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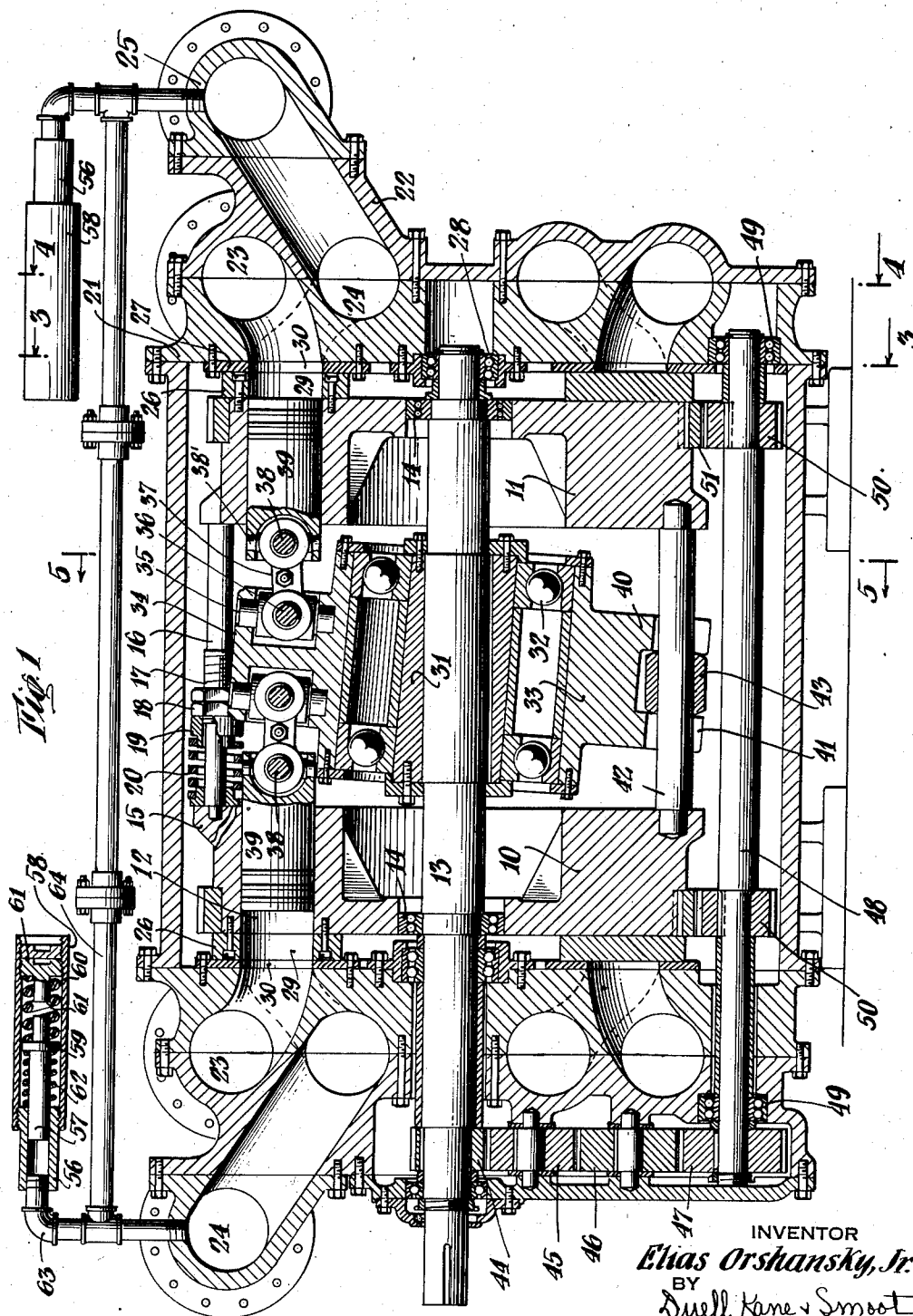
E. ORSHANSKY, JR

