UNIDIRECTIONAL, ROTARY VARIABLE DELIVERY FLUID PUMP

Fig. 1.

Fig. 9.

Fig. 10.

Lawrence M. Garner
Edward S. McConnohie

Inventors

By

Attorneys
UNIDIRECTIONAL, ROTARY VARIABLE DELIVERY FLUID PUMP

Lawrence M. Garner and Edward S. McConnoble, Covert, Mich.

Application September 25, 1947, Serial No. 778,120

5 Claims. (Cl. 103—120)

1 This invention comprises novel and useful improvements in a hydraulic transmission and more specifically pertains to a uni-directional rotary pump of variable capacity and reversible flow. The invention relates generally to that type of hydraulic transmission mechanism incorporating therein a fluid motor, or pump, constituting the driving means of the transmission or coupling and a driven motor which is connected to the driving motor or pump by suitable conduits whereby a subject of fluid is delivered under the pressure imparted thereto by the driving pump to the driven motor and returned then to the driving pump. In such transmissions, it has heretofore been well known to vary the speed ratios of the pump and motor by varying the capacity of the former or the latter. This invention is particularly adapted for use in such a system and it is contemplated that a constant capacity motor, from which power may be employed and taken off in various known methods and ways, shall be actuated at different speed ratios from a driving pump whose capacity may be varied and whose direction of fluid flow may be reversed, by the novel and improved mechanism set forth in this application.

Although the improved variable capacity pump forming the subject of this invention is primarily intended for use in a hydraulic transmission of the character above set forth, it will be readily understood that it is also possessed of utility and is adapted for use in various other fields and environments by reason of its being reversible as to its delivery of fluid and variable in its capacity of fluid delivery, all during a constant speed of rotation in one direction; or alternatively at varying speeds, as desired.

It is a primary purpose of this invention to provide an improved means for varying the capacity of a rotary pump while maintaining the speed of rotation of said pump constant and uni-directional.

It is an important purpose of this invention to provide a mechanism in accordance with the preceding object wherein the delivery of the pump may be varied from zero to a maximum for either direction of fluid delivery therefrom.

It is a still further object of this invention to provide a mechanism in accordance with the foregoing objects wherein a novel and improved mechanism is provided for accurately and effectively adjusting the capacity of a pump conforming to the above mentioned object, and which shall be attended by a minimum of wear of the various parts of the apparatus.

2 These, together with various ancillary objects of the invention which will later become apparent as the following description proceeds, are attained by this devise, a preferred embodiment of which has been illustrated by way of example only in the accompanying drawings, wherein:

Figure 1 is a perspective view of the pump casing;

Figure 2 is a fragmentary perspective view of a portion of the operating mechanism of the pump, parts being broken away and shown in sections to illustrate certain features of construction;

Figure 3 is a vertical longitudinal section taken through the pump's stator and rotor;

Figure 4 is a horizontal longitudinal sectional view, taken substantially upon the section line 4—4 of Figure 3;

Figure 5 is a transverse vertical sectional view taken substantially upon the section line 5—5 of Figure 3;

Figure 6 is a vertical longitudinal sectional view taken substantially upon the section line 6—6 of Figure 4;

Figure 7 is a fragmentary detailed view upon an enlarged scale taken substantially upon the section line 7—7 of Figure 6;

Figure 8 is a perspective view of one of the rotor blades of the invention;

Figure 9 is a lower plan view of one of the stator head members of the invention;

Figure 10 is a fragmentary detailed view taken substantially upon the section line 10—10 of Figure 9;

Figure 11 is a perspective view of an element forming a part of the invention;

Figure 12 is a perspective view of a further form of rotor blade constituting the preferred construction thereof in accordance with this invention;

Figure 13 is a vertical longitudinal sectional elevation through the invention showing the construction of the stator head; and

Figure 14 is a vertical transverse sectional view taken substantially upon the section line 14—14 of Figure 13.

Referring now more specifically to the annexed drawings wherein like numerals designate similar parts throughout the various views, 10 refers generally to the reversible and variable delivery pump forming the subject of this invention.

The pump casing includes side plates 12 and 14 clamping therebetween a pair of identical upper and lower head and manifold members 16 by means of cap screws 18 engaging bores 20 in the
head members 16, see Figure 10, or by means of other suitable fastening means. If desired, through bolts might be employed to secure the above mentioned components into a rigid assembly. The interior of the casing or stator is provided with an annular chamber or recess 32, Figure 8, to receive the rotor assembly.

