T. J. PAGEL.

ROTARY PUMP.

APPLICATION FILED MAR. 28, 1917.

1,252,160.

Patented Jan. 1, 1918.

3 SHEETS—SHEET 1.

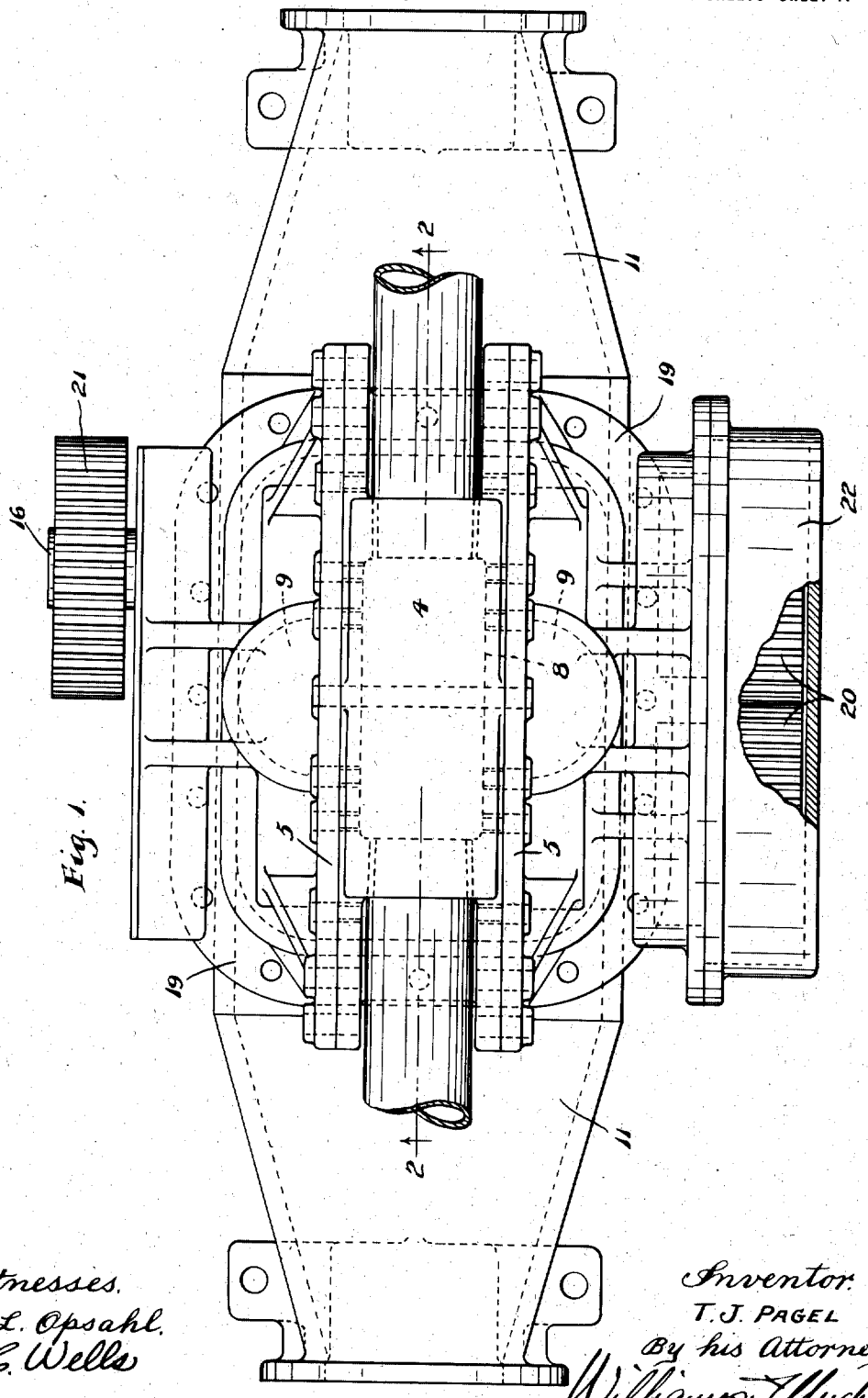

Fig. 1.

