechanic, in assembling the

device, to know when the slot 16 is in the desired perpendicular position.

To assemble this particular type of valve, the ball valve 5 is first placed within the cylindrical projection 15 whereupon the plug 9 is screwed down to the position shown. The wire 10 is then passed through the slot 16 as well as the hole in the ball valve, and into the desired one of the recesses 14. The principal advantage derived from the construction in Fig. 3 is that the by-passing current of pressure fluid is confined within the limit of the chamber or projection 15, thereby causing the ball valve 5 to respond with greater alacrity than if the by-passing current had the unrestricted area to pass through as in Fig. 1. For wells using a large volume of pressure fluid the form in Fig. 1 is satisfactory, but where the volume of compressed fluid is limited, the form in Fig. 3 represents the proper type of valve, principally because of its greater sensitivity and capability of more delicate adjustment.

The form in Fig. 5 follows the lines in Fig. 3, in that it provides for still more delicate adjustment in case the volume of compressed fluid to be used in flowing the well is very small. Fig. 1, as already indicated, allows a free by-passing of compressed fluid around the ball valve 5. The form in Fig. 3 practically limits the by-passing of such fluid to the projection or chamber 15, but in Fig. 5, use is made of a bushing or valve cage plug 18 (Fig. 6) of a design even restricting the space within which the spring wire 10 operates.

This space or slot 19 is wide enough to accommodate the wire, there being a substantially central bore or chamber 20 in which the ball 5 is operable, as already known. One extremity of the bore 20 is counter-sunk at 21 to receive the correspondingly beveled end of the plug or bushing 9. It is observed that the solid bottom of the bushing 18 has the plurality of holes 14 in which the spring wire 10 is variously set, as in other forms previously described.

Figs. 7, 8 and 9 illustrate an arrangement much on the order of that in Fig. 5, the main difference being that the spring wire 10 includes a coiled portion 22 in the lower half to avoid the dragging effect of the slight shortening and elongation of the spring wire resulting at the extremities when straight, as in the foregoing forms. The constructions in Figs. 7 and 8 permit both ends of the spring wire 10 to remain firmly seated upon the bases of the bore and recess 12 and 14 during all positions of the spring.

The coiled portion 22 furthermore provides greater resiliency than could be obtained in a perfectly straight spring wire, thus permitting greater lateral travel of the spring and ball valve 5 with less variations in spring tension than could be obtained by use of the foregoing straight wire. The modified spring therefore has the double advantage of greater resiliency in its horizontal movement, and at the same time will allow the ball valve 5 to move in a straight line between the ports 6 and 7 without compelling the ball to lift either up or down. Otherwise the construction is the same as in Fig. 5, as is readily seen.

Figs. 10 and 11 again illustrate a type patterned after the arrangement in Fig. 5, the main difference in this as well as the type to follow being in the arrangement of the spring wire 10 which is now known as of the vibratory type. The upper end of this wire extends but a short distance beyond the slotted bushing 9, the lower end being firmly gripped between the adjacent ends of a

pair of adjusting screws 23 at a point slightly above the recess 14 in which the lower end of the wire is seated.

It is by means of the adjusting screws 23 that the type of valve in Fig. 10 is made to serve the purposes of either the tubing or casing method of flowing the well. By properly adjusting the screws 23 the ball valve 5 is moved into proximity either with the port 6 or port 7, thus permitting the ball to seal-off against the seat of either port. All lost motion or free movement of the spring wire is avoided by the firm and positive grip with which it is held between the adjusting screws. The bottom recess 14 or landing serves merely as a convenient pocket into which the lower end of the spring is placed in order that the spring may be centrally positioned with reference to the adjacent ends of the adjusting screws before the latter are caused to come into adjusting contact with the spring wire.

Figures 12 and 13 illustrate another modification of the vibratory type. The former spring wire is now replaced by a non-flexible pin or shaft 24, flattened between points as indicated at 25 (Fig. 15), and rounded at its extremities, as shown. The flattened portion 25 is enlarged at 26 to receive the spring guide lug 27. This spring guide lug is made according to any one of several methods, the purpose thereof being to hold in place the adjacent ends of coiled springs 28 which allow certain required movements of the pin or shaft 24 and thereby make the support of the valve 5 (Fig. 12) yieldable, even though the pin or shaft 24 is non-flexible. It is observed that the recess 14 is now tapered to provide for this movement. Adjusting screws 23 afford evident means for adjusting the ball valve 5 in a proper position relative to the ports 6 and 7 by compressing the coiled springs 28 in the proper direction. The form in Fig. 12, as well as that in Fig. 10, is equally adaptable to either tubing or casing methods.

Figs. 16, 17 and 18 illustrate another form of the vibratory type in which the ball valve 5 is provided with a groove 29 around the circumference to occupy the bifurcation 30 (Fig. 18) of the spring 10 which now comprises a flat piece. The valve is regarded as impaled by the support 10 (Fig. 16) inasmuch as its furcations go through the groove 29.

One or more of the flat springs 10 may be employed (the number of spring leaves depending upon the thickness of the spring material), the lower end being securely held between the adjusting screws 23. The flat spring 10 is just wide enough for an easy working clearance in the rectangular cored out spring or ball valve chamber 4 (Fig. 17). It will be observed that each end of the cored out chamber is closed by a plug 31 which is of a diameter sufficiently greater than the width of the passage to insure a complete and safe closure.

