

May 3, 1949.

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2,469,097

VARIABLE CAPACITY SLIDING VANE PUMP

Filed July 11, 1944

2 Sheets-Sheet 1

fig. 1.

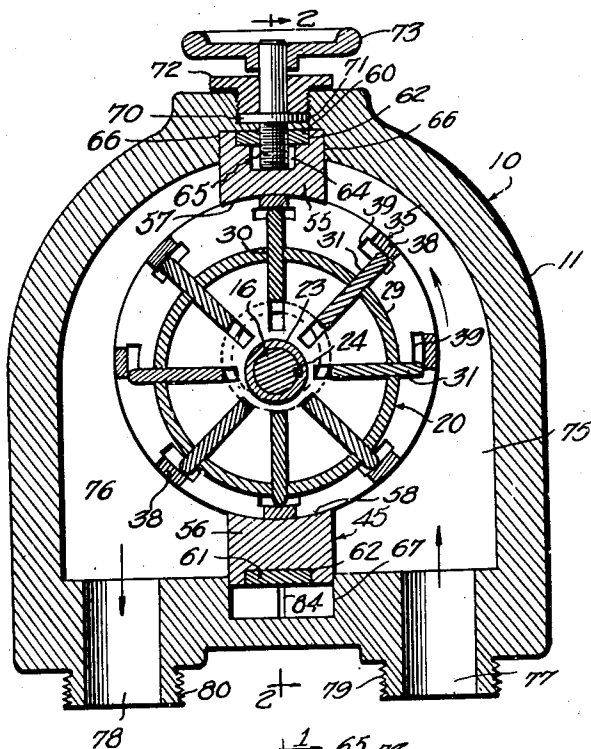
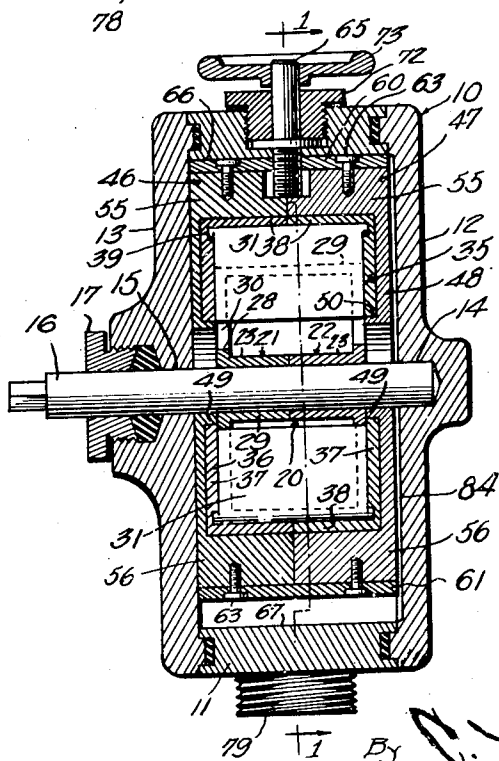


fig. 2.