Witnesses,
H. L. Opsahl.
E. C. Wells

Inventor:
T. J. PAGEL
By his Attorneys,
Williamson & Merchant

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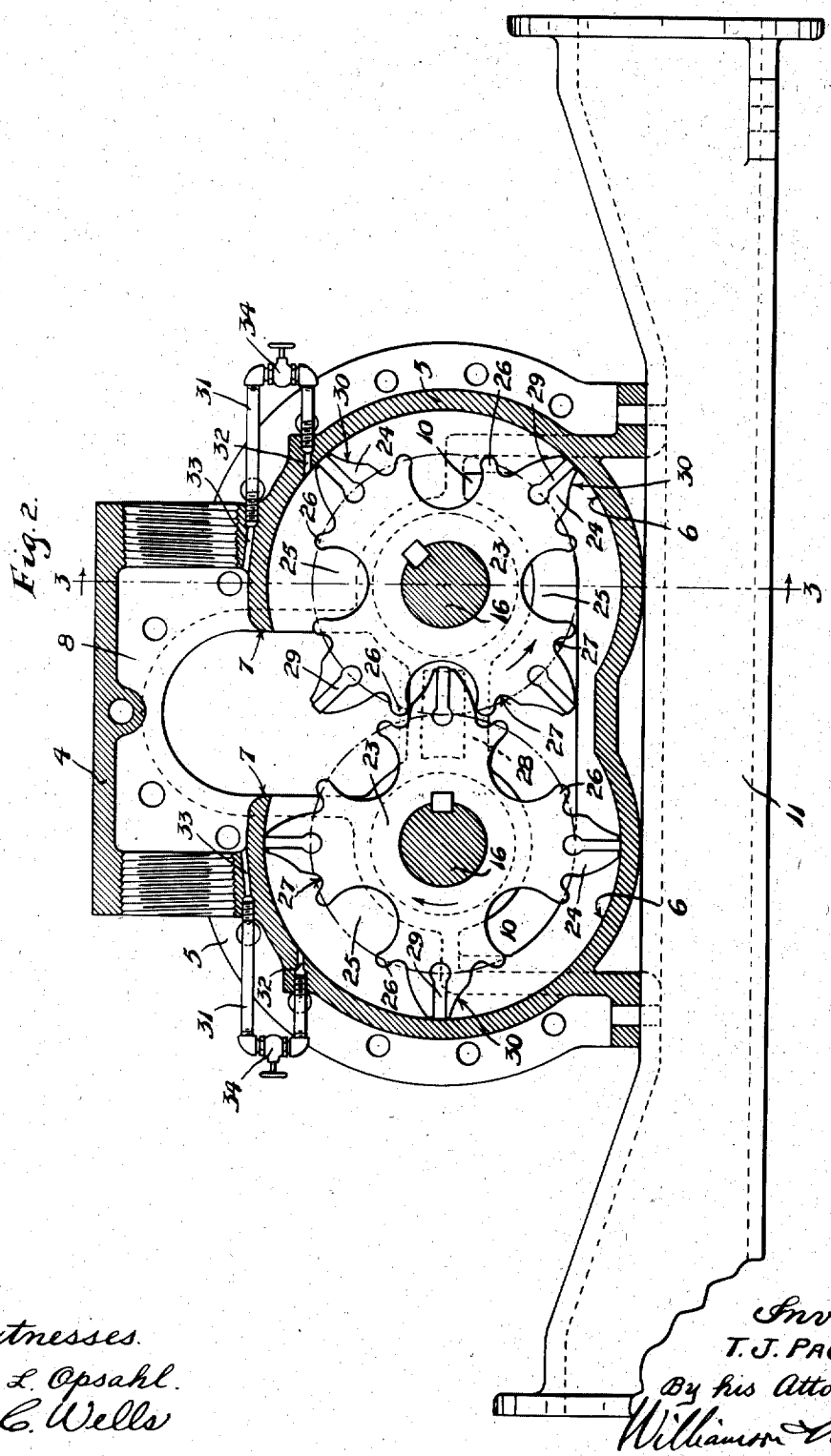
3 SHEETS—SHEET 2.

Fig. 2.



