Dec. 11, 1945. M. P. HOLMES 2,390,590

HYDRAULIC DEVICE

Filed Feb. 18, 1944 2 Sheets-Sheet 1

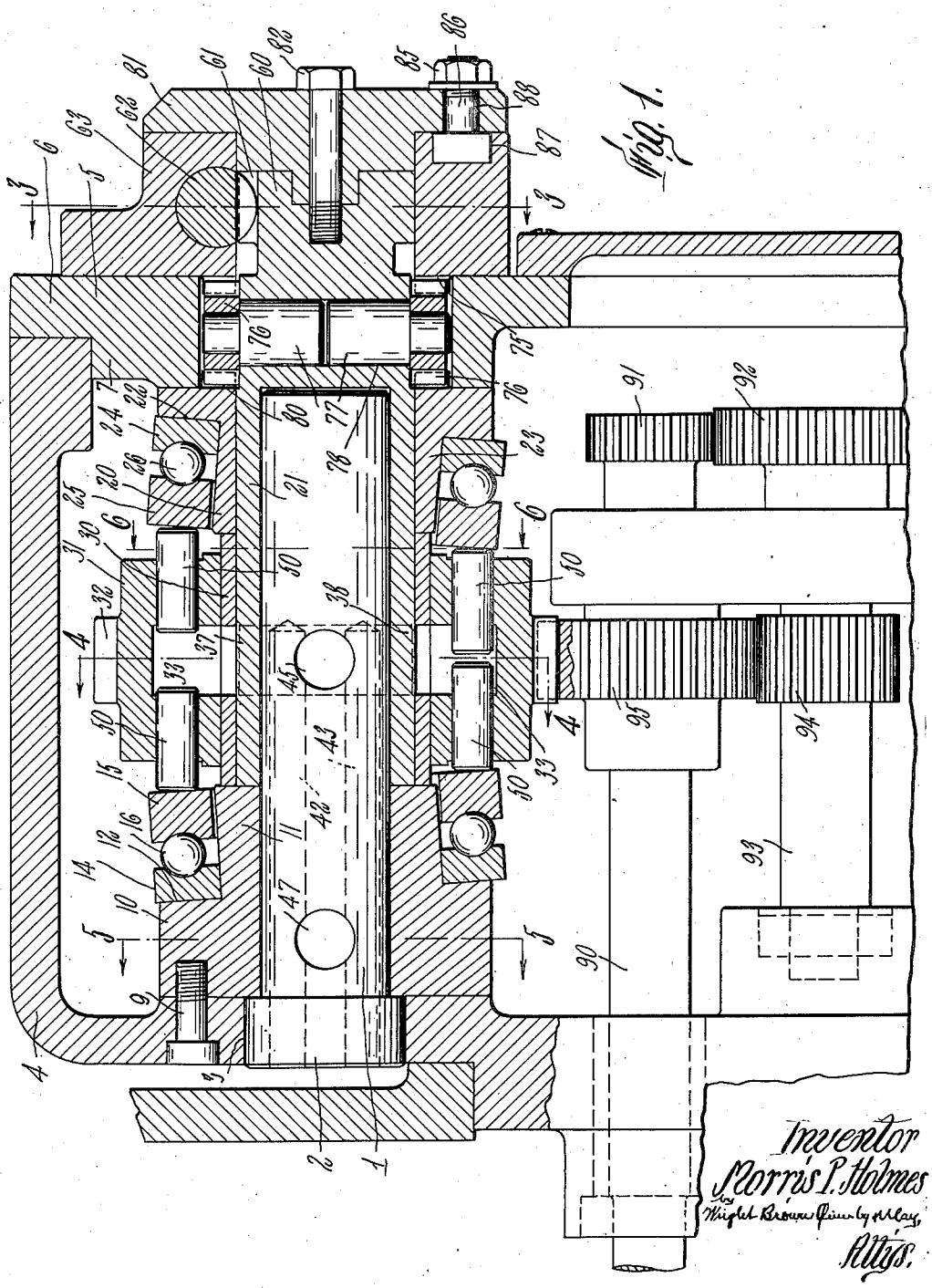


Fig. 1.

