Dec. 26, 1950 C. W. CLINE 2,535,267

ROTARY VANE PUMP

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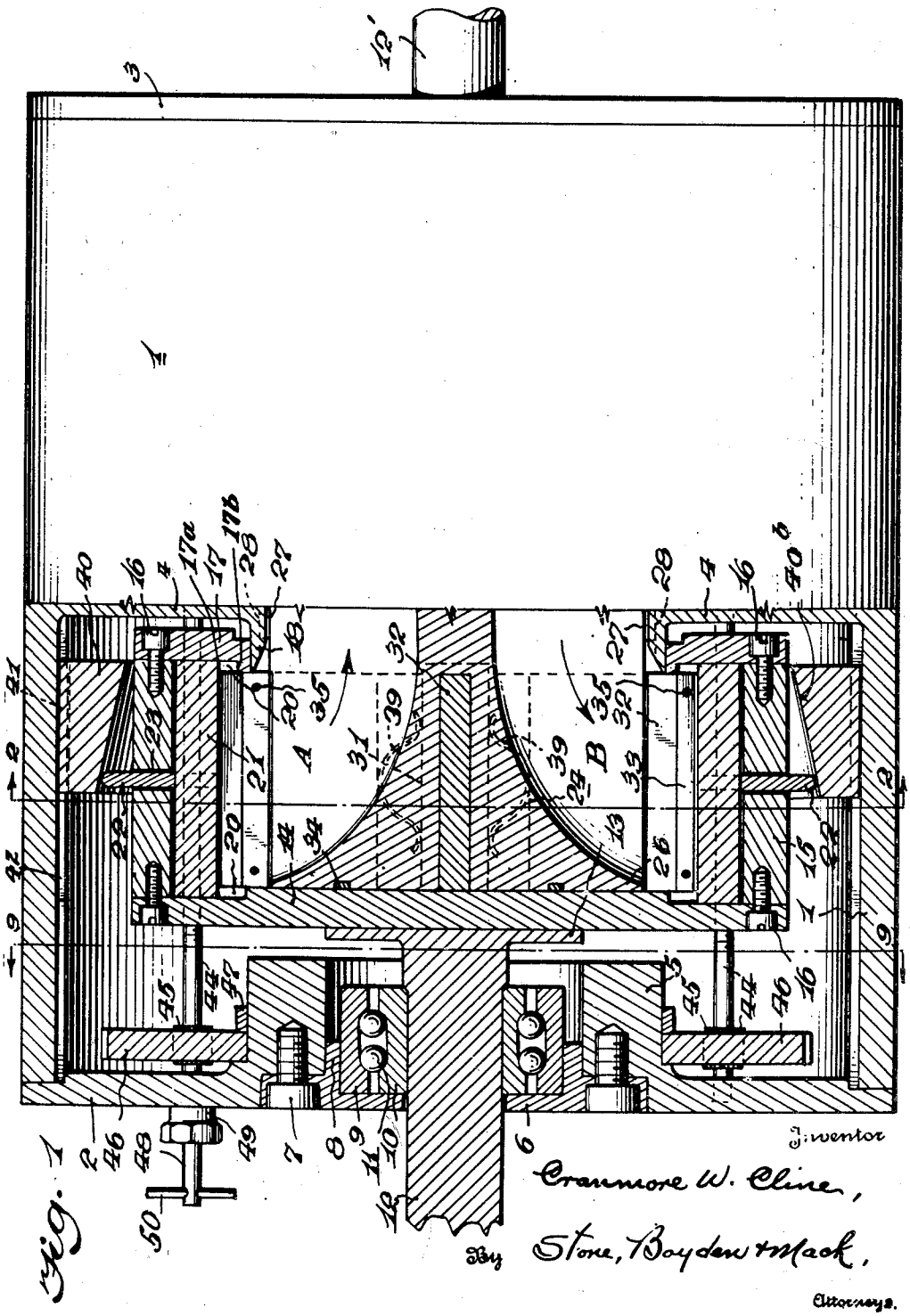


Fig. 1

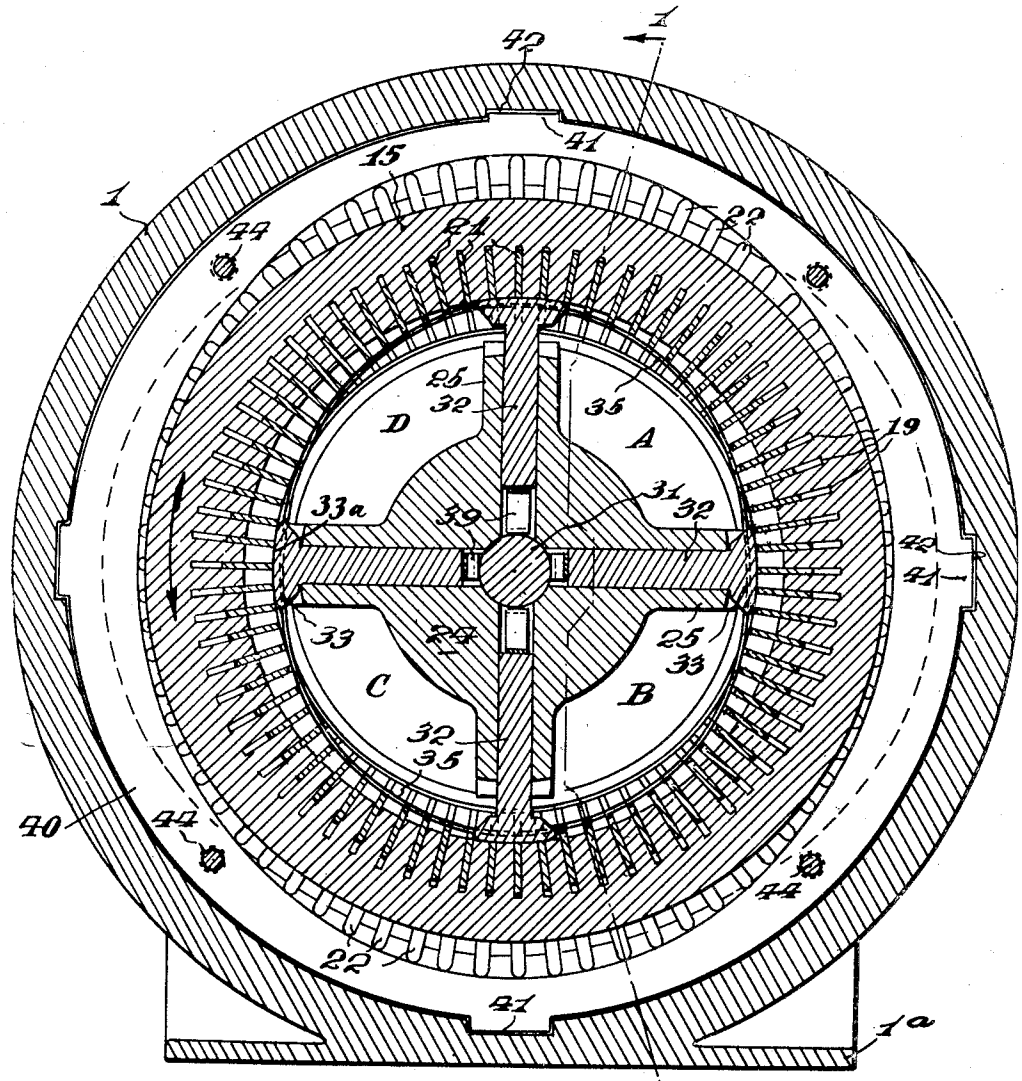
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ROTARY VANE PUMP