Upon the side of plate 12 is an outwardly disposed boss 24 provided with an outwardly opening chamber or cavity 26, see Figures 4 and 5, which has a cover plate 23 removably secured by screws. Generally rectangular end plates 32 complete the stator casing, being detachably fastened as by screws 34 (Figures 1, 3, 4 and 5), to the head members 16 and side plates 12 and 14 by means of bosses 36 (Figure 13).

The head members 16 are shaped to form fluid inlet and discharge conduits 38 and 40, the fluid flow therethrough being reversible, as set forth hereinafter. As shown best in Figures 3, 4 and 13, the upper and lower heads 16 are spaced from each other, and with the side plates 12 and 14, define a pair of oppositely and horizontally disposed guide chambers 52 within which are elastically journaled a pair of slides 44 of generally rectangular shape, having their outer ends adapted to abut the adjacent surfaces of end plates 52 while their inner ends 48 are arcuately shaped for a purpose which will presently appear. Adjacent their arcuate surfaces 46, the slides 44 are provided on opposite sides with lateral arcuate ribs 48. As will be apparent, the slides 44 may move horizontally between the central casing 22 and the end plates 32.

The side plates 12 and 14 are provided with aligned bores 59 through which extends a rotary power shaft 52 upon which is rigidly secured, as by keys 84, an annular drum or rotor 56 (Figures 3 and 4) consisting of a hub 55, an annular web 57 and a laterally enlarged annular rim 59, upon which are formed circumferentially spaced, laterally extending, radial notches 58 which slidingly receive U-shaped rotor blades 62, shown in Figures 3, 4 and 12. Each blade is provided with a rounded inner and outer edges 52 and 64 respectively, the former being notched at 66 to form bifurcated leg members 68, which extend radially of and in radial slots in the sides of the annular rim 59 and embrace the flange 51 of the rotor 56. The depth of notches 58 and 66 is such that the outer end 44 of the blades may be selectively recessed within the periphery of the rotor and extended into sliding and fluid tight sealing engagement with the inner periphery of the pump chamber in a manner to be now set forth.

Loosely received in the casing chamber 22 are a pair of outer eccentric rings 70 disposed on opposite sides of the above mentioned slides 44 and medially disposed ribs 71 as shown in Figures 9, 10 and 14, on the inner surface of heads 16. The outer circumferences of these rings 70 are toothed as at 72 while the inner diameter is circular but eccentrically disposed relative to their outer peripheries. Rotatably journaled in the outer eccentric rings are a pair of inner eccentric rings 74 whose inner circumference is eccentric with respect to its outer periphery. The inner rings are provided with annular grooves 76, on their adjacent surfaces, which are concentric with their inner circumference and slidingly receive the above mentioned ribs or shoulders 48. At diametrically opposite points the outer side surfaces of the rings 76 are provided with laterally extending cylindrical bosses or stub shafts 78, shown in Figures 2, 8 and 7.

The stub shafts 78 are rotatably journaled by means of eccentric bores 80, Figure 11, in the circular discs 82 which latter are revolvably journaled in bores 84 in the annular disc 86 rotatably received on opposite sides of rotor hub and rim 55 and 59 and outer and inner eccentrics 70 and 74. These discs 86 are provided with circumferential teeth 88 of the same pitch and matching with the teeth 72 of the outer eccentrics.

It can thus be seen by particular reference to Figure 4 that the annular discs 86 support the inner eccentrics 74 which, in turn, carry the outer eccentrics 70, upon the shaft 52. Further, the inner surfaces of discs 86, define with the inner circumferences of eccentric rings 74, the inner surfaces of slides 44 and the inner surfaces of ribs 11, a cylindrical pump chamber 90. The arrangement is such that when the gear teeth 72 and 88 are rotated in opposite directions, by a means to be later set forth, the outer circumferences of the outer eccentric rings 70 rotate concentrically with the shaft 52, while the inner circumferences of the outer eccentric rings, and the outer circumferences of the inner eccentric rings, rotatably journaled therein, rotate eccentrically with respect to the main shaft 52 whereby the inner circumferences of the inner eccentrics are moved with a straight line motion in the horizontal plane of the axis of shaft 52, thereby moving the chamber 90 enclosing the rotor 56, to vary the eccentricity of the axis of the rotor in said chamber between the limiting positions defined in Figure 6 by the vertical planes a—a and b—b. The vertical plane c—c represents a neutral position, at which point the axis of chamber 90 coincides with the axis of shaft 52 whereby the rotor is centered in said chamber.