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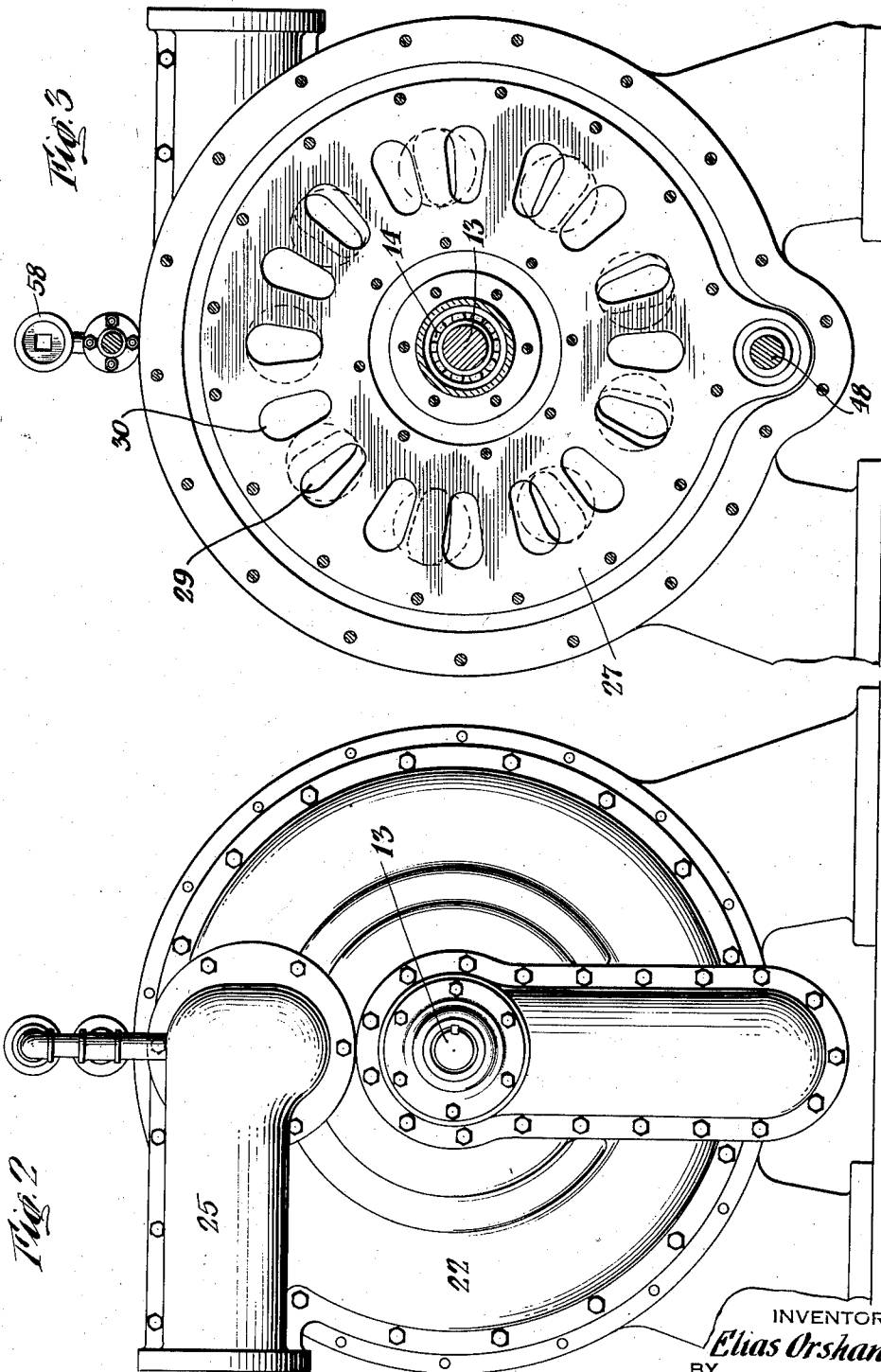
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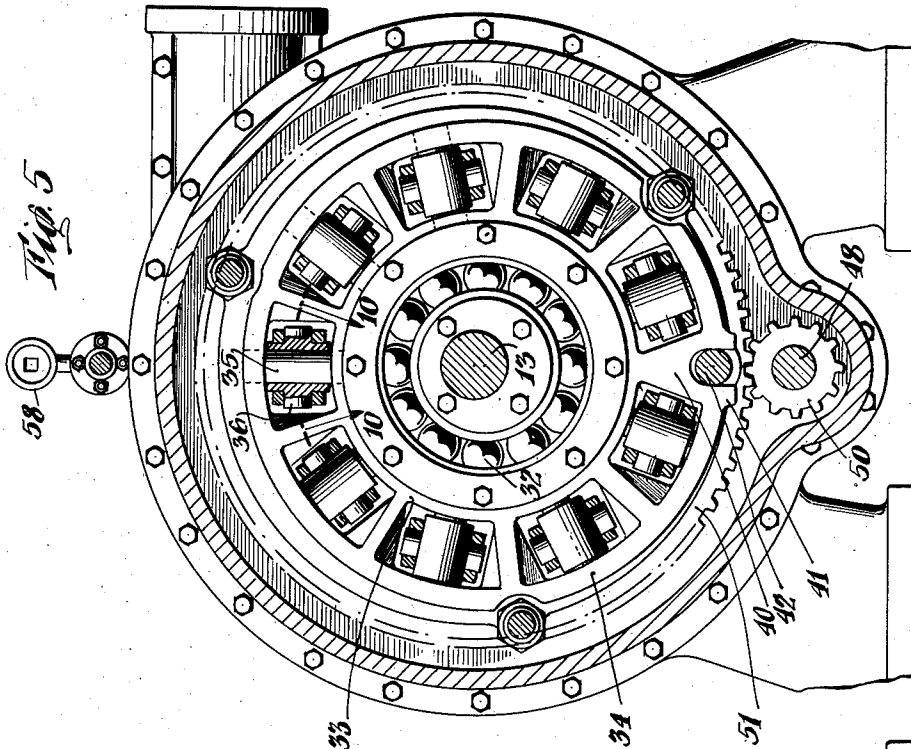
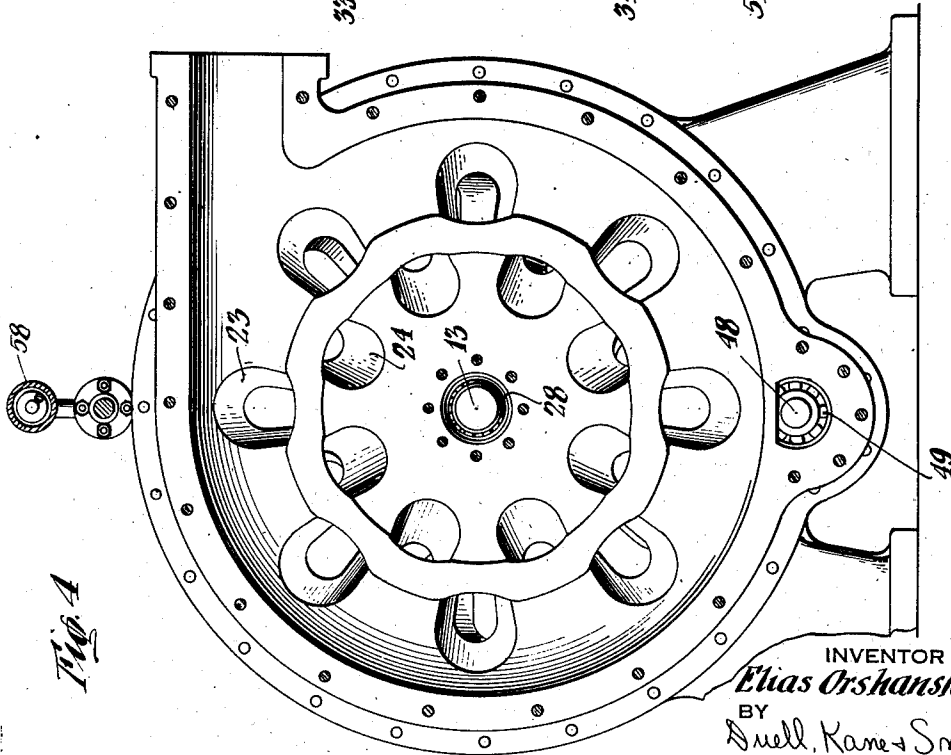
