April 18, 1950 — G. F. AUSTIN ET AL — 2,504,945

APPARATUS OF THE RECIPROCATING PISTON TYPE FOR DELIVERING FLUIDS

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FIG.1.

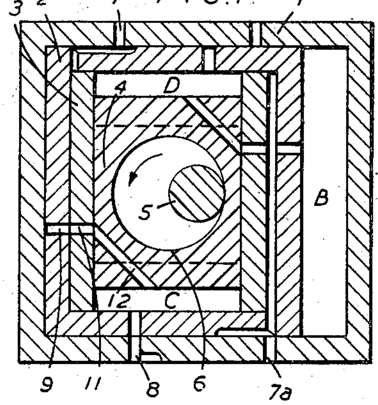

FIG.2.

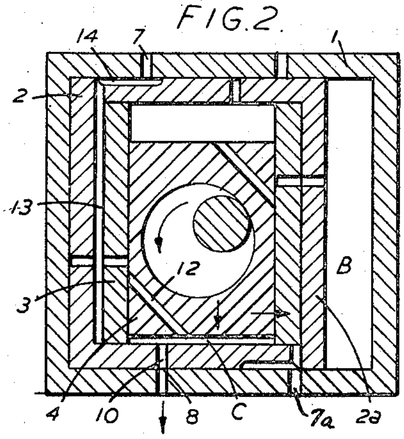

FIG.3.

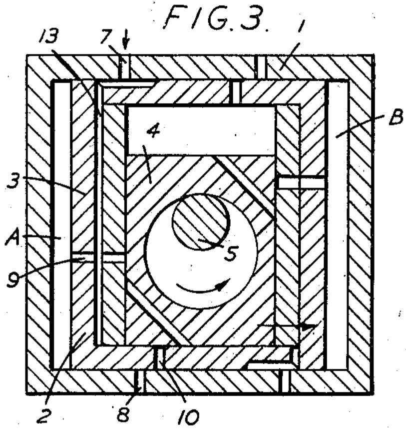

FIG.4.

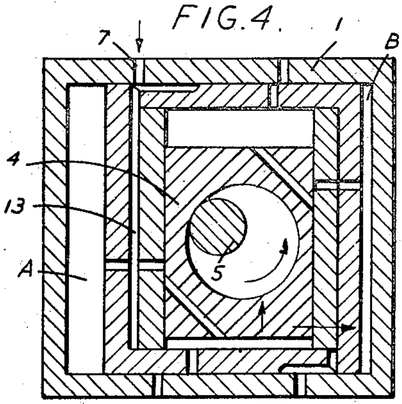

FIG.5.

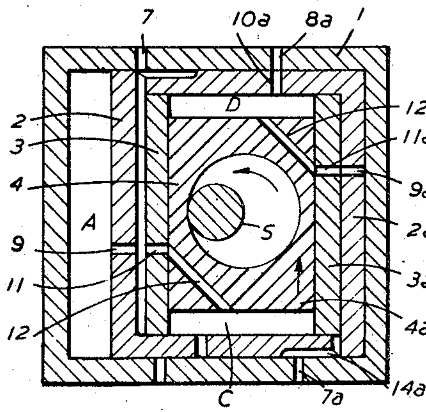

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FIG. 6.

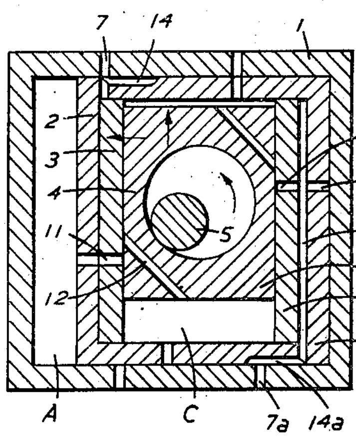



FIG. 7.