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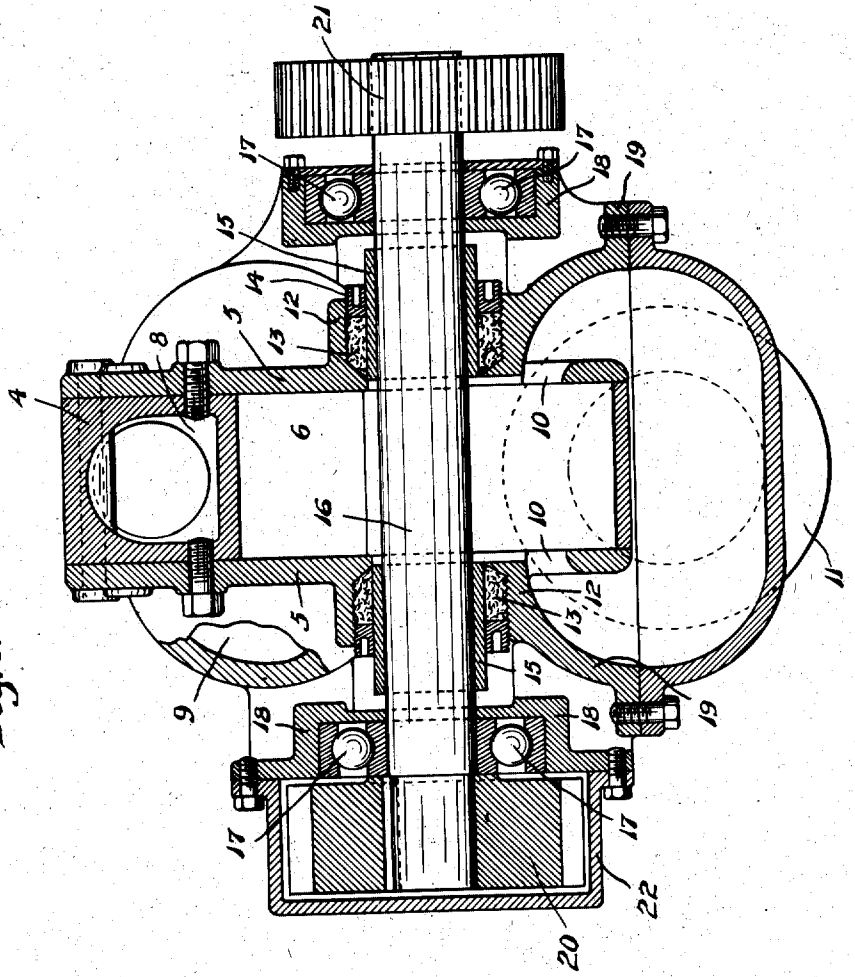

Fig. 3.

Witnesses.
H. L. Opsahl.
E. G. Wells

Inventor.
T. J. PAGEL.
By his Attorneys
Williamson & Merchant

UNITED STATES PATENT OFFICE.

THEODORE J. PAGEL, OF MINNEAPOLIS, MINNESOTA.

ROTARY PUMP.

1,252,160. Specification of Letters Patent. Patented Jan. 1, 1918.

Application filed March 28, 1917. Serial No. 157,909.

To all whom it may concern:

Be it known that I, THEODORE J. PAGEL, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Rotary Pumps; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My present invention relates to rotary pumps and is in the nature of a refinement of, or improvement on, the pump disclosed and broadly claimed in my prior Patent No. 1,085,290, of date, January 27, 1914. Generally stated, the invention consists of the novel devices and combinations of devices hereinafter described and defined in the claims.

In the accompanying drawings which illustrate the invention, like characters indicate like parts throughout the several views.

Referring to the drawings:

Figure 1 is a plan view of the improved pump, some parts being broken away.

Fig. 2 is a vertical section taken on the line 2—2 of Fig. 1, the base of the pump being shown in full, and some parts being broken away; and

Fig. 3 is a transverse section taken through the pump on the line 3—3 of Fig. 2.

The main case of the pump is preferably made up of an intermediate section 4 and head plates 5, bolted, or otherwise, rigidly secured thereto, with water-tight joints. The intermediate or body member 4 is formed with intersecting cylindrical piston chambers 6, which, at their upper portions, are separated by a gap 7 that leads to a tubular dome 8, the ends of which are open and are adapted to be connected to discharge pipes, not shown. The gap 7 and pocket 9 afford an exhaust port which permits the water to be discharged laterally in both directions as well as radially outward, all as will hereinafter more fully appear.

