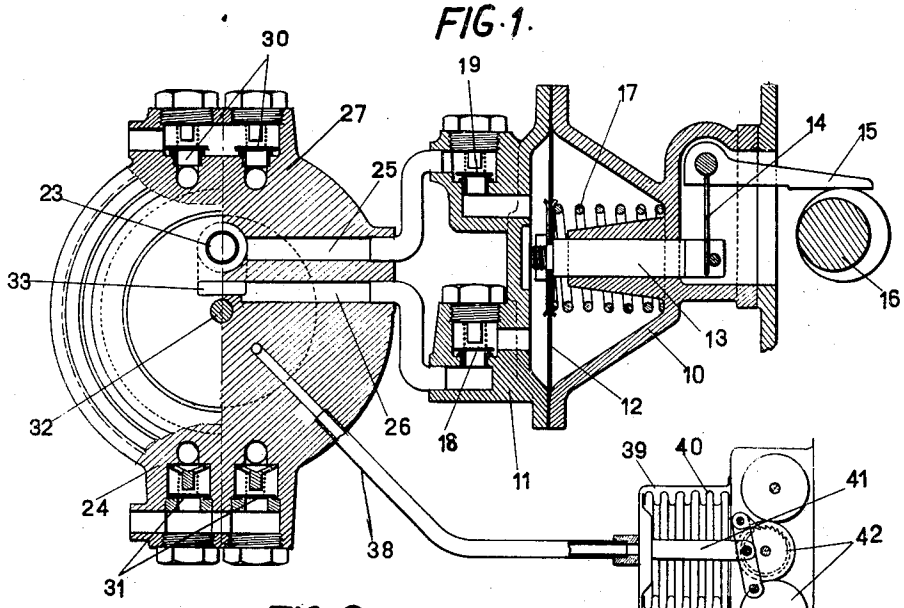
July 12, 1938. E. PELICH 2,123,577

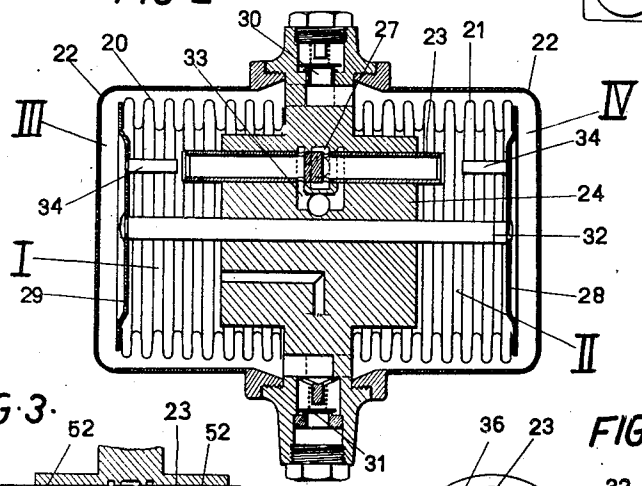
FLUID MEASUREMENT APPARATUS

Filed Oct. 17, 1934

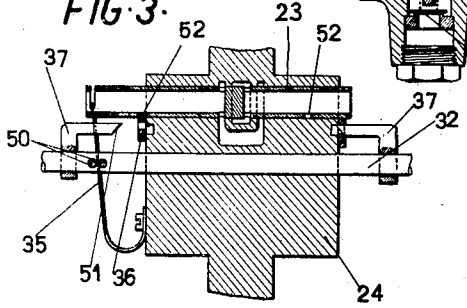
FIG·1.



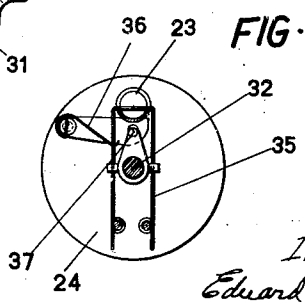
FIG·2.



FIG·3.



FIG·4.



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UNITED STATES PATENT OFFICE

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FLUID MEASUREMENT APPARATUS

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8 Claims. (Cl. 103—152)

This invention relates to a device for the accurate measurement of fluids delivered to the point of consumption in a continuous flow but in a variable manner. It is known, that, for instance the fuel consumption of combustion engines is not in proportion to the output of the engine, to say nothing of the fact that the complicated relationship of both these factors is always also governed by the immediate state of the engine. Therefore pumps are used to supply the fuel, suitably driven directly by a motor with a regular speed, but working with changeable length of stroke or size of space adapted to the consumption of fuel. The measurement of the output of such pumps is not possible in practice. A pump, which would make measurement possible, would have to work with a constant stroke or space, and, at a speed or with numbers of strokes changeable according to consumption of fuel, demands such complicated arrangement of the drive, that it is considered impracticable to carry out in construction. Counting apparatus of turbine or other already known principle may also be considered unsuitable for the problem under consideration since they are, on one hand, inaccurate and unreliable and on the other a noticeable resistance to fluid flow is brought about by the insertion of such an apparatus, which the fluid in conveyance must overcome.