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Fig. 2



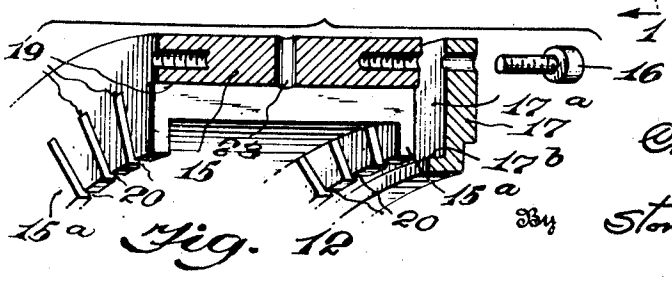


Fig. 12

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Fig. 4

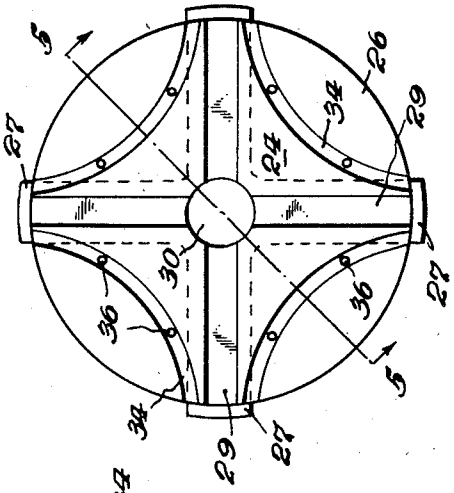


Fig. 6

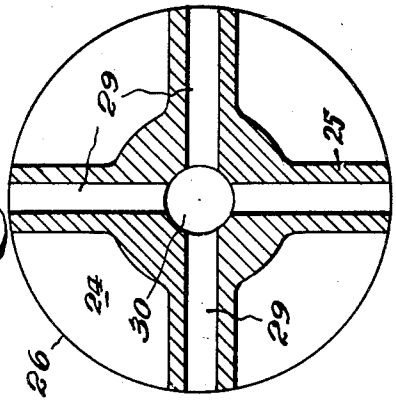


Fig. 3

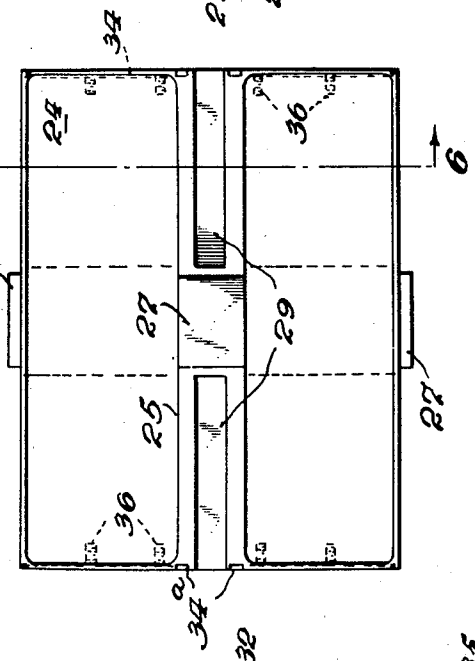


Fig. 5

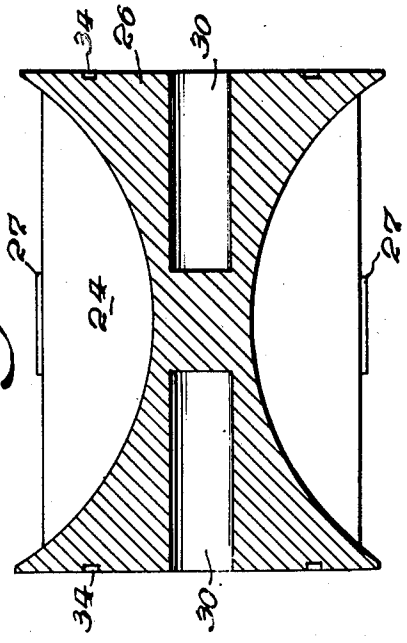


Fig. 7

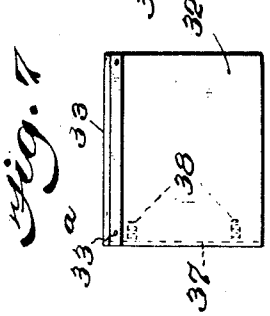
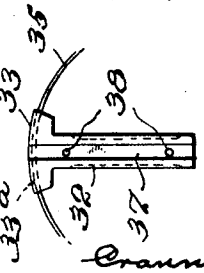