Each head plate 5 is formed with a lateral admission port 10 of peculiar construction and the form of which will be hereinafter more fully considered. In the preferred construction, the pump casing is rigidly secured on a tubular base casting 11, the ends of which, as shown, are open for the intake of water, or other liquid to be pumped.

In line with the axes of the intersecting piston chambers 6, the head plates 5 are formed with outstanding stuffing boxes 12 containing packing 13 subject to screw-threaded glands 14, which latter surround and closely engage sleeves 15, preferably of bronze and which are shrunk, driven, or otherwise rigidly secured on transversely extended piston shafts 16. These piston shafts 16 are, as shown, mounted in ball bearings 17 of any suitable construction, mounted in bearing hubs 18 shown as cast integral with the head plates 5, being connected thereto by suitable flanges and ribs.

The head plates 5, from points below the stuffing boxes 12 and above the intake ports 10, have downwardly and outwardly curved base flanges 19 that are bolted, or otherwise rigidly secured with liquid-tight joints, to the central top portion of the base casting 11. Here it should be noted that the base casting 11 has an opening in its top conforming to the inner line of said downwardly and outwardly curved base flanges 19, so that the said base casting 11 is in constant communication with both of the lateral admission or intake ports 10 from end to end thereof.

At one end, the piston shafts 16 are provided with intermeshing spur gears 20 of the same diameter, and one of the said shafts, at its opposite ends, is shown as provided with a spur gear 21 from which power may be transmitted to the pump. The gears 20 are shown as incased by a housing 22 detachably secured to the hub 18 of the adjacent head plate and adapting the said gears 20 to be run in oil.

Working in the intersecting cylindrical piston chambers 6 and secured, one to each of the piston shafts 16 are rotary gear-like pistons 23, each of which, as shown, has four main teeth or fluid propelling lugs 24 and four intervening tooth cavities 25. Of course, the number of propelling teeth and tooth cavities may be varied. At least one surface of each propelling tooth 24 is preferably constructed on the line of an involute curve developed from pitch circles indicated by dotted lines on Fig. 2. The tooth cavities 25 are formed almost entirely radially inward of the pitch circles, but are extended

slightly beyond said pitch circles by lug-like portions 26 that are arranged to engage corresponding but reverse depressions 27 of the coöperating pistons. The contacting extremities of the lugs 26 are so circumferentially spaced that they will closely engage an intermeshing tooth 24 approximately on the pitch line thereof, when the said tooth is turned closely to the vicinity of a straight line intersecting the axes of the two pistons (see particularly Fig. 2). Here it may be noted that the lower lines of the discharge ports or pockets 9 are separated from the upper extremities of the intake ports 10 by bridge surfaces 28 that are slightly wider than the maximum width of any one of the said tooth cavities 25, so that no tooth cavity can at any time form a direct connection between the said intake and discharge ports. The said propelling teeth or lugs 24 are provided with suitable packing strips or blades 29.

The peculiar form of intake ports 10 may now be considered, and it will be noted that the extremities thereof, are curved and are concentric to the axis of the respective rotary pistons, and furthermore, it will be observed that the curved outer lines thereof follow approximately the pitch lines of the two rotary pistons. With this arrangement, the tooth cavities, in passing the said curved extremities, lie almost wholly radially inward of the outer lines of said intake ports while considerable portions of the propelling teeth lie radially outward of the outer lines of said intake ports. These long extensions of the intake port, under rotation of the rotary pistons in the direction of the arrow marked thereon in Fig. 2, give a relatively long interval of time for the tooth cavities and the space between the propelling teeth to be completely filled with water. The said arrangement also introduces the water first to the more slowly moving radially inner portions of the propelling lugs 24 of the rotary pistons and permits the water to be thrown gradually radially outward and into contact with the surrounding cylindrical walls of the piston chambers, and this not only reduces strain on the parts by eliminating water impact, but insures the operation of the pump at full capacity.

Giving still closer attention to said lateral intake ports 10, it will be seen that they extend from the plane of the intermediate connection of said piston chambers along the opposite lines of travel of the teeth of the respective pistons, and that they have a total length, greater than double the depth of the deepest tooth cavity measured radially inward from the pitch line; and it may be also noted that said intake ports extend to points beyond two parallel planes intersecting the respective axes of the two pistons, at right angles to a common plane through said axes; and it may be further noted that they extend to points approximately opposite the ends of the bridges or bridge surfaces 28, which separate the intake and discharge ports.

