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2,880,677

VARIABLE VOLUME VANE PUMP

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2 Sheets-Sheet 1

Fig. 1.

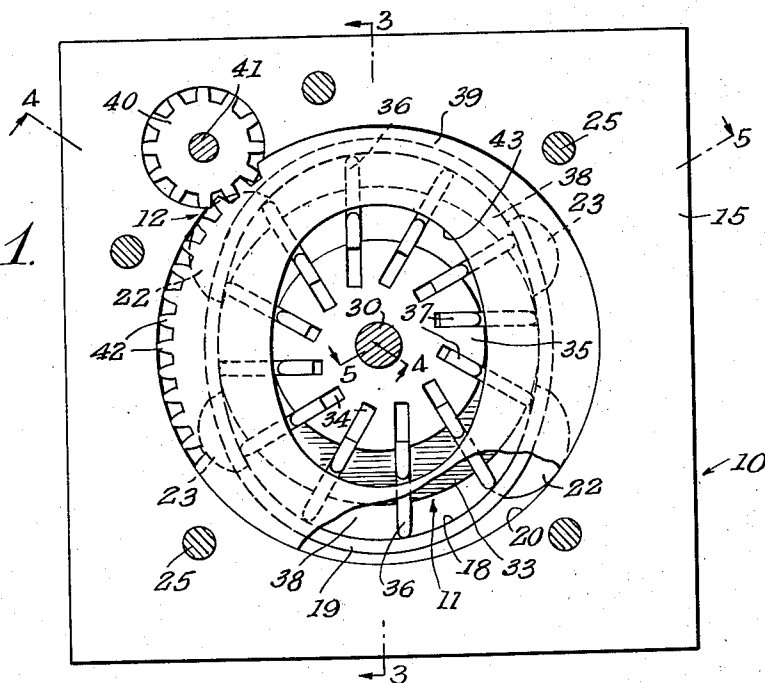
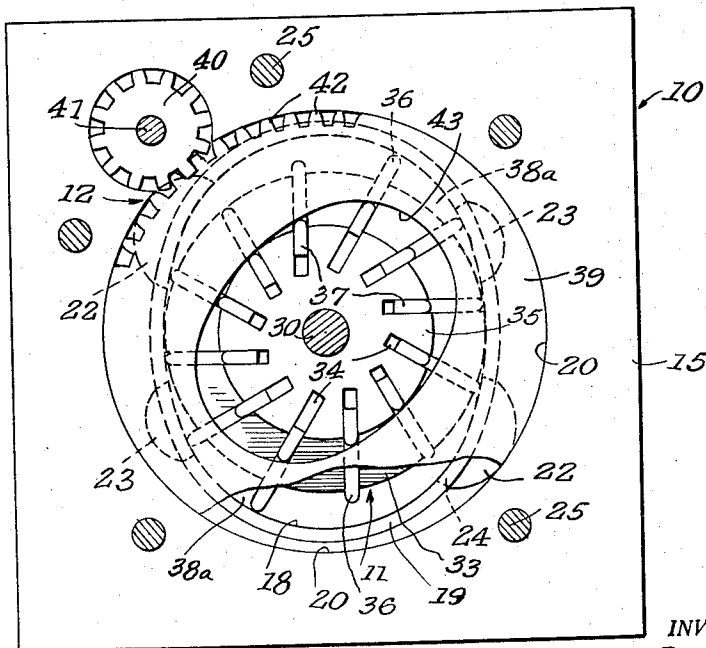


Fig. 2.



