Dec. 24, 1946. W. H. DE LANCEY 2,413,034

FLUID METER

Filed June 2, 1944 3 Sheets-Sheet 1

Fig. 1.

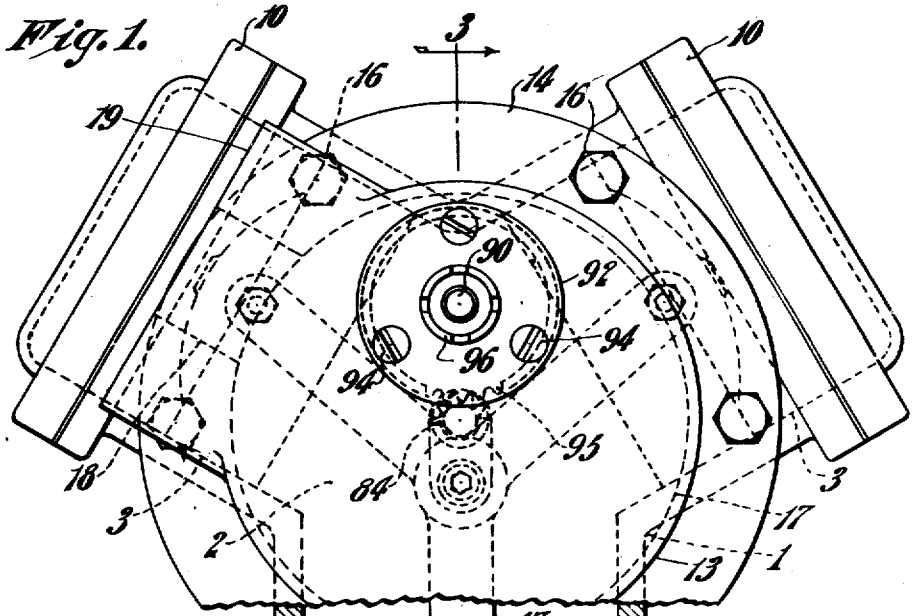


Fig. 2.

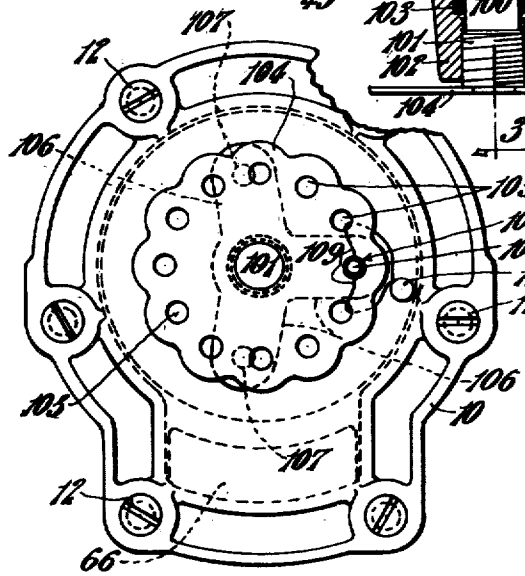
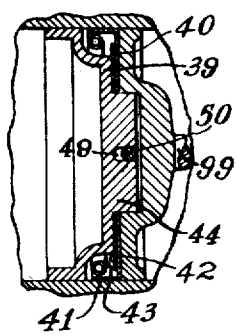


Fig. 9.



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Fig. 3.