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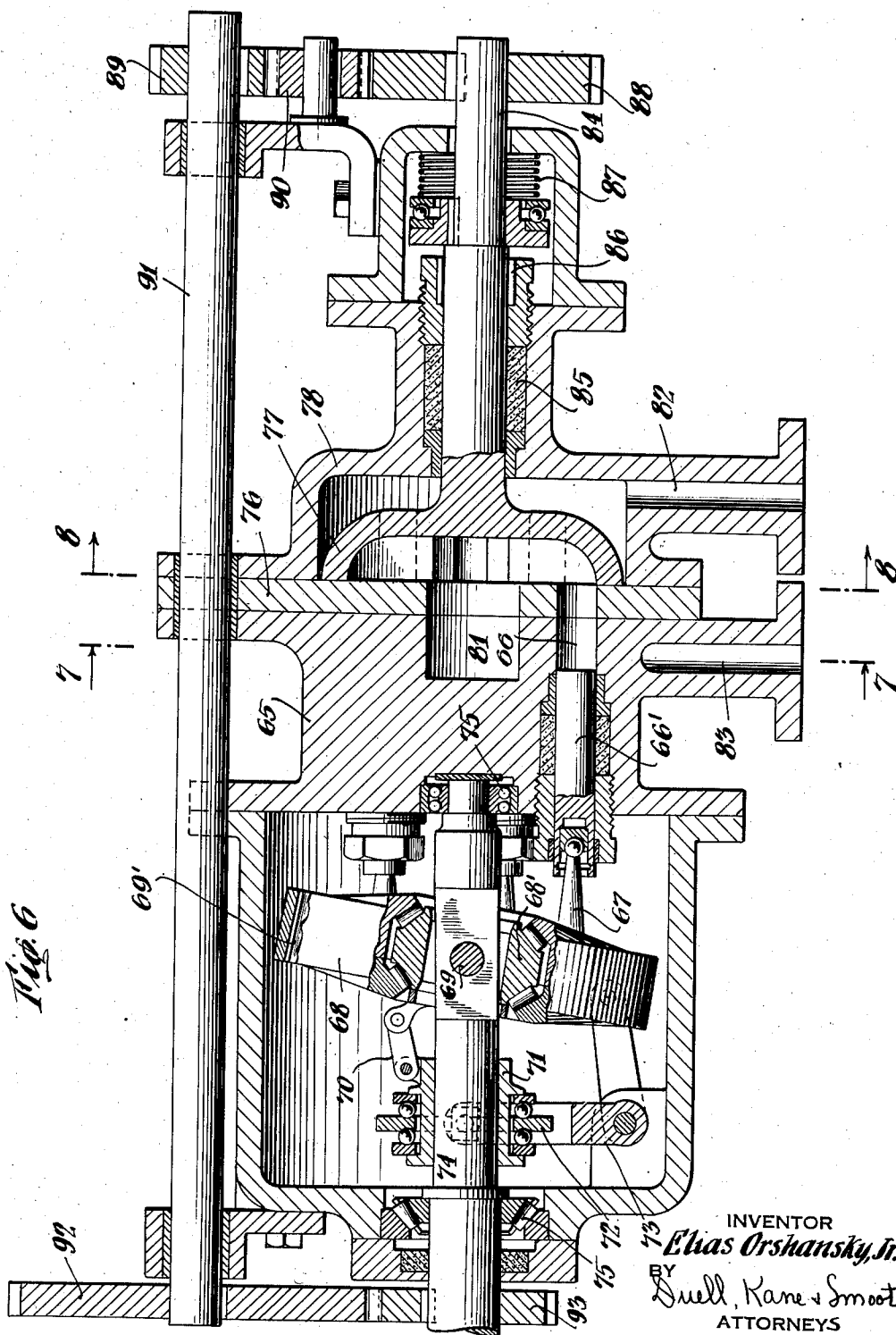
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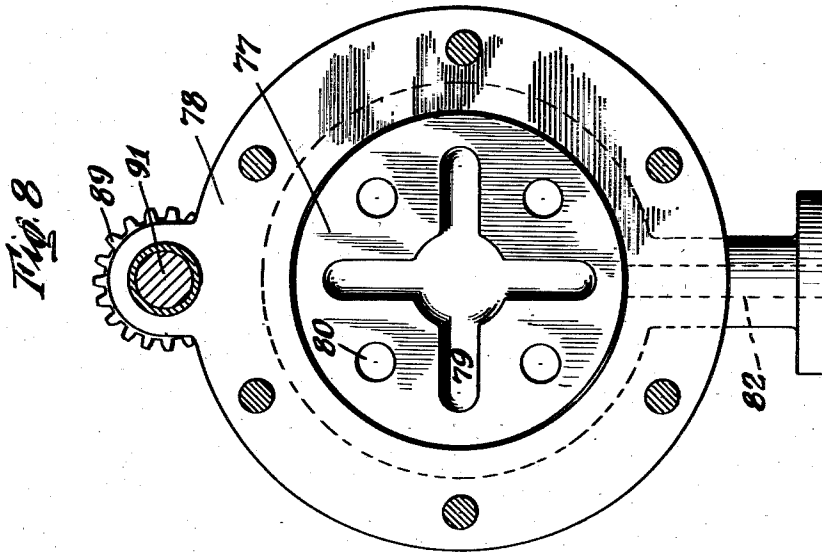
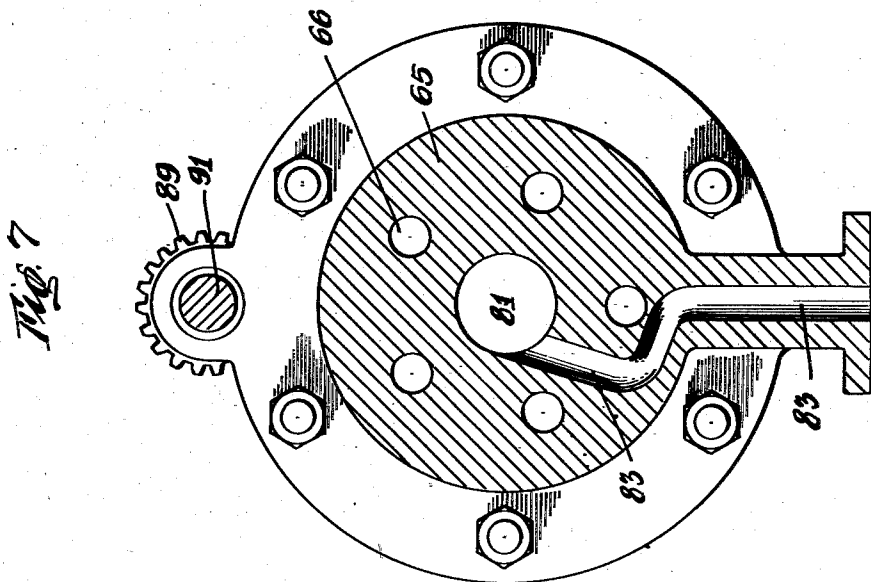
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7 Sheets-Sheet 5