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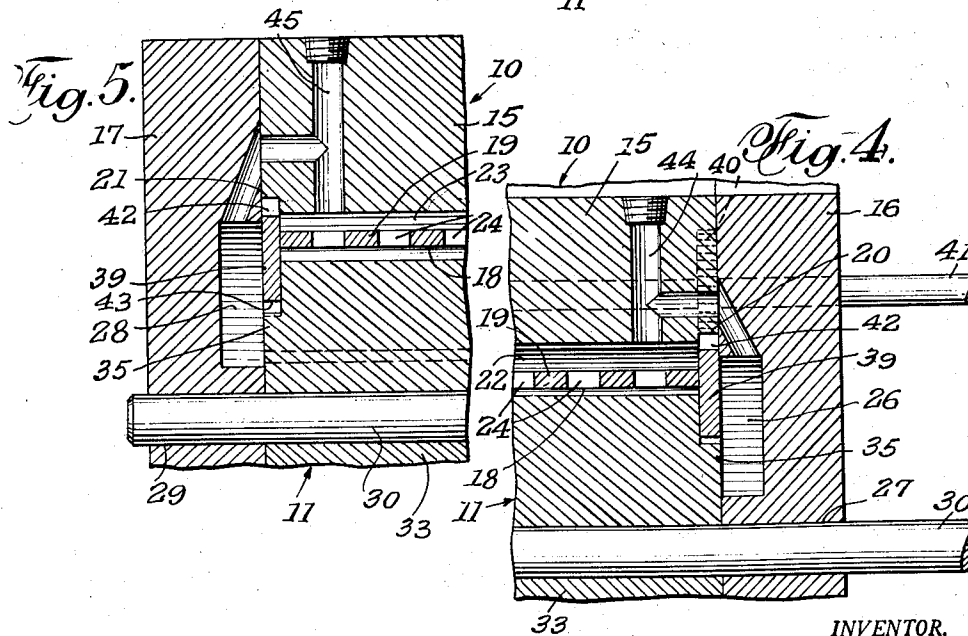
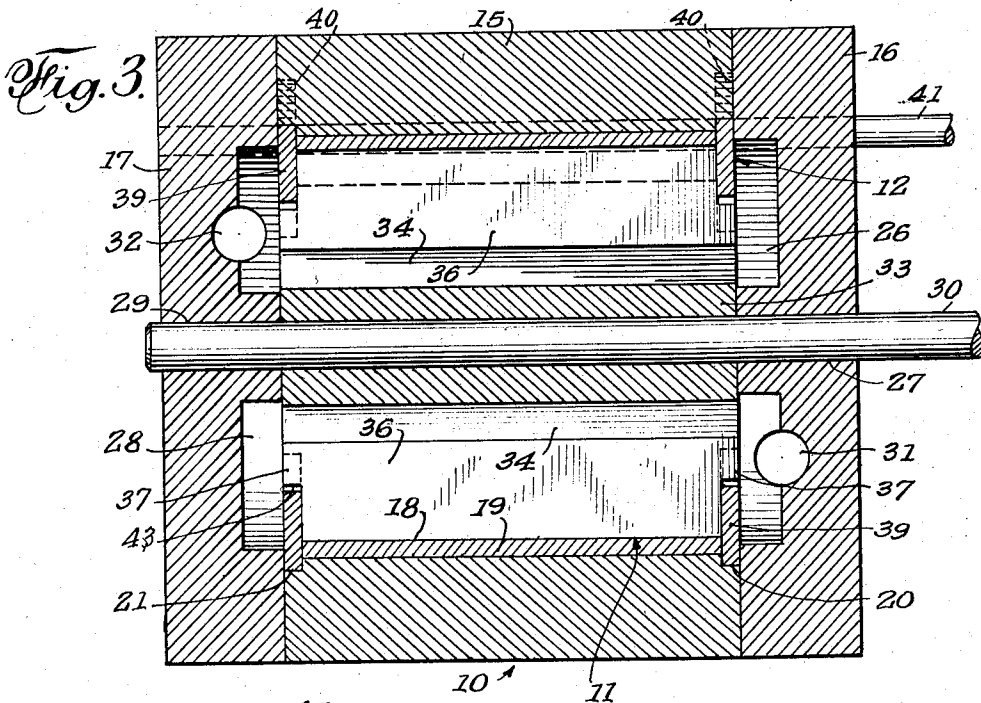
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VARIABLE VOLUME VANE PUMP

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9 Claims. (Cl. 103—120)

This invention relates to a variable volume vane pump and deals more particularly with a pump that can be adjusted to vary the output, as desired, while retaining a constant speed of operation.

There are many instances where it is desired to change the output of a pump while retaining a constant speed. The automotive field is one area of use of such pumps and their use in feeding fuel enables efficient engine speed regulation coupled with high operating efficiency. Further, constant speed-variable output pumps are useful wherever variations in the properties of fluids being handled affect efficiency of operation of machines, the same having adjustability to vary the output of such pumps at constant speeds.

In order to provide an efficient and highly satisfactory constant speed-variable output vane pump, it is an object of the present invention to provide novel control means for the pump vanes to vary their fluid-moving capacity, as desired.

Another object of the invention is to provide a vane pump of the character above referred to in which the means controlling the pumping position of the vanes is circumferentially adjustable, thereby enabling a relatively large adjustment increment while producing relatively smaller adjustment changes.