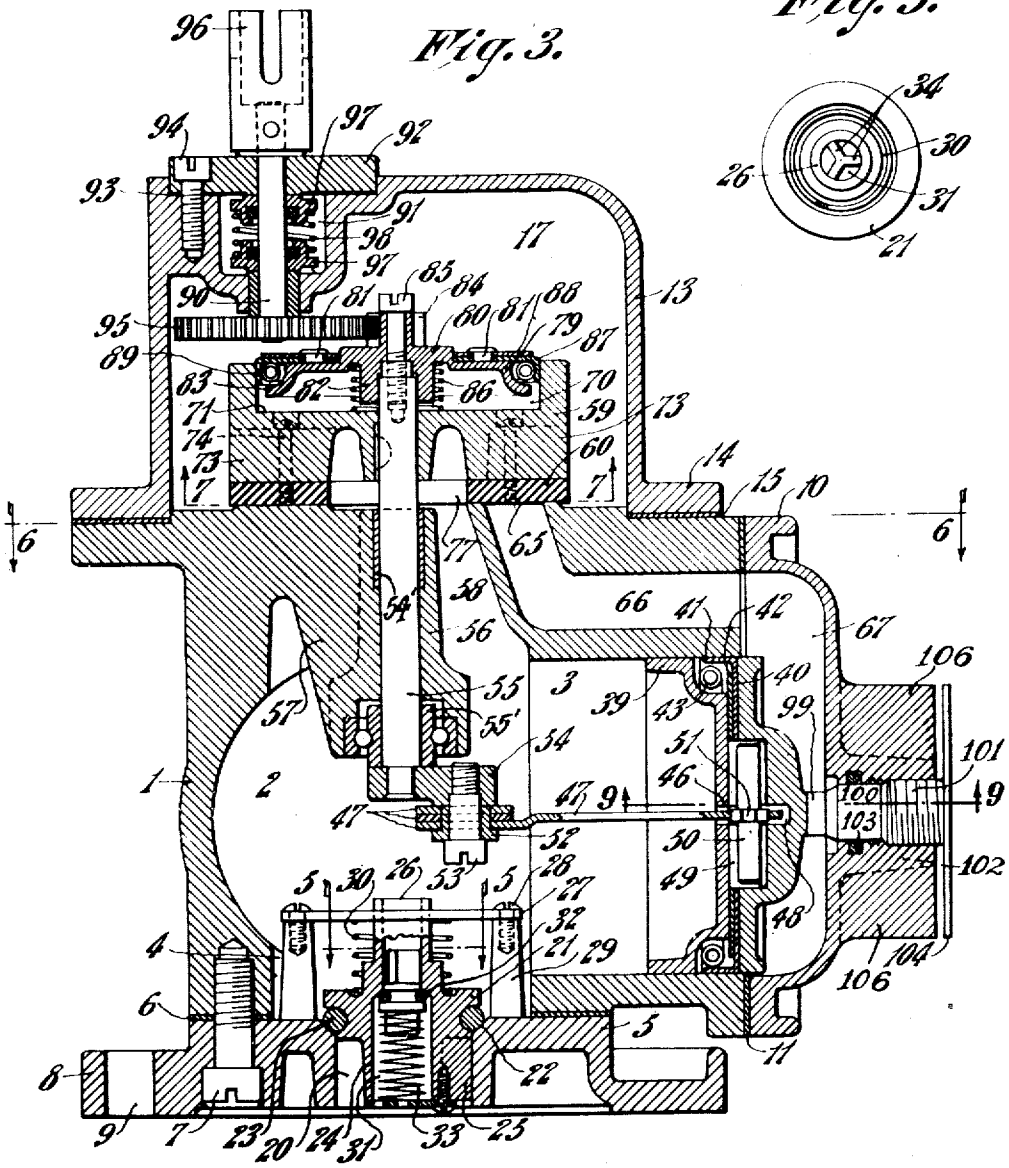
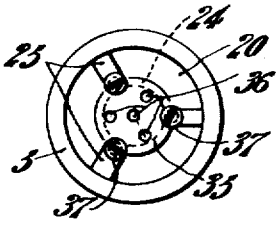


Fig. 5.

Fig. 4.



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Fig. 6.