To attain the foregoing straight line shifting of the axis of pump chamber 90, the eccentricities of the inner diameters of the inner and outer eccentrics are equal; while the eccentricity of the bore 80 of disc 82 is equal thereto. Thus, rotation of disc 86 by their gear teeth 88, and opposite rotations of the outer eccentric rings 70 by their teeth 72 cause rotation by means of discs 82 and shafts 78 of the inner eccentric rings. This horizontal movement of the inner eccentrics 74 and chamber 90 is accomplished and guided by horizontal displacement of the guiding slides 44 in their guide ways 42 through the inter-engaging ribs and grooves 48 and 76.

For an understanding of the means for adjusting the pump chamber attention is now directed to Figures 2, 4 and 6. A central shaft 92 is journaled as at 94 in the chamber 28 of the boss 24, and provided with a worm gear 96, meshing with oppositely disposed gears 98 and 100 carried by shafts 102 and 104 journaled in the plate 12 and opposite plate 14. The shafts 102 and 104 extend into transverse bores 105 in the head members, see Figures 13 and 5, and are provided with pairs of identical gears 108 and 110 respectively spaced to constantly mesh with the teeth 88 and 72 of the outer discs 86 and outer eccentrics 70 respectively. Consequently, the shaft 92 is rotated by any suitable means, not shown, the gears 109 and 110 are rotated at the same speeds in opposite directions thereby producing the horizontal straight line shifting of the pump chamber components, as above mentioned.

Obviously, any desired position of adjustment between the limiting positions a—a and b—b may be attained. The effects of this adjustment are to vary the capacity and delivery of the pump in the following manner.
Referring to Figures 3 and 6, the pump chamber is at its extreme left hand position, whereby the right side of the rotor has zero clearance with the surface 46 and adjacent inner surfaces of rings 14, whereby no flow of fluid can occur directly between passages 38 and 46. Simultaneously, maximum clearance is provided between the left side of the rotor and the adjacent surfaces of chamber 90. Consequently as the rotor moves counterclockwise, fluid is carried around the chamber 90 by the blades 60 from the inlet 38 and discharged at the outlet 40. Obviously, as the chamber 90 is moved towards the right, the volume of fluid in the rotor is reduced while an increased volume is provided on the right which provides a return from the delivery side (or pressure) 40 back to the inlet (or suction) side 38, thereby reducing the effective capacity and delivery of the rotary pump to the passage 40.

When the chamber has reached the position c-c of Figure 6, it will be evident fluid escaping will be equal to fluid carried around by the blades 60 and the delivery or pressure of the pump through the conduit 40 will be zero.

As the chamber 90 is shifted beyond the neutral position c-c and towards the limiting position b-b, the volume at the right will exceed that at the left, whereby the rotor, will carry more fluid from 40 to 38 than is delivered around the chamber 90 from 38 to 40 resulting in a reverse flow at the passages 40 becoming the suction or inlet side and 38 becoming the pressure or outlet side.

Obviously, for a given speed of rotation of the rotor, the delivery of the pump may be reversed and varied from zero to a maximum for either direction of pump rotation.

It will be observed that the blades establish a fluid tight sealing engagement at their outer curved edges 64 with the inner circumference of the cylindrical pump chamber 90, bearing against the full width of the chamber upon the inner eccentrics 74, and alternatively upon surfaces 46 of slides 44; while the sides 68 of the blades abut the inner surfaces of disks 86. The annular outer surfaces of ring 99 complete the cylindrical pump chamber.

In order to ensure that the outer edges 64 of blades 60 will at all times contact the periphery of chamber 90, a pair of rings 112 which may be serrated on one side to relieve any internal restraining pressure, are loosely positioned on each side of the flange or web 57 between the hub 85 and rim 99 of the rotor. Since the pump chamber 90 is cylindrical, the rings are of sufficient diameter to engage the inner edges 62 of the bifurcated legs 68 of the blades and maintain their outer edges 64 in substantial engagement with the chamber 90. Thus, during turning of the rotor, as the blades on one side move inwardly of the rotor, due to the eccentricity of rotor and chamber, those on the opposite side are moved outwardly by the rings 112. This feature is of value chiefly in starting the pump, in order that all vanes or blades may be in engagement with the chamber wall, since centrifugal force may be relied upon to insure this contact during operation.