A further object of the invention is to provide a vane pump of the character described, the output or pressure of the pump being adapted to be utilized for effecting sealing pressure among the several parts.

The invention also has for its objects to provide such means that are positive in operation, convenient in use, easily installed in a working position and easily disconnected therefrom, economical of manufacture, relatively simple, and of general superiority and serviceability.

The invention also comprises novel details of construction and novel combinations and arrangements of parts, which will more fully appear in the course of the following description. However, the drawings merely show and the following description merely describes, one embodiment of the present invention, which is given by way of illustration or example only.

In the drawings, like reference characters designate similar parts in the several views.

Fig. 1 is an end view, with part of the housing removed, of a vane pump according to the present invention, the same being shown adjusted to maximum output capacity.

Fig. 2 is a similar view of said pump as adjusted to have a lower output capacity.

Fig. 3 is a cross-sectional view as taken on the plane of line 3—3 of Fig. 1 and including the housing part removed from Fig. 1.

Figs. 4 and 5 are fragmentary cross-sectional views as taken on the planes of the respective lines 4—4 and 5—5 of Fig. 1.

The pump that is illustrated comprises, generally, a housing 10, a vane-carrying rotor means 11 operatively disposed in said housing, and means 12 for adjusting the

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limit of the fluid-displacing positions of the vanes of the means 11 to provide volumetric variation of the pump output.

The housing 10 is shown as comprising a stator 15, and end caps 16 and 17 that respectively constitute the input and output ends of the housing.

The stator 15 is preferably provided with a through bore 18 of oval or elliptic form, as best seen in Figs. 1 and 2. In this instance, said bore is shown as comprising the inner face of a liner 19. At the ends of the stator, said bore 18 opens on circular concentric counterbores 20 and 21 that are quite shallow, as shown.

The stator is shown as provided with diametrically opposite inlet ports 22 and with suitably phased diametrically opposite outlet ports 23. Both pairs of ports 22 and 23 are formed to be longitudinally coextensive with the elliptical bore and opening thereinto. The liner 19, where the ports are disposed, is provided with a series of circumferentially arranged slots 24 (Figs. 4 and 5), the communication between bore 18 and the respective ports being through said slots.

As shown in Figs. 1 and 2, the four ports are in alternate arrangement and located on oblique lines between the long and short diameters of the elliptical bore. It will be understood that the present pump has two fluid-displacing portions between adjacent inlet and outlet ports and it will be clear that only one inlet and one outlet port may be provided, in which case the bore 18 would be elliptic where these ports are provided and cylindrically circular opposite the ports. In other words, the present pump has a dual pumping action in that opposite sides of the rotor means 11 are simultaneously displacing fluid.

The end caps 16 and 17 may be affixed to the stator 15 as by tie bolts 25 or other suitable means. The input cap 16 is formed to have an inlet chamber 26 that is concentric with a central bore 27. The output cap 17 is similarly provided with a chamber 28 and with a bore 29. Said bores 27 and 29 are aligned and constitute bearings for a drive shaft 30.

The chamber 26 has communication with an inlet line 31 and, similarly, the chamber 28 has communication with an outlet line 32. It will be noted that said chambers are directed and open to the stator bore 18.

The rotor means 11 is fitted into said stator bore 18 and comprises a rotor 33 affixed to the drive shaft 30 and of a diametral size to fit the small diameter of the bore 18. Said rotor 33 is shown with a set of longitudinal slots 34 that are uniformly spaced and, in this instance, shown as tangential to a small circle generated on the center or axis of the rotor shaft. Said slots open on the periphery of the rotor and also are open at the opposite ends of the rotor. Said opposite ends of the rotor 33 are diametrically reduced to form extensions 35. As shown, said slots are of such depth that the same cut into said extensions 35.

In each said slot is slidingly fitted a vane 36, the rotor thereby being provided with a set of vanes that, either centrifugally or by suitable spring means in the slots, are projected in a direction toward the bore 18 during rotation of the rotor means 11. The vanes are fully coextensive, longitudinally, with the rotor and are formed at the opposite ends to have extensions 37. Unless restrained, said vanes 36 will all be projected into contact with the bore 18—a condition that is shown in Fig. 1. It will be clear that, in such condition, the pump will operate in the usual way at maximum volumetric displacement of fluid between each inlet 22 and the respective outlets 23 into which the vanes displace the fluid. The space 38 defined between adjacent vanes and between the subtended portions of the bore and rotor

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defines a volumetric unit of displacement that is constant during operation of the pump when all of the rotor vanes are in rotor bore contact.