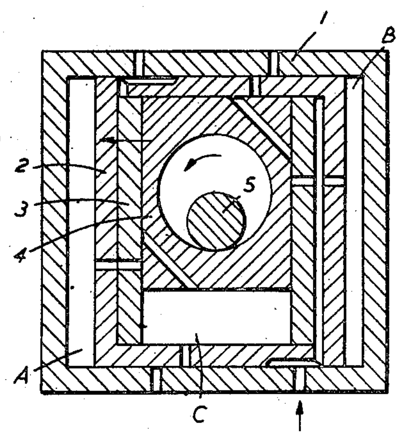
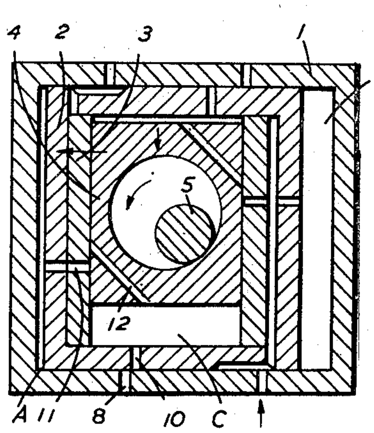



FIG. 8.

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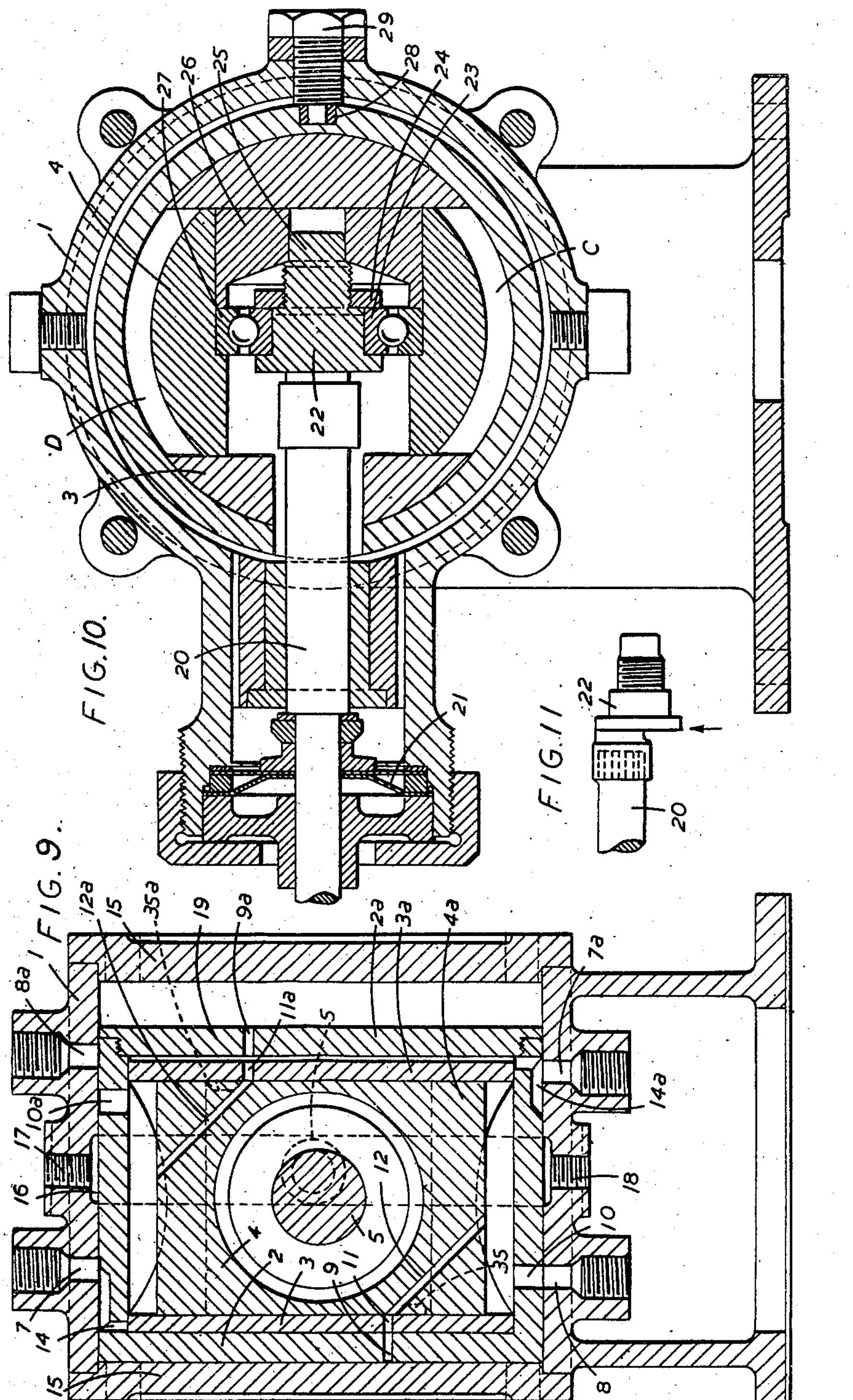


FIG. 10.