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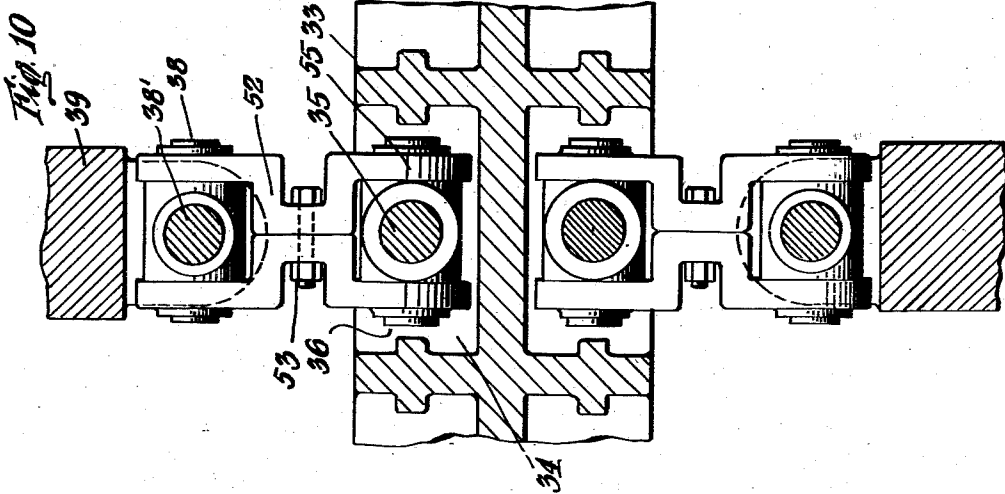
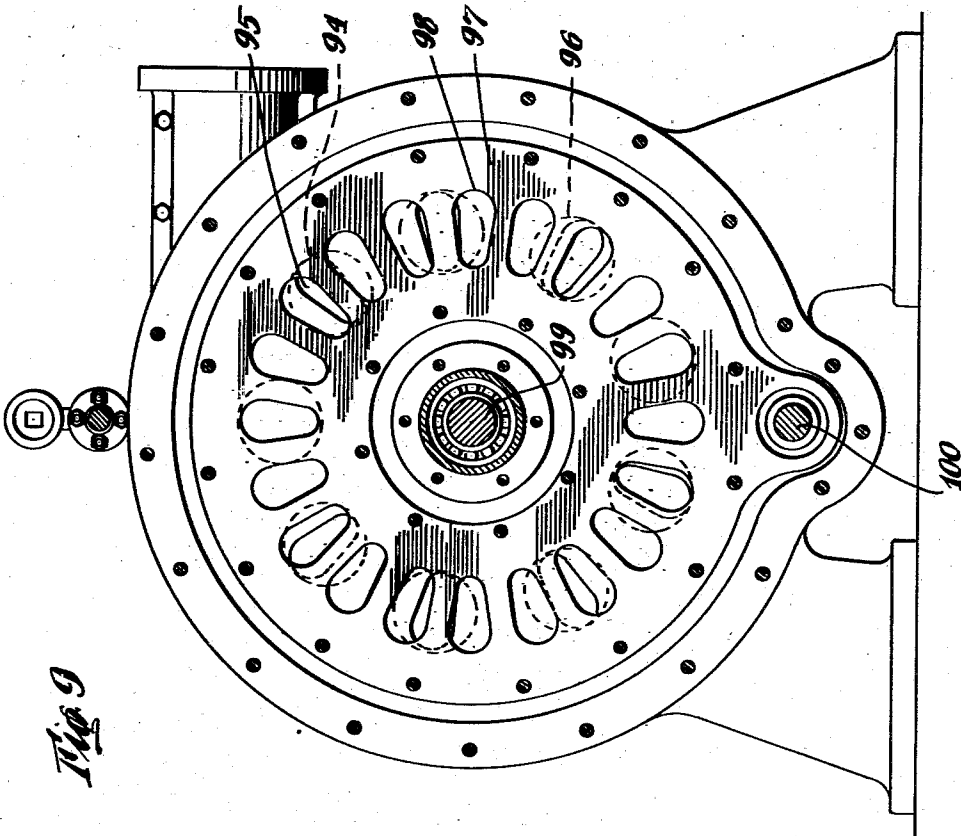
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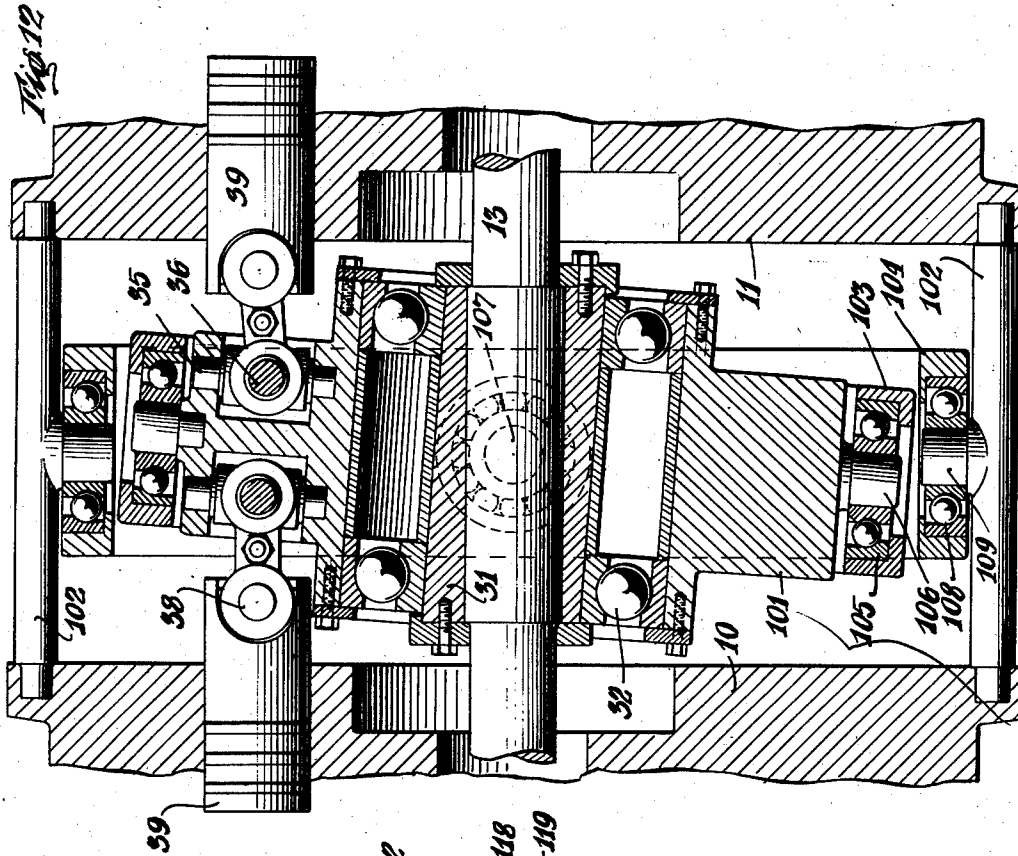
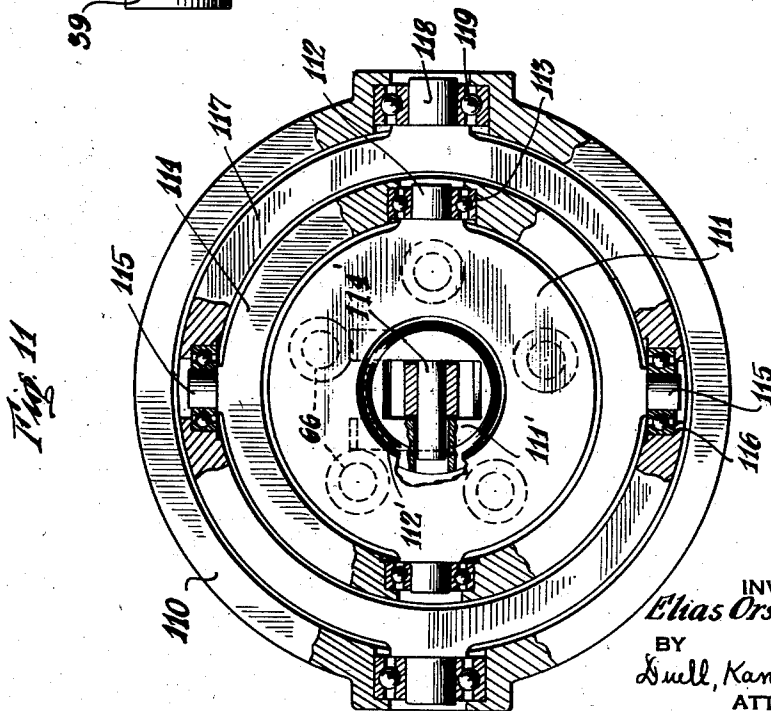
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PUMP