The means 12 is provided for controlling the projected positions of the vanes to, thereby, vary the volumetric displacement between the respective inlets and outlets of the pump. In this instance, said means 12 is shown as two similar plates 39 that fit the counterbores 20 in which they have bearing so as to be rotationally or circumferentially adjustable. Such adjustment may be effected through the medium of a pair of pinion gears 40 on a control shaft 41, and gear teeth 42 on the peripheral edge of each said plate 39 and in mesh with the teeth of said gears. Rotation of shaft 41 results in adjustable rotation of the plates 39.

Each plate 39 is formed to have an oval or elliptic opening 43 that has generally the same characteristics as the oval bore 18 except that opening 43 is smaller. The small diameter of opening 43 is such as to accommodate the mentioned extensions 35 of the rotor. Thus, recognizing the slight variations entailed in the tangential disposition of the vanes, the surface of oval bore 18 and the wall defining oval opening 43, when aligned, as in Fig. 1, are parallel or substantially so. It is this arrangement that permits full projection of the vanes while traversing the long diameter portions of the bore 18.

When this parallelism between the bore 18 and the opening 43 is destroyed by an angular shift of the plates 39, the extensions 37 of the vanes will encounter those portions of the walls defining the openings 43 that are aligned with the long axis of the bore 18. Thus, as shown in Fig. 2, as the vanes pass by these portions of the pump, they will be held retracted and thus spaced from the surface of bore 18. Depending on the degree of angular adjustment of the plates 39, one or more of the vanes may be thus held retracted. Fig. 2 shows a position in which two vanes are held so retracted. It will be clear, therefore, that these vanes do not have fluid displacement position and can achieve such a position only when they reach a portion of oval opening 43 that permits contact with the bore 18. In Fig. 2, the volumetric sizes of spaces 38a, being substantially smaller than the size of spaces 38, above described, cause a commensurately smaller fluid displacement toward outlets 23. It will be clear that the degree of circumferential adjustment of the plates 39 determines the pumping capacity of the rotor, and it is clear that said plates can be adjusted to a position where no pumping occurs since the respective inlets and outlets will be direct communications and none of the vanes will be in fluid displacing position.

While the inlets and outlets may be directed through the stator 15, it is preferred to bypass them to the chambers 26 and 23, respectively. To this end, each inlet port 22 is connected to chamber 26 by passages 44 and, thus, to inlet line 31, and each outlet port 23 is connected to chamber 28 and to outlet line 32 by passage 45. Therefore, at the outlet side of the housing, the chamber 28 contains pressure that is greater than on the inlet side. Said pressure is effective on the plate 39 on that side to produce a force that urges said plate in a direction to the plate 39 on the inlet side. Thus, any manufacturing tolerance clearances may be closed by effecting an endwise seal among the moving parts of the rotor. Of course, the plate 39, on the pressure side, is suitably mounted to effect such sealing.

While the foregoing has illustrated and described what is now contemplated to be the best mode of carrying out my invention, the construction is, of course, subject to modification without departing from the spirit and scope of the invention. It is, therefore, not desired to restrict the invention to the particular form of construction illustrated and described, but to cover all modifications that may fall within the scope of the appended claims.

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

1. A pump of the character described, comprising a stator having an oval bore and provided with two pairs of inlet and outlet ports opening on said bore and located on oblique lines between the major and minor axes of said bore, a cylindrically circular rotor coaxial with and disposed in the bore and of a diametral size to fit the minor axial width of the bore, a set of more than two sliding vanes carried by the rotor and projectable in a direction toward engagement with the oval bore to seal thereagainst, each vane having a lateral projection, and means having an oval opening therein rotationally adjustable on the axis of the rotor and the stator bore, whereby, when said oval bore and oval opening are axially aligned, the projections of the vanes are clear of said oval opening and all of the vanes are in sealing engagement with the entire oval bore, said aligned position of bore and opening constituting the maximum pumping position of the pump, whereby, when the bore and opening are axially angularly displaced, the projections of the vanes are held retracted and from engaging the bore by said oval opening during at least a portion of the travel of the vanes, and the number of the vanes so held retracted increasing to a maximum as the angular displacement approaches a perpendicular relationship between the oval pump bore and the oval opening.

