T. & W. MOSS.

FLUID PRESSURE APPARATUS.

APPLICATION FILED OCT. 29, 1910.

998,376.

Patented July 18, 1911.

4 SHEETS—SHEET 1.

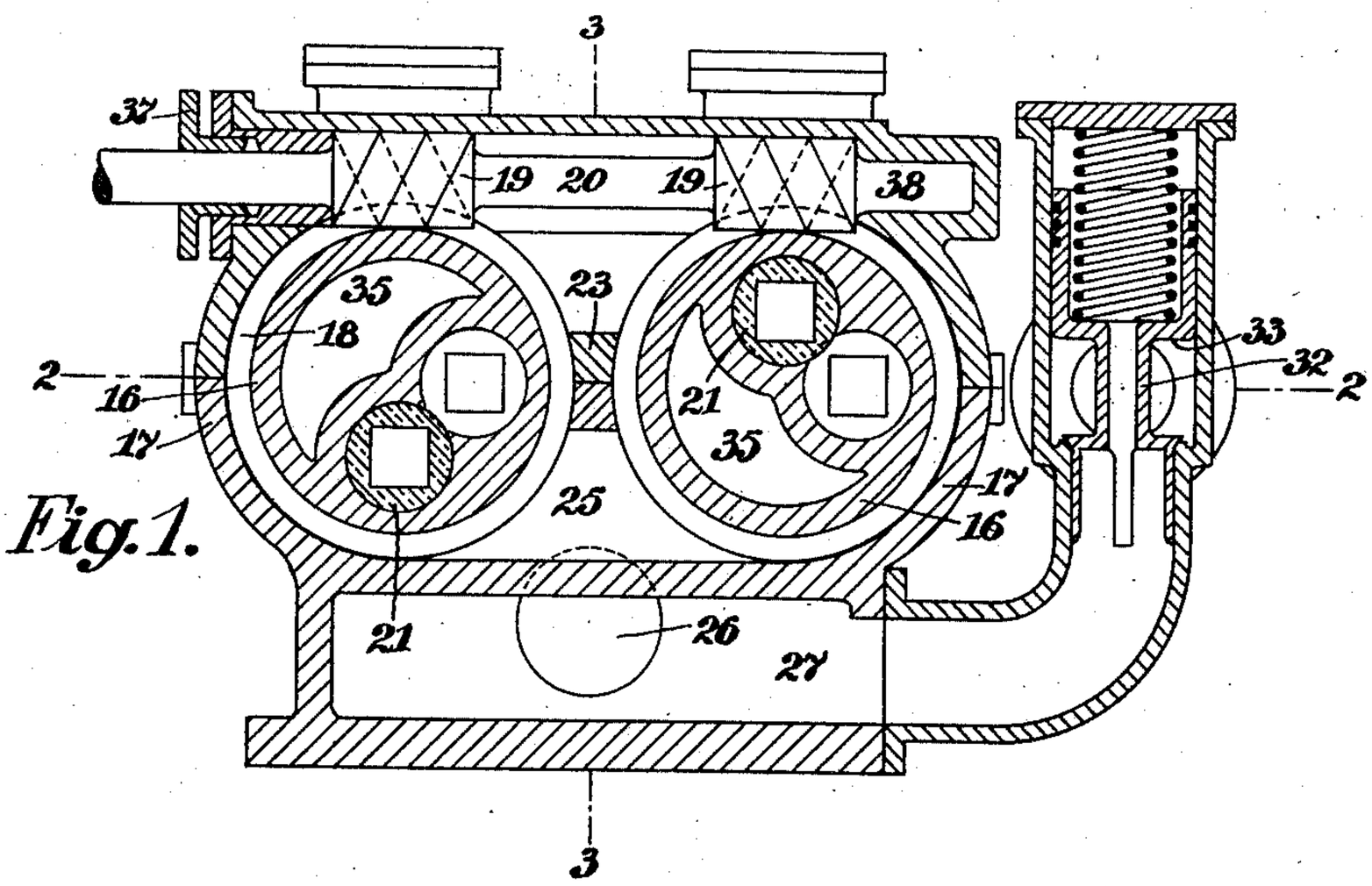

Fig. 1.