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Application October 21, 1937, Serial No. 170,207

2 Claims. (Cl. 103-162)

This invention relates to a structurally and functionally improved pump, the present application being a continuation in part of the subject matter disclosed in my prior application for United States Letters Patent on Pump, filed July 28, 1936, Serial No. 92,954.

It is an object of the invention to provide a mechanism of this character by means of which fluids of any desired type may be distributed at desired velocities and/or pressures with the expenditure of but minimum effort.

A further object is that of constructing a pump which will offer an even load factor or resistance throughout substantially its entire range of operation and in which, moreover, the several cylinders will be controlled by valve mechanism in such manner that power losses incident to controlling the fluid flow into and from the cylinders will be negligible, aside from the fact that an extremely uniform flow will result.

Another object is that of providing a unit of this type in which the losses due to leakage will be minimized; this desirable result being particularly noticeable under high pressure operating conditions.

Still another object is that of furnishing a pump embodying relatively few parts, each individually simple and rugged in construction and operating over long periods of time with freedom from all difficulties.

With these and other objects in mind, reference is had to the attached sheets of drawings illustrating practical embodiments of the invention, and in which:

Fig. 1 is a sectional side view of one form of pump with certain of the parts broken away to disclose underlying construction;

Fig. 2 is an end elevation of such pump;

Figs. 3, 4 and 5 are transverse sectional views taken along the lines 3-3, 4-4 and 5-5, respectively, and in the direction of the arrows as indicated in Fig. 1;

Fig. 6 is a view similar to Fig. 1, but showing an alternative form of construction;

Figs. 7 and 8 are transverse sectional views taken respectively along the lines 7-7 and 8-8 and in the direction of the arrows as indicated in Fig. 6;

Fig. 9 is a view similar to Fig. 3, but showing a slightly different arrangement of valve mechanism;

Fig. 10 is a face view showing the detailed structure of one of the piston rods which is preferably employed;

Fig. 11 is a transverse view with certain of the

parts in section and showing a form of structure which may be conveniently embodied in the apparatus as illustrated in Fig. 6; and

Fig. 12 shows an alternative form of wobble plate support to be included in a structure similar to that shown in Fig. 1.

While the teachings of the present invention may be followed and embodied in various types of apparatus, they are of particular value when included in a pump having a number of cylinders preferably arranged in the form of an annular series and which cylinders are movable with respect to a valve plate or similar unit. By relative movement, there is included movement of the cylinder block in cooperation with a relatively stationary valve unit or member; movement of the latter in cooperation with a stationary cylinder block, or conjoint movement of both block and valve unit. In any event, such relative movement provides for periodic communication between intake ports and outlet ports and a given cylinder. If the piston within this cylinder has its movements timed in relation to the coupling of the cylinder with the ports, then a proper operation obviously follows in accordance with well known practice.

The present invention is of particular value where comparatively high pressures are employed and the fluid pressure itself may—according to the teachings of the present invention—be utilized to assist in providing a proper sealing relationship between the valve unit and the cylinders so that leakage is reduced to a minimum. It is well recognized in constructions of this nature that considerable difficulty has been encountered because, with the high contact pressures which must necessarily exist, the friction losses incident to the relative movement of the valve unit and cylinder would be so great that any advantages following from the use of such a construction would be largely, if not completely, outweighed by these losses.

With this in mind, the present invention aims to provide an apparatus in which a plurality of cylinders and a plurality of pairs of ports are employed, but in which the pairs of ports differ by one in number from the number of cylinders. Preferably these pairs of ports should be one less in number. A vernier action is relied upon in order to provide for proper registration between the cylinders and the ports of the valve mechanism. Accordingly, while relative movement of these ports or their equivalents and the cylinders does occur, the speed of such movement is comparatively negligible. Thus, despite the fact that

high contact pressures must, of necessity, be employed between the member or members presenting the ports and the cylinders or cylinder block, the resultant friction loss will be comparatively low.

Thus, referring primarily to Figs. 1 to 5, the numerals 10 and 11 indicate blocks which, as shown, are formed with nine cylinders 12. These blocks are rotatably supported upon a shaft 13 by means of bearings 14. The blocks are formed with outwardly projecting lugs 15, and the lugs on the opposite blocks are aligned so that between a pair of the same there is supported a rod 16, conveniently having a screw-threaded portion 17, and which mounts one or more nuts 18. Adjacent the innermost of these elements is a collar 19 serving to confine the outer end of a spring 20, the inner end of which may react against the adjacent block. In the embodiment under consideration, three of these rods have been employed, as has been shown particularly in Fig. 5. It is, of course, apparent that any desired number of the same may be utilized and that, in any event, a factor will thus be presented which will serve to force the blocks outwardly and in opposite directions.

It is at this time to be understood that a pump embodying the teachings of the present invention may include any suitable number of banks of cylinders and may, in fact, embrace (as hereinafter described in connection with Figs. 6, 7 and 8) merely a single bank. In view of the fact that in the example illustrated in Figs. 1 to 5, inclusive, the opposite ends of the unit are generally similar, the description, insofar as practicable, will be confined to one of such ends.