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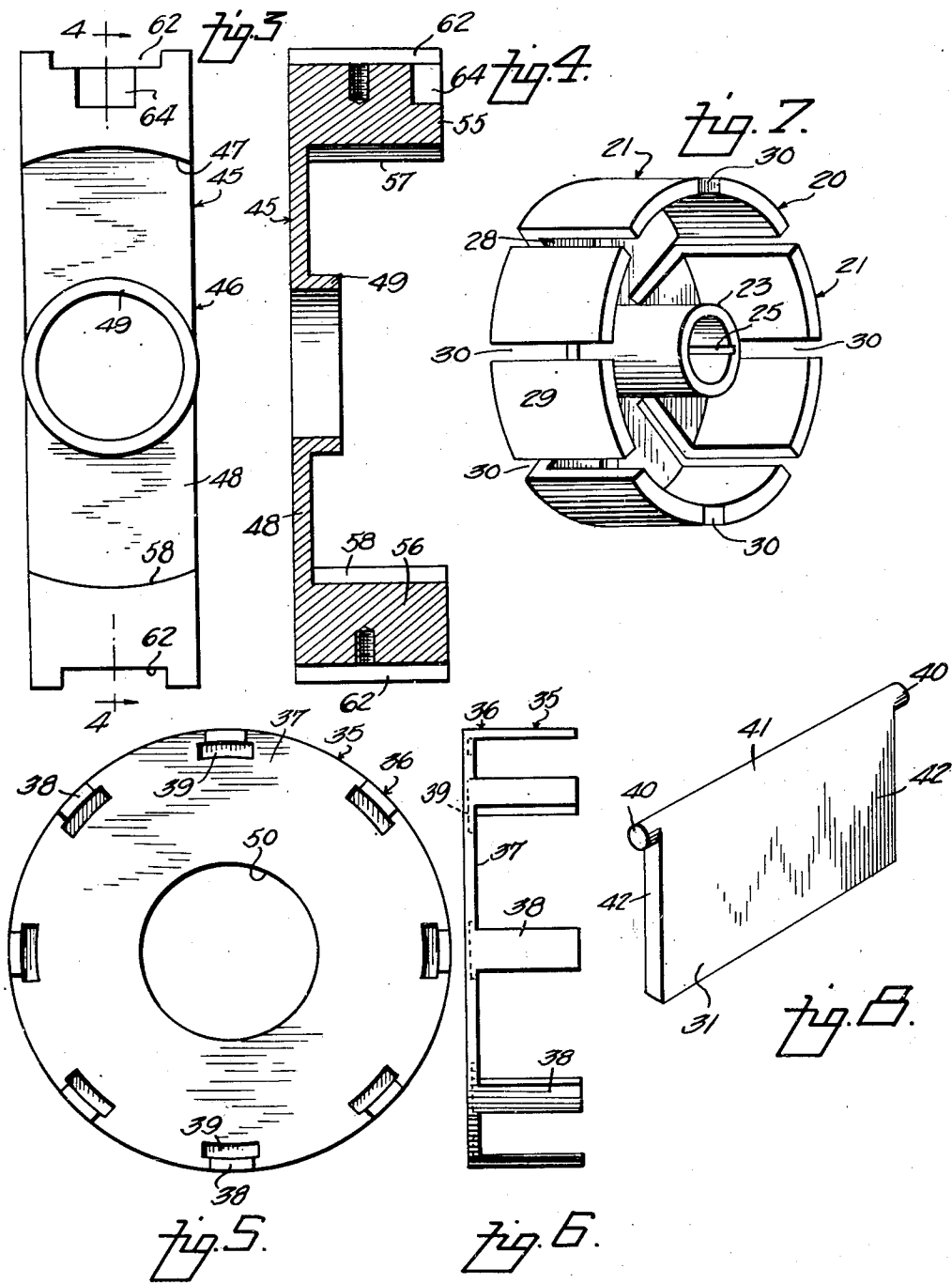
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VARIABLE CAPACITY SLIDING VANE PUMP

Filed July 11, 1944

2 Sheets-Sheet 2



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2,469,097

VARIABLE CAPACITY SLIDING VANE PUMP

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Application July 11, 1944, Serial No. 544,361

8 Claims. (Cl. 103—120)

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This invention relates to pumps, and more particularly to a pump of the positive displacement eccentric sliding vane type.

In pumps of the particular type referred to, it is the common practice to provide a rotor having radially or similarly slidable vanes operating in conjunction with abutments separating the intake and outlet sides of the pump. In order for such a pump to function smoothly and without pulsations it is essential that the space between the radially outer edges of each adjacent pair of blades be spaced apart a distance approximately equal to the width of each abutment when moving past such abutment. This is relatively easily accomplished in a fixed-capacity pump, but is difficult of accomplishment in a pump of variable capacity where relative movements of the parts are provided to vary the pumping capacity. Such adjusting movements vary the distance between the radially outer edges of the vanes. In such a pump, each abutment must be made of a width equal to the maximum width between the adjacent ends of the blades and when such ends of the blades are moved closer together incident to the making of adjustments to vary the capacity of the pump, there is a "blind spot" in the movement of the space between each adjacent pair of blades past the abutments, there being an appreciable interval of time during which the pumping action substantially ceases. This results in a substantial pulsating action during the operation of the pump.

An important object of the present invention is to provide a novel pump (or motor) particularly intended for the pumping of liquids and wherein novel means is employed for varying the pumping capacity.