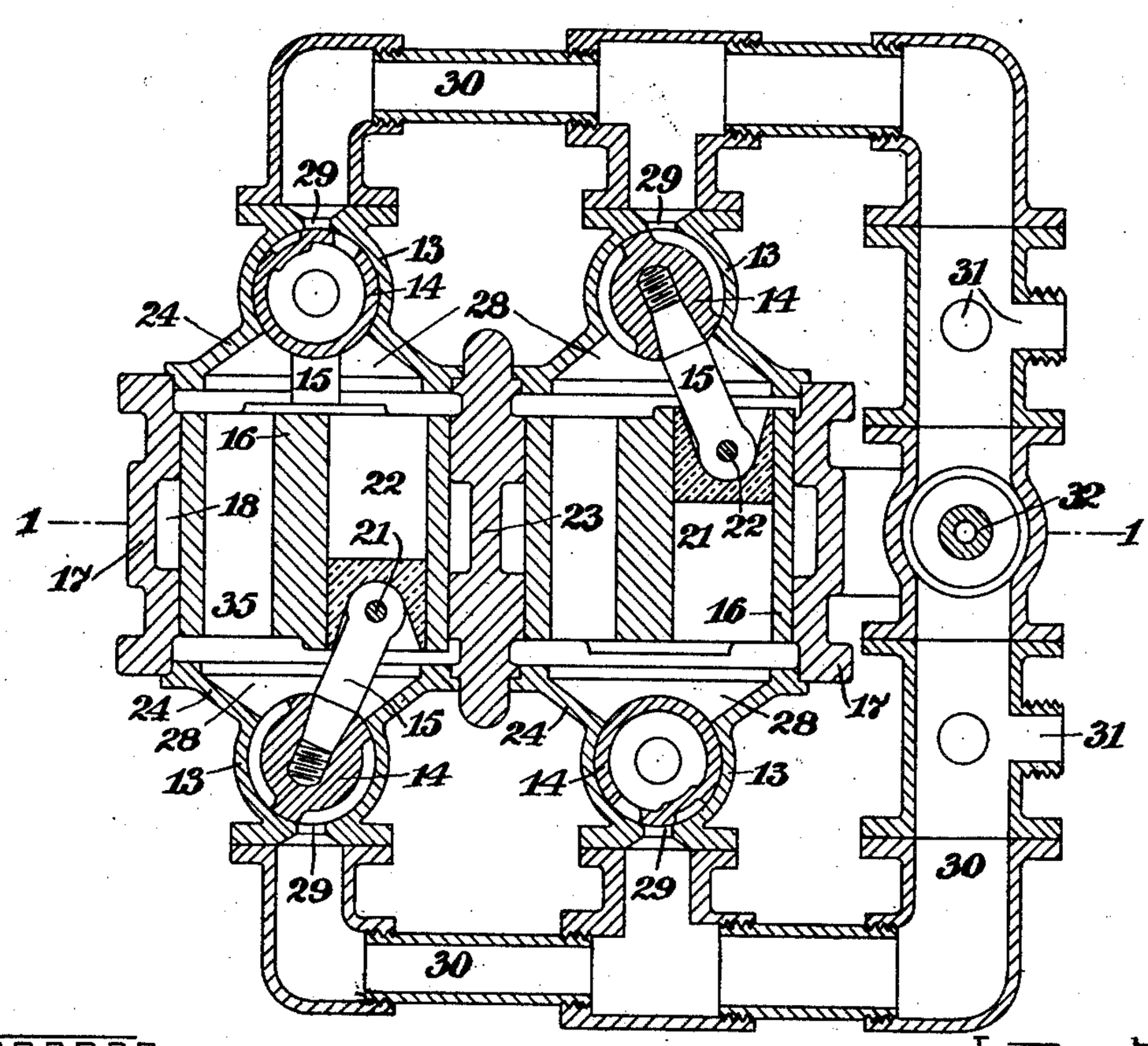

Fig. 2.

Witnesses

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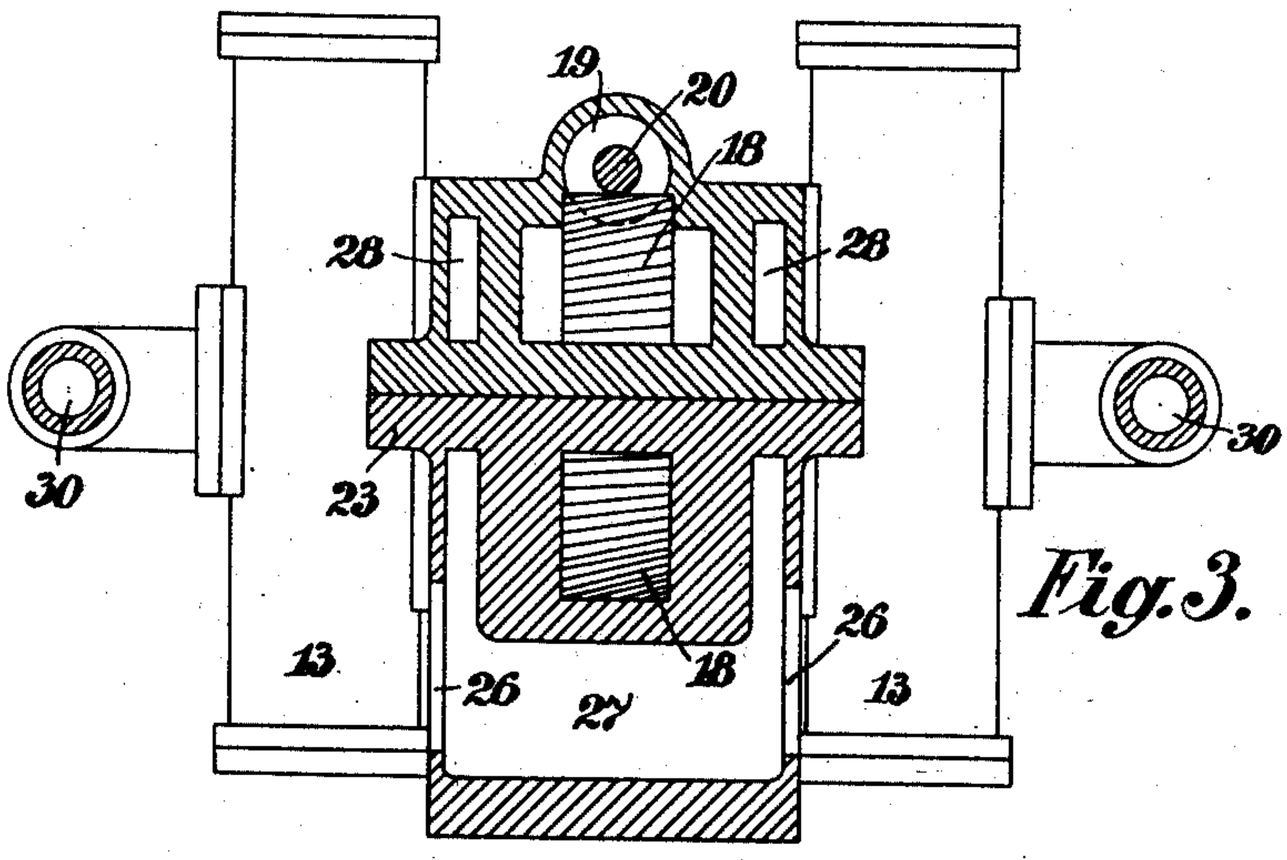

Fig. 3.