Accordingly, the numeral 21 indicates a head to which an outer section 22 may be coupled. This head and section furnish in aggregate a low pressure or intake passage 23 and a high pressure or discharge passage 24. A further section 25 may be coupled to section 22 and provide a continuation of the high pressure passage. It would, of course, be feasible to have the cylinder block or the outer ends of individual cylinders bear directly against the inner face of head 21. This, however, I have found not to be desirable because of the wear which would necessarily occur on the part of the cylinders and the head. Rather, it is preferable to associate with the block or its equivalent a bearing ring 26, the outer face of which bears against a corresponding ring 27 fixed to head 21. In this manner, elements are presented which may readily be renewed when occasion arises, such renewal being capable of being effected at minimum expense and with but little delay. It is also to be observed that member 27 is of greater area than ring 26 and, in fact, extends to a point at which it may support an anti-friction bearing 28 cooperating with shaft 13.

While the cylinders 12 are in each instance preferably circular in cross section, the openings 29 in member or ring 26 conveniently include side walls extending along lines radial from the center of shaft 13 and connected by arcuate end edge portions. Such openings 29 are furnished in member 26 in line with each of the nine cylinders. Openings 30 of similar configuration are formed in the plate or member 27. Such openings in the illustrated example are sixteen in number, and adjacent openings control respectively the intake and exhaust of the cylinders to and from passages 23 and 24. The distance between adjacent openings 30 may the-

oretically be exactly equal to the width of one of the openings 29. As a practical matter, however, it is in certain respects preferred that the distance between adjacent openings 30 be slightly less than the width of one of the openings 29. If such a construction is resorted to there will be less danger of the oil or other fluid trapping, with consequent hammering and inefficient operation of the unit. In any event, it will be appreciated that if the cylinders are moved with respect to the head 21, they will successively communicate with the individual openings 30, and that during one revolution of the block or cylinder bank with respect to the head, each of the nine cylinders will successively communicate with each of the eight pairs of discharge and inlet ports. As shown, especially in Fig. 4, the intake passage may extend at a tangent to the unit, this being also illustrated in Fig. 2, it being understood that a similar extension or passage lies immediately to the rear of the same and communicates with the intake passage 23, as shown in Fig. 1.

Disposed intermediate the cylinder blocks 10 and 11 is a wobble plate structure. In the embodiment under consideration the angularity of this structure is fixed. Accordingly, this mechanism may include an eccentric bushing 31 fixed to shaft 13 and mounting anti-friction bearings 32 of the thrust type which, in turn, are enclosed by a ring member 33. The latter, as shown especially in Fig. 5, has nine extensions 34 including, in each instance, opposed and outwardly projecting socket portions. Extending across the latter are wrist pins 35 having opposed trunnions 36 projecting perpendicular to their axes. These trunnions swingingly mount the inner ends of connecting rods 37, the outer ends of which are coupled to wrist pins 38, secured under conditions of universal movement to pistons 39. These pistons are disposed one in each of the bores of cylinder blocks 10 and 11, and it will thus be obvious as shaft 13 rotates, ring member 33 will be oscillated to reciprocate the pistons 39 through the universal structure provided at 35-36. Ring member 33 is furnished with a further projection 40 which functions as a reaction member. To this end it may include a pair of forks 41 slidably straddling a rod 42, extending between blocks 10 and 11. Between the pairs of forks 41 this rod may slidably mount a bearing block 43.

As a consequence, it is obvious that while the wobble plate is free to oscillate as the shaft 13 rotates, its functioning portion (ring 33) will not rotate with respect to the cylinder blocks. Accordingly, the projections 34 will remain at all times aligned with respect to the cylinders and excepting only the small amount of arcuate movement which will occur incident to rotation of shaft 13.

In the embodiment under consideration, the valve structure is stationary and the cylinder block moves with respect thereto. In order to drive this block, shaft 13, which is suitably coupled to a power source (not shown), mounts a gear 44. The teeth of this gear mesh with a gear 45, in turn meshing with gear 46, the teeth of which engage a final gear 47. The latter gear is fixed to a shaft 48 having rotatable bearing—as for example by anti-friction units 49—in the heads of the pump. Secured to this shaft are gears 50, the teeth of which mesh with an annular series of teeth, preferably formed in bands 51, suitably secured to blocks 10 and 11.

The parts are so proportioned that to each nine revolutions of shaft 13, the cylinder block moves one complete revolution as afore noted. During such single revolution, each cylinder will have successively registered with eight inlet ports and eight discharge ports. Consequently, for each revolution of shaft 13, the cylinder blocks will have advanced one-ninth of a revolution (i. e., 40°). Incident to such advance, a given piston will not be in precisely the same position as existed at the beginning of the revolutions of shaft 13. Rather it will be necessary for that shaft to advance 45° for such piston position to be re-established. In other words, a vernier action is set up, and in this manner it is entirely feasible to utilize, for example, eight pairs of ports with nine cylinders, so that the relative speed of the valve mechanism and cylinder units may be diminished to a great extent.

Before concluding consideration of the form of apparatus primarily illustrated in Figs. 1 to 5 inclusive, it is to be understood that while certain of the units have been shown as including a single portion, they may actually—for convenience of manufacture and/or assembly—be formed of a number of elements. Thus, referring to Fig. 10, it will be observed that the rods generally indicated by the numeral 37 may actually embrace similar portions 52 coupled to each other as, for example, by bolt and nut structure 53, and providing, in aggregate, at one end of a fork 55 for association with trunnions 36, and at their opposite ends presenting a suitable opening to accommodate the wrist pin 38 of a given cylinder.

Additionally, it will be understood that in the operation of a unit such as that shown in these figures, at least an initial and adequate seal will be established by springs 20 between the high pressure or discharge passage and the cylinders which at that moment are in various stages of their exhaust strokes. After pressure has once been built up, it is obvious that by providing for a proper ratio of reaction surfaces, the unit may operate so that the greater the pressure the more effective the seal. In other words, considering the specific structure illustrated, the ports in the ring 26 are of smaller area than the cylinders. Consequently as the pistons move outwardly, fluid reacting against the inner faces of the plates will tend to force the blocks outwardly or, in other words, maintain the sealing contact between the adjacent surfaces of the blocks and valve structures. This effect may be enhanced, diminished, or nullified, according to the relative areas of the surfaces, and the springs or any equivalent structure may be depended upon to provide for initial or complete operative sealing.