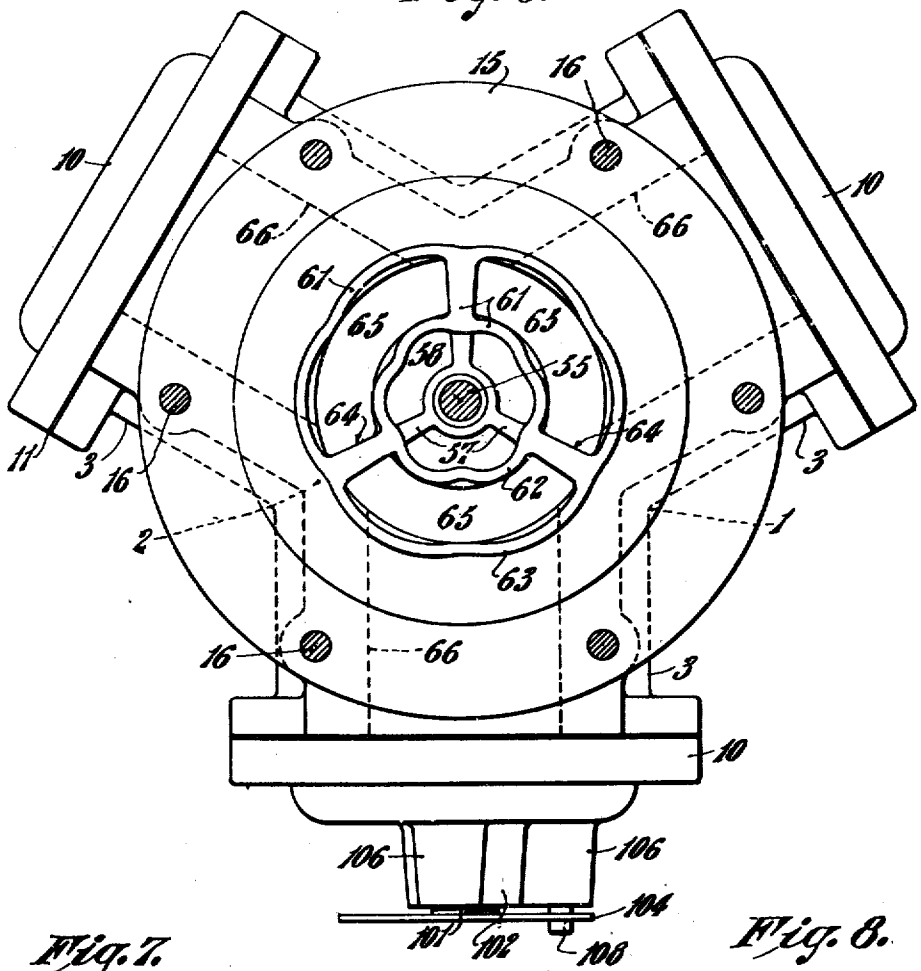


Fig. 7.

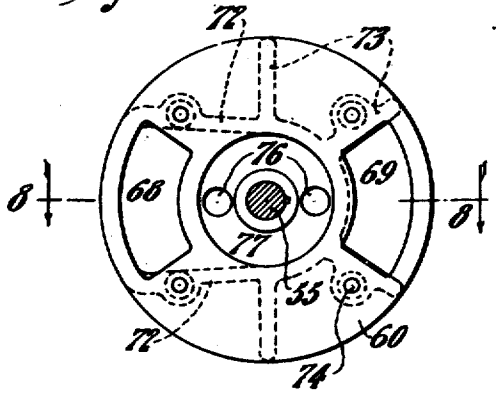
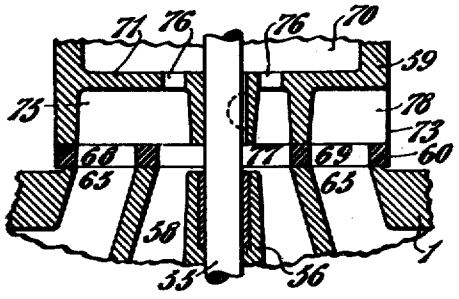


Fig. 8.



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UNITED STATES PATENT OFFICE

2,413,034

FLUID METER

Warren H. De Lancey, Springfield, Mass., assignor to Gilbert & Barker Manufacturing Company, West Springfield, Mass., a corporation of Massachusetts

Application June 2, 1944, Serial No. 538,485

9 Claims. (Cl. 73—247)

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This invention relates to improvements in meters of the reciprocating piston type.

Meters of this type embody pistons, which are driven by the fluid being measured, and a crankshaft for actuating the valve of the meter and for operating a counter or registering mechanism, together with provision for lost motion in the connections between the crankshaft and at least one of the pistons and a calibration stop for such piston to control the amount of such lost motion and thereby vary the stroke of such piston and thus the displacement of the meter.

The general objects of the invention are to simplify and improve the construction of a meter of the stated type to the end that it may be manufactured at relatively low cost and yet give better and more efficient performance; to provide a rugged construction which is calculated to have a long life of useful service; to provide for close accuracy of measurement; to provide for smooth drive of the counter or registering mechanism without substantial pulsations; to provide for low friction loss; to provide for quick purging of the meter of air when initially started; and to prevent hydraulic binds, such for example as sticking of the valve.

More particularly, the invention provides a meter, having a plurality of cylinders and pistons, with means for admitting fluid to the inner ends of the cylinders, whereby the pistons are forced outwardly by the high-pressure fluid. This arrangement enables the calibration stop to be of simple form and located in the cylinder head where it is conveniently accessible. The former disadvantage that the arrangement results in a high-pressure upward thrust tending to unseat the valve, is overcome by the use of a chamber in the valve which is in constant communication with the high pressure fluid and which has one wall on which the fluid acts in a direction such as to seat the valve and to an extent such as to exceed the lifting thrust on the valve and a second and opposed wall independent of the valve to transfer the reactive thrust of the fluid pressure to the casing. By this arrangement, the valve may be held to its seat under relatively low pressure, thereby avoiding rapid wear of the valve and its seat and avoiding sticking of the valve.

Another object of the invention is to provide in a meter of the class described a piston construction of simplified and improved form, susceptible to manufacture by molding and capable of being made of plastics if desired.

Another object of the invention is to provide in a meter of the class described, connecting rods which are relatively flexible and means for supplying the high pressure liquid to the inner

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sides of the pistons so that the connecting rods are always under tension and never subject to compression which would buckle the rods.

A further object of the invention is to provide in a meter of the class described, a connecting rod which is of relatively thin, flat form and can be made in a punch press, and to provide a novel form of wrist pin, which is non-rotatable in the connecting rod, and a novel form of connection between all the connecting rods and the crank pin to enable these thin rods, which of themselves do not provide adequate bearing area, to be successfully used.

These and other objects of the invention will best be understood as the detailed description proceeds and they will be pointed out in the appended claims.