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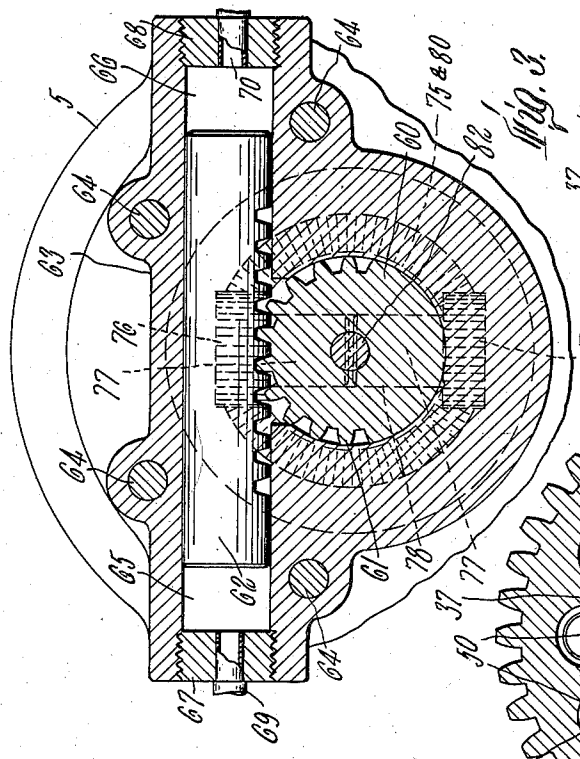


Fig. 3.

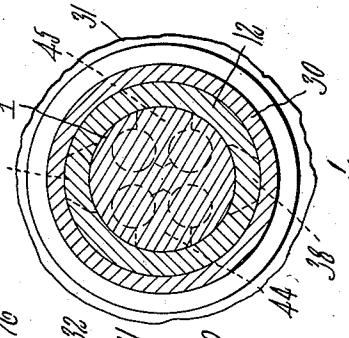


Fig. 6.

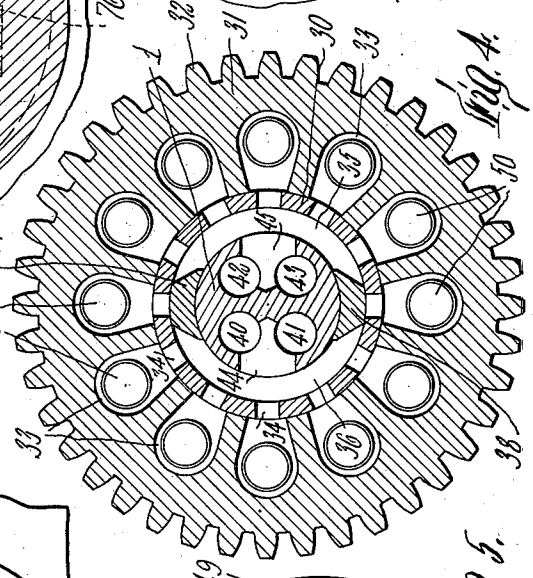


Fig. 4.

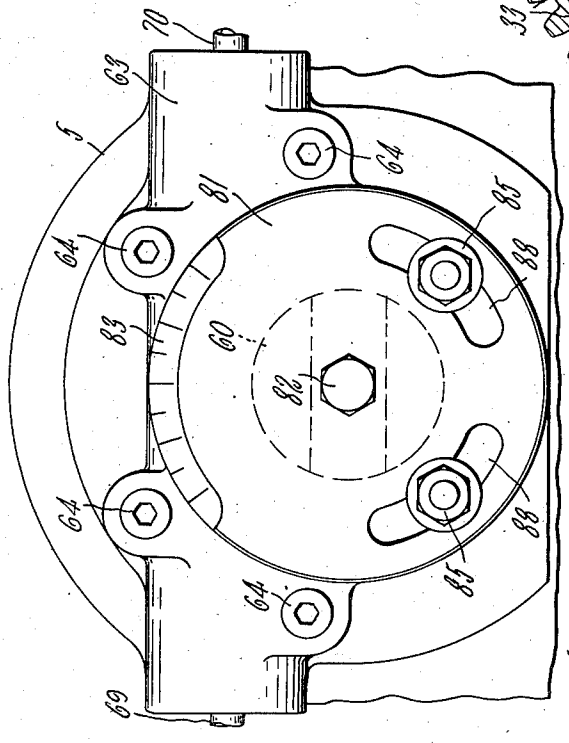


Fig. 2.