FIG. 11

FIG. 9.

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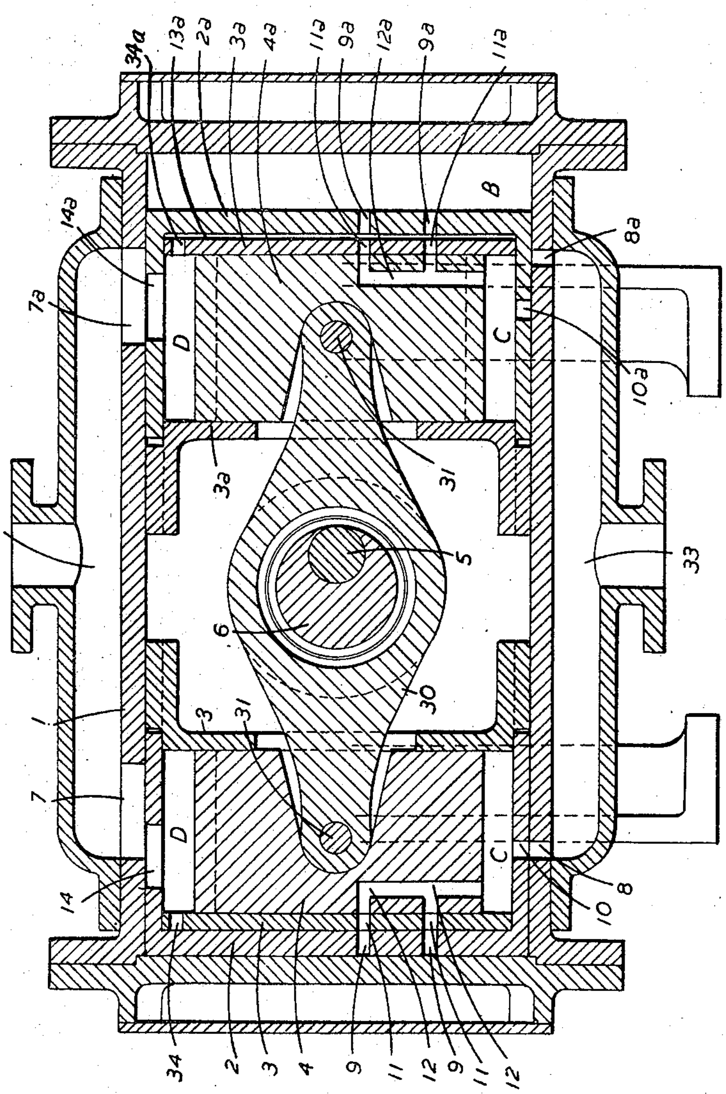
FIG. 12

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Patented Apr. 18, 1950 2,504,945

# UNITED STATES PATENT OFFICE

2,504,945

## APPARATUS OF THE RECIPROCATING PISTON TYPE FOR DELIVERING FLUIDS

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Application September 24, 1945, Serial No. 618,130
In Great Britain November 18, 1944

8 Claims. (Cl. 103—163)

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This invention relates to pumps and compressors of the reciprocating piston type constructed for the delivery of fluids.

The object of the invention is apparatus having an improved capacity/weight or power/weight ratio; which is simple in construction; which is compact, reliable in operation, and capable of being made at low cost.

Reference may be made to the accompanying drawings in which

Figures 1–8 are cross-sectional elevations in diagrammatic form of one form of the invention, showing the relative positions of the several parts as they appear at different and succeeding phases of the cycle of operations.

Figures 9 and 10 are sectional views at right angles of a constructional form of the invention embodying the parts included in Figures 1–8, and Figure 11 is a fragmentary view of some of the members included in Figures 9 and 10.

Figure 12 is a sectional elevation of a modification using two single-acting pistons instead of one double-acting as illustrated in the preceding figures.

