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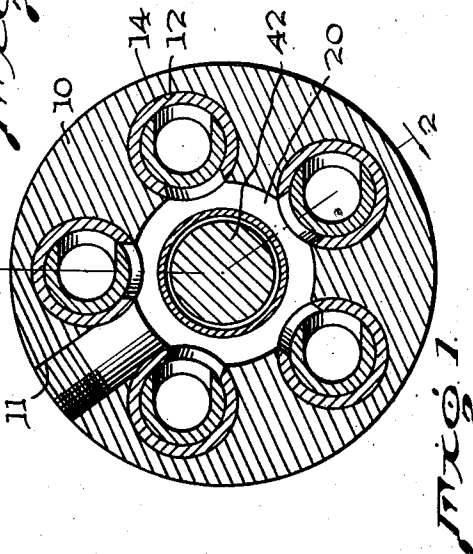
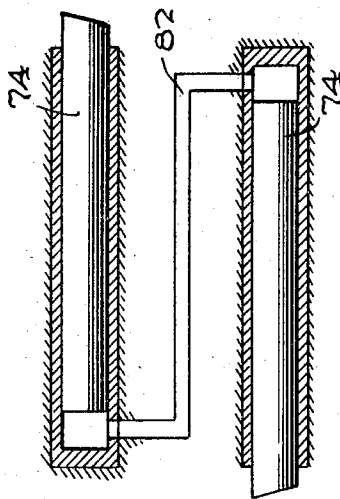
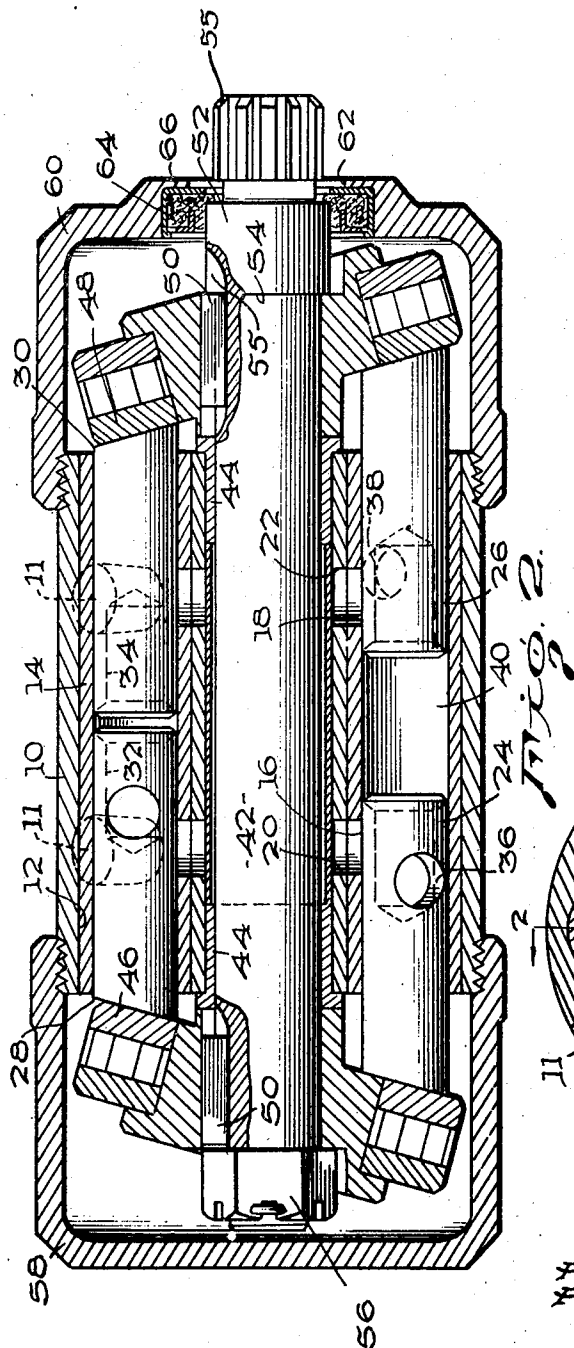
A. R. PARILLA ET AL