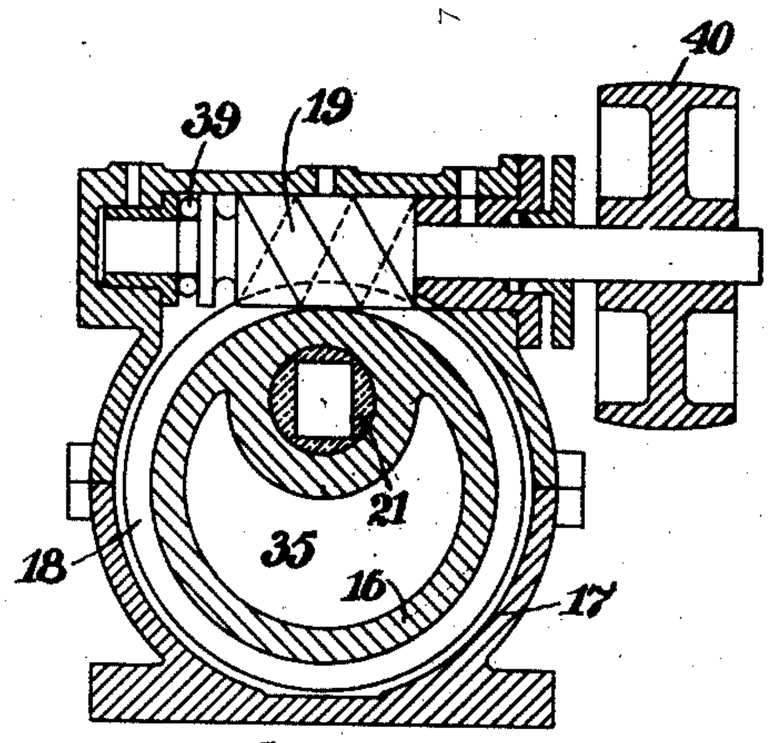

Fig. 4.

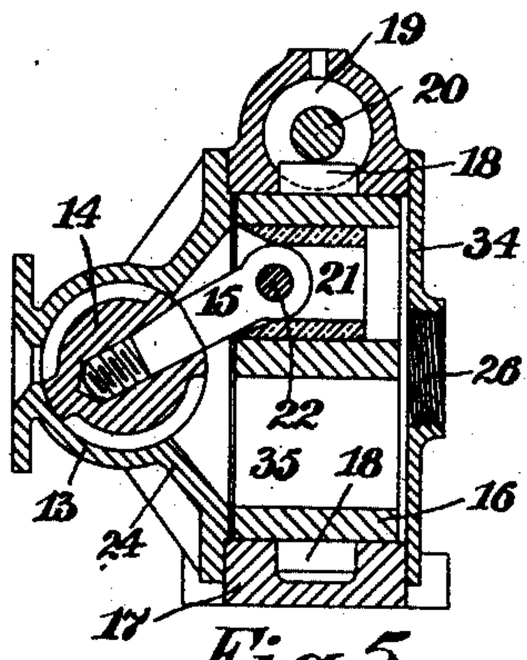

Fig. 5.

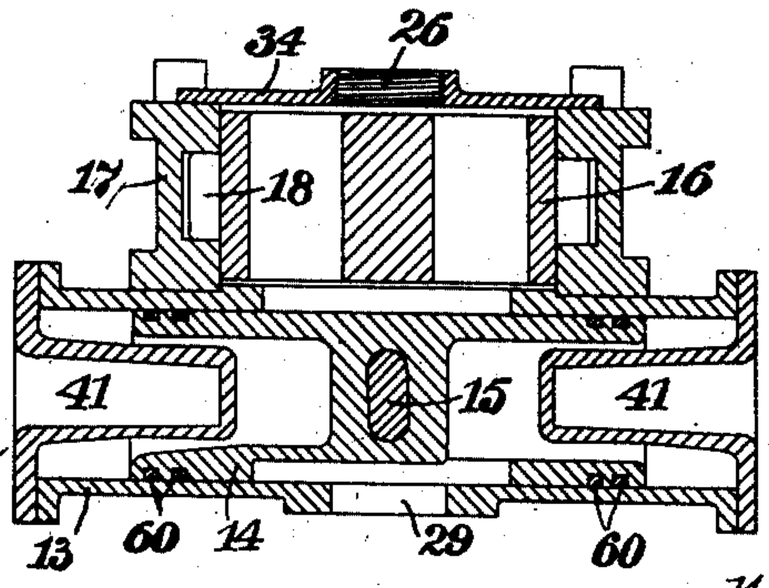

Fig. 6.

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4 SHEETS—SHEET 3.