Apparatus illustrated in the diagrams Figures 1–8 includes a casing 1 closed at each end referred to hereinafter as a cylinder though it may be of other formation such as rectangular; a double ended-piston 2, 2*a* slidable therein; a double-ended motion-transmitting and port-controlling member 3, 3*a* disposed within the piston with such endwise clearance that it has a limited dimension of axial float relatively thereto; a driving part 4, 4*a* also double-ended which fits laterally inside the said member but is capable of relative up or down movement; a driving shaft 5 at the centre of the casing; and an eccentric 6 for converting the rotary motion of the shaft into lateral motion of the three parts embracing the driving block, the intermediate member and the piston; and which also resolves a component of the shaft motion into an up and down movement of the driving part. The sense of such motions and movements are so described for facilitating an understanding of the working of the apparatus as depicted in the diagrams, but they are to be considered as relative since the functioning would be the same if the apparatus were arranged in a plane at right angles to that shown, or in an intermediate position.

The major compression chambers formed by the end walls of the cylinder and the adjacent end faces of the pistons are indicated by A, B; the minor chambers between the top and bottom walls of the driving part and the bore of the major piston member by C, D. Through the peripheral walls of the cylinder are formed two inlet passages 7, 7*a* at top and bottom respectively, and two outlet or delivery passages 8, 8*a* at bottom and top respectively. The piston 2 has a delivery passage 9 through its end wall and

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another 10 through its peripheral wall, and the piston 2*a* has similar passages 9*a*, 10*a*; the driving member has inclined delivery conduits 12, 12*a* for establishing communication between the major and minor chambers respectively, by way of a horizontal passage 11, 11*a* in the two ends of the intermediate member, at a selected pressure in the major chambers.

In the positions of the several parts indicated in Figure 1, delivery of compressed fluid from the left hand major compressing chamber has just terminated, the intermediate member 3 abuts the inner face of the piston 2, the driving part 4 is in mid vertical position within the member 3, and the eccentric throw is horizontal.

Assuming an angular movement of the driving shaft 5 and the eccentric 6 in an anti-clockwise direction, it will be seen that such movement produces two actions, as will be evident by reference to Figure 2, which occur concurrently. There is a downward displacement of the driving part 4 which functions as a minor piston and expels fluid from the lower minor compressing chamber C by way of the passages 10, 8 in the lower peripheral walls of the major piston and the cylinder which are in register, the inclined passage 12 having moved out of register with the passage 11.

Accompanying the downward displacement of the driving part 4 is a lateral movement which is transmitted to the intermediate member 3 which is thereby moved to the right for a limited distance within and in relation to the major piston, the major piston however remaining static throughout such limited distance so that a passage is formed by the space 13 between the left hand face of the intermediate member 3 and the adjacent right hand face of the piston 2. Such space is placed in communication with the top fluid inlet 7 in the cylinder by means of a right angle conduit 14 in the upper peripheral wall of the major piston uncovered by the lateral movement of the intermediate part, so that immediately the major piston is moved to the right by the next succeeding turning motion of the driving shaft and eccentric as depicted in Figure 3, the major chamber A on the left is connected by the passage 9 through the piston end with the upper inlet 7 and induces fluid flow into the chamber.

During the first portion of the intake stroke of the piston 3, the driving part 4 has continued its downward displacement forcing fluid from the chamber C until the passage 10 de-registers with the passage 8, the bottom end of its stroke being reached when the driving shaft and eccentric have turned through 90° from the commencing position of Figure 1 to that of Figure 3 where the throw is upright.

Further rotation of the driving shaft continues the common sliding movement of the driving part, the intermediate member, and the major piston to the right, a further stage in the cycle being illustrated in Figure 4, during which the induction chamber A continues to grow in volume with the intake passages continuing in communication by way of the elongated limb of the inlet passage 7, and the driving part 4 executes the first portion of its upward stroke.

Said movements continue until the end of the intake stroke of the major piston is reached which coincides with the arrival of the driving part and minor piston 4 at mid-stroke and the full registration of the transfer passage 12 in the minor piston with horizontal passage 11 in the intermediate member. Such registration by way of passage 9 in the major piston, provides communication between the major chamber A and the minor chamber C which are thus at a common pressure and have a common fluid connection with the inlet 7. The driving shaft and eccentric at this stage have revolved through 180° from their initial position to terminate the first half of the cycle.