Fig. 8



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ROTARY VANE PUMP

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Fig. 9

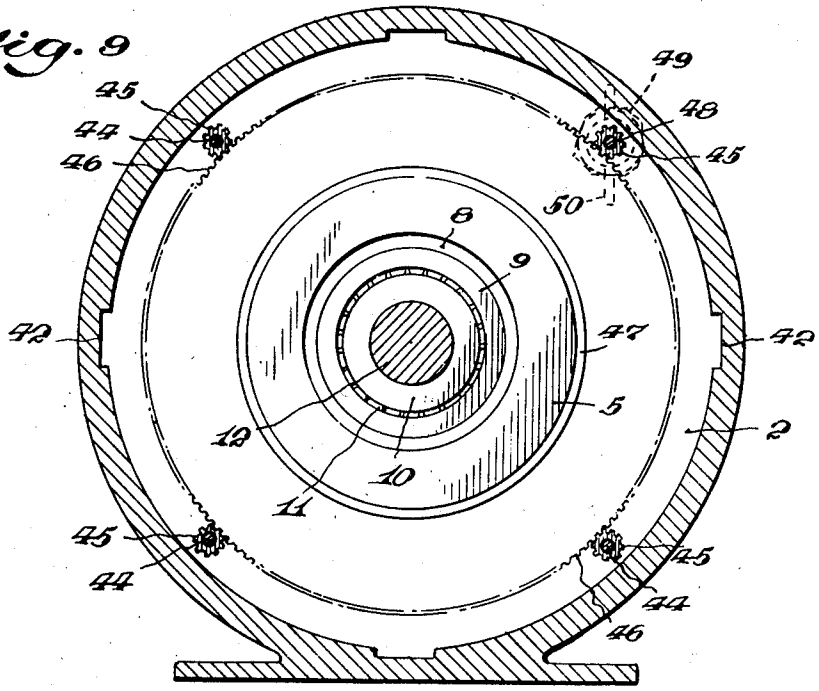


Fig. 10

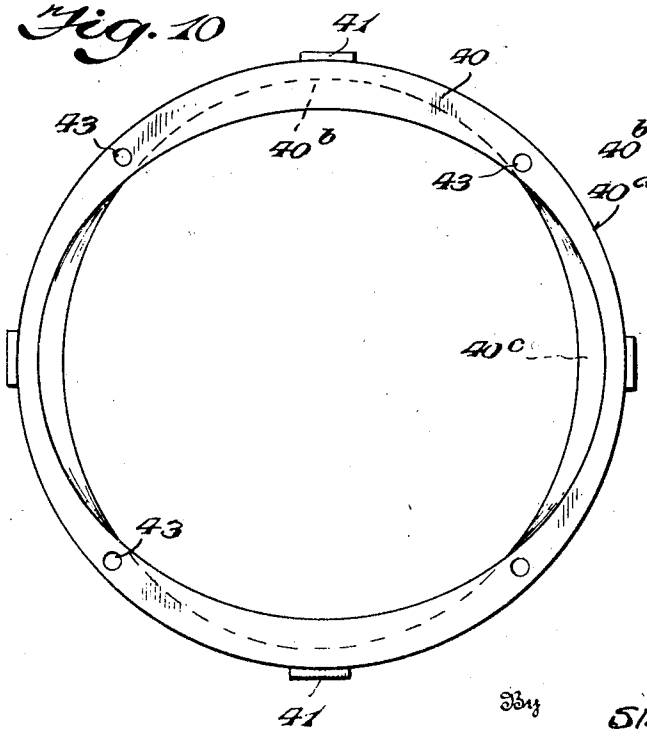
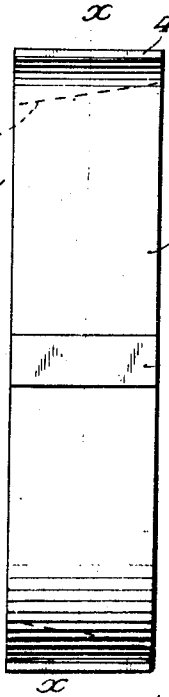