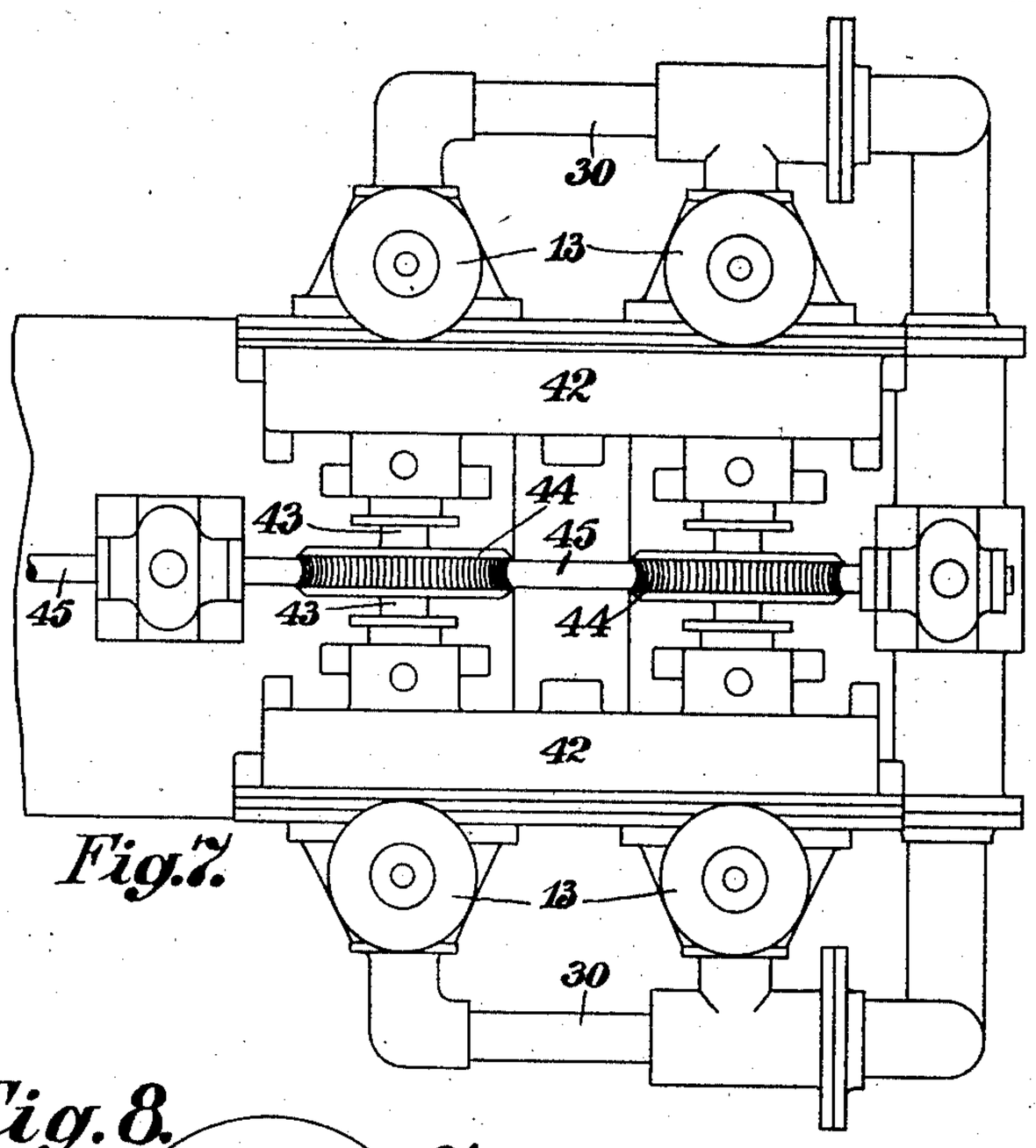


Fig. 7.

Fig. 8.

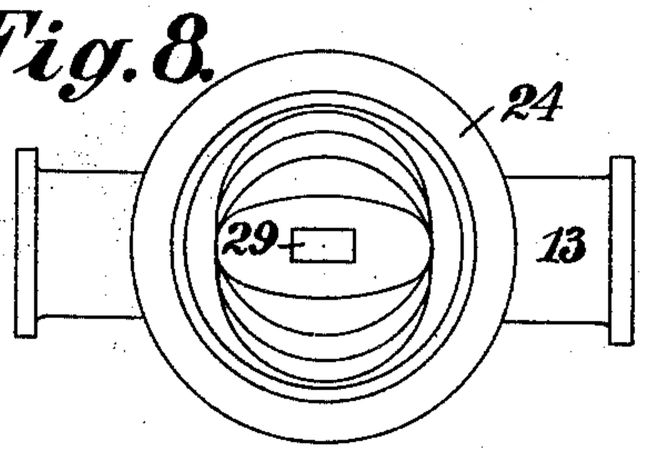
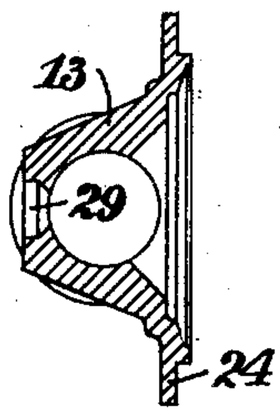


Fig. 9.



