June 5, 1934. W. C. MULLER 1,961,592

VARIABLE CAPACITY PUMP OR MOTOR

Filed Jan. 18, 1929 4 Sheets-Sheet 1

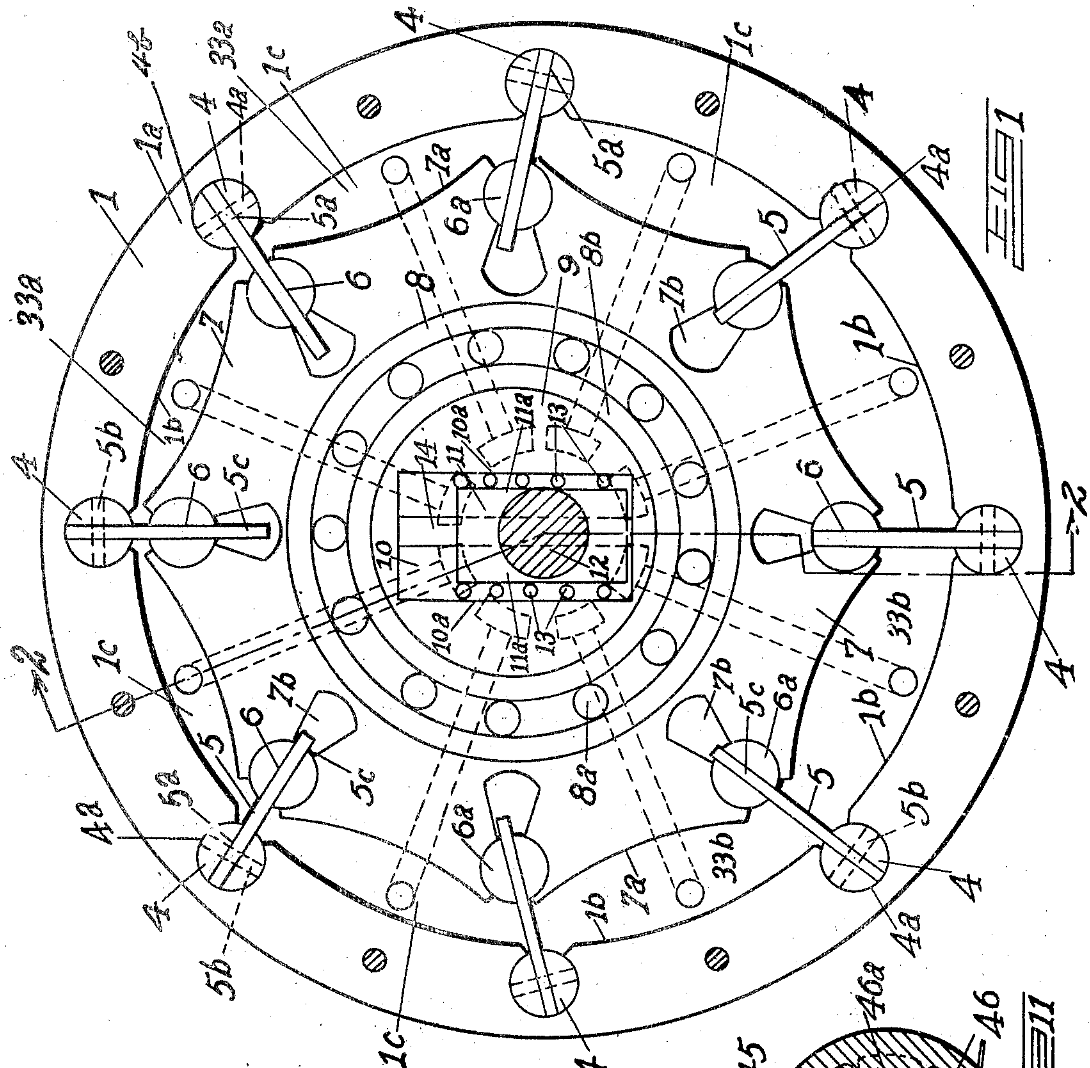

Fig. 1

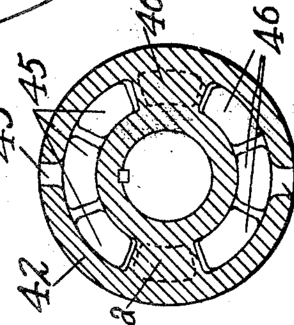

Fig. 11

INVENTOR.
Wolfgang Carl Muller

BY

Allen & Allen
ATTORNEYS.