2,428,809

FLUID APPARATUS

Filed July 17, 1944

2 Sheets-Sheet 1



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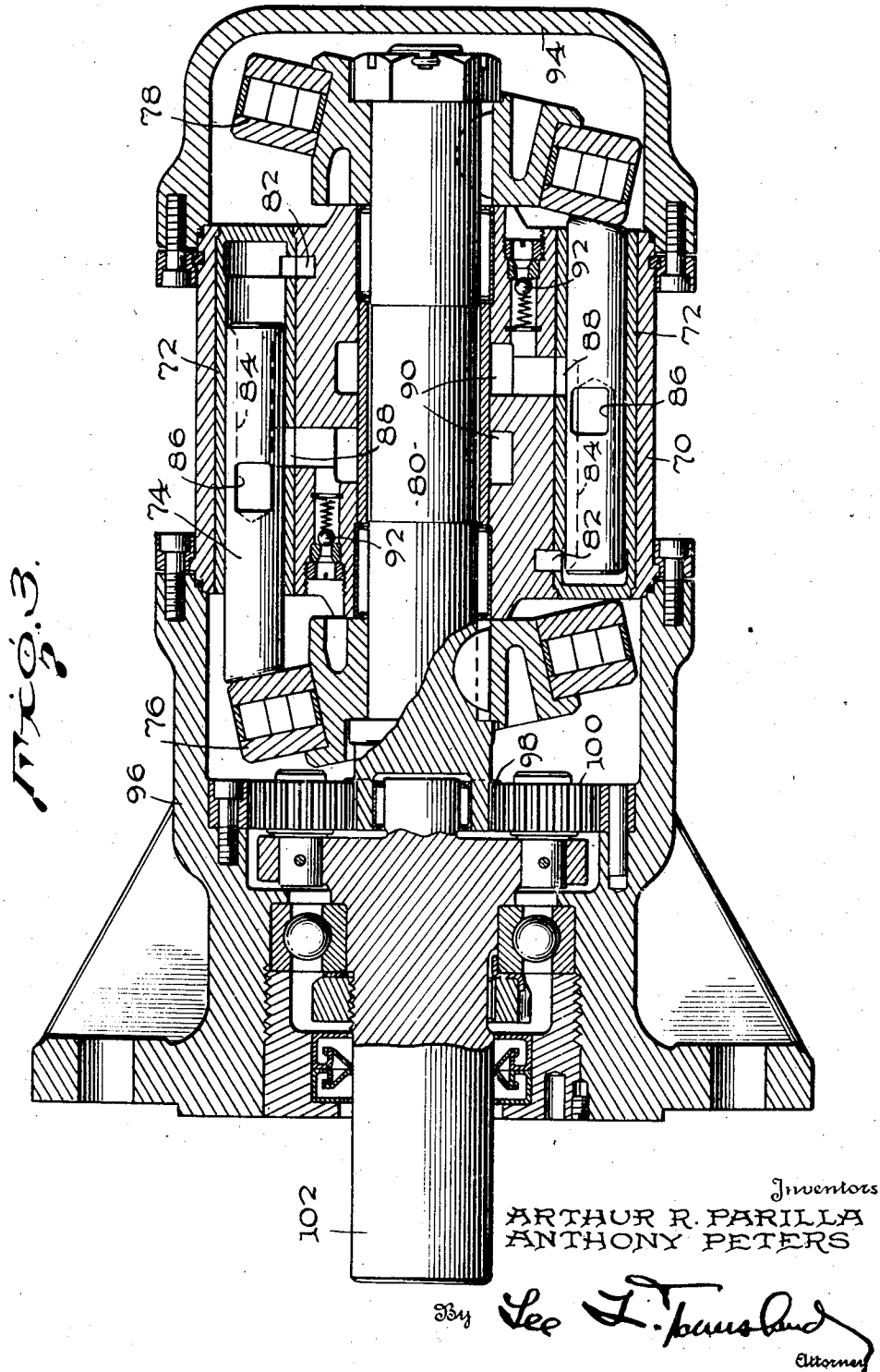
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UNITED STATES PATENT OFFICE

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FLUID APPARATUS

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21 Claims. (Cl. 103—157)

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This invention relates to fluid apparatus adapted to serve as a pump or motor.