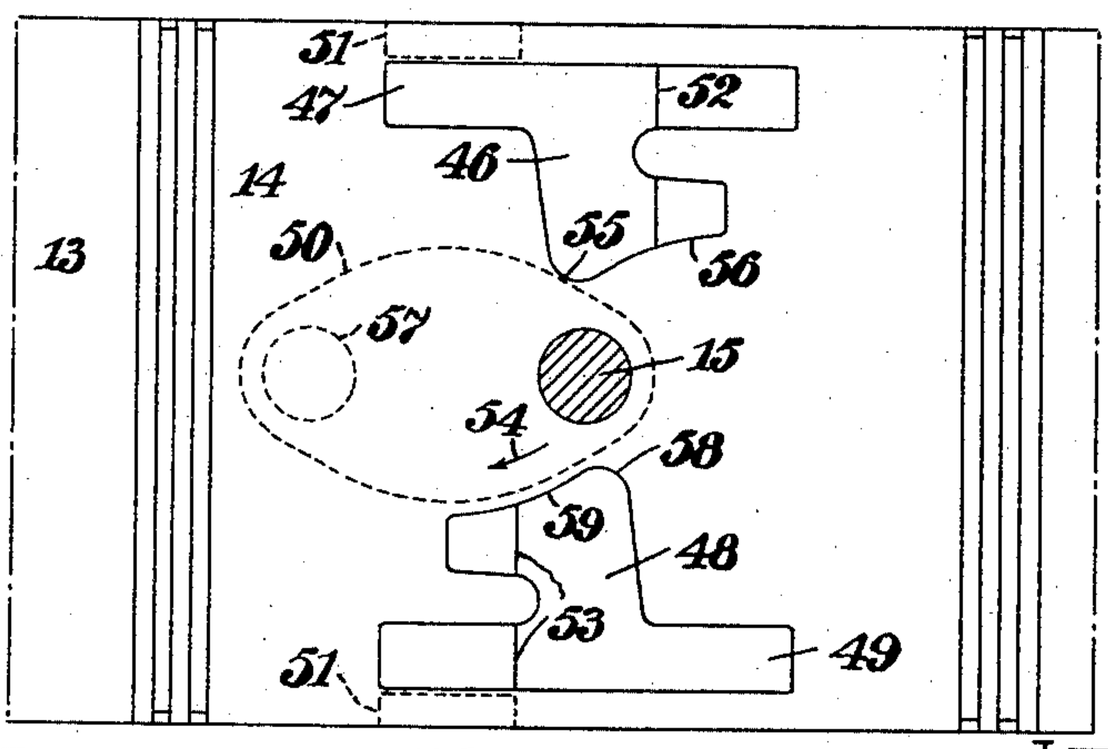


Fig. 10.

Witnesses

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4 SHEETS—SHEET 4.

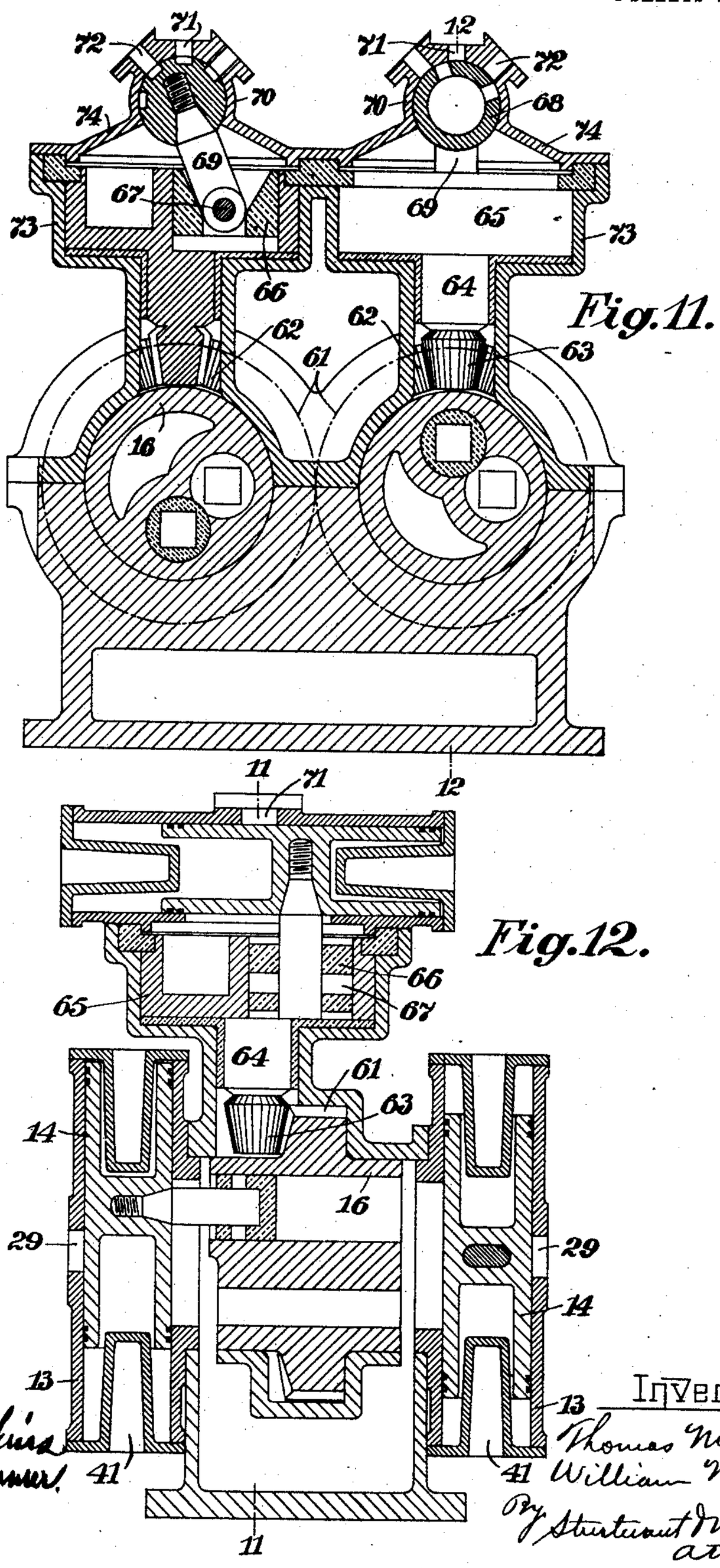

Fig. 11.

Fig. 12.

Witnesses

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UNITED STATES PATENT OFFICE.

THOMAS MOSS, OF PORTSMOUTH, AND WILLIAM MOSS, OF WIGAN, ENGLAND.

FLUID-PRESSURE APPARATUS.

998,376. Specification of Letters Patent. **Patented July 18, 1911.**

Application filed October 29, 1910. Serial No. 589,707.