June 5, 1934.

W. C. MULLER

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4 Sheets-Sheet 2

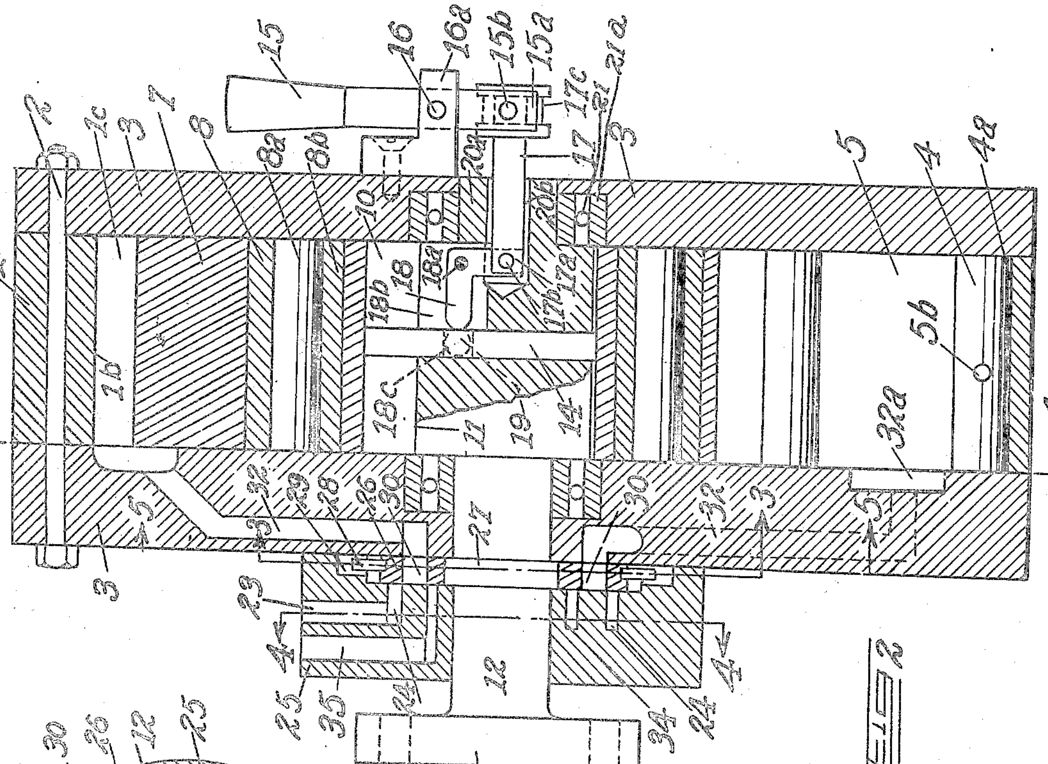

FIG. 2

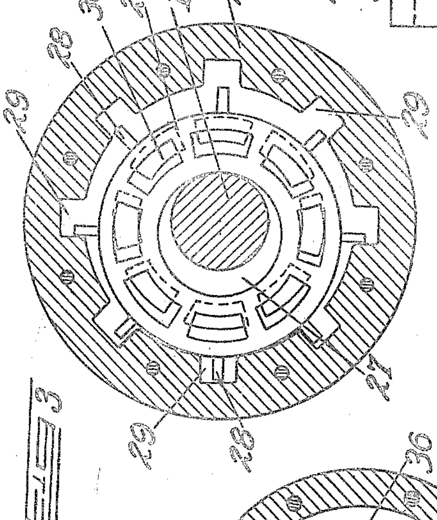

FIG. 3

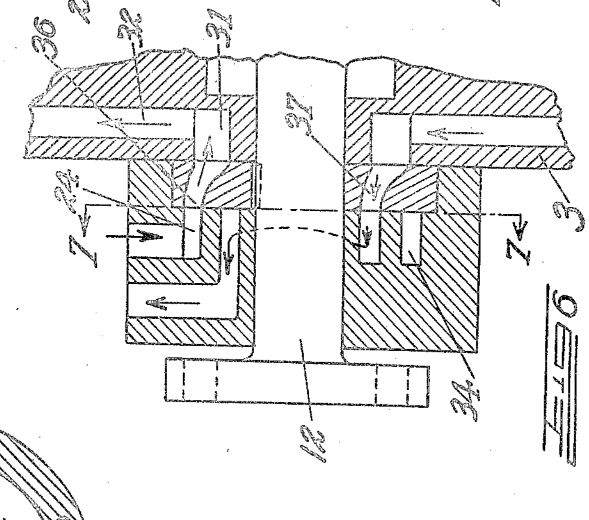