2. A pump of the character described, comprising a stator having an oval bore and provided with two pairs of inlet and outlet ports opening on said bore and located on oblique lines between the major and minor axes of said bore, a cylindrically circular rotor coaxial with and disposed in the bore and of a diametral size to fit the minor axial width of the bore, a set of sliding vanes carried by the rotor and projectable in a direction toward engagement with the oval bore to seal thereagainst, a plate at each end of the rotor having an oval opening therein and coaxial with both the rotor and stator bore, said vanes being provided with extensions engaged with the walls of said openings to limit the projection of said vanes, and means to angularly adjust said plates on the axis of the rotor to change the axial relationship of the oval bore and the oval openings, whereby, when said bore and openings are axially aligned, the projections of the vanes are clear of said oval openings and all of the vanes are in sealing contact with the entire oval bore and, when said bore and openings are axially angularly displaced, the projections of the vanes are held retracted from engaging the bore by said oval openings during a portion of the travel of the vanes, the pump being adjusted to maximum pumping capacity when the oval bore and the oval openings are aligned, to a minimum pumping capacity when the oval bore and oval openings are perpendicular, and to a variable pumping capacity between minimum and maximum according to the degree of the angular adjusted positions of the bore and openings.

3. A pump of the character described, comprising a stator having an oval bore and provided with two pairs of inlet and outlet ports opening on said bore and located on oblique lines between the major and minor axes of said bore, a cylindrically circular rotor in the bore and of a diametral size to fit the minor axial width of the bore, a set of sliding vanes carried by the rotor and projectable in a direction toward engagement with the oval bore to seal thereagainst, a plate at each end of the rotor having an oval opening therein and coaxial with both the rotor and stator bore, said vanes being provided with extensions engaged with the walls of said openings to limit the projection of said vanes, and means to angularly adjust said plates on the axis of the rotor to change the axial relationship of the oval bore and the oval openings, whereby, when said bore and openings are axially aligned, the projections of the vanes are clear of said oval openings and all of the vanes are in sealing contact with the

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entire oval bore and, when said bore and openings are axially angularly displaced, the projections of the vanes are held retracted from engaging the bore by said oval openings during a portion of the travel of the vanes, the pump being adjusted to maximum pumping capacity when the oval bore and the oval openings are aligned, to a minimum pumping capacity when the oval bore and oval openings are perpendicular, and to a variable pumping capacity between minimum and maximum according to the degree of the angular adjusted positions of the bore and openings, the means to angularly adjust said plates comprising a control shaft, a pair of pinion gears carried by said shaft and rotational therewith, and gear teeth on the peripheries of the plates and engaged with said pinion gears.

4. A pump according to claim 2, said stator being provided with an end cap having a chamber therein and in communication with the outlet of the pump, passages connecting the outlet ports of the pump and said chamber to supply said chamber with outlet pressure, the plate at the end of the stator provided with said cap being subject to said pressure to urge the same into sealing engagement with the rotor.

5. A pump of the character described, comprising a stator having a bore that has the form of an oval that is defined by a major and a minor axis, an inlet and outlet port opening on said bore and located on oblique lines between said minor axis and the transverse major axis of the bore, a cylindrically circular rotor on an axis coincidental to the intersecting axes of the bore, the diameter of said rotor being the same as the length of such short axis, a set of more than two sliding vanes carried by the rotor and projectable in a direction toward engagement with the bore to seal thereagainst, and angularly adjustable means coaxial with the rotor and the stator bore engaged with the vanes to limit the projection thereof, whereby, when said bore and openings are axially aligned, the projections of the vanes are clear of said oval openings and all of the vanes are in sealing contact with the entire oval bore and, when said bore and openings are axially angularly displaced, the projections of the vanes are held retracted from engaging the bore by said oval openings during a portion of the travel of the vanes, the pump being adjusted to maximum pumping capacity when the oval bore and the oval openings are aligned, to a minimum pumping capacity when the oval bore and oval openings are perpendicular, and to a variable pumping capacity between minimum and maximum according to the degree of the angular adjusted positions of the bore and openings.