The invention will be disclosed with reference to the accompanying drawings, in which—

Fig. 1 is a top plan view, partly in section, of a meter embodying the invention;

Fig. 2 is an end view of one of the cylinder heads, showing part of the calibrating means and the sealing means therefor;

Fig. 3 is a cross sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a bottom plan view of the inlet valve shown in Fig. 3;

Figs. 5, 6 and 7 are sectional views taken on the lines 5—5, 6—6 and 7—7, respectively, of Fig. 3;

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 7; and

Fig. 9 is a fragmentary sectional view taken on the line 9—9 of Fig. 3.

Referring to these drawings; the meter includes a casing comprising a body member 1 (Fig. 1), having a central chamber 2 and three cylinders 3, spaced 120 degrees apart and radiating from, and communicating at one end with, the central chamber. The latter has a large opening 4 (Fig. 3) in its bottom wall and such wall is faced off to receive a bottom closure plate 5, which is secured to the body with a gasket 6 clamped therebetween by a plurality of cap screws, one of which is shown at 7 in Fig. 3. This plate 5 has a flange 8, with a plurality of holes, such as 9 therethrough, whereby it may be fastened to the outlet of an air separator, for example, or to any other suitable means from which liquid is supplied to the meter. Each cylinder 3 has its outer end closed by a head 10 which is secured to the end of the cylinder, with a gasket 11 clamped therebetween by a plurality of cap screws 12 (Fig. 2). The meter casing further includes a top cover 13 having a flange 14 which is fastened to a faced-off part of the top of body 1 with a gasket 15 clamped therebetween, by a

plurality of cap screws 16. The space within the cover 13 constitutes an outlet chamber 17. The latter has an outlet passage 18 (Fig. 1) through the flange 19, which is adapted for connection to an outlet pipe.

The inlet to the meter is by way of a passage 20 which is provided in the closure plate 5 (Fig. 3) and which opens into the central chamber 2. An inwardly-opening, valve 21 controls the admission of liquid through passage 20 and prevents return flow. The plate 5 has a seat 22 for valve 21 with which seat the valve packing (in the shape of a torus ring 23 of rubber or the like) cooperates. The valve has a depending stem 24 with wings 25 (Fig. 4) which guide it in passage 20. The valve 21 also has an upwardly extending hollow stem 26 which is slidably guided in a plate 27, secured at its ends by screws 28, one to each of a pair of posts 29 upstanding from plate 5. A spring 30, coiled around stem 26, acts between plate 27 and the upper face of valve 21 with a tendency to close the valve.

A back-flow passage 31 extends through both the hollow-stems 24 and 26 and the valve 21. A valve 32, which is mounted in that portion of passage 31 having the larger diameter and which is pressed upwardly by a spring 33, cooperates with a seat formed at the intersection of the large and small portions of the passage to control the latter. Valve 32 has vanes 34 (Fig. 5) to guide it in the small portion of passage 31. A plate 35, having a plurality of holes 36 therethrough, is secured by screws 37 to the lower end of the valve stem 24 and acts as a seat for spring 33. The passage 31 enables back flow of liquid to relieve pressure due to expansion of the liquid, valve 32 opening whenever the force due to pressure of the liquid and acting on the valve exceeds the force due to the spring 33.

Slidably mounted in each cylinder 3 is a piston 38. As herein shown, each piston includes two parts 39 and 40, which are made of plastic or any other suitable material and between which the circular portion of the piston leather 41 and its washer 42 are clamped. Member 39 is recessed to receive an annular spring 43 for pressing the annular portion of the piston leather against the wall of the cylinder. The member 39 has a central cylindrical hub 44 which fits into a correspondingly-shaped recess in member 40, whereby these parts are brought into coaxial relation. The members 39 and 40 are held together by a plurality of cap screws 45. The hub 44 has a slot 46 therethrough to provide clearance for the connecting rod 47. The member 40 has a similar slot 48 for the same purpose. Located one on each side of the slot 46 and extending at right angles thereto, are two recesses 49 extending from the outer face of the hub inwardly and terminating with semi-cylindrical inner sides. These recesses are U-shaped in cross section and are intended to receive, one in each, the cylindrical ends of a wrist pin 50. The recess 49 in at least one of the pistons is somewhat greater in depth than the diameter of the cylindrical ends of the wrist pin so that there is a certain amount of lost motion between such piston and its connecting rod. Centrally between its ends, the wrist pin is formed with a portion 51 of hexagonal or other non-circular shape, which closely fits in a correspondingly-shaped hole in the outer end of its connecting rod. The wrist pin cannot turn in its connecting rod, which is of thin rectangular cross section, but is forced to turn in the recesses 49, which provide bearings of adequate area.