FIG. 6

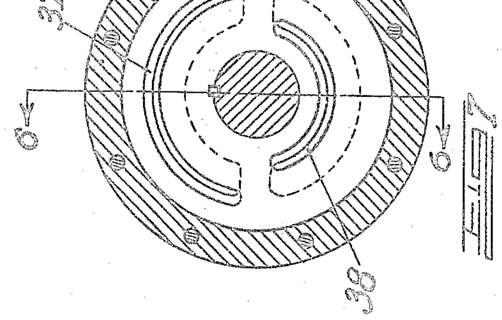

FIG. 7

INVENTOR.
Wolfgang Carl Muller

BY

Allen & Allen
ATTORNEYS

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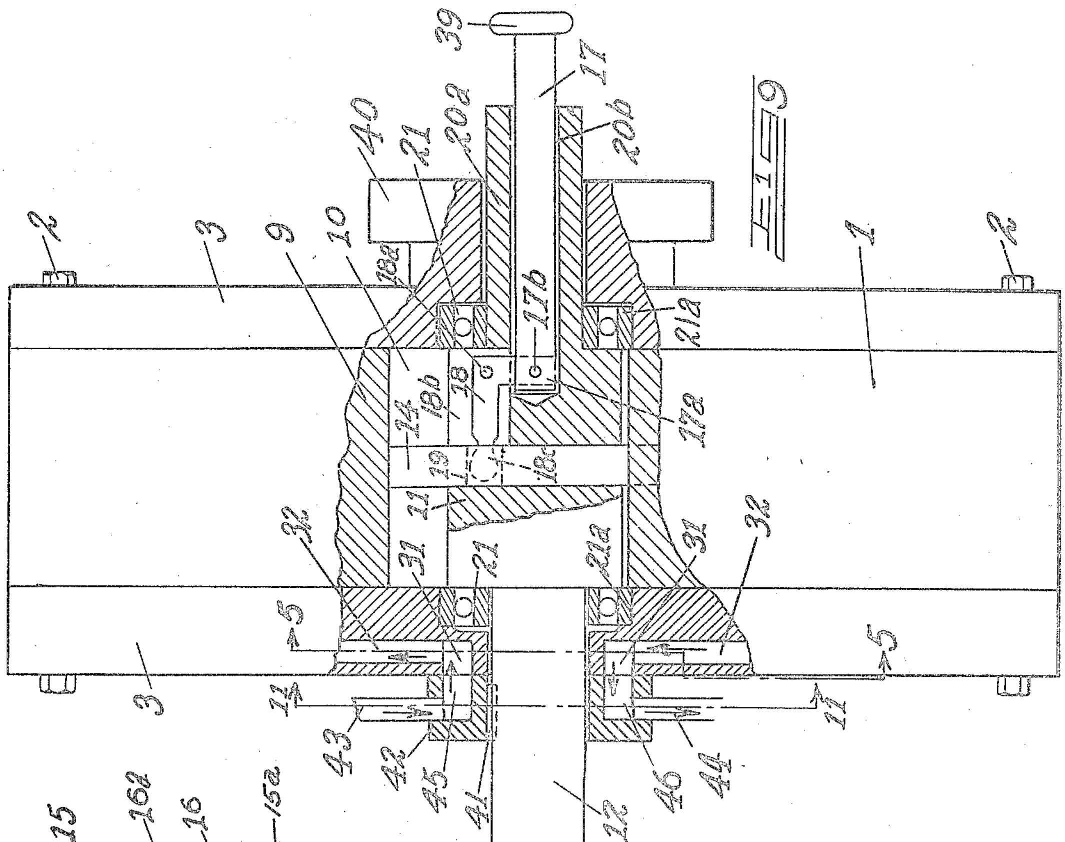