To all whom it may concern:

Be it known that we, THOMAS MOSS and WILLIAM MOSS, subjects of the King of Great Britain, residing at Portsmouth, in the county of Hants, and Wigan, in the county of Lancaster, respectively, both in the Kingdom of England, have invented certain new and useful Improvements in Fluid-Pressure Apparatus, of which the following is a specification.

This invention relates to fluid pressure apparatus of the type wherein one or more cylinders are used with pistons which both reciprocate and oscillate in the cylinders, said pistons having crank arms rigidly affixed to them, while the movements of the pistons in their cylinders serve to open and close inlet and outlet orifices communicating with the cylinders. A device of this kind designed for use as an engine or pump is described for instance in the specification of Patent Number 950945 granted to the present applicants on March 1st, 1910.

The present invention has for its object to provide an improved construction with a simplified form of inlet and outlet ports, and also improvements in the design and arrangement of the apparatus to obtain balanced pressures and thrusts, and for other purposes as hereinafter more fully set forth.

In the accompanying drawings:—Figures 1, 2 and 3 are sectional views illustrating a four cylinder mechanism constructed according to the invention; Fig. 1 being a sectional elevation taken on the line 1—1 of Fig. 2; Fig. 2, a sectional plan taken on the line 2—2 of Fig. 1; and Fig. 3, a cross section taken on the line 3—3 of Fig. 1; Figs. 4 and 5 are two sectional elevations at right angles to one another showing a single-cylinder double-acting apparatus; and Fig. 6 shows a longitudinal section through the cylinder of Figs. 4 and 5; Fig. 7 is a plan view illustrating a modification of the four cylinder apparatus shown in Figs. 1 to 3; Fig. 8 is a side elevation; and Fig. 9 is a cross section of a cylinder constructed according to this invention; Fig. 10 is a diagram showing the form of the ports or embayments in the piston, the surface of which latter is shown developed; Figs. 11 and 12 are two views showing a particular application of the device according to the present invention; Fig. 11 being a section on the line 11—11 of Fig. 12; and Fig. 12, a section on the line 12—12 of Fig. 11.

In the form of apparatus shown in Figs. 1, 2 and 3, the device is illustrated as arranged to operate as a four-cylinder pump. There are four vertically arranged cylinders 13 each containing a double acting piston 14 which may be hollow ended for instance as shown in Fig. 6, and may have embayments in it as hereinafter described in connection with Fig. 10. Each piston has a crank arm 15 screwed or otherwise fixed into the piston at its center part and passing out through an opening at the side of the cylinder through a dish-shaped flange portion 24 as seen in the plan view, Fig. 2, and in Figs. 8 and 9. 11 are disks or drums mounted to revolve in a casing 17 which provides supporting surfaces for the cylindrical parts of the drums 16 near their ends. The casing 17 is made in two parts, lower and upper as shown, each formed with or carrying one half of the bearing surfaces for the end parts of the two drums 16. The two parts of the casing 17 are tied together at the center by webs 23. The dish-shaped flange portions 24 of the cylinders are bolted on to the sides of the casing 17 opposite the ends of each of the drums 16. In the middle of the circumference of each drum 16 is formed a ring of projecting worm wheel teeth 18 adapted to be engaged by worms 19 on a shaft 20 extending horizontally across the top of the casing 17. The shaft 20 may pass through a gland 37 at one end, while its other end may be formed as at 38 resting in any suitable bearing in the casing. The worms 19 are oppositely threaded, and the worm teeth 18 are cut oppositely so that the thrusts due to the drive between the worms and worm wheels of the two drums will tend to balance one another as these drums are driven by the worms 19 in opposite directions of rotation. The worms 19 are preferably double threaded. The lower half of the casing 17 forms an oil well in

the space marked 25 in Fig. 1 for supplying the gear teeth 18 with lubricant. Each of the drums 16 is formed with two cylindrical apertures parallel with its axis for receiving sliding blocks 21 shaped as shown in Figs. 1 and 2, and having gudgeon pins 22 therein acting as pivots for the ends of the crank arms 15. The blocks 21 work in the cylindrical apertures of the drums 16 from opposite sides or faces. The blocks 21 of course slide in and out of the cylindrical apertures in the drums 16 as the pistons move up and down, the positions of the blocks varying as the angularity of the crank arms 15 relative to the axis of the drums varies.

It will be noticed that the cylindrical apertures in the drums intersect to some extent. This is merely a matter of convenience in making, and causes no difficulty as the blocks 21 in adjacent cylindrical apertures never reach their innermost positions at the same time, and always remain at a little distance from one another in the drums. The block 21 shown at the bottom position in the left-hand drum 16 in Fig. 1 is that of the left-hand cylinder at the top of Fig. 2. The other block in the same drum is then of course the one shown in section in Fig. 2 in connection with the cylinder at the lefthand bottom corner of that figure; for the right-hand drum in Fig. 1 the block 21 shown in section at the topmost position operates in connection with the cylinder shown at the bottom righthand part of Fig. 2, while the block shown in section operates in connection with the remaining cylinder as seen in that figure.

Assuming that the apparatus is to work as a hydraulic pump it may be explained that the water enters by orifices 26, Figs. 1 and 3, and reaches a chamber 27 formed in the base of the lower half of the casing 17. The chamber 27 extends up the sides of the casing 17 through narrow spaces 28 as seen in Figs. 2 and 3, thus communicating with the faces or ends of the drums 16. The water can thus flow from the chamber 27 into all the flanged casings 24 leading to the cylinders 13. Owing to this construction it will be seen that the fluid pressure on opposite faces of the drums 16 will be the same, or practically the same so that there will be no end thrust due to the fluid on these drums. The openings through the drums will further insure this. The water is admitted to the cylinders through the crank arm openings in them and through embayments described below with reference to Fig. 10, passing through the pistons to the ends thereof, and being expelled through the embayments and through rectangular outlet openings 29 communicating with pipes 30 which lead to discharge orifices 31.