Under certain circumstances it is found desirable to provide for a cushioning effect such that surges, hammering, and other detrimental factors will not come into being. One method of overcoming this difficulty may be found in employing one or more units including, for example, a cylinder 56 within which a piston 57 is movably mounted in a casing 58 enclosing an outward extension of the piston. This extension may have a flange 59 against which the inner end of a spring 60 reacts, the outer end of such spring bearing against a plug assembly 61. Interposed between the inner face of flange 59 and the outer end of cylinder 56 is a spring 62. The value of this spring may be fractional to the value of spring 60. It accordingly follows that with cylinder 56 connected to high pressure passage 24, by means, for example, of a branch 63, any surge

or sudden compounding of pressure will force piston 57 outwardly against the resistance of spring 60. This spring should preferably be of the constant pressure type, although of course its resistance will vary throughout its range of compression. As the pressure drops, spring 60 will force piston 57 inwardly and the latter will be cushioned by spring 62, so that hammering will not occur. For the sake of efficiency, the high pressure passages of both block-valve assemblies 10 may be connected by a branch 64 and a second unit similar to 56 to 62 inclusive may be furnished as shown in Fig. 1, thus assuring equalization throughout these passages.

Now, referring to the structure shown in Figs. 6 to 8, inclusive, it will be observed that in this embodiment the cylinder block is stationary, while the valve mechanism moves. Thus, the numeral 65 indicates a block which is stationary and which, as shown in Fig. 7, is formed with five cylinders 66. Within each of these a piston 66' reciprocates and to this end is coupled to a connecting rod 67. The latter ends of the rods are coupled in any suitable and desired manner to a wobble plate 68. This plate may be mounted for rocking movement upon a pin 69 and it is oscillated by any convenient operating mechanism such as link 70, collar 71, and fork 72, forming a part of crank 73.

The specific structure of the wobble-plate may include a gimbal ring 69' supporting a member 68, mounted upon a hub 68' by means of anti-friction bearings; the pin 69 being directly coupled to the hub. The driving shaft for pin 69 is mounted in anti-friction bearings 75.

While the valve mechanism may move in direct contact with the block, it is preferred to interpose between these elements a bearing plate 76 which has ports corresponding in number and, if desired, in area to the cylinders. These ports, of course, are aligned with the cylinder bores. The valve body 77, as illustrated, bears against the plate 76 and is enclosed within a housing 78. This valve, as shown especially in Fig. 8, is formed with four pairs of ports. The intake ports may be in the form of a cross-shaped passage 79 and the exhaust ports may be in the form of openings 80. It is to be observed that ports 80 are, as indicated in Figs. 6 and 8, entirely segregated from the branches 78 and that the latter communicate with bores 81 which may be formed in both plate 76 and block 65 while the passages defining openings 80 communicate with the space to the rear of valve body 77. This space may be in communication with a passage 82 while space or bore 81 communicates with the passage 83, leading to a suitable source of fluid supply.

Body 77 may have secured to it a shaft 84 encircled by suitable packing 85 and retained by a bushing 86. A spring 87 may be furnished to normally urge body 77 into sealing contact with plate 76. Thus, an initial condition of sealing is provided for and it will be observed, as shown in Fig. 6, that the face of body 77 which is exposed to the high pressure passage is of such area that the body will be forced into sealing contact with plate 76 and in proportion to the pressures which are built up. The counter-action incident to the fluid expressed from cylinder 66 and acting against the inner face of body 77 will, of course, be negligible, due to the relatively small area which is available to such a reaction. Also, the suction strokes of pistons 66' will contribute to the sealing effect.

Secured to shaft 84 is a gear 88 which drives 75

a gear 89 by means of an interposed idler 90. Gear 89 may be secured to shaft 91, in turn mounting a gear 92, the teeth of which mesh with the gear 93 secured to shaft 74. While the size of the individual gears may be as desired, the ratio of drive of shaft 74 with respect to shaft 84 should be 4:1. This is in view of the fact that five cylinders and four pairs of ports are provided. Also, it is preferred that as shown the ratio between gears 92-93 be 2:1 and that a similar ratio exist between gears 89 and 88.

Thus, in this form of construction the cylinder block is stationary, contrary to the embodiment illustrated in Figs. 1 to 5 inclusive, and again a vernier action takes place, it being observed that to each revolution of shaft 74 shaft 84 rotates 90°. In other words, such a movement of the valve body occurs to each complete operating cycle of one cylinder and it is to be borne in mind that while shafts 74 and 84 rotate in opposite directions, it is the relative movement of these shafts which govern this action, so that with five cylinders each pair of ports will have been successively presented to each cylinder while shaft 84 has rotated once and shaft 74 has rotated five times.

The factor to be borne in mind is that with the block rotating the piston-driving shaft moves in a direction similar to that of the block. Also, conceding that one less number of pairs of ports is employed, this shaft will rotate as many times as there are cylinders, while the valve shaft is performing one complete revolution. In the case of a stationary block, the piston-driving shaft will rotate as many times as there are pairs of ports in the valve unit, while one exhaust and one inlet port traverse the bank or block of cylinders. In other words, conceding that nine cylinders and eight pairs of ports are employed and with the block rotating, nine revolutions of the piston driving shaft will be necessary to secure one complete revolution of the valve body with respect to the cylinder block. With the same construction, but with the cylinder block stationary, the piston driving shaft will rotate eight times, while the valve body completes one revolution with respect to the cylinder block or bank and in a direction opposite to that in which such shaft rotates.

In certain instances, it may be desirable to provide one pair of ports in excess of the number of cylinders utilized. As a general statement, this will decrease the efficiency of the unit because of higher relative speeds which must necessarily occur between the block and the valve body. Nevertheless—and as afore mentioned—in certain types of installations the advantages derived by employing one more pair of ports than cylinders may outweigh the disadvantages resulting from this construction. It is to be borne in mind, however, that under these circumstances and still considering nine cylinders, but ten pairs of ports, the cylinder block will, if movable, rotate in a direction opposite to the direction of rotation of the wobble plate or the shaft supporting the same. Such speed of rotation will, under the circumstances afore named, be one-ninth of the wobble plate or shaft speed.

With the cylinder block stationary, and again conceding that nine cylinders and ten pairs of ports are employed, the valve rotates in the same direction as the wobble plate or shaft associated therewith. Such rotation of the valve is at a speed equal to one-tenth the speed of the wobble plate or shaft associated therewith.

Of course, if different numbers of cylinders and/or ports are employed, the same conditions will govern. These may be summarized as follows:

(a) With the cylinder rotating and valve stationary, and there being one more pair of ports than cylinders, the speed of the cylinder block equals

$$\left(\frac{1}{\text{Number of cylinders}} \right) \times \text{wobble plate speed} \quad 10$$

The direction of movement of the cylinder block will be opposite to the direction of rotation of the wobble plate.