Fig. 11



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Fig. 14

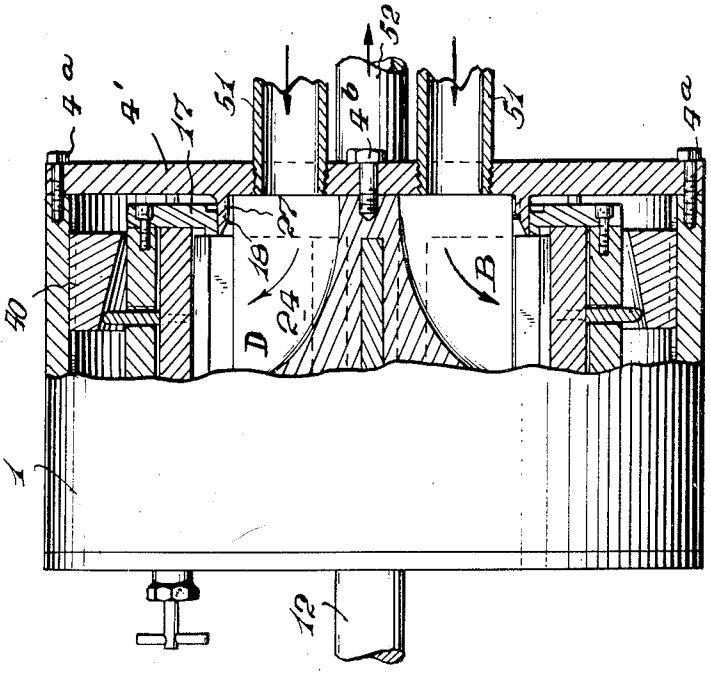
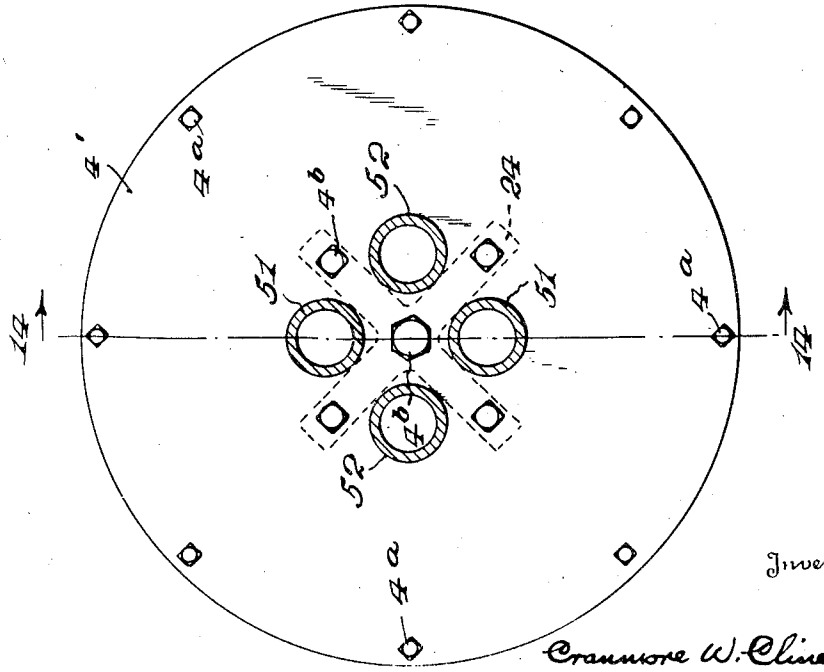


Fig. 13



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UNITED STATES PATENT OFFICE

2,535,267

ROTARY VANE PUMP

Cranmore W. Cline, Jacksonville, Fla.

Application April 9, 1945, Serial No. 587,298

15 Claims. (Cl. 103—120)

1

This invention relates to fluid pumps or motors, and more particularly to pumps or motors of the rotary vane type.

As is well known, rotary vane machines of this general nature are reversible in their action, that is to say, that when driven by outside power they serve as a pump but when supplied with fluid under pressure, they operate as a motor. Hence, in the following description of the details of construction, and in the appended claims, I shall, for simplicity, refer to my improved machine as a pump, it being understood that identically the same machine may also be used as a motor.

The general object of the invention is to devise an improved rotary vane pump which shall have no large radial loads, and which shall be simple in construction and efficient and durable in operation.

Among the specific objects are to provide an improved design in which there is a relatively small area of contact between the moving parts; in which the plates between which the vanes are confined rotate with the vanes, thus allowing a higher pressure to be exerted on the vanes and eliminating the continuous shearing or scraping of the fluid from such plates, as in pumps of the prior art; and in which novel and advantageous means for varying as desired the displacement of the pump is provided.

My improved design is especially suited for embodiment in fluid drives or transmissions. For this purpose I propose to employ two substantially identical units mounted in close proximity to each other, preferably in the same housing, and having in common between them a single fluid-confining and directing means for causing the fluid to circulate through them in a closed cycle. With such an arrangement one unit serves as a pump and the other as a motor, and a further object of the invention is to provide improved means whereby both the speed and direction of rotation of the motor unit may be governed merely by the manipulation of a cam element controlling the operation of the pump unit. More specifically, the invention contemplates an annular cam surrounding the vanes, and means whereby it may be manipulated to vary the radial movement of the vanes.

With the above and other objects in view, and to improve generally on the details of such apparatus, the invention consists in the construction and arrangement of parts hereinafter described and claimed, and illustrated in the accompanying drawings, forming part of this specification, in which drawings—

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Fig. 1 is a view of a fluid transmission embodying the invention and comprising coupled pump and motor units, the pump unit being shown in longitudinal section, and the motor unit in side elevation;

Fig. 2 is a transverse section through the pump unit, taken substantially on the line 2—2 of Fig. 1, looking in the direction of the arrows;

Fig. 3 is a view in side elevation of the central fluid guiding member shown in section in the first two figures;

Fig. 4 is an end elevation of such central member;

Fig. 5 is a sectional view taken substantially on the line 5—5 of Fig. 4, looking in the direction of the arrows;

Fig. 6 is a transverse section taken substantially on the line 6—6 of Fig. 3, looking in the direction of the arrows;

Fig. 7 is a side elevation showing one of the radial abutments carried by the central member;

Fig. 8 is an end elevation of the abutment shown in Fig. 7, and also illustrating a fragment of a cooperating element;

Fig. 9 is a transverse section taken substantially on the line 9—9 of Fig. 1, looking in the direction of the arrows;

Fig. 10 is a view in side elevation of the cam ring which I employ for controlling the radial movement of the vanes of the pump unit;

Fig. 11 is an edge elevation of said cam ring;

Fig. 12 is a fragmentary perspective view partly in section, showing the parts of my improved rotary housing;

Fig. 13 is an end elevation of a slightly modified construction of apparatus comprising a pump unit only; and

Fig. 14 is a fragmentary longitudinal section similar to Fig. 1, but taken on the line 14—14 of Fig. 13 looking in the direction of the arrows.

Referring to the drawings in detail and more particularly first to Figs. 1 and 2 thereof, my improved apparatus comprises a cylindrical casing 1, having a suitable base 1a, and closed at its ends by circular plates 2 and 3.

A transverse partition 4 extends across the casing and divides it into two similar units, namely a pump unit and a motor unit. Since these units are substantially identical in construction, only the pump unit has been illustrated in detail.