In Figs. 1 and 2, 32 represents a relief or by-pass valve which is adapted to be lifted by the water pressure in the pipes 30 if a predetermined limit of pressure is exceeded, thus allowing the water to flow back to the inlet chamber 27. The by-pass valve 32 is spring controlled in the example shown although of course it might be weighted. Its upper face 33 is larger in area than the rear of the valve proper so that the valve will lift when the pressure on the excess area of the surface 33 exceeds the downward pressure of the spring or weight. The object of this by-pass valve arrangement is to enable the water fed from the pump to be controlled at a distance without risk of damaging the pump or bursting the pipes.

Referring now to Figs. 4, 5 and 6, it will be seen that a single cylinder pump is shown with a horizontal cylinder 13 the arrangement otherwise corresponding as far as possible with that of Figs. 1, 2 and 3. The parts are lettered to correspond, and the only important difference is that the water is admitted through a port 26 in a disk 34 at the side of the drum 16 opposite from that at which the flange 24 of the cylinder is attached. The water flows through the space left at 35 in the drum 16 in passing from one side to the other of the drum. The drum is driven by a worm 19 on the shaft 20 as before, this shaft being shown as having a ball thrust bearing at 39 to take the end thrust. 40 is a pulley by which the worm shaft 20 is driven. The piston 14 has its ends hollowed or coned inwardly as seen in Fig. 6, and the cylinder may have corresponding inwardly projecting ends 41.

The construction shown in Fig. 7 differs from that shown in Figs. 1, 2 and 3 only in that there are two separate casings 42 instead of the casing 17 for a pump having four cylinders 13, and there is a separate disk similar to 16 for each of the cylinders 13, there being two disks in each of the casings 42. The disks are mounted in pairs on shafts 43 carrying worm wheels 44 at the center, and a longitudinal shaft 45 passing beneath the worm wheels 44 carries worms gearing with these wheels. The worms and worm wheels are oppositely threaded so as to avoid end thrust on the shaft 45. The shaft 45 therefore corresponds in its working with the shaft 20, Figs. 1, 2 and 3, and practically all that has been done is to split the drums 16 into two parts with a separate worm wheel 44 on the shaft between them, instead of having the worm teeth 18 on the center part of the drums as in Figs. 1, 2 and 3.

The manner in which the fluid enters the cylinders and is exhausted therefrom remains to be described. In Fig. 10 is shown

the development of a piston surface. It will be seen that there are two embayments in the piston one of which is marked 46, 47, and the other 48, 49. The parts 46 and 48 are the inlet portions of the embayments, and the parts 47 and 49 are the outlet portions. The circle at the center represents the crank arm 15. The dotted part 50 of approximately oval shape represents the form of the opening at the inlet side of the cylinder 13 through which the crank arm 15 works. The dotted rectangles 51 represent two halves of the exhaust opening 29 of the cylinder which opening is rectangular in shape. The piston is solid at the center, but is hollow at the ends as seen in Fig. 6. The left-hand end of the part 47 of the upper embayment in Fig. 10 is comparatively shallow and does not go through to the interior of the piston at this end. The right-hand ends of the parts 46 and 47 of the embayment are however, cut in beyond the line 52 (which represents the righthand edge of the center part of the piston), so that the parts 46 and 47 communicate with the interior of the righthand end of the piston. The line 53 similarly represents the left-hand end of the center part of the piston, and it will be seen that the parts 48 and 49 of the other embayment open into the left-hand end only of the piston. The arrow 54 represents the direction in which the crank arm 15 is moving at the moment relatively to the dotted opening 50. At the instant chosen none of the parts of the embayments are open either to the inlet or exhaust. Directly after the arm 15 has moved a little however, the curved head 55 of the part 46 of the upper embayment will pass over the edge of 50, and will admit fluid through 46 into the righthand end of the piston and cylinder. At the same time the lower left-hand edge of the part 49 of the lower embayment will be moving over 51 thus allowing the liquid from the lefthand end of the cylinder to be expelled through the exhaust opening. The admission continues until just before the pin 15 reaches the dotted position 57 when the curved edge 56 of the embayment 46 will have just moved out of the area 50. The part 49 of the lower embayment will also then have just left the outlet aperture 51. During the return stroke of the piston the admission and exhaust will be reversed, the part 48 admitting to the lefthand end of the piston and cylinder while the part 47 exhaust from the righthand end. The part 46 is shown connected to the part 47 by a neck or slot, and the part 48 is similarly connected to the part 49. This is not essential as this neck could be closed without altering the working of the device. The head 55 of the embayment 46, and the corresponding head 58 of the embayment 48 may be enlarged slightly if required to give lead in admission. Also the edge 56 of the embayment 46 and the corresponding edge 59 of the embayment 48 may be cut back more if required to give an earlier cut-off before the end of the stroke. The curves 56 and 59 must of course correspond with the curves of the opening 50 where they move away from this latter.