Although the form of blade 60 having rounded edges 62 and 64, shown in Figure 12, is regarded as the preferred form, in some instances the modified blade forms of Figure 8 may be found desirable, this form of blade 114, having beveled outer edges 118 and with its inner edges curved upon a radius whose focus point is the apex of the bevel of the outer edge.

Since numerous modifications will readily occur to those skilled in this art, after a consideration of the accompanying description and drawings, it is not desired to limit the invention to the exact construction shown and described, but all suitable modifications and equivalents may be resorted to, falling within the scope of the appended claims.

What is claimed is new, as follows:

1. A uni-directional, rotary variable delivery fluid pump comprising: a stator; a shaft journaled in said stator, a rotor on said shaft, said rotor being provided with a plurality of radially slidable vanes adapted for impelling a fluid; a rotor housing defining a pump chamber around said rotor and movable with respect to said stator for varying the capacity of said pump, said rotor housing including a pair of disks concentric with and rotatable with respect to said shaft and disposed on opposite sides of said rotor, and a pair of axially spaced inner rings encircling said rotor and having their inner and outer circumferences eccentric with respect to each other; said stator having a pair of aligned guide chambers therein communicating with said pump chamber between said rings on diametrically opposite sides of said rotor; said rotor, said rotor being in diametrically opposite sides of said rotor; said rotor sliding together with said rings, extending the full width of said pump chamber; inter-connecting means between said slides and said inner rings, said means permitting circumferential movement of said inner rings with respect to said slides and preventing radial movement of said inner rings with respect to said slides; means eccentrically journaling said inner rings on said disks and means for selectively rotating said disks and thereby moving said inner rings in a straight line direction parallel with the central axis of said guide chambers; means providing a first fluid passage communicating between the outside and inside of said stator on one side of said guide chambers axis, and means providing another fluid passage communicating between the outside and inside of said stator on the opposite side of said guide chambers axis, movement of said chamber in one direction causing fluid to flow through the chamber and passage in one direction and movement of said chamber in the opposite direction reversing said flow of fluid.

2. The device defined in claim 1 including also: outer rings journaled on each of said inner rings, the inner and outer circumferences of said outer rings being eccentrically disposed with respect to each other, the degree of eccentricity thereof being equal to the eccentricity of the journaling of said inner rings on said disks and said respective eccentricities being oppositely disposed with respect to each other so that rotation of said disks and said outer rings in directions opposite to each other will effect said straight line movement of said inner rings in a direction parallel with said guide chambers axis and thereby effect movement of said slides along said axis.

3. Means defined in claim 2 wherein the means for selectively rotating said disks comprises: a drive shaft disposed radially of said disks and journaled on said stator; first and second driven shafts journaled on said stator; driving connection between said drive shafts and each of said driven shafts; a first inter-connecting means between said first driven shaft and said disks for rotating the disks in one direction upon rotation.
of the drive shaft; and a second inter-connecting means between the second driven shaft and the outer rings for rotating the outer rings in a direction opposite to the directional rotation of said disks upon rotation of said drive shaft.

4. Device defined in claim 2 wherein the means for selectively rotating said disks comprises: a drive shaft disposed radially of said disks and journaled on said stator; first and second driven shafts journaled on said stator; a driving connection between said drive shaft and each of said driven shafts; said disks having circumferentially spaced teeth on their outer peripheries; a first pair of gears mounted on said first driven shaft engaging the teeth on said disks for rotating the disks in one direction upon rotation of said drive shaft; said outer rings having circumferentially spaced teeth on their outer circumferences; and a second pair of gears mounted on said second driven shaft engaging the teeth on said outer rings for rotation of the outer rings in a direction opposite to the directional rotation of said disks.

5. Device defined in claim 2 wherein the interconnection between said inner rings and said disks is provided by cooperating grooves and ribs on each thereof.

LAWRENCE M. GARNER.
EDWARD S. McCONNOLIE.

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