A further object is to provide such a mechanism wherein the effective space between the radially outer ends of each adjacent pairs of vanes is maintained constant so that the pumping action is not affected regardless of the adjustment of the vanes relative to the abutments.

A further object is to provide such a mechanism wherein a rotary member is driven by the vanes and is adjustable relative to the axis of rotation of the rotor while the latter rotates about the same axis, the rotating member being constructed and arranged to provide a predetermined effective space between the radially outer ends of the vanes to provide a smooth, constant pumping force regardless of adjustments in the pumping capacity of the mechanism.

A further object is to provide a pumping mechanism of the type referred to wherein the de-

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sired results are accomplished with a single easily operable capacity-adjusting means.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the drawings I have shown one embodiment of the invention. In this showing—

Figure 1 is a sectional view through the pump taken perpendicular to the axis of the rotor, the plane of section being approximately on the line 1—1 of Figure 2,

Figure 2 is a section taken on line 2—2 of Figure 1,

Figure 3 is a face view of one of the abutment frame members,

Figure 4 is a vertical sectional view through the same, taken on line 4—4 of Figure 3,

Figure 5 is a face view of one member of a control cage assembly,

Figure 6 is a side elevation of the same,

Figure 7 is a detail perspective view of one of the rotor members, and

Figure 8 is an enlarged detail perspective view of one of the vanes.

Referring to Figure 1, the numeral 10 designates the casing as a whole comprising a body 11 closed at its ends by heads 12 and 13. These heads are provided with any suitable bearings 14 and 15 to rotatably support a drive shaft 16, the head 13 through which the shaft projects to be driven being provided with a suitable packing gland 17. A rotor indicated as a whole by the numeral 20 is driven by the shaft 16. This rotor comprises complementary sections 21 and 22 (Figure 2) for convenience in assembly, as will become apparent, and the sections of the rotor are identical in form. Accordingly only one rotor section need be illustrated in detail, and reference is made to Figure 7 in which is shown a perspective view of one of the rotor sections. Each rotor section comprises a hub 23, and as shown in Figure 2, the hub portions of the two rotor sections abut and are mounted on the shaft 16, the rotor being keyed to the shaft as at 24 (Figure 1) each hub 23 being grooved as at 25 to receive the key 24 which preferably is a unitary key extending from end to end of the rotor. It will be obvious that the shaft 16 may be suitably connected to any source of power to rotate the rotor 20 through the hub portions 23 thereof.

Each rotor section further comprises an end wall 28 and an integral cylindrical wall 29 concentric with the hub portion 23. The end and cylindrical walls of each hub section are radially slotted as at 30 to receive a plurality of vanes 31.

It will be apparent that each slot 30 of each rotor section is aligned with one of the slots 30 of the other rotor section and that the ends of the cylindrical walls 29 of the two sections abut. Accordingly it will be apparent that each slot 30 of each rotor section and its corresponding slot in the other section is adapted to receive one of the vanes 31, and as shown in Figure 2 the ends of each vane are flush with remote surfaces of the end walls 28 of the rotor. Each of the slots 30 extends radially inwardly of each end wall 28 to a depth substantially greater than the width of each vane and accordingly the vanes are adapted to move radially in the slots.

The rotor and the vanes 31 are arranged within a rotary control unit indicated as a whole by the numeral 35. For assembly purposes, the unit 35 also is formed of complementary sections which are identical with each other and each of which is indicated as a whole in Figure 2 by the numeral 36. One of the complementary sections of the control unit is shown in Figures 5 and 6. Each such section comprises a body 37 substantially in the form of a disk having circumferentially spaced integral inwardly extending fingers 38, the fingers of each control unit section being arranged in alinement with the respective fingers of the other section in abutting relationship. Accordingly, the unit 35 as a whole may be construed as comprising end disk-like walls 37 with fingers 38 extending thereacross. The fingers 38 are formed as concentric sections of a cylinder as will become apparent. Inwardly of each finger 38, the corresponding disk 37 has its inner face circumferentially slotted as at 39 and referring to Figure 8 it will be noted that each vane 31 is provided with opposite extensions 40 of circular cross-section engageable in opposite slots 39. The outer edge 41 of each blade 31 is substantially semi-circular in cross-section and forms a continuation of the radially outer half of each projection 40. Each of the projections 40 corresponds in diameter to the width of the slot 39 in which it is arranged and each blade 31 has its end edges 42 contacting the inner faces of the disk 37. The flow of fluid past the end edges of each of the vanes 31 accordingly is prevented.