FIG. 9

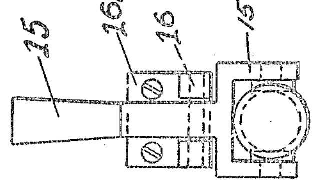

FIG. 10

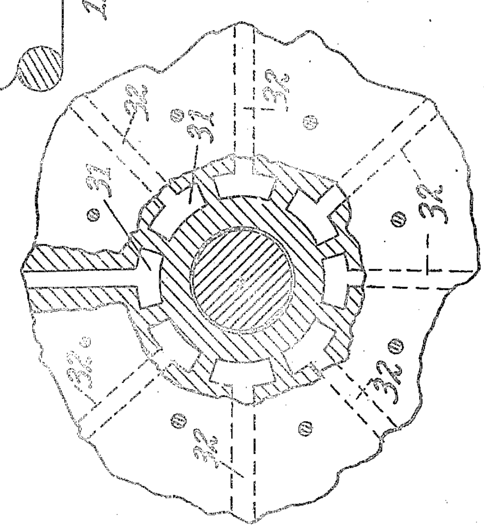

FIG. 5

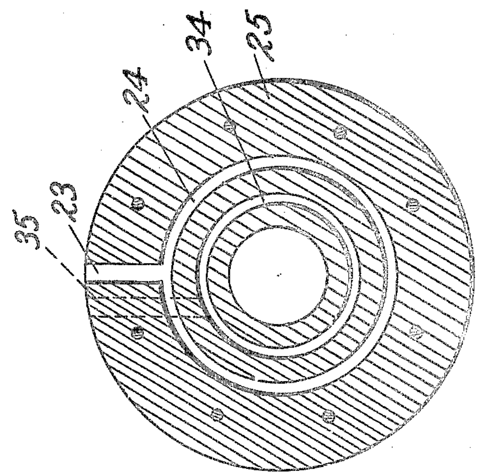

FIG. 4

INVENTOR.
Wolfgang C. Muller
BY
Allen & Allen
ATTORNEYS

VARIABLE CAPACITY PUMP OR MOTOR

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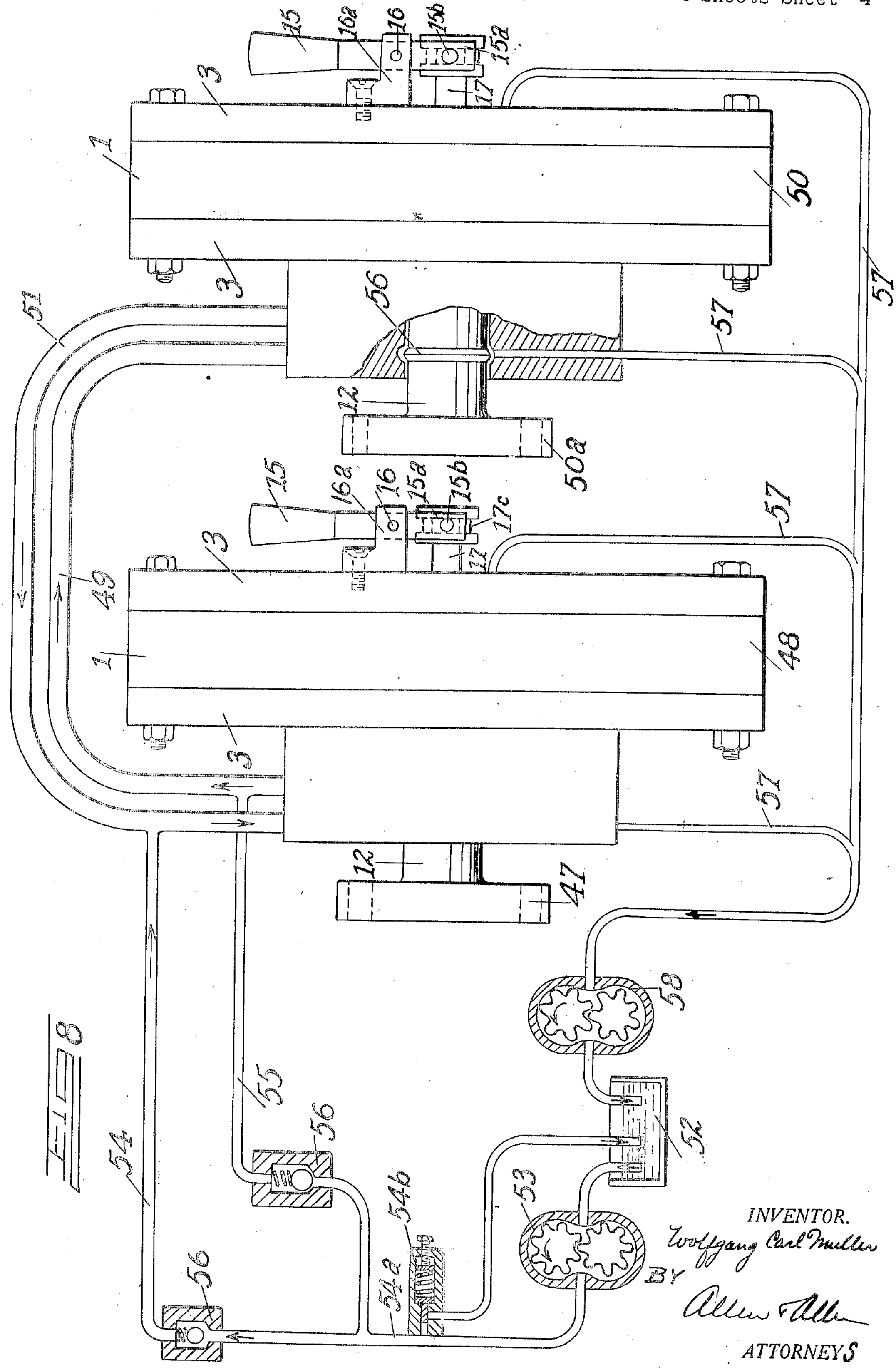

INVENTOR.
Wolfgang Carl Muller
BY
Allen & Allen
ATTORNEYS

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UNITED STATES PATENT OFFICE

1,961,592

VARIABLE CAPACITY PUMP OR MOTOR

Wolfgang Carl Muller, Cincinnati, Ohio

Application January 18, 1929, Serial No. 333,452

3 Claims. (Cl. 103—120)

My invention relates to hydraulic machines that can be used as pumps or motors in which means are provided to vary the delivery of fluids when the machine is used as a pump or vary the speed of the machine when it is used as a motor.

It is an object of my invention to provide a hydraulic machine that can readily be used as a motor or pump without modification of the structural elements.

Another object is to provide a pump or motor power transmission unit in which the friction between working parts has been decreased to a minimum thereby insuring longer life to the mechanism.

Broadly it is the object of my invention to provide a hydraulic machine which can be used either as a pump or motor, with regulating means to control the volume of fluids delivered when used as a pump and the same means to control the speed of the machine when it is used as a motor.

These and other objects will be more specifically pointed out in the specifications and drawings forming part of this specification, in which I have illustrated a preferred embodiment of my invention, variations of which will readily occur to those skilled in the art.

In the drawings:—

Figure 1 is a section on the line 1—1 of Figure 2 and shows the internal structure of my unit.

Figure 2 is a section taken on the line 2—2 of Figure 1 showing liquid passages and adjusting lever.

Figure 3 is a section taken on the line 3—3 of Figure 2 showing the distributor ring.

Figure 4 is a section on the line 4—4 of Figure 2 showing inlet and outlet channels.

Figure 5 is a section on the line 5—5 of Figure 9 showing radial channels to compression chambers.

Figure 6 is a section on the line 6—6 of Figure 7 showing an alternate distributor ring.

Figure 7 is a section on the line 7—7 of Figure 6.

Figure 8 is a diagrammatic view showing my hydraulic units arranged to form a transmission system.

Figure 9 is a side elevation of a modification of my unit when shaft is stationary and housing is rotated, with part in section.