6. A pump of the character described, comprising a stator having a bore that has the form of an oval that is defined by a major and a minor axis, an inlet and outlet port opening on said bore and located on oblique lines between said minor axis and the transverse axis of the bore, a cylindrically circular rotor on an axis coincidental to the intersecting axes of the bore, the diameter of said rotor being the same as the length of such short axis, a set of sliding vanes carried by the rotor and projectable in a direction toward engagement with the bore to seal thereagainst, a plate at each end of the rotor having an opening therein smaller than and of the same axial characteristics of the bore, said vanes being provided with extensions engaged with the walls of said openings to limit the projection of the vanes, and means coaxial with the rotor and the stator bore to angularly adjust said plates on the axis of the rotor to change the axial relationship of the bore in the stator and the openings in the plates, whereby, when said bore and openings are axially aligned, the projections of the vanes are clear of said oval openings and all of the vanes are in sealing contact with the entire oval bore and, when said bore and openings are axially angularly displaced, the projections of the vanes are held retracted from engaging the bore by said oval openings during a portion of the travel of the vanes, the

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pump being adjusted to maximum pumping capacity when the oval bore and the oval openings are aligned, to a minimum pumping capacity when the oval bore and oval openings are perpendicular, and to a variable pumping capacity between minimum and maximum according to the degree of the angular adjusted positions of the bore and openings.

7. A pump of the character described, comprising a stator having a bore that has the form of an oval that is defined by a major and a minor axis, an inlet and outlet port opening on said bore and located on oblique lines between said minor axis and the transverse axis of the bore, a cylindrically circular rotor on an axis coincidental to the intersecting axes of the bore, the diameter of said rotor being the same as the length of such short axis, a set of sliding vanes carried by the rotor and projectable in a direction toward engagement with the bore to seal thereagainst, a plate at each end of the rotor having an opening therein smaller than and of the same axial characteristics of the bore, said vanes being provided with extensions engaged with the walls of said openings to limit the projection of the vanes, and means coaxial with the rotor and the stator bore to angularly adjust said plates on the axis of the rotor to change the axial relationship of the bore in the stator and the openings in the plates, whereby, when said bore and openings are axially aligned, the projections of the vanes are clear of said oval openings and all of the vanes are in sealing contact with the entire oval bore and, when said bore and openings are axially angularly displaced, the projections of the vanes are held retracted from engaging the bore by said oval openings during a portion of the travel of the vanes, the pump being adjusted to maximum pumping capacity when the oval bore and the oval openings are aligned, to a minimum pumping capacity when the oval bore and oval openings are perpendicular, and to a variable pumping capacity between minimum and maximum according to the degree of the angular adjusted positions of the bore and openings, the means to angularly adjust said plates comprising a control shaft, a pair of pinion gears carried by said shaft and rotational therewith, and gear teeth on the peripheries of the plates and engaged with said pinion gears.

8. A pump of the character described, comprising a stator having an oval bore and a concentric circular counterbore at each end of the oval bore, the stator being provided with two pairs of inlet and outlet ports opening on said bore and located on oblique lines between the major and minor axes of said bore, a cylindrically circular rotor coaxial with and disposed in the bore and of a diametral size to fit the minor axial width of the bore, said stator being provided with a concentric annular shoulder at each end and in respective alignment with the mentioned counterbores, a set of sliding vanes carried by the rotor and projectable in a direction toward engagement with the oval bore, a circular plate in each counterbore and having an oval opening therein, the mentioned annular shoulders of the stator extending into said oval openings and said openings each having a diameter on its minor axis of the same size as said annular shoulders, the proportions of the oval bore in the stator and the oval openings in said plates being substantially alike, extensions on the opposite ends of the vanes and engaged in said oval openings of the plates to limit projection of said vanes, and means to angularly adjust both plates simultaneously to change the axial relationship of the oval bore and the oval openings, whereby, when said bore and openings are axially aligned, the projections of the vanes are clear of said oval openings and all of the vanes are in sealing contact with the entire oval bore and, when said bore and openings are axially angularly displaced, the projections of the vanes are held retracted from engaging the bore by said oval openings during a portion of the travel of the vanes, the pump being adjusted to maximum pumping capacity when the oval bore and the oval openings are

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aligned, to a minimum pumping capacity when the oval bore and oval openings are perpendicular, and to a variable pumping capacity between minimum and maximum according to the degree of the angular adjusted positions of the bore and openings.

9. A pump according to claim 8 in which said stator is provided with an end cap having a chamber therein and in communication with the outlet of the pump, passages connecting the outlet ports of the pump and said chamber to supply said chamber with outlet pressure, the plate at the end of the stator provided with said cap being subject to said pressure to urge the same into sealing engagement with the rotor.

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