The mechanism further comprises an abutment frame indicated as a whole by the numeral 45 and this cage also is formed of complementary sections 46 and 47 which are identical with each other for the purpose of assembling the sections, and one of the sections is shown in detail in Figures 3 and 4. Each abutment cage section comprises an elongated side wall 48 having an inner inwardly extending hub portion 49 forming a bearing to be received in an opening 50 formed through each disk 37 concentric thereof. It will become apparent that the two bearings 49 of the two cage sections 46 and 47 rotatably support the control unit 35.

Each cage section 46 and 47 is provided at its upper and lower ends with abutment elements 55 and 56 respectively, the abutment elements of the two cage sections abutting each other as is true of the two abutment elements 56, as shown in Figure 2. The radially inner surfaces of the two abutment elements thus formed are indicated by the numerals 57 and 58 respectively. Such surfaces are sections of a cylinder and are concentric with each other and with the bearing 49 and fingers 38, the latter having their radially outer surfaces operating over the surfaces 57 and 58 as will be clear in Figure 1. The cage sections 46 and 47 are preferably secured to each other

by an upper connecting plate 60 and a lower connecting plate 61, such plates being recessed into the cage sections as at 62 and secured thereto by screws 63. The contacting faces of the abutment elements 55 are recessed as at 64 to freely receive the lower end of the screw 65 threaded through the plate 60. This screw is for the purpose of vertically adjusting the cage 45 and for guiding such cage, the body 11 of the casing 10 is transversely grooved at its top and bottom as at 66 and 67 respectively, these grooves being closed at their ends by the heads 12 and forming vertical guides for the abutment cage.

The screw 65 is provided with an annular flange 70 arranged in a recess 71 formed in the top of the casing body 11, and the flange 70 is held in position by a nut 72. The flange 70 fixes the screw 65 against vertical movement but is rotatable in the bottom of the recess 71. The screw 65 may be rotated in any suitable manner and for this purpose a hand wheel 73 has been illustrated in Figure 1.

The abutment cage and the rotating parts of the mechanism divide the casing 10 into chambers 75 and 76 which will be respectively the inlet and outlet chambers of the pump depending upon the direction in which the shaft 16 is driven. If this shaft is driven in a counterclockwise direction as indicated in Figure 1, the chambers 75 and 76 respectively will be the inlet and outlet chambers. Suitable passages 77 and 78 communicate with the chambers 75 and 76 respectively and threaded extensions 79 and 80 may be formed integral with the casing body 11 for connection with suitable pipe lines as will be apparent.

It will be apparent that it would be impossible to prevent the accumulation of liquid in the lower pocket 67 due to leakage around the bottom end of the cage 45. The recess 51, if otherwise sealed, would retain the liquid and interfere with downward movement of the cage 45. Accordingly one of the casing heads 12 or 13 is grooved for communication between the upper and lower pockets 66 and 67. In the present instance, the head 12 is shown as being provided with a narrow groove 84 through which fluid can be displaced from one of the pockets 66 or 67 and through which a corresponding amount of fluid may flow to the other pocket.

The operation of the mechanism is as follows, consideration first being given to the mode of assembling the various elements. The rotor is first assembled on the shaft 16 and keyed thereto with the vanes 31 arranged in the slots 30, whereupon the complementary sections of the control unit 35 will be slipped in position from opposite ends of the shaft 16 until the ends of the fingers 38 abut as shown in Figure 1. The sections of the abutment cage 45 are similarly moved in position from opposite ends of the shaft, whereupon the plates 60 and 61 are attached to complete the assembly of the elements within the casing 10. These assembled elements are then placed within the casing body 11, the upper and lower ends of the abutment cage being slidable endwise through the slots 66 and 67. The heads 12 and 13 are then applied and secured in any suitable manner, and these heads preferably have leakproof connection with the casing body 11. When the elements are properly assembled, the opening in the plate 60 to receive the screw 65 will be arranged in axial alinement with the recess 71, whereupon the nut 72 will be slipped over the upper end of the stem of the screw 65. The screw 65 will be threaded in the plate 60 and the nut 72

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screwed down into position. The handle 73 then may be attached to the upper end of the stem of the screw.