Wobble plate pumps or motors are customarily equipped with complex valves and timing mechanisms arranged at points externally of the cylinders and pistons. In accordance with the present invention, it is proposed to rotate as well as reciprocate the pistons of such an apparatus, the pistons serving to valve ports in their cylinders as they rotate. To balance thrust loads, and for other purposes which will become apparent to those skilled in the art, it is preferable to utilize a pair of pistons moving in opposite directions during the major portion of a cycle. However, to reduce negative work and attain maximum efficiency, it is desirable to have the pistons operate slightly out of phase for a portion of the cycle in some instances.

The pistons constituting a pair can be arranged coaxially, or, where it is desired to reduce the length of an installation, they may be arranged parallel and coextensive in inter-connected cylinders. In the latter case, the asymmetrical relationship will occur without dephasing the wobble plates if the angular displacement of the cylinders is properly selected.

By rendering the cylinders and pistons non-rotatable with respect to their common housing, the mass of rotating parts can be maintained low, resulting in reduced inertia loads during rapid acceleration.

The pump or motor of the present invention may be said to comprise a cylinder having inlet and outlet ports, a reciprocable and rotatable piston received in the cylinder, an inclined element relatively rotatable with respect to the cylinder and an inclined surface cooperating with the inclined element for rotating the piston as the relative rotation between the cylinder and inclined element occurs. A plurality of such cylinders, provided in pairs can be opposed or angularly offset, and a relatively rotatable wobble plate can cooperate with one piston of each such pair. The wobble plates can be arranged out of phase a desired amount to reduce the amount of negative work to a minimum consistent with efficient operation. Relative rotation between the wobble plates and cylinders is attended by rotation of the pistons within their respective cylinders, by virtue of which, the cylinder ports are opened and closed in timed relationship, the path of fluid passing therethrough being determined by suitable channels provided for the pistons.

A more complete understanding of the invention will follow from a detailed description of the appended drawings, wherein:

Figure 1 is a transverse section through one form of the invention;

Figure 2 is a longitudinal section taken along the line 2—2 of Figure 1;

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Figure 3 is a sectional elevation of a modified form of construction; and

Figure 4 is a diagrammatic representation of the relationship of elements in a construction of the type shown in Figure 3.

As represented in Figs. 1 and 2, a barrel 10 is provided with a pair of ports 11 serving to admit and exhaust fluid, the use of the device as a pump or motor determining which is an admission port and which is an exhaust port. These ports are indicated by broken lines in Fig. 1. The barrel 10 also contains equally spaced cylindrical bores 12 for the reception of cylinder sleeves 14 whose axes are equally spaced radially from a common center. Each cylinder sleeve is provided with fluid ports 16 and 18 which register with annular channels 20 and 22, respectively, provided in the barrel. Those sleeves are made fast to the barrel in any convenient manner to maintain the ports in desired registry with their respective channels.

Each sleeve receives a pair of pistons 24 and 26 whose remote ends 28 and 30 are closed and inclined at a predetermined angle and whose proximate ends contain opposed counterbores 32 and 34. Intersecting these counterbores are transverse ports 36 and 38, respectively, formed through the piston walls. Rotation of the pistons during their reciprocation causes registration of the various transverse ports with the corresponding cylinder ports to control the passage of fluid to and from the variable chamber 40 defined between the opposed ends of the pistons.