In this same connection, it should be recalled that the matching mouths of the base casting 11 and the outwardly curved base flanges 19 of the head plates 5 are much wider than the piston chambers 6, and are of such longitudinal extent as to be in communication with the lateral intake ports 10, from end to end of said ports, as best shown in Figs. 2 and 3.

The said positions, extent and relations of said intake ports 10, in the opposite walls of the cylinders or piston chambers 6, relative to the travel lines of the piston teeth, relative to the bridges 28, and relative to the supply from the base casting 11 through said long matching mouths of said casting 11 and the outwardly and downwardly extending flanges 19 of the face plate 5, of greater width than the chambers 6 and of a length equal to the intake ports, constitute highly serviceable improvements over the structure disclosed in my prior patent and over the entire prior art, so far as known to me.

In respect to the said bridges or bridge surfaces, 28, which separate the lateral intake ports from the lateral discharge ports, it may be seen, by reference to Fig. 2, that the same are wider than the width of a tooth cavity measured on the chord of the pitch line, but that the whole of the lap, afforded by this greater width, is on the suction side of the bridge. In other words, there is no lap on the exhaust or pressure side of the said bridges, but, on the contrary, the cut-off comes when the teeth are in line with the axes of the piston, as shown in Fig. 2.

By inspection of Fig. 2, it will also be seen that I cut away or reduce the rear sides of the propelling teeth 24, as shown by the line 30. This detail is of importance, when considered in its relations to the teeth cavities 25, the lugs 26, lug seats or depressions 27, the lateral exhaust ports afforded by the gap 7 and recesses 9, and the bridges 28, without lap on the pressure or exhaust side; for the reason that thereby a large amount of clearance is afforded, both for the radial and lateral escape of the water from between the teeth and teeth cavities, and which continues so long or so late, as to prevent the caging of any but an extremely small amount of water in the interdental space between one of the teeth 24 and one of the cavities 25, at the time of the cut-off, or as the parts are shown in Fig. 2. In other words, there is a lateral escape from between the approaching parts, on the exhaust side, until the intermeshing teeth and teeth cavities coincide with the line or plane

through the axes of the two pistons. The tooth cavity 25 is deeper than the tooth 24 which intermeshes therewith, and is also wider than the said tooth, inward of the pitch line of the cavity, thereby affording an abundance of clearance for this little bit of caged water, and which clearance remains practically constant, throughout the further movement of the intermeshing parts, until they begin to unmesh or open on the suction side of the bridges. Hence, there can be no compressing action on this little bit of caged water, at any time, and no water-lock can possibly be produced, but, on the contrary, the water simply passes from one side to the other of the tooth within the cavity. The lap on the suction side of the bridge is slight, and, in view of the character of the teeth and teeth cavities and their relations to each other and to the bridges, above noted, the intermeshing parts will begin to separate and open, on the suction side of the bridge, so soon after leaving the central position, shown in Fig. 2, that no appreciable vacuum, and hence, no appreciable drag can be produced. In fact, the said intermeshing parts begin to separate, at the lower pitch lines, almost co-incidently with the cut-off from the exhaust at their upper pitch lines, thereby affording a slight opening between the lower surfaces, shown in contact in Fig. 2, and thence through the adjacent notch 27 of the left hand piston into the suction chamber; and hence, there is practically no vacuum ever produced and no drag whatever occurs.

It should be noted that the reduced or cut-away portion of the back of the tooth 24, shown by the line 30, does not extend inward quite to the pitch line, and it must not do so, because when the intermeshing teeth and teeth cavities are in their central positions on line with the axes of the piston shafts, as shown in Fig. 2, both sides of the teeth and teeth cavities should be in contact on said pitch line.