As shown in Figure 6, the major piston is static during the first portion of the lateral return motion of the driving part and of the intermediate member 3 whereby the top face of the latter obturates or closes the upright limb of the piston passage 14 and with it the inlet 7. While the inlet is thus being closed by the right to left lateral motion, the upward movement of the driving part 4 isolates the minor chamber C from the major chamber A since the transfer passage 12 is moved out of line with the communicating passage 11 in the intermediate member. The lateral float of the intermediate member being thus absorbed, the three organs comprising the driving part 4, the intermediate member 3, and the piston 2 move in unison to the left and compression commences in the major chamber A, one intermediate stage being depicted in Figure 7 with the eccentric throw upright and the driving part and minor piston 4 at the top of its stroke, and a further stage in Figure 8 with the eccentric throw at 45°—the compression chamber A still further reduced in volume, and the transfer passage 12 approaching the passage 11 in the intermediate member.

Continued descent of the minor piston 4 connects the major chamber A with the minor chamber C by registration of transfer passage 12 with the passage 11, while concurrently the minor chamber C is coupled with the outlet 8 in the peripheral wall of the cylinder 1 by means of the passage 10 in the peripheral wall of the piston 2, such coupling being made by virtue of the right to left motion of the major piston. The final positions of the three co-operating parts (moving concurrently in the manner described) at the end of the compression stroke of the major piston are indicated in Figure 1 from which point the cycle re-commences with induction into the major chamber and expression or delivery of fluid from the minor chamber C.

If desired, apparatus according to the invention may be constructed to be double-acting, i. e. two separate actions from a single cylinder. In the diagrams, such an embodiment is shown wherein aspiration in one chamber is accompanied by delivery from the other, the several parts are arranged symmetrically about a horizontal line and about a vertical line, and the operations and their sequence pertaining to the right hand half of the compressor are exactly similar to those already described in connection with the left hand half. A comparison of Figure 6 with Figure 2 will make clear that the inlet 7a at the bottom of the cylinder in Figure 6 has been



connected with the passage 13a for the right hand compressor in exactly the same manner as the inlet 7 at the top with the passage 13 in Figure 2 for the left hand compressor, and by the same action i. e. the lateral float of the intermediate member within the major piston.

As the major right hand piston moves to the left, the chamber B grows in volume as shown successively in Figures 7, 8, and 1 to the termination of the aspiration stroke. The lateral float of the intermediate member then comes into action again to isolate the inlet 7a from the chamber B so that continued rectilinear movement of the major piston 2a compresses the fluid in the chamber as indicated by Figures 3 and 4 until the several delivery passages 9a, 11a, 12a, 10a and 8a are placed in series communication as depicted in Figure 5, such coupling of the major compression chamber B with the outlet port in the cylinder corresponding to that illustrated in Figure 1 for the left hand compressor, in each case the eccentric throw being horizontal and the driving part 4 at the middle of its stroke, and the two angular positions of the driving shaft being 180° apart.

Similar parts in the halves of the compressor have the same numerals of identification but those of the right hand compressor are distinguished by the addition of the postfix *a*.

A compressor constructed in accordance with the invention of the double-acting type embodying the parts and actions described is depicted in Figures 9, 10 and 11 wherein the cylinder 1 is built up of an annulus closed at each end by a cover 15 and provided with a counterbore 16 to accommodate a lubricating pad to which lubricant is fed through a top hole 17 and from which used oil may be drained from a bottom hole 18. Conveniently, the double-ended piston is composed of two sections, an annulus with one end disc integral and an end plate 19 closing the open end.

Driving arrangements may include a power shaft 20 journalled in the casing, provided with a fluid sealing device 21, and connected by key, splines, or the like with the offset eccentric stub shaft 22. The latter carries the inner race 23 of a ball bearing held by screw and nut 24, and has a spigot part 25 arranged to register with a hole in a plug 26 inserted in a rebate formed in the bore of the driving part 4, said plug also serving to locate endwise the outer race 27 of the ball bearing.

To prevent turning of the major piston member about its axis, a longitudinal groove is machined therein to engage a locating guide 28 held by the inner end of a screw 29 anchored in the casing, or other appropriate means may be incorporated.

As will be apparent from Figure 10, the compression chambers, the double-ended piston slidable therein, the intermediate member, and the driving part are each of cylindrical formation; the piston member and the intermediate member have a purely rectilinear motion axially of the casing; while the driving part has a compound motion with one component axially as aforesaid and the other transverse to the axis. Since the several motions controlling the various passages are identical with those already expounded and illustrated in Figures 1 to 8, no further explanation is needed.