The three connecting rods 47 have their inner ends overlapping and superposed one upon another. The upper and lower of such ends, shown in Fig. 3, are respectively offset upwardly and downwardly to lie on opposite sides and flatly against the faces of the unoffset central end. These superposed ends are mounted upon a flanged bushing 52 with freedom to turn thereon. The bushing is mounted to turn on a stud 53, forming the crankpin of a crank 54, which is fixed to the lower end of a shaft 55. The latter is rotatably supported in upper and lower bearings 54' and 55' formed in a central hub 56, supported by spider arms 57 in an outlet passage 58 leading vertically upwardly from the center of chamber 2. The upper bearing 54' is a sleeve bearing of hardened steel. The lower bearing 55' is an anti-friction bearing, such as a ball bearing, and is designed to take both the radial and axial load. The shaft projects upwardly above the top of body 1 and into the outlet chamber 17, where it is slidably keyed to a distributing valve and connected by means to be described to drive a counter or registering mechanism.

The distributing valve comprises a body 59, which may be of molded plastic material, and a facing 60, which may be of carbon and which rotatably engages finished valve seat surfaces 61 on the top wall of body 1. These surfaces are the upper end faces of inner and outer walls 62 and 63, respectively, and radial division walls 64. The inner wall 62 surrounds the central outlet passage 58 and the walls 62, 63 and 64 together mark off a circular series of arcuate ports 65 surrounding said central passage. The walls 62 and 63 are not truly circular but vary in radius by a distance at least equal to the thickness of the walls. This arrangement enables any gum, which may be deposited between the valve and its seat, to be wiped off rather than carried around and around in a circle and accumulate to cause sticking of the valve. The ports 65 are connected by passages 66, cored in body 1, one above each cylinder, to the clearance space 67 in the head of such cylinder. The carbon face 60 of the valve has two arcuate ports 68 and 69 therethrough, located 180 degrees apart. The upper part of the body 59 has a cylindrical recess 70 in its upper face having a circular bottom 71. This wall is spaced from the parallel carbon block 60 by an endless flange 72 of the configuration shown in Fig. 7 and by several fins 73 radiating from such flange. The block 60 is secured to body 59 by screws 74 which pass through these flanges and fins. The flange 72 marks off a space 75 which constantly communicates at its inner end with the central passage 58 and at its outer end with the inlet port 68. There are holes 76 in the wall 71 which connect cylinder 70 with space 75 but, except for said holes, the port 68 in the carbon block and the central hole 77 in the latter, the space is closed. The arcuate port 69 at its upper end constantly communicates with a space 78 between two fins 73, which space at its outer end is in constant communication with the outlet chamber 17.

When the port 69 of the valve communicates with the passage 66 of one cylinder, the outer end of that cylinder is connected to the outlet chamber 17 and the piston in that cylinder will move outwardly by the high pressure in inlet chamber 2 to expel the liquid from such cylinder. The crank 54 will be rotated by the pull of the connecting rod or rods of the piston or pistons that are being pushed outwardly by the high inlet

pressure. At times, only one piston will be pushed outwardly and at other times two of the pistons will be pushed outwardly. The pressure strokes of the pistons overlap to some extent and enable a substantially smooth movement of the crank and a substantially uniform flow of liquid free from pulsations of any substantial degree. As the valve moves to bring its port 68 into communication with a port 66 of a cylinder, the piston in such cylinder is being drawn inwardly by the crank 54 and liquid will enter the cylinder and eventually fill the same.

A piston is mounted in the cylinder 70 in the upper part of the valve body 59. This piston includes a die-cast member, having a circular plate 79, with a central hub 80 and a plurality of studs 81 upstanding therefrom; a depending hub 82; and a marginal spring support 83 of arcuate section. Integral with and upstanding from hub 80 is a pinion 84. The hub 82 is mounted on the upper end of shaft 55 and is held thereto by a screw 85 which passes through pinion 84 and hub 80 and threads into shaft 55. A spring 86 encompasses hub 82 and acts between wall 71 and plate 79. The circular portion of the piston leather 87 is superposed on plate 79 and a metal washer 88 is superposed on the circular portion. Both said portion and the washer have holes to receive studs 81 and a central hole to fit over hub 80. The upper ends of the studs 81 are rivetted over upon the washer to hold the piston leather to plate 79. The annular flange of the piston leather engages the circumferential wall of cylinder 70 and is pressed thereagainst by an annularly-formed coil spring 89 resting on support 83.

The register driving means includes a shaft 90 mounted in upper and lower bearings, one in the lower wall of a cylindrical depression 91 in the upper wall of cover 13 and one in a plate 92 which closes the upper end of said recess. This plate 92, with an intervening gasket 93, is clamped to cover 13 by a plurality of cap screws 94. Fixed on the lower end of shaft 90 is a gear 95 which meshes with pinion 84. Fixed on the upper end of shaft 90 is one section 96 of a coupling adapted to receive a mating coupling section on the lower end of the drive shaft of the register.