Figure 10 is a front elevation of my shifting lever for varying the speed of transmission or volume of delivered fluid, as shown in Figure 2.

Figure 11 is a sectional view along the lines 11—11 of Fig. 9.

I have shown a main circular casing 1 to which is fastened, by means of bolts 2, side plates 3 to form a housing. Around the body 1*a* of the casing, I have located segments 4 which are free to rotate in pockets 4*b*. These segments do not make a complete revolution but oscillate a certain number of degrees with every revolution of the shaft.

Blades or baffles 5 are secured in the openings 5*a* between the segments 4 by means of pins 5*b*. The blades 5 extend from the segments 4 to other segments 6*a* which are rotatably mounted in a blade ring 7 and their ends 5*c* are slidably mounted in the spaces 6 between the segments 6*a*. The blades extending between the segments control the movement of the blade ring and prevent the inner blade ring from rotating about its axis but permitting it to move bodily in a circular path. While the blades 5 and the segments 4 act as an integral unit, it is preferable to form them as separate parts which are thereafter secured together, since this facilitates accurate formation of the segments 4 to cylindrical contour so that they may accurately fit the pockets 4*b*.

Referring to Figure 1, it will be seen that the particular blade ring illustrated is octagonal in shape and each of the sides 7*a* is concave. I do not, however, wish to limit myself to this particular number of sides. The concave sides 7*a*, together with the inner circumference 1*b* of the main casing and the blades, form compression and expansion pockets 1*c* for the fluids passing through the pump or motor depending on the use to which the mechanism is put. In order to provide clearance for the reciprocating and oscillatory motion of the blades, I have provided pockets 7*b* in the blade ring. As has been mentioned, the blade ring does not rotate but only oscillates, moving bodily in a circular path. An outer race 8 of a roller bearing 8*a* is rigidly mounted in the blade ring and moves with it.

An inner race 8*b* is rigidly mounted on an adjustable eccentric bushing 9. The amount of eccentricity of this bushing determines the diameter of the circular path through which the blade ring moves and the volume of fluid which passes through the unit on each revolution of the shaft, and in order to vary this eccentricity, I have provided a rectangular slot 10 in the eccentric bushing in which is mounted a rectangular block 11 fixed to the shaft 12. The eccentric bushing is slidably mounted with relation to the rectangular block and shaft, having rollers 13 which are mounted between the walls 10*a* of a rectangular opening in the bushing and the sides of the block

11a. The position of the eccentric bushing is controlled by means of a pin 14 extending across the greatest length of the rectangular opening in the eccentric bushing. This pin is slidably mounted in the rectangular block 11 and the shaft 12 and thus provides means for moving the eccentric bushing to vary the extent of motion of the blade ring.

To move the eccentric bushing with relation to the shaft, there is shown a lever 15 fulcrumed on a pin 16 in a bracket 16a which is mounted on the plate 3. This lever has a bifurcated end 15a for connecting it to a sliding rod 17 extending through opening 20b in the shaft and an opening in the rectangular block. In the bifurcated end 15a are pins 15b which engage in a groove 17c on an enlarged end of the sliding rod for moving it to the right or left so that the rod is left free to rotate with the rectangular block and shaft. On the inner end 17a of the rod 17 a bell crank 18 is pivotally mounted by means of the pin 17b. This bell crank 18 is fulcrumed on a pin 18a in a slot 18b in the rectangular block, and has a rounded end 18c engaging in a slide 19 in the pin 14. When the bell crank is rocked on its fulcrum the rounded end will move the pin and bushing to change the eccentricity of the bushing to a value corresponding to a desired speed or volume to be obtained. The movement of the bushing 9 results in a variation in the distance between the center of the shaft and the center of the bushing, and hence causes a variation of the amplitude of movement of the blade ring. By moving the bushing 9 across zero eccentricity the direction of rotation will be changed, if the unit is used as a motor. The same manipulation applied on the unit when used as a pump will reverse the direction of the flow of liquid.

The shaft 12 is rotatively mounted on ball bearings 21 fixed in the side plates at 21a. On its left end is shown fixedly mounted a coupling 22 for driving the shaft. I do not necessarily require a coupling, as a gear, pulley, or any other means for transmitting power to or from the shaft may be used. When the hydraulic mechanism is used as a motor the shaft may be used for driving a given machine. When the mechanism is used as a pump this shaft will be driven by a prime mover.