Figs. 11 and 12 show a pump of a type such as that shown in Figs. 1 to 3, modified in some respects to adapt it to be driven by an engine of a type such as that forming the subject of our Patent Number 950945 hereinbefore mentioned. The disks 16 are in this case formed with spur teeth 61 which gear together, and each disk also has bevel teeth formed on it at 62, gearing with bevel pinions 63 on the lower ends of vertical shafts 64. The shafts 64 are attached to disks 65 in which work sliding blocks 66 bearing the pivots 67 for the crank arms 69 of pistons 68 working in cylinders 70. These cylinders may receive steam, compressed air or other fluid under pressure through inlets at 71, the exhaust being through outlets at 72. The casing of the pump is extended upward at 73 to carry the disks 66 and the casting 74 bearing the cylinders 70. The manner in which the engine pistons 68 operate to drive the disks 65 will be well understood from the specification of the former patent above referred to, and it will be evident that the drive from the disks 65 will be transmitted through the pinions 63 and bevel wheels 62 to the disks 16 of the pump. Of course any other suitable form of engine might be used to drive the pump, either through the mechanism shown in Figs. 11 and 12 or through any other suitable mechanism or gearing.

With pumps constructed as hereinbefore described it is possible to work with water under pressure from a suitable source such as a street hydrant, and to use the pump for adding to this pressure; the pumps will therefore be useful for fire engines and so forth where it is desired to increase the pressure of supply. When the pump is used for fire engine purposes, with a hose pipe leading to a nozzle at a distance, the nozzle may have a stop tap which will enable the fireman to control the amount of water from the nozzle, while if the pump is working fast enough to supply more water the by-pass valve 32, Fig. 1, will be opened as before stated to allow the water to circulate in the pump. The pump may therefore be continuously worked although the supply taken from it is varying or is even inter-

mittent. A pump made as hereinbefore described will occupy very little space in comparison with the work which it will do. It is possible to run the pump at a comparatively high speed because there are no clack valves or the like which would take time to move automatically, and would therefore limit the speed. The pumps may be made as hereinbefore described with any desired number of cylinders, and it has been found experimentally that a pump of this type will supply slightly more water than would be expected from the volume of each cylinder because apparently the water in the embayments becomes thrown out by its inertia at the end of each stroke.

It will be evident that the constructions hereinbefore described are suitable for fluid pressure engines as well as for pumps. The heads 55 and 58 of the embayments 46 and 47 could be extended if required to give any necessary amount of lead, and the parts 47 and 49 could also be cut as desired to vary the period of opening and closing the exhaust. The exhaust apertures 29 need not necessarily be rectangular as shown and if they were oval or circular for example the ends of the exhaust portions 47 and 49 of the embayments might be shaped to correspond. The parts 47 and 49 might also be curved if required instead of being straight as shown, the curvature corresponding for example to the curved path of movement of a point on the surface of the piston. Of course if the apparatus were used as an engine the pistons would drive the drums 16, and these would have to be geared in such a way to a shaft that they could transmit power thereto. This can be readily done if required and needs no further description. The pistons can be packed in any suitable way as for instance by packing rings 60, Fig. 6; or they might have screwed-on ends containing packing rings. The cylinders might also have flat ends instead of inwardly dished ends 41 in case the apparatus was to be used as a liquid pump because it is not so important in such cases to expel all the liquid at each stroke. For a fluid pressure engine however, working with steam or compressed air, the inwardly dished ends 41 would be needed with hollow ended pistons as shown.

We declare that what we claim is:—

1. In combination, a piston having two apertures or embayments in its circumference communicating with opposite ends of the piston, each embayment having a head portion connected by a neck to a long rear portion, an arm projecting from the piston between the heads of the two embayments, a cylinder adapted to receive the piston and having an aperture through which the said arm works, and having also a second aperture, means operating with the said arm and causing the piston to move longitudinally and also to oscillate circumferentially in the cylinder, the parts being so formed that in the said movement the head portions of the embayments alternately become exposed to the opening in the cylinder through which the said arm works and the long rear portions of the embayments alternately become exposed to the second opening in the cylinder, means for conveying a fluid to the opening through which the arm works, and means for carrying away fluid from the second opening in the cylinder.

2. In combination, a piston having a central disk portion with a cylindrical portion extending at each side thereof, and having two apertures or embayments in the cylindrical portion, opening respectively into the piston at opposite sides of the central disk, each embayment having a head portion and a long rear portion, an arm attached to and projecting from the piston between the two head portions of the embayments, a cylinder adapted to receive the piston and having two openings therein through the first of which the projecting arm works, means operating with the said arm, whereby the piston is caused to reciprocate longitudinally and at the same time to oscillate circumferentially in the cylinder, whereby also the heads of the embayments are brought alternately under the opening through which the arm works, while the rear portions of the embayments are brought alternately under the second opening in the cylinder, means for conveying fluid to the opening in the cylinder through which the arm works, and means for carrying away fluid from the second opening in the cylinder.

3. In combination, four cylinders, a rotating member adjacent to each cylinder, shafts directly connecting the said rotating members in pairs, worm wheels on said shafts, a worm shaft, whereby the said worm wheels are driven, the worms and worm wheels being cut to rotate simultaneously in opposite directions for the purpose of balancing the thrusts thereon one against the other, a piston in each cylinder and a projecting arm thereon working through an aperture in the cylinder, means connecting the said arm to the rotating member adjacent to the cylinder, whereby the piston is caused to move longitudinally and to oscillate at the same time circumferentially in its cylinder as the member is rotated, two embayments in each piston communicating respectively with the opposite ends thereof, and having head portions adapted to be exposed alternately at the opening of the cyl-

inder through which the arm works, and having also rear portions, an outlet on the cylinder adapted to communicate alternately with the rear portions of the embayments as the piston moves in the cylinder, and means for conveying a fluid to the openings of the cylinders through which the said arms work.

In witness whereof, we have hereunto signed our names this 12th and 10th day of October 1910, respectively, in the presence of the subscribing witnesses.

THOMAS MOSS.
WILLIAM MOSS.

Witnesses as to Thomas Moss:
HARVEY J. BOWERSTOCK,
CHARLES JACK.
Witnesses as to William Moss:
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