According to the invention for accurate measurement of fluids delivered to the point of consumption in a continuous but variable manner, two double-acting pistons pumping units cooperate together in a positive manner, one of said units consisting of two front walls of the pistons coupled mechanically together and moving in a common casing. This unit encloses in its interior, as a second pumping unit two further working chambers divided by a fixed middle body provided with a distribution mechanism and transmission channels, said working chambers on both sides of the front walls of the pistons being selectively joined together, so that, by connecting independently the outer and inner chambers so that the inner chambers form driving chambers whereas the outer chambers form pumping chambers or all four chambers are connected together in such a manner that the pressure fluid is conveyed through them as in a liquid motor.

A special arrangement of said four chambers may be such that each of both outer chambers is connected diagonally to the corresponding opposite inner chamber.

According to a further feature of the new invention a system of two pumps may be used functionally connected by an hydraulic transmission, one of which, an auxiliary pump, so called, adapts the transmitted driving force to the variable consumption of fluid, and with power in relation to the consumption. The hydraulic transmission acts on the second or actual liquid pump of a constant length of stroke or size of working space, so that the output of the whole system is determined by a certain number of strokes which may be easily recorded by a very simple mechanical counting machine.

The auxiliary pump, fitted with a suitable diaphragm absorbs, by means of the special flexible transmission member, just sufficient power as is necessary to supply the liquid. By the functioning of this transmission member, the pump works with changeable length of strokes or size of space. The auxiliary pump, for the adaption of the constant drive to the changeable consumption of fluid, works with the auxiliary medium, the energy of which in the hydraulic transmission is used to drive the pump proper, the constant strokes of which are counted by a simple mechanical apparatus. The inserted hydraulic transmission at the same time serves to transmit the irregular output of the auxiliary pump to the measurable output of the pump proper, which constantly performs equal strokes, of course, of a different number in a given unit of time.

The pump proper, again fitted, advantageously, with a diaphragm receives the energy from the auxiliary pump, on one side, transmitted by means of the transmission medium, and uses it on the other side for pumping the fluid. The movements of the diaphragm act by intermediary of mechanical or hydraulic pressure or other means to effect the operation of the pawl and ratchet keyed to the main shaft of the counting machine.

An example of the system carried out according to the invention is to be seen in the schematic drawing in which Fig. 1 shows a section of both pumps with hydraulic transmission, Fig. 2 is a longitudinal section of the pump proper and Figs. 3 and 4 are details of the distribution valve device in axial section.

A device for the accurate measurement of fluids delivered to the point of consumption in a continuous flow but in a variable manner is shown in Fig. 2 in which two double-acting pumping units cooperate together in a positive manner, one of said units consisting of two front walls **28**, **29** of the pistons **20**, **21** coupled mechanically together by the rod **32** and moving

in a common casing 22. This unit encloses in its interior a second pumping unit consisting of two further working chambers divided by a fixed middle body 24 provided with a distribution mechanism and transmission channels as described below, said working chambers on both sides of the front walls 28, 29 of pistons 20, 21 being joined together. Thus, by connecting independently the outer and inner chambers III, IV and I, II respectively the inner chambers I, II may form driving chambers whereas the outer chambers III, IV may form pumping chambers, or all four chambers may be connected together in such a manner that the pressure fluid is conveyed through them as in a liquid motor.

A special arrangement of said four chambers I to IV may be such that each of both outer chambers III or IV is connected diagonally to the corresponding opposite inner chamber II or I respectively.

According to the further embodiment of the invention, Fig. 1, the auxiliary pump in the case under consideration, is fitted with a diaphragm 12 and has between the body 10 and the lid 11 such diaphragm 12 tightly gripped and is set in motion by the rod 13. The rod 13 engages a spring 14 which is provided with a lever 15 having an up and down travel, one end of which is fitted against the driving shaft cam 16. Another spring 17 acts on the diaphragm 12 in opposition to the spring 14 and the differential action of these springs effects the pumping action of the diaphragm.

The valve 18 admits the transmission liquid, such as oil, into the pumping chamber between the diaphragm 12 and the lid 11, and the valve 19 passes it to the distribution device of the pump proper.

The pump proper, in the chosen case, according to Fig. 2, consists of a pair of bellows, cylindrical corrugated diaphragms, (sylphons or bellows) 20, 21, so joined, that they function alternately, in a piston-like manner, in a common casing 22, so that while one part, in receiving the transmission fluid, expresses the liquid supplied, the other part, in exhausting the transmission liquid sucks up the conveyed liquid. The distribution device for the transmission fluid serves to ensure equal length of the stroke and size of pumping chamber. This device accurately regulates the points of return of the double-acting diaphragm piston.