The apparatus is now ready for operation and it will be obvious that while it is particularly intended for the pumping of liquids, it is equally operative for pumping any fluid such as gases and is also operative as a motor. Assuming that the device is operating as a pump with the shaft 16 rotating in a counterclockwise direction, and the parts arranged as shown in Figure 1, fluid will be supplied to the chamber 75 and will be pumped into the chamber 76 to be discharged therefrom. With the abutment frame 45 in its uppermost position as shown in Figure 1, the pump will be operating at its maximum capacity to pump in the direction indicated. Rotation of the shaft 16 drives the rotor 20 and the space between each adjacent pair of vanes 31 radially outwardly of the rotor wall 29 will increase in size as such spaces move upwardly at the right hand side of the device as viewed in Figure 1. These spaces or pockets reach their maximum size when a line bisecting the angle between two adjacent vanes 31 reaches a point coinciding with a vertical plane through the axis of the shaft 16. Beyond such point, each of the spaces or pockets starts to decrease in capacity as will be obvious, and the fluid displaced from the pockets is forced into the chamber 76. This operation, in itself, is conventional.

Assuming that the pump is to be operated at a fixed capacity the parts may be so designed that each of the pumping spaces or pockets is closed to the intake space 75 and instantly opened to the space 76, in which case a smooth continuous flow is provided. This, however, will not occur in a pump of this character which is designed for variation in the pumping capacity. This fault is taken care of in the present apparatus. The control unit 35 rotates on the hubs 49 of the abutment cage and is always concentric with such hub portions, whereas the rotor is always concentric with the drive shaft 16. The slots 39 hold the radially outer edges of the vanes 31 in contact with the inner faces of the associated control unit fingers 38, the vanes thus being caused to move radially in and out as the apparatus operates.

Whereas in conventional pumps of this character the width of the radially outer end of each pumping space or pocket is defined by the radially outer ends of the vanes, the radially outer ends of these pockets in the present case have their limits defined by the fingers 38. The adjacent faces or edges of each adjacent pair of fingers 38 are spaced apart a distance approximately exactly equal to, but in any event not greater than, the width of each of the abutment elements 55 and 56. It will become apparent, therefore, that regardless of any adjustment of the mechanism to vary the capacity of the pump, the effective width of the outer end of each pumping pocket is always the same, this width being such that each pocket is closed to the chamber 75 and instantaneously opened to communication with the chamber 76, and accordingly there is no gap or "dead spot" in the pumping operation.

Adjustment in the pumping capacity is secured by operation of the handle 73 to rotate the screw 65. Assuming that the capacity of the pump is to be decreased, the screw 65 will be turned to move the abutment cage 45 downwardly, the lower end of the cage moving downwardly into the recess 77. Such downward

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movement of the cage transmits similar bodily movement to the control unit 35 since this unit is rotatable on the hub elements 49. At the same time, the rotor 20 will remain in its same axial position and the maximum capacity of the pumping pockets will be progressively reduced. This progressive reduction takes place until the zero pumping point is reached, namely, when the control unit 35 and the rotor 20 are coaxial. The pumping action may be reversed by continuing downward movement of the abutment cage 45, the axis of the hub elements 49, surfaces 57 and 58 and control unit 35 then moving below the axis of the shaft 16.

With the parts in the position shown in Figure 1 with the cage 45 at its uppermost position, the projections 40 of the vanes 31 will be arranged in the bottoms of the horizontally opposite slots 39. The control unit 35 is rotated by the projections 40 and under the conditions stated, the rotation, against which there is no resistance except negligible friction, will be governed by the projections 40 of the vane 31 nearest the left hand side of the apparatus. This is true up to the neutral or zero pumping point. Assuming the parts to be stationary for the purpose of illustration, rotation of the handle 73 to move the cage 45 and control unit 35 downwardly will result in the projections 40 of the vanes at the sides of the apparatus moving relatively upwardly in the slots 39. The horizontally opposite projections 40 will reach the tops of the corresponding slots 39 when the fully reversed pumping position is reached. During reverse operation of the pump, the projections 40 at the right hand side of the apparatus as viewed in Figure 1 will effect rotation of the control unit 35 by engagement with the upper ends of the slots 39 at the left hand side of the apparatus.