It is further observed that the upper end of the leaf spring 10 is partially cut-away or concaved at 32 (Fig. 18), the purpose of this being that the end of the spring may conform reasonably with the lower contour of the uppermost plug 31. This arrangement also has the advantage of enabling the by-passing pressure fluid to impart actuating force to the spring in order that as much as possible of the pressure differential may become available in actuating the ball valve 5. The construction in Fig. 16 is equally adaptable to either the tubing or casing method of flowing wells.

Although use of a ball valve 5 is made in the foregoing various modifications, it is made evident that a rather wide variety of mountings therefor may be employed, the main division of these being as between the bowing type in Figs. 1 to 9, and the so-called vibrating type in Fig. 10 to Fig. 18. In the first type the ends of the supporting wire 10 are more or less fixed, whereas, according to the second type, one end of the mounting 10 is quite free. Brief reference to the mode of operation will remind the reader that the flow of compressed fluid into one or the other of the ports 6 and 7 will urge the ball valve toward the opposite port, a seating of the ball valve being accomplished when the internal and external pressures reach or exceed a predetermined differential.

In any case the support or mounting for the valve 5 operates on the principle of a reed, bending or swaying as it may be compelled to do by the pressure against the valve, but returning to the original position as the pressure is relieved. To this end the support comprises a slender, elongated member which is yieldable according to any one of the various modes disclosed.

I claim:—

1. A valve body having a chamber and a port, a valve and a wire supporting the valve in the chamber, and a bushing screwed into position upon the body having a confronting port and slotted means respectively sustaining the valve in line with the ports and accommodating the wire, said bushing having a screw driver slot in alignment with the wire slot indicating when the wire slot is in proper position in the chamber.

2. A valve body having a chamber with ports, valve means located in the chamber, a resilient element having a formation for sustaining the valve means in line with the ports, and a plug closing an end of the chamber and being adjustably mounted upon the valve body, said plug and the opposite end of the chamber having a bore and a recess, respectively, for the reception of the ends of said resilient element.

3. A valve body having a chamber with ports, means capable of functioning as a valve located in the chamber, a resilient element located in the chamber one end thereof being seated in any one of a plurality of recesses in one end of the chamber, said element having means for sustaining the valve means in line with the ports, and a closure plug for the opposite end of the chamber having a conically formed bore receiving the opposite end of said element, said plug being adjustably mounted.

4. A valve body having a chamber with ports, a valve, resilient means supporting the valve, and means, containing the valve and guiding it between the ports, forming a chamber tending to confine pressure fluid flowing through the ports thus increasing the sensitiveness of reponse of the valve means, and being slotted to accommodate the resilient means.

5. A valve body having a chamber with a port, a bushing having a confronting port, a projection extending from the bushing across the chamber in turn providing a chamber restricting the passageway of fluid flowing from one port to the other, means functioning as a valve being located in the projection-chamber, and resilient means mounted in the valve body chamber extending through the projection and valve means and tending to hold the valve means in a predetermined position with respect to the ports.

6. A valve body having a chamber with an intervening port, a bushing having a confronting port, valve means located between the ports, a resilient element located in the chamber and carrying the valve means, said resilient element normally sustaining the valve means in a predetermined position in reference to the ports, and a projection extending from the bushing containing the valve means and being slotted to permit passage of the resilient element.

7. A valve body having a chamber with an intervening port, a bushing having a confronting port, valve means disposed between the ports, a resilient element located in the chamber carrying the valve means and tending to hold the valve means in a predetermined position in reference to the ports, and a projection of the bushing located in the chamber having a passage containing the valve means and being slit to receive the resilient element, said projection practically confining fluid flowing through the ports to said passage thus rendering the valve means sensitive to small volumes of fluid.

8. A valve body having a chamber with ports, a spring wire lengthwise of the chamber and being mounted at the extremities of the chamber, valve means mounted upon the wire, and a cage for the valve means keeping the latter in line with the ports, and being slotted for passage through and free play of the spring wire.

9. A valve comprising a body having an elongated chamber and confronting ports, a valve element, yieldable means extending substantially midway along the chamber and carrying the valve element medially of the ports in a normally unseated position, said valve being subject to motion between said ports by fluid flowing through the ports, means for mounting the yieldable means at one end of the chamber, and means engaging said yieldable means at a point between the valve element and its mounting, said engaging means being adjustable to vary the zone of vibration of the yieldable means and of the valve element with respect to the ports.

10. A valve body having a chamber with ports, valve means situated in the chamber, a non-flexible non-pivoted element located within the chamber carrying the valve means in line with the ports, means at one end of the chamber providing a mounting for said non-flexible element enabling lateral movement thereof when the valve means is influenced by the pressure of fluid flowing through said ports, and resilient means bearing upon the non-flexible element from opposite sides tending to maintain the valve means in a predetermined position between the ports.

11. A valve body having a chamber with ports, valve means situated in the chamber, a non-flexible non-pivoted element located within the chamber carrying the valve means in line with the ports, means at one end of the chamber providing a mounting for said non-flexible element enabling lateral movement thereof, when the valve means is influenced by the pressure of fluid flowing through said ports, resilient means bearing upon the non-flexible element from opposite sides tending to maintain the valve means in a predetermined position between the ports, and means for variously adjusting the tension of said resilient means.

12. A valve body having a chamber with ports, there being a recess at one end of the chamber, valve means located in the chamber between the ports, a non-flexible pin supporting the valve means, said pin being rounded at the ends respectively to receive the valve means and to seat in said recess, resilient means bearing against the pin said pin having means retaining said resilient means, and adjustable means contacting the opposite ends of the resilient means.

13. A valve body having a chamber with ports, a valve, non-pivoted means supporting the valve, and means containing the valve and guiding it between the ports and being slotted to let the non-pivoted means pass through.

ALEXANDER BOYNTON.