The distribution device is constructed of an axial travelling slide valve 23 which travels in a bore of the middle body 24. The suction and discharge valves of the auxiliary pump open by means of pipings and channels 25, 26 into the middle body 24. The transmission fluid flows, through the channel 25, to the distribution chamber 27, from which the hollow slide valve 23 passes it into the inner working chambers of the diaphragms 20, 21. According to Fig. 2, the transmission fluid flows from the chamber 27 through the right cavity of the slide valve 23 to the inner chamber of the diaphragm 21, pressing against its front wall 28 and so expressing the conveyed fluid from the body 22 by the valve 30 to the outlet pressure piping. The front wall 28 is connected by the rod 32 to front wall 29 of the diaphragm 20. From the inner chamber of the diaphragm 20 the transmission fluid is exhausted through the left cavity of the slide valve 23 and the chamber 33 to the auxiliary pump. The conveyed fluid is thus sucked through the suction operated valve 31 into the chamber between the front wall 29 and the casing 22.

At the end of this phase of action a regulatable buffer 34 strikes against the slide valve 23 and shifts it axially to the opposite position, the working phase being reversed. The channel 25 thereby connects, by the intermediary of the left cavity of the slide valve 23, with the inner work chamber of the diaphragm 20. At the same time the inner chamber of the diaphragm 21 is connected by means of the right cavity of the slide valve 23 and the chamber 33 to the exhaust channel 26.

For sudden movements of the slide valve 23 from one extreme position to the other, the buffer 34 (Fig. 2) may be substituted by a flat spring 35, fitted to the front surface of the middle body 24 and carried by pins 50 (Fig. 3) on the rod 32. By the movement of the rod 32 in either direction from the middle position, the spring 35 is flexed whereupon the spring pawl 36 is lifted out of the gap 52 of the slide valve by the wedge surface 51 of the regulatable pin 37 on the rod 32. The slide valve thus lifted suddenly moves to the opposite position by the action of the flexed spring.

With this reversing mechanism acting on the slide valve the points of return of both diaphragms are accurately determined and with that is always ensured the constant length of the strokes and also the size of the work chamber. Therefore the quantity of supplied fluid may be given directly by the number of working cycles of the diaphragm pair so that it is possible to measure a supplied quantity by the simple addition of an ordinary mechanical counter to the rod 32, for instance.

Should the recording mechanism be so far removed from the measuring apparatus proper that the lever transmission causes difficulty, the action of the measuring mechanism may be effectively carried out hydraulically, for example. To carry out this effect, one or both of the inner work chambers of the diaphragm pair are connected by a system of piping 38 to the working chamber of the casing 39 of the auxiliary diaphragm 40, the rod 41 of which transmits the relayed movements to the counter 42.

What I claim is—

1. A pumping system including a reciprocating pump having a casing, a pair of pistons for dividing the space in said casing into four main compartments, a central member in said casing forming a partition therein, and a rod for connecting said pistons together, an auxiliary pump having a casing, a diaphragm in said last casing, a pair of valves, ducts for connecting said valves to ports in said central partition member, and means for oscillating said diaphragm for moving a liquid in said last casing through one of said valves and one of said ducts into one of said four main compartments for moving said pistons and forcing the liquid from another of said four main compartments through another of said ducts and the other of said pair of valves into said second casing, means for feeding a fluid medium being pumped into another of said four main compartments and means for conveying said fluid medium from the last of said main compartments simultaneously through the action of said pistons and said auxiliary pump.

2. A device for accurate measurement of fluids delivered to the point of consumption in a continuous flow but in a variable manner comprising a double-acting pumping unit, said unit including a

casing, a central member positioned in said casing, a pair of pistons for dividing the space in said casing into four compartments having fluid media therein, a rod for connecting said pistons together through said central member, and a valve system in said central member, an auxiliary pump having a casing, a fluid in said casing, a diaphragm and a pair of valves, ducts for connecting each of said valves to said first valve system, means for moving said diaphragm of said auxiliary pump for transmitting said fluid through one of said pair of valves, and one of the valves of said valve system to one of said four compartments for moving said pistons and for exhausting fluid from another of said compartments through said valve system, another of said ducts and the other of said pair of valves to said auxiliary pump, and means for feeding a fluid to be transferred from one point to another into another of said four compartments and means for receiving fluid from the last of said four compartments simultaneously as said pistons are being moved through the operation of said auxiliary pump.