The recesses 66 and 67 are in communication with each other through the small groove 84 formed in the head 12, and accordingly with the recess 67 filled with the liquid being pumped, downward movement of the cage 45 will displace fluid from the pocket 67 upwardly through the groove 84 and a corresponding amount of fluid will flow into the upper end of the pocket 66.

From the foregoing it will be apparent that the present device provides an efficient smoothly operating pump which is capable of a graduated and even reversible pumping operation without the disadvantageous pulsating actions which would be present in the absence of the control unit 35. This unit functions to fix the width of the radially outer extremity of each pumping pocket regardless of the adjusted position of the abutment cage 45 and the elements which are vertically movable therewith.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred example of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. A pump comprising a casing having a fluid inlet and a fluid outlet, a rotor mounted in said casing, radial vanes carried by said rotor and radially slidable relative thereto, abutment means arranged in said casing between said inlet and said outlet, means for varying the degree of eccentricity of said abutment means relative to said rotor to vary the capacity of the pump, a device having portions forming sections of a cylinder extending across and in operative engage-

ment with the radially outer ends of said vanes and rotatable against said abutments, the space between adjacent pairs of said portions of said device predetermining the maximum width of the pumping pocket between each adjacent pair of vanes, said device being rotatable concentric with said abutment means, said device having end walls provided with spaced circumferentially extending slots, and projections carried by said vanes and engaging in said slots to rotate said device upon rotation of said rotor.

2. A pump comprising a casing having a fluid inlet and a fluid outlet, a rotor having a cylindrical wall and spaced side walls provided with spaced radial slots, vanes slidable in said slots, diametrically opposite abutments in said casing between said inlet and said outlet, said abutments having radially inner faces formed as sections of a cylinder, means for bodily moving said abutments to vary the degree of eccentricity of the axes of said rotor and the radially inner faces of said abutments to vary the capacity of the pump, and a device having end walls and spaced portions extending therebetween with each such portion arranged radially outwardly of and in engagement with the adjacent end of one of said vanes, said portions of said device having their radially outer faces formed as sections of a cylinder corresponding in diameter to and concentric with the radially inner faces of said abutments, and having their radially inner faces formed as sections of a cylinder, the adjacent edges of adjacent pairs of said portions of said device being spaced apart a distance equal to the width of each of said abutments.

3. A pump comprising a casing having a fluid inlet and a fluid outlet, a rotor having a cylindrical wall and spaced side walls provided with spaced radial slots, vanes slidable in said slots, diametrically opposite abutments in said casing between said inlet and said outlet, said abutments having radially inner faces formed as sections of a cylinder, means for bodily moving said abutments to vary the degree of eccentricity of the axes of said rotor and the radially inner faces of said abutments to vary the capacity of the pump, a device having end walls and spaced portions extending therebetween with each such portion arranged radially outwardly of and in engagement with the adjacent end of one of said vanes, said portions of said device having their radially outer faces formed as sections of a cylinder corresponding in diameter to and concentric with the radially inner faces of said abutments, and having their radially inner faces formed as sections of a cylinder, the adjacent edges of adjacent pairs of said portions of said device being spaced apart a distance equal to the width of each of said abutments, and means carried by said abutments for rotatably supporting said device.

4. A pump comprising a casing having a fluid inlet and a fluid outlet, a rotor having a cylindrical wall and spaced side walls provided with spaced radial slots, vanes slidable in said slots, diametrically opposite abutments in said casing between said inlet and said outlet, said abutments having radially inner faces formed as sections of a cylinder, means for bodily moving said abutments to vary the degree of eccentricity of the axes of said rotor and the radially inner faces of said abutments to vary the capacity of the pump, a device having end walls and spaced portions extending therebetween with each such portion arranged radially outwardly of and in

engagement with the adjacent end of one of said vanes, said portions of said device having their radially outer faces formed as sections of a cylinder corresponding in diameter to and concentric with the radially inner faces of said abutments, and having their radially inner faces formed as sections of a cylinder, the adjacent edges of adjacent pairs of said portions of said device being spaced apart a distance equal to the width of each of said abutments, means connecting said abutments to each other, and means carried by said connecting means for rotatably supporting said device.