(b) With the cylinder block stationary and the valve rotating, and again having one more pair of ports than the number of cylinders, the speed of movement of the valve will be equal to

$$\left(\frac{1}{\text{Number of cylinders} + 1} \right) \times \text{wobble plate speed} \quad 20$$

The direction of valve movement will be the same as that of the wobble plate.

(c) Where one less pair of ports than cylinders is employed, and with the cylinder block rotating and the valve stationary, the speed of the cylinder block will equal

$$\left(\frac{1}{\text{Number of cylinders}} \right) \times \text{wobble plate speed}$$

The direction of the cylinder block will be the same as that of the wobble plate.

(d) Again, with one less pair of ports than cylinders, and with the cylinder block stationary and the valve rotating, the speed of the valve will equal

$$\left(\frac{1}{\text{Number of cylinders} - 1} \right) \times \text{wobble plate speed}$$

The direction of valve movement will be opposite to that of the wobble plate.

A construction schematically illustrating the use of one more pair of ports than cylinders is shown in Fig. 9, in which it will be seen that there has been specifically shown a stationary block to which a plate 94 is secured. This plate, in the same manner as shown in Fig. 3, has ports 95 aligned one with each of the cylinders 96. Overlying plate 94 is a plate 97 formed with pairs of exhausts and intake ports 98. Ten pairs of such ports are provided. These, of course, communicate with a valve mechanism which may correspond in all respects to the structures especially shown in Figs. 1 and 4. The shaft 99 in Fig. 9 corresponds, of course, to the shaft 13, and the shaft 100 corresponds to shaft 48, the desired ratio of drive, as afore indicated, being conveniently provided by gearing or other suitable mechanism connecting these shafts and the valve driving shaft.

In this form of mechanism the valve, of course, rotates in the same direction as the wobble plate or shaft 99 and at a speed equal to one-tenth the speed of the wobble plate and shaft. This is, of course, conceding that a direct connection exists between the wobble plate and shaft without any reduction gearing, such construction being contemplated throughout the several forms illustrated.

In this final form of construction, it is again apparent that the desired vernier action is present and that it is feasible to construct a pump embodying this particular design and still have such small relative movement between the valve and the block that friction losses will be reduced well below practical limits. It has been found

as a consequence of such design, that a very even and desirable flow of fluid occurs and that pressures may, without difficulty, be built up which are adequate for, substantially, all commercial needs.

Attention is finally directed to Figs. 11 and 12 in which there has been illustrated forms of gimbals which may, in some instances, be employed in preference to the somewhat simplified form of mountings shown generally in Figs. 1 and 6. Referring primarily to Fig. 12, the same reference numerals have been utilized to identify parts which are more or less identical with those heretofore described. It will, however, be noted that the plate 101, corresponding to plate 33, has its diameter reduced, or else the distance between diametrically opposite rods 102 (corresponding to rods 42) has been increased. In any event, interposed between body 101 and rods 102 are a pair of concentrically disposed rings 103 and 104. The innermost of these rings is connected by an anti-friction bearing 105 and a hub or stub shaft 106 to plate or body 101. At points spaced ninety degrees from this point of connection, this ring is connected by a similar structure indicated at 107 to ring 104. The latter, in planes similar to the structures 105—106, is connected by means of anti-friction bearings 108 with stub shafts 109 fixed one to each of rods 102 and at diametrically opposite points in such series of rods. For the sake of simplicity of illustration, no showing has been made of a structure such as indicated at 17 to 20, it being obvious that the same may be employed, if necessary.

Similarly, in the construction indicated in Fig. 11, which has particular application to an apparatus of the type especially shown in Figs. 6, 7 and 8, it will be observed that a gimbal structure is provided by either reducing the diameter of wobble-plate 68 or increasing the space within the surrounding casing 110 so that bearings do not extend directly from the plate into the encircling casing or equivalent mounting structure. Thus, the numeral 111 identifies a plate corresponding to plate 68 of Fig. 6. Extending from this plate at diametrically opposite points are stub shafts or hubs 112, supported in anti-friction bearings 113. The latter are mounted by a ring 114 encircling and spaced from plate 111. At points spaced ninety degrees from the structure indicated at 112 and 113 are hubs 115, which may form parts of ring 114. These hubs or stub shafts are supported in anti-friction bearings 116, in turn supported by a ring 117 spaced from and concentrically disposed with respect to ring 114. This latter ring, at points ninety degrees spaced from the structure of 115—116, has stub shafts or hubs 118 resting in anti-friction bearings 119, mounted by the encircling casing or equivalent supporting structure 110. Plate 111 is, of course,

mounted for oscillation with respect to the driving member, as, for example, by employing a pin 114' which mounts the inner element 111' of an anti-friction bearing 112', the outer member of such bearing forming a part of, or being mounted by plate 111.

Of course, in connection with either of the structures illustrated in Figs. 11 and 12, it will be understood that any number of functionally equivalent or substitute mechanisms might be employed. The point of primary importance is that a gimbal or similar form of support is furnished which, while not allowing of improper movements of the parts, freely permits any correct movement without any tendency towards binding or distortion.

Obviously, numerous changes in construction and re-arrangement of the parts might be resorted to without departing from the spirit of the invention as defined by the claims.

Having thus described the invention, what is claimed as new and desired to be protected by Letters Patent is:

1. A pump including two annular series of cylinders disposed in opposed relationship, a shaft extending centrally of both cylinder series, a wobble plate secured to said shaft, pistons connected to said plate and disposed one within each of said cylinders, valve mechanisms including pairs of inlet and outlet ports disposed in cooperative association with said cylinders, means connected to said shaft for effecting relative rotation of said valve mechanisms and cylinders, means responsive to the pressure developed within said cylinders for varying the sealing contact of said cylinders with respect to said valve mechanisms and means coupling opposed cylinders to each other and including resilient means for forcing said cylinders in opposite directions and into sealing contact with said valve mechanisms.

2. A pump including two annular series of cylinders disposed in opposed relationship, a shaft extending centrally of both cylinder series, a wobble plate secured to said shaft, pistons connected to said plate and disposed one within each of said cylinders, valve mechanisms including pairs of inlet and outlet ports disposed in cooperative association with said cylinders, means connected to said shaft for effecting relative rotation of said valve mechanisms and cylinders, means responsive to the pressure developed within said cylinders for varying the sealing contact of said cylinders with respect to said valve mechanisms, rods extending between said different series of cylinders and springs associated with said rods and acting against the inner ends of said cylinders to force the opposite cylinder ends into sealing contact with the valve mechanisms associated therewith.

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