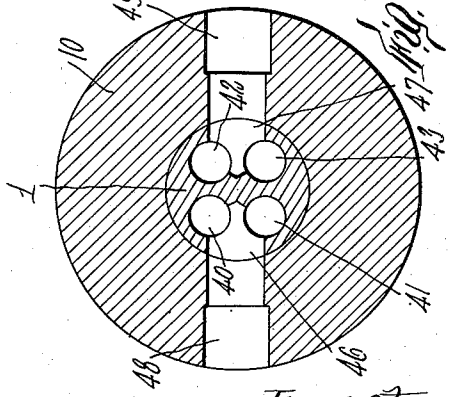


Fig. 5.

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UNITED STATES PATENT OFFICE

2,390,590

HYDRAULIC DEVICE

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Application February 18, 1944, Serial No. 522,889

2 Claims. (Cl. 121—62)

This invention relates to hydraulic devices of the type which include a plurality of variable capacity chambers rotating between sloping cam surfaces operatively related to the chambers for alternately and successively causing or allowing the chambers to expand and contract, fluid being directed to the expanding chambers and discharged from the contracting chambers. While the invention is applicable to hydraulic devices, whether used as meters, motors, or pumps, it is illustrated herein as applied to a metering device having a plurality of plungers carried by a cage in opposed circular series about its axis, and serving by their axial motions to vary the capacity of chambers into which each pair of opposed plungers extends, the cage being rotated between a pair of opposed cam surfaces inclined to the perpendicular to the axis, one of the cam surface elements being angularly adjustable about such axis with respect to the other so as to vary the metering capacity of the device. Valve means are employed to separate the expanding chambers from those which are contracting, and fluid connections are made to the chambers on opposite sides of the valve. It will be evident that when the inclinations of the cam faces are exactly opposite to each other, the greatest possible amount of expansion and contraction of the meter chambers occurs so that the metering capacity is at the maximum during the rotation of the cage, while when the inclinations of the cams are in the same direction the metering capacity is at its minimum and if these inclinations are equal, and the plungers are of the same diameter, no flow will be allowed since as one plunger is moving in, the opposed plunger in the same chamber is moving out at the same rate.

In order to obtain a uniform rate of flow variation as the one cam face is turned, it is found necessary to turn the valve one-half as much in the same direction, the points at which the chambers change between expanding and contracting moving at this rate away from the maximum capacity position in line with the directions of slope of the chambers, and one object of the present invention is to provide means whereby the valve is moved one-half the extent of angular adjustment between the two cams.

Further objects and advantages will appear from a more complete description of an embodiment of the invention shown in the accompanying drawings in which

Figure 1 is a central longitudinal sectional view through a meter embodying the invention and its immediate drive mechanism, the meter being adjusted for maximum metering capacity.

Figure 2 is a fragmentary right end elevation of the same.

Figures 3 to 6 are detail sectional views on correspondingly numbered section lines of Figure 1.

Referring to the drawings, at 1 is indicated a supporting shaft having a head 2 which is seated in an opening 3 in a casing member 4. This casing member is shown as open at one end, but may be closed off by a plate 5 having a marginal flange 6 engageable with the open end of the member 4, and an extension 7 which fits within a portion of this open end. Upon the shaft 1 adjacent to the head 2 there is fixed, as by screws 9, an abutment 10 which has a central hub portion 11 extending from a shoulder face 12 inclined to the perpendicular to the axis of the shaft 1. As shown the exterior of the hub 11 is arranged at right angles to the cam face 12 and furnishes a seat for a thrust ball bearing comprising an outer raceway 14 seated against the inclined face 12, a raceway 15 which is free to rotate about the hub 11 and the balls 16 which engage between the raceways 14 and 15. The inner raceway 15 is therefore free to rotate in a plane angularly disposed to the perpendicular to the axis of the shaft 1.

There is a somewhat similar abutment 20 positioned adjacent to the opposite end of the shaft 1, but this abutment instead of being stationary, is journaled for angular adjustment on a valve sleeve 21, which, in turn, is journaled upon the shaft 1. The abutment 20 has an inclined end face 22 which is shown as of the same inclination as the face 12 of the abutment 10, and also a hub 23 perpendicular to the face 22. These parts carry a second thrust ball bearing, the outer raceway 24 of which is seated against the abutment face 22 and the hub 23 and the inner raceway 25 of which may rotate, and has interposed between it and the outer raceway 24 the balls 26.