The barrel 10 is centrally bored to receive a shaft 42 in suitable bearings 44, both ends of the shaft projecting beyond the barrel to receive wobble plates 46 and 48 keyed to the shaft by keys 50. Near one end of the shaft there is provided an enlargement 52 defining a shoulder 54 against which one of the wobble plates abuts, the shaft terminating in a gear or splines 55 for engagement with a driving or driven instrumentality, depending upon the use to which the apparatus is put. The opposite end of the shaft is threaded to receive a nut 56 which provides an adjustment for end-play and serves to draw the wobble plate-shaft assembly together.

The ends of the barrel are threaded to receive caps 58 and 60 for enclosing the wobble plates. One of the caps 58 has a closed end, whereas the other, 60, contains a perforation 62 through which the splined or geared end of the shaft 42 projects. A counterbore 64 is formed in the cap 60 for reception of a sealing element 66 which engages the enlargement 52 near the end of the shaft.

Where the wobble plates 46 and 48 are mounted in phase with one another, the two pistons in any one cylinder will reciprocate symmetrically, reaching their dead-center positions simultaneously. Sealing the valve ports requires closing

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one port before dead-center and opening the other after dead-center. Where reversible motor operation is desired, these distances or angles should be equal. Such an arrangement introduces a tendency to compress fluid trapped in the chamber 40 while both valves are closed, resulting in peak pressures against which the motor does negative work, reducing efficiency and promoting leakage. Moreover, there is no tendency for one of the pistons to follow its wobble plate until after one of the valve ports has been opened. Hence the angle of overlap is necessarily limited.

By setting the wobble plates slightly out of phase on their shaft, a pair of pistons in a cylinder will move asymmetrically so that their dead-center positions will not concur. This permits uni-directional movement of the pistons near their inner dead-center positions, obviating the development of peak pressures, reducing the element of negative work and increasing efficiency.

It will be noted that the counterbored pistons provide for a substantial amount of fluid even when the pistons approach dead-center, thus limiting the compression ratio of the system. This counterboring also promotes a sealing tendency, since fluid under pressure will tend to expand the piston skirt and provide an improved seal with respect to the cylinder sleeve.

With this out-of-phase operation, there is no tendency of the pistons to dwell near the dead-center and the inclined ends of the pistons will continuously tend to bear upon their respective wobble plates.

The modification shown in longitudinal section in Fig. 3, and supplemented diagrammatically by Fig. 4, comprises a construction embodying the same principles as described with reference to Figs. 1 and 2, but permits a reduced length of the apparatus. In Fig. 3, a barrel 70 contains inlet and outlet ports, not shown, similar to the ports 11 of Fig. 1, and a plurality of cylinder sleeves 72 into which are fitted pistons 74. These pistons are inclined at one end for engagement with one of the inclined wobble plates 76 and 78 which are secured to a shaft 80, which, together with the wobble plates, rotates with respect to the barrel. The head ends of the pistons are interconnected by a channel 82 to produce an effect similar to that encountered where two pistons are arranged in a single cylinder. The pistons are provided with counterbores 84 as in the preceding case, intersected by ports 86 formed transversely through the piston walls for registry with ports 88 through the cylinder sleeves. Fluid is supplied and discharged through channels 90 which are connected with suitable tubing, not shown.

Check valves 92, provide for the return of fluid which may leak past the pistons, to the return line of the main hydraulic system. This eliminates a third tube connection as a drain-line required with some apparatus of this type.

One end of the shaft 80 is provided with a gear 98, which through reduction gearing 100, cooperates with a shaft 102 which may drive or be driven, depending upon use of the mechanism as a pump or a motor. In this modification, the pistons may be properly phased by properly spacing the cylinders angularly, without dephasing the wobble plates themselves.

Rotation of the pistons in their cylinders is effected by their contact with the wobble plates and the fluid pressure which causes them to bear upon the wobble plates. This effect is produced by virtue of torsional moments produced to rotate the pistons should they tend to bind or for some

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other reason fail to rotate. It is clear that any failure of the pistons to rotate, as set forth, contact between them and the wobble plates would be no longer uniformly distributed, but the effective center would shift from the piston axis to a point displaced therefrom. In the event of such shift, a torsional moment would be produced equal to the product of the extent of shift and the force component normal to the piston axis. Since the restoring force increases as a function of the distance of the center of the applied force from the piston axis, it follows that the end of the piston will tend to maintain its area of contact with the wobble plate at a maximum.