My unit is novel in the respect that it will function in two ways; that is, the shaft can be rotated or held stationary. When the shaft is held stationary I provide driving means for rotating the housing when the unit is used as a pump, and means for utilizing the rotation of the housing for driving other mechanism when the unit is used as a motor and I obtain the reverse results of a condition in which the shaft is rotated.

In Figures 2, 3 and 4 I have illustrated a preferred valve system which controls the flow of fluids to and from the pump or motor. When the unit is used as a pump fluids are drawn into the hole 23 and pass to an annular groove 24 within a hub 25 fixed to the main housing. A distributor ring 26 is oscillated by an eccentric 27 mounted on the shaft 12. Secured in the periphery of the distributor ring are pins 28 which are free to slide in pockets 29 in the hub 25. These pins prevent the distributor ring from rotating with the shaft and limit it in an eccentric bodily motion.

The fluid on leaving the annular groove passes through elongated curved slots or ports 30 in the distributor ring. These curved slots, as indicated in Figure 5, communicate with similarly arranged slots 31 in the side plates 3. The slots 31 register with channels 32 which lead to the compression chambers 1c.

The distributor ring and plate have the same number of slots and their movement is timed to properly control the passage of fluid to and from the mechanism. While the distributor ring is oscillating its slots will periodically provide passages for the flow of liquid through the circular inlet groove in the hub 25 and through the curved slots in the plate 3. From these slots the fluid is drawn into the compression chamber through the channels 32 in the plate 3 by the suction caused by the motion of the blade ring enlarging the volume of these chambers.

Referring to Figure 1 and considering the operative cycle when the shaft rotates in a clockwise direction, the chambers 33a are in position to begin taking in fluid when the chambers 33b have reached the stage of complete expansion and are ready to expel the fluid through the passages 32a in the compression chambers and back through the channels 32. The channels 32 alternate as intake and discharge passages. At any one time during the cycle of operation each of the chambers will be in part or complete expansion or compression position.

From the channels 32 the fluids pass through the curved slots 30 in the distributor ring through another annular groove 34 which forms an outlet concentric with the inlet groove 24 and out through the discharge opening 35 in the hub 25. The distributor ring is timed with the movement of the blade ring so that its slots will periodically connect the channels 32 with the inlet and outlet grooves 24 and 34 respectively, in the hub 25 in the proper relation, and as shown is 90° ahead of the blade ring in its direction of rotation.

When the unit is used as a motor the fluids will be forced into the inlet 23 instead of being drawn in as is the case when the mechanism is employed as a pump. When the machine is used as a motor each chamber will alternately receive and discharge fluid and cause the blade ring to oscillate bodily thereby rotating the shaft 12 which can then drive a machine.

In order to change the direction of rotation of the shaft I change my inlet and outlet connections so that liquid passes into the unit through opening 35 and out through 23.

Figures 6 and 7 show an alternative valve system for controlling the flow of fluids. In this case I provide a disc 36 which is keyed to the shaft 12 and rotates with it. In this disc there are two semi-circular slots 37 and 38. As the disc rotates the slots 37 and 38 will alternately align themselves with the inlet and outlet grooves 24 and 34 in the hub 25 and form open passages to the slots 31 and channels 32 in the plate 3 and permit the fluid to be directed properly during the cycle of operation. In Figure 6 I have indicated by arrows the direction of flow of the liquid for one particular alignment of the valve. This same condition is repeated for each compression chamber while the shaft is rotating.

If I wish to keep the shaft stationary it can be accomplished by the arrangement of parts shown in Figure 9. In this instance I provide the sliding rod with a button 39, in place of a lever, to vary the movement of the blade ring. A gear 40 is rigidly fastened to the housing and rotates it or is rotated by it, depending on whether the unit is operating as a pump or as a motor. On the shaft 12 is mounted, by means of a key 41, another type of valve plate 42 which is shown in detail in Figure 11. In this valve plate there is an inlet opening 43 and outlet opening 40 for the fluid. The fluid enters through the port 43 and passes into the pockets 45 which are identical with the pockets 31 shown in Figure 5. The space forming the pockets 45 constitutes a single compartment which registers with the openings 31 during the intake cycle. During the outlet cycle the pockets 46 form a compartment which registers with the openings 31. The flow of the fluid from two separate compression chambers in this case is shown by arrows on Figure 9. The section 46*a* (Figure 11) is a dividing wall between the pockets 45 and 46 and prevents the fluid from flowing directly from one to the other.