Within the chamber 91 are upper and lower seal rings 97, each mounted on shaft 90 and pressed apart by an intervening spring 98, coiled around the shaft. The seal rings are pressed against the upper and lower walls of chamber 91 and they tightly fit and revolve with shaft 90, thus preventing leakage from the meter around the shaft.

For calibrating the meter, means are provided for varying the stroke of one of the pistons, such as that shown in Fig. 3. An abutment 99 is adapted to be engaged by this piston to limit its outer stroke. This abutment is formed on the inner end of a cylindrical shank 100 having its outer end 101 threaded into a central hub 102 on the head 10 of the cylinder. A seal ring 103 in this head engages the smooth shank 100 and prevents leakage from the cylinder along the shank and screw. Fixed to the outer end of screw 101 is a wheel 104 having a circular series of twelve equally spaced holes 105. Radiating from hub 102 are a series of arms 106 each having near its outer end a hole 107 spaced radially from the axis of wheel 104 by the same distance as holes 105. The upper and lower holes 107 in Fig. 2 are spaced 100 degrees from the intermediate and right hand hole 107. The wheel 104 is adapted

to be held in place by a pin 108 which is passed through one of the holes 105 and one of the holes 107. The pin may then be held in place by a wire 109 passed through a hole 110 in the outer end of pin 108 and through two adjacent unoccupied holes 105 and having its ends brought together and held by a lead seal 111. The spacing of the holes 107 is such as to enable the pin 108 to hold wheel 104 in 36 positions of angular adjustment. When the abutment has been moved to the desired position, one of the holes 105 may register with one of the holes 107 in which case the pin 108 is passed through these registering holes. If no one of the holes 105 registers with any hole 107, the wheel 104 is turned until the two holes 105 and 107 that are nearest to registering, do register. And the maximum movement necessary to bring two such holes into register is no more than 10 degrees. Assuming that screw 101 has 20 threads to the inch, the maximum axial movement of abutment 99 from its exact position of adjustment to one where wheel 104 can be held by pin 108 is no more than one thirty-sixth of five one-hundredths of an inch or .00139 and if the cylinder is assumed to be two and one-half inches in diameter, the maximum displacement is seven one-thousandths of a cubic inch. The meter may thus be adjusted with exceedingly close accuracy.

The arrangement whereby the fluid is admitted to the inner ends of the cylinders 3, while not new of itself, is important in that it enables the use of simple, inexpensive but nevertheless reliable means for calibration and enables such means to be placed in a conveniently accessible location. Thus, a simple abutment 99, adjustable by being screw-threaded into the head 10 of one of the cylinders, suffices for the purpose. This abutment is located in the path of the piston and the latter is forced against the abutment, thereby limiting its stroke. There is lost motion between wrist pin 50 and its piston and more or less of this lost motion is taken up according to the location of the abutment, whereby the stroke of the piston and thus its displacement may be varied.

It has heretofore been considered objectionable to have the pistons thrust outwardly by the high pressure fluid because there results a high pressure upward thrust tending to unseat the valve. To overcome this objection, the valve has the chamber 70 formed therein and in constant communication with the passage 58, whereby the high pressure fluid may act on the bottom wall of the chamber and press the valve to its seat with a force greater than the upward force tending to unseat the valve. This chamber 70 has a second and opposed wall, independent of the valve, in this case the piston 80, which transmits the reactive thrust of the fluid in chamber 70 to the casing. In this case, fluid under outlet pressure (several pounds per square inch less than the inlet pressure) tends to move the piston downwardly. The unbalanced thrust on the piston 80, tending to lift it and shaft 55, is taken by the antifriction bearing 55', which is designed for this purpose, and transmitted to the casing 1.

It is not possible to perfectly balance valve 59 because the pressures acting on it vary as it rotates and according to its angular position. However, the predominating force, tending to hold the valve to its seat is made as low as feasible. In addition, the carbon facing of the valve provides for a low coefficient of friction.

The piston construction is simple and inexpen-

sive to manufacture. The parts 38 and 40 may be made by molding, as from Bakelite or other suitable plastic material, and require no finishing other than tapping of the holes for the screws 45, which hold these parts together. The connecting rods can be made in a punch press and the wrist pins can be made in an automatic screw machine. These rods being subject only to tension may be made of small cross section. They are light weight and relatively flexible and would buckle under compressive force if the pistons were forced inwardly by the high pressure liquid. The non-circular central part of the wrist pin has a press fit in the connecting rod. To assemble the parts of the piston, the inner end of a connecting rod is passed through the slot in the part 38, bringing the wrist pin against the outer face of such part. Then, the piston leather 40, its washer 42 and spring 43 are laid in place on part 38, after which part 40 is superposed on part 38 and held thereto by the screws 45. In use, each wrist pin turns entirely in its recess in the piston, thereby providing the adequate bearing area that could not be had in a connecting rod of the type described. The connection of the wrist pin between two parts of the piston is novel and this arrangement allows the wrist pin to be located far out in the piston. The connecting rod can thus be made longer and thus have less angularity with less resulting side thrust on the piston. The bushing 52 provides a connection having the requisite bearing area between the inner ends of all the connecting rods and the crank pin. The connecting rods merely articulate on the bushing. The rotary movement is between the bushing and the crankpin. This arrangement enables the use of the simple, inexpensive form of connecting rod, herein described.