An annular boss 5 projects inwardly from the end plate 2, and a cover plate 6, held in place by screws 7, closes the outer end of the central opening in the boss 5 and is provided with an inwardly

extending annular rim or flange 8 which fits snugly within the boss 5.

The outer raceway 9 of ball bearings 11 is seated within the flange 8, while the inner raceway 10 is press fitted on a shaft 12 by which the pump unit is driven.

At the inner end of the shaft 12 is a radial flange 13 to which is rigidly secured the rotor of the pump unit. This rotor comprises a housing made up of end plates 14 and 17, secured by means of screws 16 to a cylindrical rim member 15. The plate 17 is of annular form and its inner edge rotates around and snugly fits an annular flange 18 projecting axially from the transverse partition 4.

The rim member 15, as best shown in Fig. 12, is provided with inwardly extending radial flanges 15*a*. A series of radial slots are cut transversely through the inner portion of the rim member, these slots extending into the body of the rim member, as indicated at 19, and also through the flanges 15*a*, as indicated at 20. The inner faces of the side plates 14 and 17 are formed with annular peripheral grooves, such as shown at 17*a* in Fig. 12, and these grooves fit snugly against the sides of the flanges 15*a*.

Working freely in each radial slot 19, 20 slides a vane 21, these vanes being of a radial width less than the depth of the slots 19, 20, so that they may move radially therein. The inward movement of these vanes is limited by the shoulders such as 17*b* at the inner edges of the grooves such as 17*a*.

Each vane 21, as best shown in Fig. 1, is provided with a central stem 22 which projects freely through an opening 23 in the rim member, for a purpose hereinafter described.

Mounted within the rotor is a fixed central member or stator designated in its entirety by the numeral 24. While this member is shown in Figs. 1 and 2, it is perhaps best illustrated in Figs. 3–6 inclusive. Generally circular in transverse section, it is formed with a hub and four radially extending, relatively thick partitions 25, spaced 90° apart. The ends of the member 24 are circular and flat, as indicated at 26. On the outer edge of each partition 25, at its center, is a projecting lug or spline 27, which lugs or splines fit into corresponding slots or key ways 28 formed in the inner edge of the transverse partition 4, as shown in Fig. 1. By this means the central member is fixed to the casing and is held against rotation.

Referring again to Figs. 3, 4 and 6, it will be seen that each partition 25, on each side of the splines 27, is formed with a radial slot or guideway 29, these slots opening out through the ends of the partition, as shown in Figs. 3 and 4. Central bores or openings 30 are formed in each end of the member 24, as shown in Figs. 5 and 6, and the slots 29 extend into these central bores. The purpose of the central bores 30 is to permit the machining of the insides of the slots 29. When assembled for use however, as illustrated in Figs. 1 and 2, a plug 31 is inserted in each of the bores 30 so as to completely fill the same.

Floating freely in each slot 29 is a radial abutment 32. This is of the form shown in Figs. 2, 7 and 8 and is provided with a relatively wide head 33 having an arcuate outer face. These radial abutments are arranged in diametrically opposed pairs.

In order to provide a fluid tight fit within the housing of the rotor, the ends of the member 24 are formed with grooves 34 in which are placed packing strips 34*a* held as by means of screws 36, and similar packing strips 37 are set into grooves at the outer ends of the abutments 32, and secured as by screws 38 (see Figs. 4, 7 and 8).

Means are provided for urging the abutments 32 yieldingly outward in the slots 29, such means being illustrated in the drawing as leaf springs 39 interposed between the inner ends of the abutments and the plugs 31.

It will be understood that the relative positions of the abutments 32 and the vanes 21 is such that as the rotor revolves, the inner edges of these vanes sweep over the arcuate outer surfaces of the heads 33 of the abutments. It will be further understood that centrifugal force tends to throw the vanes outwardly and to maintain them at the extreme outer limit of their movement.

I therefore provide means for controlling the radial movement of the vanes, both as to extent and angular position relative to the abutments, it being understood that by thus varying the movement of the vanes the displacement and direction of delivery of the pump unit can be controlled.

My improved means for governing the movement of the vanes comprises an annular ring 40 surrounding the rotor and having an inner cam surface on which the ends of the stems 22 bear and ride. The outer surface 40*a* of this cam ring is circular so as to fit the casing 1 and it is provided with a plurality of projecting splines 41 which are slidably held in keyways 42 cut in the inner surface of the casing 1.

By reference to the drawings, and more particularly Figs. 10 and 11 thereof, it will be seen that the profile of the inner surface of the cam ring at each side face of the ring is substantially an ellipse, the pairs of abutments being disposed substantially on the major and minor axes of the ellipse. It will be further seen that the ellipses at the opposite side faces have their major axes disposed at right angles to each other. In other words, the major axis of one ellipse is parallel with the minor axis of the other. While the contour at each side face of the cam has been described as substantially elliptical, there preferably will be, in actual practice, an arc of about 15° at the ends of the axes which is truly circular. This is for the purpose of avoiding radial movement of the vanes while they are subjected to high pressures, as will be understood by those skilled in the art. The portions of the contour between the circular arcs are laid out so as to provide for uniform acceleration of the vanes. When, therefore, in the specification and claims, the words "ellipse" or "elliptical" are used, the terms will be understood as meaning an ellipse modified as above described. Thus, the inner face of the cam ring presents a continuous warped surface, a section through the ring at the ends of the major axis of either ellipse, showing an inner surface having a transversely inclined contour, as indicated at 40*b* in Fig. 11. Moreover, this inclined surface at the right and left hand sides of the ring, as viewed in Fig. 10, faces toward the observer, as indicated at 40*c*, while the inclined surface at the top and bottom of the ring faces away from the observer. At a point half way between the major axes of the two ellipses, a transverse section through the ring would show an inner surface which is not inclined, but substantially axial, such point marking the transition between the inclined inner surfaces which face in opposite directions at opposite sides of the ring.