Between the abutments 10 and 20 the valve sleeve 21 has journaled thereon a second sleeve 30, which, in turn, carries a cage member 31 provided on its outer face with a gear portion 32. The cage 31 is provided with a plurality of chambers 33 arranged in circular series about the axis of the shaft 1, each communicating through a port 34 through the sleeve 30 with one or the other of a pair of arcuate slots 35 and 36 arranged in diametrically disposed relation through the valve sleeve 21, these slots 35 and 36 being spaced by a pair of diametrically opposed vanes 37 and 38. The shaft 1 is shown as provided

with four longitudinally arranged passages arranged in pairs at 40, 41 and 42, 43, and in axial alinement with the ports 34 of the sleeve 30, these sets of passages 40, 41 and 42, 43 open out through the opposite side faces of the shaft 1 through the holes 44 and 45. Toward the head 2 of this shaft these passages open up through similar ports 46 and 47 which also mate passages 48 and 49 extending out through the abutment 10 at diametrically opposite sides. From these passages 48 and 49 may extend pipe connections (not shown), one leading from a motor cylinder (not shown) and the other leading to a supply tank from which fluid may be circulated by a pump (not shown) in a fluid pressure system, the rate of flow through which is to be regulated by the metering device.

Each of the chambers 33 of the cage 31 has extending through fitting openings in its opposite end walls, a pair of opposed plungers 50, the outer ends of which ride against the adjacent faces of the ball bearing raceways 15 or 25, (Figure 1). These plungers 50 are movable axially and by this motion more or less change the effective volumes of the chambers 33. Thus, as shown in Figure 1, the plungers 50 at the top of the figure project very little into the corresponding chamber so that the volume thereof is at a maximum, while at the lower portion of the cage 31, the plungers 50 extend well into the chamber and make its effective volume much less. The amount of projection of the plungers into the various chambers is controlled by the positions of the inner faces of the raceways 15 and 25, respectively, pressure of fluid within the chambers acting to force the plungers outwardly as far as is permitted by these raceways. The slopes of the faces 12 and 22 of the cam members determine the relative movements of these plungers as the cage is rotated, the thrust ball bearings being interposed in order to reduce friction, the inner raceways 15 and 25 being permitted by these ball bearings to rotate with the cage 31.

When the slopes of the faces 12 and 22 are in opposite directions, as shown in Figure 1, it is evident that the maximum relative motions of the opposed pairs of plungers 50 occur. Should one of these faces be turned relative to the other so that they both slope in the same direction and by equal amounts, rotation of the cage 31 would cause no change in effective volumes of the chambers 33 since the amount by which one set of plungers is moved in and out would be directly compensated for by an equal and opposite movement of the plungers of the other set. From this it will be evident that changing the angular relation from the slopes being opposed to the slopes being in the same direction will result in a corresponding variation in change of capacity of the chambers during rotation of the cage. This change of capacity represents the volume of fluid which is permitted to pass through the meter device at each revolution. Consequently it governs the rate of flow of fluid in the fluid pressure system, it being noted that the liquid passes into one of the passages 35 or 36 and discharges through the other, the vanes 37 and 38 of the valve separating the chambers into two sets, the chambers of one set expanding while the chambers of the other set are contracting as the cage rotates.