The meter has high efficiency because of the reduction of friction losses. Such losses are kept low because of the low pressure needed to hold the valve to its seat, the low coefficient of friction between the valve and its seat, and the use of the anti-friction bearing to take the unbalanced thrust on the crankshaft. Long life results from these same factors. The low pressure holding the valve to its seat, the facing of the valve, the use of a hardened bearing 54' and of an anti-friction bearing 55' result in materially lessened wear and thus materially increased life.

The meter is free from pockets in which air may be trapped and, when initially started up will quickly purge itself of air. It is not necessary to pump more than 10 to 15 gallons of liquid before all air will be driven out of the meter.

The use of three cylinders, spaced 120 degrees apart, results in a smooth flow of liquid from the meter substantially free from pulsations. The strokes of the pistons overlap in part and in such a way as to give substantially uniform rotation of the crankshaft. The driving of the counter or registering mechanism is thus effected smoothly and without pulsations of any material degree.

The invention thus provides an improved meter construction designed for manufacture at low cost, for efficient and smooth operation, for close accuracy of measurement and for a long life of useful service.

I claim:

1. In a fluid meter, a casing having a plurality of cylinders radiating from a central chamber, a plurality of pistons one in each cylinder, a crankshaft mounted centrally in one wall of

said chamber with its axis at right angles to the axes of said cylinders, a crank on the inner end of said shaft, connecting rods between said pistons and crank, there being lost motion in the connections between said crank and one of the pistons, a calibration stop adjustably mounted in the outer end of the cylinder containing the last-named piston and located in the path thereof; said casing having an inlet passage opening into said chamber, an outlet chamber and an outlet passage leading out of said central chamber through said wall; a valve on the outer end of said shaft and seating on said wall, said casing having passages one for each cylinder each leading from the outer end of its cylinder to and terminating with a port in said wall, said ports adapted to be connected successively by said valve to said outlet passage and subsequently to said outlet chamber, said valve having a chamber in constant communication with said outlet passage, said last-named chamber having two opposed walls, one chamber wall being on the valve and the thrust of the high pressure fluid thereon being in a direction such as to move the valve to its seat and being greater than the thrust of the high pressure liquid tending to unseat the valve, the other chamber wall being independent of the valve and taking the reactive thrust of the high pressure fluid in said chamber and transmitting it to said casing.

2. In a fluid meter, a casing having a plurality of cylinders radiating from a central chamber, a plurality of pistons one in each cylinder, a crankshaft mounted centrally in one wall of said chamber with its axis at right angles to the axes of said cylinders, a crank on the inner end of said shaft, connecting rods between said pistons and crank, there being lost motion in the connections between said crank and one of the pistons, a calibration stop adjustably mounted in the outer end of the cylinder containing the last-named piston and located in the path thereof; said casing having an inlet passage opening into said chamber, an outlet chamber and an outlet passage leading out of said central chamber through said wall; a valve on the outer end of said shaft and seating on said wall, said casing having passages one for each cylinder each leading from the outer end of its cylinder to and terminating with a port in said wall, said ports adapted to be connected successively by said valve to said outlet passage and subsequently to said outlet chamber, said valve having a cylinder therein, a piston in said last-named cylinder fixed to said crankshaft and subjected on its inner face to the high pressure in said central chamber and on its outer face to the lesser pressure in said outlet chamber, and bearings in said casing for said shaft including an anti-friction bearing to take the unbalanced thrust on said crankshaft.

3. In apparatus of the class described, having a piston made up of inner and outer members, a piston packing between the members, and means for clamping the members and packing together, and having a crankshaft and crank therefor; a connecting rod of thin flat form connected at one end to said crank, and a wrist pin fixed in the other end of the connecting rod, the inner member having a slot therethrough and through which the outer end of the connecting rod passes, one member having a recess in one face to receive the wrist pin and provide a bearing therefor, said recess being closed by one face of the other member.

4. In apparatus of the class described, having

a piston made up of inner and outer members, a piston packing between the members, and means for clamping the members and packing together, and having a crankshaft and crank therefor; a connecting rod of thin flat form connected at one end to said crank, and a wrist pin fixed intermediate its ends in the outer end of the connecting rod, one member having in one face a recess of a size and shape to rotatably receive the ends of said wrist pin, said recess being closed by one face of the other member, the inner member having therethrough a slot at right angles to the first-named slot and through which the connecting rod passes with freedom for articulating movement.