It will further be understood that a section along a median plane, perpendicular to the axis of the ring, as indicated by the dotted line x—x in Fig. 11, would show an inner surface, which at this point, is a true circle, such a plane cutting the ring at a point intermediate of the two ellipses, that is to say, the point of transition from one ellipse to the other.

From the foregoing, it will be understood that when the cam ring is in the position shown in Fig. 1, which is its extreme innermost position, the ends of the stems 22 ride upon the inner surface of the ring in a plane where such surface is elliptical, and where the major axis of the ellipse is a maximum. Thus, the inner ends of the vanes are caused to travel in an approximately elliptical path, the major axis of which is substantially equal to the internal diameter of said cylindrical rotor. If, however, the cam ring be moved outwardly, that is to say toward the left, as viewed in Fig. 1, the part of the cam surface on which the stems ride, becomes less and less elliptical until the median plane is reached, at which point, as above stated, the surface becomes circular. In other words, the shifting of the cam results in progressively decreasing the length of the major axis and increasing the length of the minor axis of the substantially elliptical path in which the vanes move. Thus, as the cam ring is shifted toward the left, the inward and outward movement or stroke of the vanes is progressively decreased, until, at the median plane, it becomes zero.

If the cam ring is moved still further toward the left, beyond the median plane, the vanes again begin to move radially as the rotor revolves, but this movement is now 90° out of phase with the previous movement.

In order to move or shift the cam ring axially as above described, it is provided with a plurality of threaded openings 43 in which engage threaded shafts 44 (see Fig. 1), which are journaled in fixed bearings. On each of these shafts is secured a pinion 45, and all of these pinions mesh with a large ring gear 46 journaled on the boss 5 and held in position by a locking ring 47. One of these shafts extends through a packing gland 49 in the end plate 2, as illustrated at 48, and is provided at its end with a handle 50 by which it may be turned. It will thus be evident that when this handle is turned the pinion with which it is connected, drives the ring gear 46, which in turn drives all of the other pinions, thus causing all of the threaded shafts 44 to rotate in unison, thereby causing the cam ring to travel axially.

Referring to Fig. 2, it will be seen that partitions 25 and abutments 32 divide the central member or stator, on the interior of the rotor, into a plurality of compartments designated A, B, C and D. It will also be seen that the inner edges of the vanes ride on and sweep over the arcuate outer surfaces of the abutments 32, the length or circumferential width of these arcuate surfaces being relatively great as compared with the space between the vanes. As the rotor turns and the vanes travel around, they are caused to move in and out radially by the cam ring above described, the abutments 32 being urged outwardly by the springs 39 so that they yieldingly engage the inner edges of the vanes, whatever may be the radial position of such vanes. Thus, the vanes at the top of Fig. 2 are in their extreme outward position and, similarly the abutment at this point is pushed out

by the spring substantially beyond the partitions 25, so as to engage the inner edges of the vanes.

The vanes shown at the right hand side of Fig. 2, however, are in their innermost position at this point, and the adjacent abutment is pushed in by the vanes to its extreme retracted position in which its head engages the end of the partition 25.

Thus, the radial spacing of the outer end of each abutment from the inner surface of said rotor is dependent upon the radial positions of the vanes in contact with such abutment, and this spacing is maintained at a maximum and minimum, respectively, for alternate pairs of diametrically opposed pairs of abutments.

It will be understood that open pockets of varying depth are formed between the vanes, and that these pockets communicate with the compartments A, B, C and D, respectively. It is only when the vanes are riding over the abutments that the pockets between them are closed.

It will be further understood that, after the parts are assembled, the compartments A, B, C and D are filled with any desired fluid, through a suitable filling opening (not shown).

It will now be seen that the vanes rotating in the direction of the arrow in Fig. 2 trap a certain amount of fluid between them, as they pass over the abutment at the right hand side. In other words, the arcuate face of the abutment, serves to close the pockets so that the fluid is confined in such pockets during the moment that the vanes are passing the abutment. By this means fluid is carried or transferred from one compartment to the adjacent compartment. Thus, in Fig. 2, fluid will be taken from compartment B and delivered into compartment A. There is no such trapping or transfer of fluid at the top and bottom of the pump unit, as shown in Fig. 2, since the vanes at this moment are in their extreme outward position and form no pockets between them. An action similar to that taking place at the right hand side of Fig. 2, is also taking place at the left hand side, and thus fluid is being taken from compartment D and delivered into compartment C.

Applicant's pump is in fact a dual or duplex pump, fluid being delivered from the chamber B into the chamber A and from the chamber D into the chamber C; thus the high pressure chambers A and C are disposed opposite each other and this results in the machine being hydraulically balanced.

Referring to Fig. 1, it will be understood that the fixed central member or stator 24 is common to both the pump unit and the motor unit and that the compartments such as A and B, above referred to, extend axially from one unit to the other through the transverse partition 4.

It will be understood that in the motor unit there is a rotor mounted on shaft 12'. This rotor surrounds these compartments the same as in the pump unit and that this rotor is provided with a series of radial vanes whose movement is controlled by means of a cam ring, just as described in connection with the pump unit. There may be the difference that in the motor unit the cam ring may be fixed, since it would ordinarily not be necessary to change the stroke or phase of the vanes of the motor unit.

In Fig. 1, the direction of movement of the fluid in the compartments is illustrated by arrows. Thus, since, as above described, the pump unit operates to deliver fluid into the compart-

ment A and thus build up pressure in this compartment, such fluid tends to flow out through compartment A into the motor unit, where it passes through the vanes of the rotor in this unit and returns to the pump unit through compartment B, thus circulating in a closed cycle. The same is true of compartments C and D. By this means the rotor of the motor unit is caused to turn.