Instead of using a double-ended piston, two separate single-acting pistons may be employed, one such embodiment being shown in Figure 12 wherein the several co-operating parts and passages which function in the same manner as those included in Figure 10, are marked with corresponding numerals and letters of reference, from which the actions will be apparent, the differences being mainly constructional. To actuate both pistons concurrently, the eccentric sheave 6 is extended in the form of a yoke 30 having its ends connected by pins 31 with the two driving parts 4, 4a by which arrangement both such parts are caused to rise and fall together. The two inlet passages 7 in the cylinder are connected together by a manifold 32, and the two delivery passages 8 by a second manifold 33. The function of the intermediate member in transmitting motion to the piston is the same as in the double-ended apparatus, but it differs therefrom slightly in its control of the intake in that a passage 34, 34a is provided in the end wall of the member next the major compression chamber communicating with the respective minor chambers D, and the sealing of the passage is effected by the end face of the member instead of by the periphery. Intake passages 7 and 14 are in continuous register and similarly passages 7a and 14a, so that the entering fluid passes through the two minor chambers D, D. Delivery passages 9 and 9a are duplicated to increase the cross-sectional area effective for a given displacement of the minor pistons.

For dealing with liquids, which are virtually incompressible, it is necessary for the major working chamber to be placed in communication with the outlet for the whole of the delivery stroke. Accordingly, the control end of each of the passages 12, 12a in the driving part 4 is lengthened as indicated at 35, 35a in Figure 9 so that they register respectively with the passages 11, 11a during the up or down movement of the driving part which corresponds to the respective delivery stroke of the relevant major piston.

The employment of the driving part instead of the conventional connecting rod allows the apparatus to be built much more compactly with a consequent improved ratio of weight and cost to given volume delivered, improved further by incorporating the features of the invention in a double-acting apparatus.

Having thus described our invention, what we claim is:

1. Apparatus of the reciprocating piston type for delivering fluids including a working chamber, a piston slidable therein, a rotary shaft having a crank or eccentric, a passage in the piston leading to the working chamber, an intermediate member having a limited amount of float relative to the piston in line with the piston movement arranged to open or close said passageway by virtue of such relative float, and a motion-transmitting part connecting the intermediate member and the piston to the crank or eccentric, said motion-transmitting part being so mounted in relation to the intermediate member that rotary movement of the shaft is resolved into two sliding motions of said part one of which motions is imparted to the intermediate member and the piston and the other of which is in transverse relation to the piston movement.

2. Apparatus according to claim 1 having a chamber in the intermediate member wherein the motion-transmitting part is movable, and communicating passages between the said chamber and the working chamber controlled by the transverse motion relative to the piston of the said part to control delivery of fluid from the working chamber.

3. Apparatus according to claim 1 having a chamber in the intermediate member wherein the motion-transmitting part is movable, passages in the motion-transmitting part, the intermediate member, the piston, and the peripheral wall of the working chamber forming a means of communication between the two chambers controlled by the transverse motion relative to the piston of the said part.

4. Apparatus according to claim 1 wherein fluid passageways to or from the working chamber are co-operatively controlled in part by the transverse motion relative to the piston of the motion-transmitting part and in part by the piston movement.

5. Apparatus of the reciprocating piston type for delivering fluids including a working chamber, a piston slidable therein, a rotary shaft having a crank or eccentric, a passageway in the piston leading to the working chamber, and an intermediate member having a limited amount of float relative to the piston in line with the piston movement arranged to open or close said passageway by virtue of such relative float, and a motion-transmitting part connecting the intermediate member and the piston to the crank or eccentric.

6. Apparatus of the reciprocating piston type for delivering fluids including a working chamber, a piston slidably mounted therein, a rotary shaft having a crank or eccentric, a motion-transmitting part operated by the crank or eccentric, and an intermediate member connecting the motion-transmitting part and the piston with the crank or eccentric, said motion-transmitting part being so mounted in relation to the intermediate member that rotary movement of the shaft is resolved into two sliding motions of said part one of which motions is imparted to the intermediate member and the piston and the other of which is in transverse relation to the piston movement.

7. Apparatus of the reciprocating piston type for delivering fluids including a working chamber, a piston slidable therein, a rotary shaft having a crank or eccentric, a passageway in the piston leading to the working chamber, an intermediate member having a movement relative to the piston arranged to open or close said passageway by virtue of such relative movement, and a motion transmitting part connecting the intermediate member and the piston to the crank or eccentric.

8. Apparatus according to claim 1 in which the working chamber, the piston, and the intermediate member are each double-ended, and the motion-transmitting part is arranged between the ends of the intermediate member.

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