5. In apparatus of the class described, having a piston made up of inner and outer members, a piston packing between the members, and means for clamping the members and packing together, and having a crankshaft and crank therefor; a connecting rod of thin flat form connected at one end to said crank, a wrist pin having a relatively short central portion of non-circular cross section and relatively long cylindrical portions one on each side thereof, said rod having in its outer end an opening therein to receive and closely fit the central portion of the wrist pin, the inner member having therethrough a slot through which the outer end of said rod passes, one member having in one face a recess of U-shaped cross section and at right angles to the slot in the inner member and closed by one face of the other member to rotatably receive the cylindrical ends of the wrist pin.

6. In apparatus of the class described, having a cylinder, a piston made up of inner and outer members with a piston packing clamped therebetween, a calibration stop adjustably mounted in the outer end of the cylinder in the path of the piston, a crankshaft, and a crank therefor; a connecting rod in the form of a thin flat strip having its inner end connected to said crank and having in its outer end a non-circular opening, and a wrist pin having a short central portion fitted in said opening and relatively long cylindrical portions one on each side of said central portion, said inner member having therethrough a slot through which the outer end of said rod passes, one member having in one face a U-shaped recess substantially equal in length to the overall length of the wrist pin and closed by one face of the other member, said recess having a width substantially the same as the diameter of the cylindrical portions of the wrist pin and a depth greater than such diameter, whereby to provide lost motion between the connecting rod and piston to enable the piston to be arrested by said stop at various positions prior to the end of the piston's stroke.

7. In a fluid meter, having a casing provided with a central chamber and a plurality of cylinders radiating therefrom and provided with inlet and outlet passages in opposite walls of said chamber and passages leading from the outer ends of said cylinders to and through said wall and terminating with ports surrounding said outlet passage, a piston in each cylinder, a valve to control said passage and ports, connections between said pistons and valve to actuate the same, a valve in the inlet passage preventing the return flow from the chamber to the passage, said valve having a passage therethrough, and a pressure relief valve normally closing the last-named passage but opening to permit flow therethrough from the chamber when the fluid in the chamber exceeds a predetermined pressure.

8. In a fluid meter, a casing having a plurality of cylinders radiating from a central chamber, a plurality of pistons one in each cylinder, a crankshaft mounted centrally in one wall of said chamber with its axis at right angles to the axes of said cylinders, a crank on the inner end of said shaft, connecting rods between said pistons and crank; said casing having an inlet passage opening into said chamber, an outlet chamber and an outlet passage leading out of said central chamber through said wall and terminating with a port; a valve slidably and non-rotatably mounted on the outer end of said shaft and seating on said wall, said casing having passages one for each cylinder each leading from the outer end of its cylinder to and terminating with a port in said wall, said valve having a chamber therein to connect the first-named port successively to the second-named ports and having a port located outside said chamber to successively connect the second-named ports to the outlet chamber, said valve having above its chamber a cylinder opening at its upper end into the outlet chamber and having a partition between the valve cylinder and said valve chamber having a relatively small fluid-conducting passage therethrough, a piston in the valve cylinder and fixed to said shaft and subjected on its lower and upper sides to inlet and outlet pressure respectively, and a bearing for said shaft in said wall adjacent said crank adapted to be engaged by said crank and take the upward thrust on said shaft.

9. In a fluid meter, a casing having a plurality of cylinders radiating from a central chamber, a plurality of pistons one in each cylinder, a crankshaft mounted centrally in one wall of said chamber with its axis at right angles to the axes of said cylinders, a crank on the inner end of said shaft, connecting rods between said pistons and crank; said casing having an inlet passage opening into said chamber, an outlet chamber and an outlet passage leading out of said central chamber through said wall and terminating with a port; a valve on the outer end of said shaft and seating on said wall, said casing having passages one for each cylinder each leading from the outer end of its cylinder to and terminating with a port in said wall, said valve having a lower chamber with upper and lower walls paralleling the first-named wall and openings in the lower wall one to continuously register with the first-named port and the other adapted to be successively connected with the second-named ports, the fluid pressure acting on the upper wall of the lower chamber exceeding that acting on its lower wall, said valve having a port outside said chamber to successively connect the second-named ports to the outlet chamber, said valve having an upper chamber with upper and lower walls generally paralleling the upper wall of the lower chamber but of greater area than the latter and a relatively small passage connecting the upper and lower chambers, the upper wall of the upper chamber being independent of the valve, whereby the fluid pressure acting on it does not tend to unseat the valve, the fluid pressure force on the lower wall of the upper chamber being greater than that on the upper wall of the lower chamber, and connections from the upper wall of the upper chamber to the casing to transmit the fluid pressure thrust on the valve to said casing.

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