From the foregoing, it will be understood that shifting of the cam ring of the pump unit axially serves to vary the displacement of the pump and thus to vary the rate at which fluid is caused to circulate through the motor unit, and hence the speed at which the motor unit is driven. Not only can the displacement of the pump be varied by shifting the cam ring, but the direction of flow of fluid, and hence the direction of rotation of the motor unit may likewise be varied in the same way. Thus, if the cam ring in Fig. 1 is shifted to the left, so that it engages the stems **22** at a point beyond the median plane, as above described, the phase of the vane movement will be shifted through 90°, with the result that pressure will be built up in compartments B and D, instead of A and C, as before. This will cause the fluid to flow in an opposite direction through the motor unit, and thus its direction of rotation will be reversed. Therefore, it will be seen that by a mere manipulation of the handle **50**, while the pump unit is being driven at constant speed, the motor unit may be reversed and its speed varied as desired in either direction.

While I have described the annular cam member as rigid, and shiftable axially to control the movement of the vanes, there are other ways in which the desired result can be accomplished. For example, the cam ring may be a flexible, resilient band, held in an axially fixed position, and means may be provided for flexing or deforming this ring at different points in its periphery, to provide the variable cam surfaces required.

Although the vanes are normally urged outwardly by centrifugal force when the machine is running, those in the upper half of the rotor would tend to move by gravity to their innermost positions when the machine stops. Thus they might project so far inward that they would not clear and ride over the ends **33** of the abutments **32** when the rotor starts up, and consequently would be damaged or sheared off. In order to prevent this, I provide a pair of guard rings **35**, preferably made of stout resilient wire. These rings pass through transverse openings **33***a* in the heads **33** of the abutments **32**, near their opposite axial ends, as indicated in Figs. 7 and 8. When all abutments are in the same radial position, these rings will be truly circular, but when two of the abutments are extended radially further than the other two, the rings assume a more or less elliptical form, as shown in Fig. 2. In all positions, they serve to radially support the vanes and limit their inward movement, so that they may ride freely over the abutments.

While the apparatus so far described is in the nature of a hydraulic transmission, comprising both pump and motor units, my improved construction also has utility when employed as a pump unit alone. This is illustrated in Figs. 13 and 14.

Referring to these figures, when it is desired to employ the pump unit alone, the partition **4**, shown in Fig. 1, is replaced by an end plate **4'**, secured to the cylindrical casing **1** as by means of bolts **41**. Furthermore, the central member **24** will terminate at its median transverse plane, at the side plate **4'**, and this side plate may be secured to the central member or structure **24** as by means of bolts **45**, engaging suitable screw threaded openings in the central structure.

Four threaded openings are formed in the end plate **4'** so positioned as to communicate with the four chambers A, B, C and D, shown in Fig. 2, and suitable pipes **51**, **52** are set into these openings. It will be understood that the operation of the pump unit serves to create suction, drawing fluid in, at two of the diametrically opposite pipes **51**, and to create pressure forcing fluid out of the other two opposite pipes **52**. The pairs of pipes may, of course, be suitably connected together so as to provide intake and discharge conduits for the pump.

What I claim is:

1. In a rotary pump, the combination with a rotary housing, of a series of radially disposed vanes mounted for radial movement therein, an annular cam ring surrounding said housing and controlling the radial movement of said vanes, the contour of the inner surface of said ring varying continuously from one side face of the ring to the other, and means for shifting said ring axially.

2. In a rotary pump or motor, the combination with a fixed central member having radial abutments dividing it into a plurality of fluid-containing compartments, of a rotor surrounding said member and having a series of radial vanes mounted for radial movement therein, means whereby said vanes co-operate with said abutments to continuously transfer fluid from one compartment to an adjacent compartment as the rotor rotates, and means for controlling the extent of radial movement of said vanes in such manner that the rate of transfer of fluid may be varied as desired.

3. In a rotary pump or motor, the combination with a fixed central member having radial abutments dividing it into a plurality of fluid-containing compartments, of a rotor surrounding said member and having a series of radial vanes mounted for radial movement therein, means whereby said vanes co-operate with said abutments to continuously transfer fluid from one compartment to an adjacent compartment as the rotor rotates, and means for controlling the extent of radial movement of said vanes in such manner that both the rate and direction of transfer of fluid may be varied as desired.

4. In a rotary pump or motor, the combination with a rotor, of a series of radially slidable, circumferentially spaced vanes carried by said rotor, an annular cam ring surrounding said rotor and controlling the radial movement of said vanes, the profile of the inner surface of said ring being substantially elliptical at both side faces thereof, but the major axis of the ellipse of one side face lying at right angles to the major axis of the ellipse of the other side face, and means for shifting said ring axially.

5. In a rotary pump or motor, the combination with a stator of a plurality of radial abutments dividing said stator into a plurality of fluid receiving compartments, a rotor surrounding said stator and carrying a series of circumferentially spaced, radially slidable vanes, the circumferential spacing of said vanes being less than the circumferential width of the outer ends of said abutments, means controlling radial movement of said vanes, and means maintaining said abutments in contact with said series of vanes, where-

by in sweeping across said abutments during rotation of said rotor, said vanes coact with each other and with the outer ends of said abutments to form pockets for carrying fluid from one of said compartments to the next adjacent compartment.

6. In a rotary pump or motor, the combination with a stator having a plurality of radial abutments dividing said stator into a plurality of fluid receiving compartments, of a rotor surrounding said stator and carrying a plurality of radially slidable, circumferentially spaced vanes, the space between adjacent vanes being less than the circumferential width of the outer ends of said abutments, means for urging said abutments outwardly into engagement with said vanes, whereby said vanes sweep across the ends of said abutments during rotation of said rotor, and means for controlling radial movement of said vanes.

7. In a rotary pump or motor, the combination with a stator having a plurality of radial partitions, of abutments radially slidable within said partitions and projecting beyond said partitions, the ends of said abutments comprising enlarged heads having arcuate outer surfaces, a rotor surrounding said stator and carrying a plurality of radially slidable, circumferentially spaced vanes, the space between adjacent vanes being less than the circumferential width of said abutment heads, means for urging said abutments outwardly into engagement with said vanes, whereby said vanes sweep across said abutment heads during rotation of said rotor, and means for controlling radial movement of said vanes.