I have further observed, in practice, that sometimes when rotary pistons of the above character are driven at overspeed, or when the water is pumped from considerable depth, the water cavities of the rotary pistons will not be completely filled and partial vacuum will be formed therein. When this happens, and the incompletely filled water cavities of the pistons are turned into communication with the exhaust or high pressure side, said partial vacuum will produce more or less severe water hammer. This water hammer, of course, is not only annoying, but decreases the efficiency of the pump and subjects the pump to intense strains which sometimes results in breaking thereof. This defect I have overcome by providing by-passes which lead from the high pressure or water outlet side of the exhaust ports, back to the intermediate portions of the piston chambers. These by-passages, as shown, are formed by small pipes 31 that connect ducts 32 of the piston chambers with ducts 33 of the outlet 8. The said pipes 31 are provided with valves 34 by means of which they may be closed or opened to any desired extent. The said ducts 32 must be located at points intermediate the intake cut-off and the opening to exhaust. The ducts 33 may be located anywhere in the exhaust or discharge passages, such as in the walls of the gap 7, the pockets 9, or the discharges in the dome 8.

With this arrangement, under rotation of the propelling wheels, in the direction stated, when the cavities of the rotary pistons which contain partial vacuum are turned into communication with the ports 32, water under high pressure from the outlet 8 will be forced through the said pipes 31 and, by supplying the necessary water, will relieve the same from partial vacuum. In this way, the water hammer is prevented. When not required, said pipes 31 may, of course, be closed, and hence, entirely cut out of action.

The device herein described is a rotary pump but it will, of course, be understood that with water supplied thereto under pressure, it would operate as a highly efficient rotary water motor. It will, therefore, be understood that I do not herein limit myself to the use of the device as a pump.

My improved pump, herein disclosed, has gone into extensive commercial use and has attained a higher record for efficiency in fire engine service than any other gear action pump ever produced, so far as I know.

What I claim is:

1. The combination with a casing provided with interconnected piston chambers, of coöperating rotary toothed pistons working in said chambers, said casing having a suitable discharge port and having, in the opposite walls of said piston chambers, at points past which the teeth of said pistons sweep, lateral fluid intake ports arranged to deliver the fluid in opposite lateral directions, from said opposite ports, directly to the cavities between the teeth of said rotary pistons, said lateral fluid intake ports extending from the plane of the intermediate connection of said piston chambers along the opposite lines of travel of the teeth of the respective pistons and having a total length greater than double the depth of the deepest tooth cavity measured radially inward from the pitch line.

2. The combination with a casing provided with interconnected piston chambers, of coöperating rotary toothed pistons working in said chambers, said casing having a suitable discharge port and having, in the opposite walls of said piston chambers at points past which the teeth of said pistons

sweep, lateral fluid intake ports arranged to deliver the fluid in opposite lateral directions, from said opposite ports, directly to the cavities between the teeth of said rotary pistons, said lateral fluid intake ports extending from the plane of the intermediate connection of said piston chambers along the opposite lines of travel of the teeth of the respective pistons to points beyond two parallel planes intersecting the respective axes of said two pistons at right angles to a common plane through said axes.

3. The combination with a casing having interconnected piston chambers, of coöperating rotary toothed pistons working in said chambers, said casing having bridges separating its discharge ports from its intake ports, and said intake ports being in the opposite side walls of said piston chambers at points past which the teeth of said pistons sweep and arranged to deliver the fluid in opposite lateral directions directly to the cavities between the teeth of said pistons and extending from the plane of the intermediate connection of said piston chambers along the opposite lines of the travel of the teeth of said respective pistons to points approximately opposite the ends of said bridges, substantially as described.

4. The combination with a casing having intersecting cylindrical piston chambers provided with lateral intake and discharge ports and bridges separating said intake and discharge ports, of coöperating rotary pistons within said chambers having coöperating teeth and teeth cavities extending entirely across the peripheries of said pistons, the said lateral intake ports extending from the plane of the intermediate connection of said piston chambers along the opposite lines of travel of the teeth of respective pistons and located radially inward of the outer ends of the piston teeth at points past which the teeth of said pistons sweep.

5. The combination with a casing provided with intersecting cylindrical piston chambers, of coöperating rotary pistons working within the said chambers, the said pistons having peripheral tooth members and coöperating tooth cavities arranged alternately and extending across the periphery of the said pistons to the side walls of the said piston chambers, said casing having suitable discharge ports and opposite lateral intake ports, said intake ports having extensions following the sides of said pistons but located radially inward of the outer extremities of the tooth members thereof, the said tooth cavities being located substantially inward of the outer lines of said port extensions.