It is found that in order to provide for a constant rate of capacity variation, as one cam abutment is turned relatively to the other, it is necessary that the valve element 21 be turned by half of the amount of the turning of the one cam plate, this being necessary in order that all of the chambers opening into one side of the valve between the vanes 37 and 38 be contracting while all the other chambers on the opposite side of these vanes are expanding, and in accordance with this invention means are provided by which this relative angular adjustment is produced. To this end, the valve sleeve 21 is extended at one end as at 60 and is there provided with a segmental gear portion 61. With this portion meshes a circular rack 62 which is slidably mounted in a casing ring 63 secured to the end casing member 5 of the meter as by means of screws 64. This circular rack bar 62 forms a plunger which is slidable within a hydraulic cylinder formed by the casing 63 and having end chambers 65 and 66 normally closed off by threaded plugs 67 and 68 through which pass pipe connections 69 and 70. By introducing fluid under pressure through one of these pipe connections 69 or 70 and discharging fluid from the other, the axial position of the plunger or rack bar 62 may be varied, thus to rock the valve sleeve 21. As a relative movement of the cam members 10 and 20 through 180° is sufficient to adjust the capacity of the meter from zero to maximum and the angular adjustment of the valve need be only one-half that amount or 90°, the gear segment 61 may be correspondingly limited in extent. Angular adjustment of the valve sleeve is caused to impart double this amount of motion in the same direction to the cam element 20. As shown this is accomplished by a geared connection therebetween. The frame member 63 is shown as provided with an integral crown gear portion 75 with which meshes a pair of pinions 76 which are journaled on plugs 77 seated in a diametrical hole 78 through the extension 60 of the valve sleeve, and these pinions 76 also mesh with a crown gear portion 80 cut in the outer end of the cam member 20. Thus as the valve sleeve is turned, the pinions 76 riding around the fixed crown gear 75 are rotated and these pinions 76 impart rotation of double the amount of rotation of the extension 60 to the cam 20. A cap 81 is shown as secured to the outer face of the valve sleeve by a central securing screw 82, this cap member 81 being preferably provided with graduations 83 which are moved around by the adjustment of the valve sleeve, thus to indicate the angular position of adjustment of this sleeve and hence the extent of flow capacity to which the metering device is adjusted. The valve may be fixed in adjusted position as by the tightening of nuts 85 on bolts 86, the heads of which are seated in sockets 87 in the frame member 63 and the shanks of which ride in arcuate slots 88 in the cap member 81.

The cage member is arranged to be rotated at the desired speed so as to permit the fluid to pass through the fluid pressure system at the rate desired in accordance with the adjustment of the capacity of the device. As shown this rotation is effected by rotation of a shaft 90 having one of a pair of change gears 91 fixed thereto which meshes with a second change gear 92 carried by a counter shaft 93. This counter shaft has fixed thereto a gear 94 which meshes with a gear 95 on a sleeve journaled on the drive shaft 90, and which, in turn, meshes with the teeth 32 of the cage. By the use of the change gears 91 and 92, the metering capacity for any given rate of rotation of the shaft 90 may be further adjusted by varying the speed of rotation of the shaft 90.

From the foregoing description of an embodi-

ment of this invention, it should be evident that various changes and modifications might be made without departing from the spirit or scope of this invention.

I claim:

1. A fluid device, comprising a stationary shaft, an angularly adjustable valve member journaled on said shaft and having a pair of diametrically oppositely disposed vanes, a cage journaled on said valve member concentric with said shaft, said cage having a plurality of chambers arranged about its axis and having ports for cooperation with said vanes, said shaft having a pair of longitudinally disposed passages opening laterally between said vanes, a pair of plungers movable parallel to said axis through end walls of said chambers, a pair of abutments one having a face in position to be operatively engaged by the outer ends of the plungers at one of said end walls and the other having a face in position to be operatively engaged by the outer ends of the plungers at the other of said end walls, each of said faces being inclined to the perpendicular to said axis, means for angularly adjusting one of said abutments about said axis relative to the other abutment to adjust the relative angular relation of their inclined faces, means for delivering fluid to one of said shaft passages and discharging fluid from the other of said passages, and means actuated by said adjusting means for turning said valve member one-half the angular distance as the relative angular adjustment of said abutment plates.

2. A fluid device, comprising a rockable valve having a pair of diametrically oppositely disposed valve vanes, a cage having an axial opening within which said valve is journaled, said cage being provided with a plurality of chambers in circular array about the axis of said opening, each communicating with said axial opening, a pair of alined plungers movable parallel to said axis through fitting openings in opposite walls of each chamber, a shaft coaxial with said valve and having a pair of longitudinally arranged passages opening on opposite sides of said valve between said vanes, a pair of abutments, one at each end of said cage, one of said abutments being fixed and the other journaled for angular adjustment on said valve, said abutments having faces inclined to the perpendicular to said axis and against which the outer ends of said plungers may operatively engage, opposed ring face gears through which said valve extends, one of said gears being fixed and the other carried by said journaled abutment, pinions carried by said valve and journaled on substantially radial axes and meshing with said gears, whereby when said valve is angularly adjusted said adjustable abutment is turned through twice the angle of valve adjustment, and means actuable to adjust said valve angularly.

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