The foregoing description covers two constructions which are intended to illustrate the invention but not to limit it, since other applications of the principles will occur to those skilled in the art. Accordingly, the scope of the invention should not be limited beyond the terms of the appended claims.

We claim:

1. Fluid apparatus comprising a cylinder having inlet and outlet ports, a reciprocable and rotatable piston fitted in said cylinder and controlling at least one of said ports, an inclined element relatively rotatable with respect to said cylinder, and an inclined surface provided for said piston and rotatable therewith for engagement with said element.

2. Fluid apparatus comprising a cylinder having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in said cylinder and controlling said ports, inclined elements relatively rotatable as a unit with respect to said cylinder, and inclined surfaces provided for said pistons and rotatable therewith for engagement with said elements respectively.

3. Fluid apparatus comprising a plurality of cylinders having inlet and outlet ports, said cylinders having parallel axes, certain of which are equally radially displaced from a common center, a reciprocable and rotatable piston fitted in each cylinder and controlling said ports, an inclined element having an axis passing through said common center, said plate being relatively rotatable with respect to said cylinders, and an inclined surface provided for each of said pistons and rotatable therewith for engagement with said elements.

4. Fluid apparatus comprising a plurality of cylinders having inlet and outlet ports, said cylinders having parallel axes, certain of which are equally radially displaced from a common center, opposed reciprocable and rotatable pistons fitted in each of said cylinders and controlling said ports, inclined elements having a common axis passing through said common center, said elements being relatively rotatable as a unit with respect to said cylinders, and inclined surfaces provided for each of said pistons and rotatable therewith for engagement with said elements.

5. Fluid apparatus comprising a plurality of cylinders having parallel axes intersecting a perpendicular plane on the circumference of a circle, said cylinders having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in each of said cylinders and controlling said ports, inclined elements mounted on a common shaft relatively rotatable with respect to said cylinders, and inclined surfaces provided for said pistons and rotatable therewith for engagement with said elements, said elements being arranged in phase.

6. Fluid apparatus comprising a plurality of

cylinders having parallel axes intersecting a perpendicular plane on the circumference of a circle, said cylinders having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in each of said cylinders and controlling said ports, inclined elements mounted on a common shaft relatively rotatable with respect to said cylinders, and inclined surfaces provided for said pistons and rotatable therewith for engagement with said elements, said elements being arranged out of phase.

7. Fluid apparatus comprising an odd number of cylinders having parallel axes intersecting a perpendicular plane on the circumference of a circle, said cylinders having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in each of said cylinders and controlling said ports, inclined elements relatively rotatable as a unit arranged at opposite ends of said cylinders and rotatable with respect to said cylinders, and inclined surfaces provided for the remote ends of said pistons for engagement with said elements.

8. Fluid apparatus comprising a plurality of cylinders having parallel axes intersecting a perpendicular plane on the circumference of a circle, said cylinders having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in each of said cylinders and controlling said ports, inclined elements relatively rotatable as a unit arranged at opposite ends of said cylinders and rotatable with respect to said cylinders, and inclined surfaces provided for the remote ends of said pistons for engagement with said elements, said elements being arranged to permit the opposed pistons of each cylinder to reciprocate in opposite directions during a major portion of a cycle.

9. A fluid pump comprising a plurality of cylinders having parallel axes intersecting a perpendicular plane on the circumference of a circle, said cylinders having inlet and outlet ports, reciprocable and rotatable pistons fitted in said cylinders and controlling said ports, inclined elements relatively rotatable as a unit arranged at opposite ends of said cylinders and rotatable with respect to said cylinders, inclined surfaces provided for said pistons for engagement with said elements, and a driving shaft for rotating said elements relatively with respect to said cylinders.