8. In a rotary pump or motor, the combination with a stator having a plurality of radial abutments dividing said stator into a plurality of fluid receiving compartments, of a rotor surrounding said stator and carrying a plurality of radially slidable circumferentially spaced vanes, means for urging said abutments outwardly into engagement with said vanes, whereby said vanes sweep across the ends of said abutments during rotation of said rotor, means for controlling radial movement of said vanes, and a resilient, annular guard ring connecting said abutments at their outer ends and bearing against the inner edges of said vanes.

9. In a rotary pump or motor, the combination with a stator, of a plurality of radial abutments dividing said stator into a plurality of fluid receiving chambers, said abutments being arranged in diametrically opposed pairs, a rotor surrounding said stator and carrying a series of circumferentially spaced, radially reciprocable vanes, the space between adjacent vanes being less than the circumferential width of the outer ends of said abutments, means for maintaining said abutments in engagement with said series of vanes during rotation of said rotor, whereby each abutment is spaced from the inner surface of said rotor a distance dependent upon the radial positions of the vanes in contact with the abutment, and means controlling the radial movement of said vanes to maintain spacing between said rotor and the ends of diametrically opposed abutment pairs at maximum and minimum respectively for alternate pairs.

10. In a rotary pump or motor, the combination with a stator of a plurality of radial abutments dividing said stator into a plurality of fluid receiving chambers, said abutments being arranged in diametrically opposed pairs, a rotor surrounding said stator and carrying a series of circumferentially spaced, radially reciprocable vanes, the space between adjacent vanes being less than the circumferential width of the outer ends of said abutments, means for maintaining said abutments in engagement with said series of vanes during rotation of said rotor, whereby each abutment is spaced from the inner surface of said rotor a distance dependent upon the radial positions of the vanes in contact with the abutment, an annular cam ring surrounding said rotor and controlling the radial movement of said vanes to maintain spacing between said rotor and the ends of diametrically opposed abutment pairs at maximum and minimum respectively for alternate pairs, and means for adjusting said cam to vary the distance through which said vanes reciprocate.

11. In a rotary pump or motor, the combination with a stator, of two pairs of radial abutments carried thereby, the abutments of each pair being diametrically opposed, a rotor surrounding said stator and carrying a series of circumferentially spaced vanes, each freely movable radially, whereby a point on the inner edge of the vane may follow a path of different shape from the profile of the inner surface of said rotor during rotation of said rotor, means for urging said abutments against said series of vanes, and an annular cam ring surrounding said rotor and controlling radial movement of said vanes, said cam ring presenting a substanially elliptical working surface, whereby the inner edges of said vanes are caused to follow a substantially elliptical path, the pairs of abutments occupying the major and minor axes respectively of the ellipse.

12. In a rotary pump or motor, the combination with a stator, of two pairs of radial abutments carried thereby, the abutments of each pair being diametrically opposed, a rotor surrounding said stator and carrying a series of circumferentially spaced vanes, each freely movable radially, whereby a point on the inner edge of the vane may follow a path of different shape from the profile of the inner surface of said rotor during rotation of said rotor, means for urging said abutments against said series of vanes, an annular cam ring surrounding said rotor and controlling radial movement of said vanes, said cam ring presenting a substantially elliptical working surface, whereby the inner edges of said vanes are caused to follow a substantially elliptical path, the pairs of abutments occupying the major and minor axes respectively of the ellipse, and means for adjusting said cam ring to modify said ellipitical path.

13. In a rotary pump or motor, the combination with a stator, of two pairs of radial abutments, the abutments of each pair being diametrically opposed, a rotor surrounding said stator and carrying a series of circumferentially spaced vanes, each freely movable radially, whereby a point on the inner edge of the vane may follow a path of different shape from the profile of said rotor during rotation of said rotor, the spacing of said vanes being less than the circumferential width of the outer ends of said abutments, means for urging said abutments against said series of vanes, and an annular cam ring surrounding said rotor and controlling radial movement of said vanes, said cam ring representing a substantially elliptical working surface, whereby the inner edges of said vanes are caused to travel in a substantially elliptical path, the pairs of abutments occupying the major and minor axes respectively of the ellipse.

14. In a rotary pump or motor, the combination with a stator of two pairs of radial abutments, the abutments of each pair being diametrically opposed, a substanially cylindrical rotor surrounding said stator and carrying a series of circumferentially spaced, radially movable vanes, the circumferential spacing of said vanes being less than the circumferential width of the outer ends of said abutments, means urging said abutments against said series of vanes, and an annular cam ring surrounding said rotor and controlling radial movement of said vanes, the working profile of said cam ring being substantially elliptical and causing the inner ends of said vanes to travel in an elliptical path during rotation of said rotor, the major axis of said ellipitical path being substantially equal to the internal diameter of said cylindrical rotor, and the pairs of abutments occupying the major and minor axes respectively of the ellipse.

15. In a rotary pump or motor, the combination with a stator of two pairs of radial abutments, the abutments of each pair being diametrically opposed, a substantially cylindrical rotor surrounding said stator and carrying a series of circumferentially spaced, radially movable vanes, the circumferential spacing of said vanes being less than the circumferential width of the outer ends of said abutments, means urging said abutments against said series of vanes,

an annular cam ring surrounding said rotor and controlling radial movement of said vanes, the working profile of said cam ring being substantially elliptical and causing the inner ends of said vanes to travel in an elliptical path during rotation of said rotor, the major axis of said elliptical path being substantially equal to the internal diameter of said cylindrical rotor, and the pairs of abutments occupying the major and minor axes respectively of the ellipse, and means for adjusting said cam to inversely vary the lengths of the major and minor axes of said elliptical path.

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