In Figure 8 I have shown a transmission system in which the housings are stationary and the shafts are driven. The flange or pulley 47 of the pump 48 is driven from any suitable source of power. Liquid is forced from the pump through the pipe 49 into the motor 50 and rotates the flange or gear 50*a* which can then drive a machine or perform other suitable work. The fluid passing through the unit returns to the pump through the pipe 51. This action of the fluid is a repeated continuous cycle.

In order to compensate for leakage of fluid in the system, I have provided an auxiliary storage tank 52 for retaining a certain amount of fluid. This tank can be open or closed, depending upon the fluid used. By means of a gear pump 53 fluid from the storage tank is forced through the pipes 54 and 55 into the pipes 49 and 51. I have provided ball check valves 56 to prevent the fluid being forced back by the units 48 and 50 into the storage tank.

In the pipe line 54*a* there is an adjustable back pressure valve 54*b* that operates automatically to relieve the system of any excess pressure that may develop.

Around the shaft 12 of each unit I provide a ring and groove 56 to catch all leaking fluid along the shaft and prevent its loss by pumping it back to the storage tank, through the pipes 57 by another gear pump 58.

When the bushing has been adjusted to a certain eccentricity the machine is started by rotating the shaft 12 of the pump. Rotating the shaft causes the blade ring to expand and contract the chambers 1c. During the expansion, while the blade ring is moving away from the inner circumference of the main casing, fluids will enter from the inlet port through the slots and channels and fill the chambers 1c. On reaching the limit of expansion the ring will start compressing the fluid and force it back through the channels and through slots of the distributor ring which will then be in line with the outlet groove and allow the fluid to escape through the outlet orifice. This fluid under pressure passes to the motor unit where it alternately fills and escapes from the chambers therein, causing the motor shaft to rotate. By adjusting the relative eccentricities of the bushings of the pump and motor units, the relative speeds of rotation of their shafts may be adjusted.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. A machine of the class described comprising a cylindrical casing, a shaft journaled axially in said casing, a rectangular block fixed centrally to said shaft within said casing, a disk having a diametrical transverse slot for receiving said block, means actuable while the machine is in operation for adjusting said disk along said slot to vary the eccentricity of said disk relative to said shaft, a member having an opening in which said disk is rotatably journaled, said member extending from end to end within said casing, and means connecting said member with the outer wall of said casing for preventing rotation of said member with said shaft and dividing the space between said member and outer casing walls into a plurality of expansible and contractible chambers.

2. A machine of the class described comprising a casing, a shaft journaled in said casing, a rectangular block fixed centrally to said shaft within said casing, a disk having a diametrical transverse slot for receiving said block, a bar extending through said block and bearing at opposite ends against the ends of said disk slot, a bell crank lever fulcrumed on said block and having one end engaging said bar, a member rotatable with said shaft and movable axially thereof engaging the other end of said lever for adjusting said bar lengthwise relative to said block and thereby the eccentricity of said disk relative to said shaft, a member within which said disk is journaled, and means including said member and casing defining variable capacity chambers alternately expanding and contracting by the rotation of said disk and to an extent determined by its eccentricity relative to said shaft.

3. A machine of the class described, comprising a casing having an outer cylindrical wall and a pair of spaced parallel end walls, a shaft journaled centrally in said end walls and extending therefrom at one end, a ring slidable between said end walls, vanes connecting said ring with said cylindrical wall and defining with said casing walls and ring a plurality of expansible and contractible chambers, an eccentric journaled in said ring, means connecting said eccentric to said shaft for adjustment of the eccentricity of said eccentric, means on the extended end of said shaft for transmitting torque through said shaft, movable means outside of said casing, and operative connections between said movable means and said eccentricity adjusting means extending into said casing and shaft from the end of said shaft opposite to said shaft extension.

WOLFGANG CARL MULLER.