10. A fluid motor comprising a plurality of cylinders having parallel axes intersecting a perpendicular plane on the circumference of a circle, said cylinders having inlet and outlet ports, reciprocable and rotatable pistons fitted in said cylinders and controlling said ports, inclined elements relatively rotatable as a unit arranged at opposite ends of said cylinders and rotatable with respect to said cylinders, inclined surfaces provided for said pistons for engagement with said elements, and an output shaft driven by relative rotation between said elements and said cylinders.

11. Fluid apparatus comprising a cylinder having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in said cylinder, wobble plates relatively rotatable with respect to said cylinder for engagement with said pistons, inclined surfaces provided for said pistons to engage said wobble plates for rotation of said pistons about their respective axes, and means provided by said pistons for controlling said ports.

12. Fluid apparatus comprising a cylinder having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in said cylinder, wobble plates relatively rotatable with respect to

said cylinder for cooperation with said pistons, inclined surfaces provided for said pistons to engage said wobble plates for rotation of said pistons about their respective axes, and means provided by said pistons for controlling said ports, said wobble plates being sufficiently out of phase to space the dead center positions of said pistons.

13. Fluid apparatus comprising a cylinder having inlet and outlet ports, a piston received in said cylinder for rotation and reciprocation, one end of said piston being inclined, an inclined element for engagement with said inclined end, means rotatably mounting said element with respect to said cylinder, and means provided by said piston for controlling the passage of fluid between said ports.

14. Fluid apparatus comprising a cylinder having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in said cylinder and controlling said ports, inclined elements relatively rotatable as a unit with respect to said cylinder, and means provided for said pistons bearing against said elements for imparting rotation to said pistons as result of relative rotation of said elements.

15. Fluid apparatus comprising a cylinder having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in said cylinder and controlling said ports by rotation, inclined elements relatively rotatable as a unit with respect to said cylinder, and inclined surfaces provided for said pistons and rotatable therewith for engagement with said elements respectively.

16. Fluid apparatus comprising a cylinder having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in said cylinder and controlling said ports by rotation and reciprocation, inclined elements relatively rotatable as a unit with respect to said cylinder, and inclined surfaces provided for said pistons and rotatable therewith for engagement with said elements respectively.

17. Fluid apparatus comprising a cylinder having inlet and outlet ports, opposed reciprocable and rotatable pistons fitted in said cylinder each controlling one of said ports, inclined elements relatively rotatable as a unit with respect to said cylinder, and inclined surfaces provided for said pistons and rotatable therewith for engagement with said elements respectively.

18. Fluid apparatus comprising a pair of communicating substantially coextensive cylinders having inlet and outlet ports, reciprocable and rotatable pistons fitted in said cylinders and controlling said ports, inclined elements relatively rotatable as a unit with respect to said cylinders, and means connected with said pistons bearing upon said elements to effect rotation of said pistons during relative rotation of said elements and cylinders.

19. Fluid apparatus comprising a cylinder having inlet and outlet ports, a reciprocable and rotatable piston received in said cylinder and controlling at least one of said ports, an inclined element relatively rotatable with respect to said cylinder, and means provided for said piston bearing against said element for imparting rotation to said piston as result of relative rotation of said element.

20. Fluid apparatus comprising cylinders having inlet and outlet ports, reciprocable and rotatable pistons fitted in said cylinders and controlling said ports by rotation, inclined elements relatively rotatable with respect to said cylinders,

and means provided for said pistons bearing against said elements for imparting rotation to said pistons as result of relative rotation of said elements.

21. Fluid apparatus comprising cylinders having inlet and outlet ports, reciprocable and rotatable pistons fitted in said cylinders and controlling said ports by rotation and reciprocation, inclined elements relatively rotatable with respect to said cylinders, and means provided for said pistons bearing against said elements for imparting rotation to said pistons as result of relative rotation of said elements.

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