3. A pumping device comprising a casing, a pair of pistons, a central partition member in said casing, a rod for connecting said pistons together, said rod passing through said partition member, a pair of flexible bellows-shaped members for connecting said pistons to opposite faces of said partition member for dividing the space in said casing into four compartments, two of said compartments being substantially enclosed by the other two of said compartments, a pair of ducts through said partition member, a movable member slidable through said partition member having tubular sections extending from said partition member into said enclosed compartments, said movable member having ports connecting to each of the tubular sections for selectively connecting said enclosed compartments to one or the other of said ducts as said movable member is moved, an auxiliary duct connected to one of said inclosed compartments and an indicating device connected to said last mentioned duct for counting the number of strokes of said pistons for indicating the quantity of liquid passing through the pumping device directly.

4. A pumping system including a reciprocating pump having a casing, a pair of pistons for dividing the space in said casing into four main compartments, a central member in said casing forming a partition therein, and a rod for connecting said pistons together, an auxiliary pump having a casing, a diaphragm in said last casing, a pair of valves, ducts for connecting said valves to ports in said central partition member, and means for oscillating said diaphragm for moving a liquid in said last casing through one of said valves and one of said ducts into one of said four main compartments for moving said pistons and forcing the liquid from another of said four main compartments through another of said ducts and the other of said pair of valves into said second casing, means for feeding a fluid medium being pumped into another of said main compartments and means for conveying said fluid medium from the last of said four main compartments simultaneously through the action of said pistons and said auxiliary pump, an auxiliary duct in said central partition member connecting to at least one of said compartments, and a hydraulically actuated indicating device connected to said auxiliary duct for counting the number of strokes of said pistons for indicating the quantity of liquid passing through the pumping device directly.

5. A device for accurate measurement of fluids delivered to the point of consumption in a continuous flow but in a variable manner comprising a double-acting pumping unit, said unit including a casing, a central member positioned in said casing, a pair of pistons for dividing the space in said casing into four compartments having fluid media therein, a rod for connecting said pistons together through said central member, and a valve system in said central member, an auxiliary pump having a casing, a fluid in said casing, a diaphragm and a pair of valves, ducts for connecting each of said valves to said first valve system, means for moving said diaphragm of said auxiliary pump for transmitting said fluid through one of said pair of valves, and one of the valves of said valve system to one of said four compartments for moving said pistons and for exhausting fluid from another of said compartments through said valve system, another of said ducts and the other of said pair of valves to said auxiliary pump, and means for feeding a fluid to be transferred from one point to another into another of said four compartments and means for receiving fluid from the last of said four compartments simultaneously as said pistons are being moved through the operation of said auxiliary pump, an auxiliary duct in said partition member and a hydraulically actuated indicating device connected to said auxiliary duct for counting the number of strokes of said pistons for indicating the quantity of liquid passing through the pumping device directly.

6. An apparatus for the accurate measurement of liquids to be delivered in variable quantities, comprising two constant stroke-length hydraulic pump units connected together, one of said pump units being adapted to drive the other of said pump units for producing in said last mentioned pump unit a constant displacement for each stroke thereof, said driving pump unit comprising, a cam shaft, a spring actuated lever mechanism having a member thereof in permanent engagement with said cam shaft, a displacing membrane also in engagement with said spring actuated lever mechanism and a casing for enclosing said membrane, a fluid medium in said casing on one side of said membrane and means for connecting said casing to said driven pump unit for driving said last mentioned pump unit through the action of said fluid medium and displacements of said membrane.

7. An apparatus for the accurate measurements of liquids to be delivered in variable quantities comprising a constant stroke-length hydraulic pump unit, a casing for said pump unit, a central partition in said casing, a pair of diaphragms attached to said central partition member one on each side thereof, an end plate for each of said diaphragms, means extending through said partition member for connecting said end plates together, a hollow slide valve supported by said partition member for alternately connecting chambers on each side of said partition to different ones of a pair of ducts formed in said central partition, a driving pump connected to said pair of ducts, means for locking said slide valve in predetermined positions, means operable by said end plates for unlocking said locking means and spring means for rapidly shifting said slide valve when said locking means is unlocked.

8. In a device for the accurate measurement of fluids the combination of a hydraulic pump, a partition in said pump, hydraulic means for driving said hydraulic pump, said hydraulic pump having a pair of pistons one on each side of a partition for defining chambers on each side of said partition, end plates for said pistons, a rod attached to both of said end plates and extending through said partition whereby said end plates are movable together, a hollow slide valve positioned in said partition for alternately connecting said chambers on each side of said partition to a pair of ducts in said partition, spring means connected to said rod and said slide valve, a locking device for locking said slide valve in predetermined positions, means carried by said rod for unlocking said locking device for permitting said spring means to move said slide valve rapidly from one position to another after said rod moves to a predetermined position, and means for connecting said pair of ducts to said hydraulic means for driving the hydraulic pump.

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