6. The combination with a casing provided with intersecting cylindrical piston chambers, of coöperating rotary pistons working within said chambers, said pistons having peripheral toothed members and cooperating toothed cavities arranged alternately and extended across the periphery of said pistons, to the side walls of said piston chambers, the said toothed members, on their backward sides, being cut away or reduced to afford clearance radially outward of their pitch lines, the said casing having intake and discharge ports, the said toothed members and toothed cavities, on both sides, having close engagement substantially on their pitch lines when turned to a line intersecting the axes of said pistons.

7. The combination with a casing having intersecting cylindrical piston chambers provided with lateral intake and discharge ports and bridges separating said intake and discharge ports, of ccöperating rotary pistons working within said chambers and having coöperating teeth and teeth cavities extending entirely across the peripheries of said pistons, said teeth being cut away on their rear sides outward of their pitch lines and said bridges being substantially without lap on their exhaust sides and provided with lap on their intake sides, substantially as described.

8. The combination with a casing having intersecting cylindrical piston chambers provided with lateral intake and discharge ports and bridges separating said intake and discharge ports, of coöperating rotary pistons working within said chambers, said pistons having coöperating teeth and teeth cavities extending entirely across the peripheries of said pistons, the said teeth being cut away on their rear sides outward of their pitch lines and said coöperating teeth and teeth cavities being constructed and arranged to have close engagement substantially on their pitch lines, on both the exhaust and suction sides of said bridges, when turned to a central line through the same and the axes of said two pistons, and said bridges being substantially without lap on their exhaust sides and provided with lap on their intake sides, substantially as described.

9. The combination with a casing having intersecting cylindrical piston chambers provided with intake and discharge ports, of cooperating rotary pistons working within said chambers having coöperating teeth and teeth cavities, the teeth being cut away on their rear sides and the cavities deeper than the teeth and wider than the teeth inward of the pitch line, substantially as described.

10. The combination with a casing having intersecting cylindrical piston chambers provided with lateral intake ports and lateral exhaust ports and bridges separating said intake and exhaust ports, of coöperating rotary pistons working within said chambers, said pistons having coöperating teeth and teeth cavities extending entirely across the peripheries of said pistons, the said

teeth being cut away on their rear sides outward of their pitch lines, the said cavities being deeper than their coöperating teeth and wider than said teeth inward of the pitch line, said bridges being substantially without lap on their exhaust sides and provided with lap on their intake sides and said teeth and cavities being constructed and arranged to have close engagement substantially on their pitch lines on the exhaust side, when turned to a central line through the same and the axes of said two pistons, substantially as described.

11. The combination with a casing provided with intersecting cylindrical piston chambers, of coöperating rotary pistons working within the said chambers, the said pistons having peripheral tooth members and coöperating tooth cavities arranged alternately and extending across the periphery of the said pistons to the side walls of the said piston chambers, and by-passages connecting the high pressure discharge passage of said casing with portions of the respective piston chambers intermediate the intake cut-off and the opening to exhaust.

12. The combination with a casing provided with intersecting cylindrical piston chambers, of coöperating rotary pistons working within the said chambers, the said pistons having peripheral tooth members and coöperating tooth cavities arranged alternately and extending across the periphery of the said pistons to the side walls of the said piston chambers, and by-passages connecting the high pressure discharge passage of said casing with portions of the respective piston chambers intermediate the intake cut-off and the opening to exhaust, the said by-passages having valves by means of which they may be closed or variably opened to any extent, at will.

13. The combination with a casing having intersecting cylindrical piston chambers provided with lateral intake and discharge ports and bridges separating said intake and discharge ports, of coöperating rotary pistons within said chambers having coöperating teeth and teeth cavities extending entirely across the peripheries of said pistons, the said lateral intake ports extending from the plane of the intermediate connection of said piston chambers along the opposite lines of travel of the teeth of said respective pistons and located radially inward of the outer ends of the piston teeth at points past which the teeth of said pistons sweep and said chambers having peripheral walls which abut the main teeth of the pistons throughout the major portion of the travel thereof.

In testimony whereof I affix my signature in presence of two witnesses.

THEODORE J. PAGEL.

Witnesses:

B. G. WHEELER,

F. D. MERCHANT.