5. A pump comprising a casing having a fluid inlet and a fluid outlet, a rotor having a cylindrical wall and spaced side walls provided with spaced radial slots, vanes slidable in said slots, diametrically opposite abutments in said casing between said inlet and said outlet, said abutments having radially inner faces formed as sections of a cylinder, means for bodily moving said abutments to vary the degree of eccentricity of the axes of said rotor and the radially inner faces of said abutments to vary the capacity of the pump, a device having end walls and spaced portions extending therebetween with each such portion arranged radially outwardly of and in engagement with the adjacent end of one of said vanes, said portions of said device having their radially outer faces formed as sections of a cylinder corresponding in diameter to and concentric with the radially inner faces of said abutments, and having their radially inner faces formed as sections of a cylinder, the adjacent edges of adjacent pairs of said portions of said device being spaced apart a distance approximately equal to the width of each of said abutments, the end walls of said device having their inner faces provided with circumferentially spaced slots, and projections carried by the ends of said vanes and engageable in said slots.

6. A pump comprising a casing having a fluid inlet and a fluid outlet, a rotor having a cylindrical wall and spaced side walls provided with spaced radial slots, vanes slidable in said slots, diametrically opposite abutments in said casing between said inlet and said outlet, said abutments having radially inner faces formed as sections of a cylinder, means for bodily moving said abutments to vary the degree of eccentricity of the axes of said rotor and the radially inner faces of said abutments to vary the capacity of the pump, a device having end walls and spaced portions extending therebetween with each such portion arranged radially outwardly of and in engagement with the adjacent end of one of said vanes, said portions of said device having their radially outer faces formed as sections of a cylinder corresponding in diameter to and concentric with the radially inner faces of said abutments, and having their radially inner faces formed as sections of a cylinder, the adjacent edges of adjacent pairs of said portions of said device being spaced apart a distance approximately equal to the width of each of said abutments, means connecting said abutments to each other, means carried by said connecting means for rotatably supporting said device, the end walls of said device having their inner faces provided with circumferentially spaced slots, and projections carried by the ends of said vanes and engageable in said slots.

7. A pump comprising a casing having opposite fluid chambers, a shaft journaled in said casing, a rotor fixed to said shaft and having radial slots,

radial vanes slidably mounted in said slots and having their radially inner edges terminating radially outwardly of said shaft, diametrically opposite abutments in said casing connected to each other and having their radially inner faces formed as sections of a cylinder, said abutments being arranged between said chambers, said casing having a recess to receive each abutment whereby said abutments are slidably connected to said casing to vary the degree of eccentricity between said rotor and the radially inner faces of said abutments, a control device having opposite end walls arranged longitudinally outwardly of said rotor and spaced portions having radially inner faces formed as sections of a cylinder in contact with the radially outer edges of the respective vanes, the adjacent edges of each adjacent pair of said portions of said device being spaced apart a distance approximately equal to the width of each of said abutments, and means wholly independent of the contact of said vanes with said portions of said device for rotating said device upon rotation of said rotor.

8. A pump comprising a casing having opposite fluid chambers, a shaft journaled in said casing, a rotor fixed to said shaft and having radial slots, radial vanes slidably mounted in said slots and having their radially inner edges terminating radially outwardly of said shaft, diametrically opposite abutments in said casing connected to each other and having their radially inner faces formed as sections of a cylinder, said abutments being arranged between said chambers, said casing having a recess to receive each abutment whereby said abutments are slidably connected to said casing to vary the degree of eccentricity between said rotor and the radially inner faces of said abutments, a control device having opposite

end walls arranged longitudinally outwardly of said rotor and spaced portions having radially inner faces formed as sections of a cylinder in contact with the radially outer edges of the respective vanes, the adjacent edges of each adjacent pair of said portions of said device being spaced apart a distance approximately equal to the width of each of said abutments, the inner faces of said walls of said device being provided with spaced circumferential slots radially inwardly of said portions of said device, and projections carried by the opposite ends of each vane and arranged in said slots, said slots acting to prevent radial movement of said vanes relative to said device.

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