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ROTARY BLOWER

Filed March 28, 1942

3 Sheets-Sheet 1

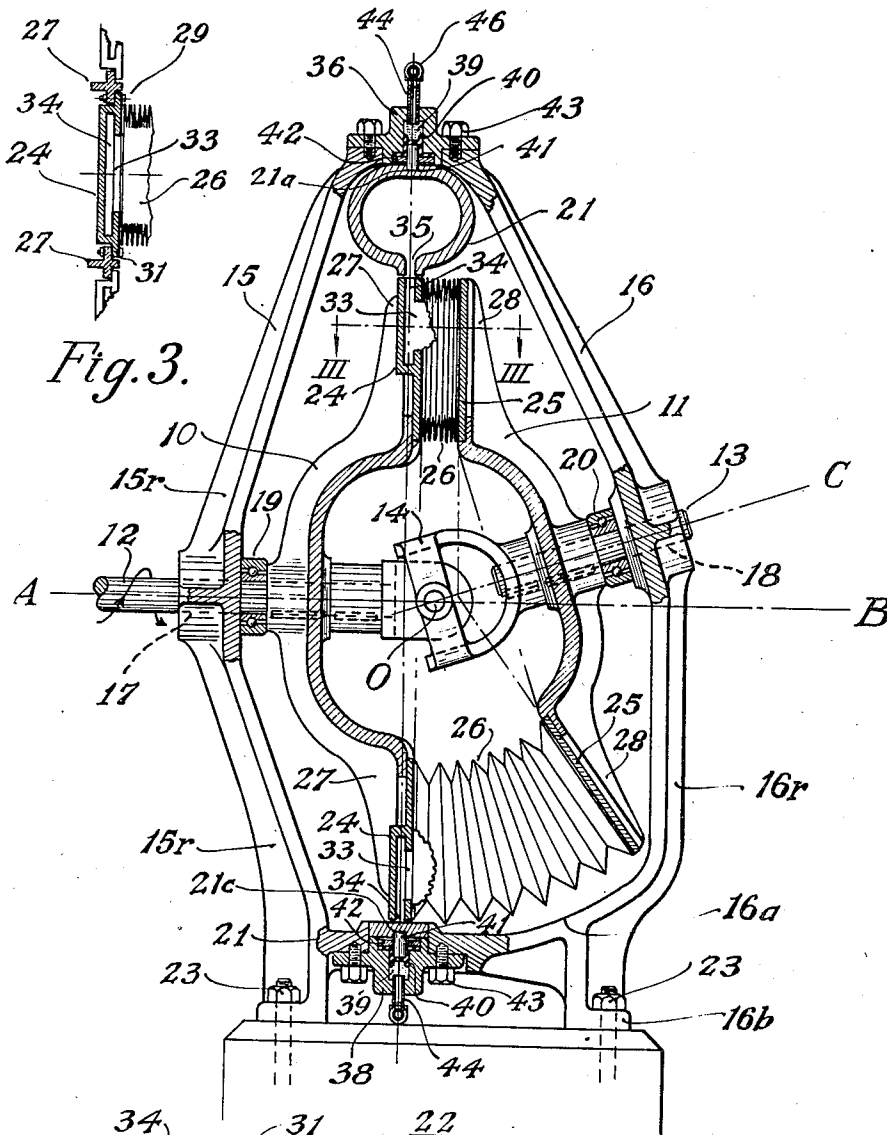


Fig. 1.

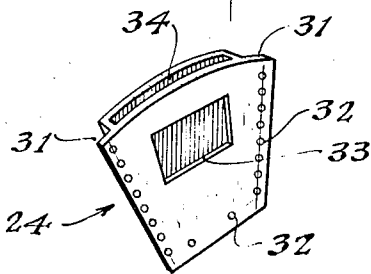


Fig. 4.

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3 Sheets-Sheet 3

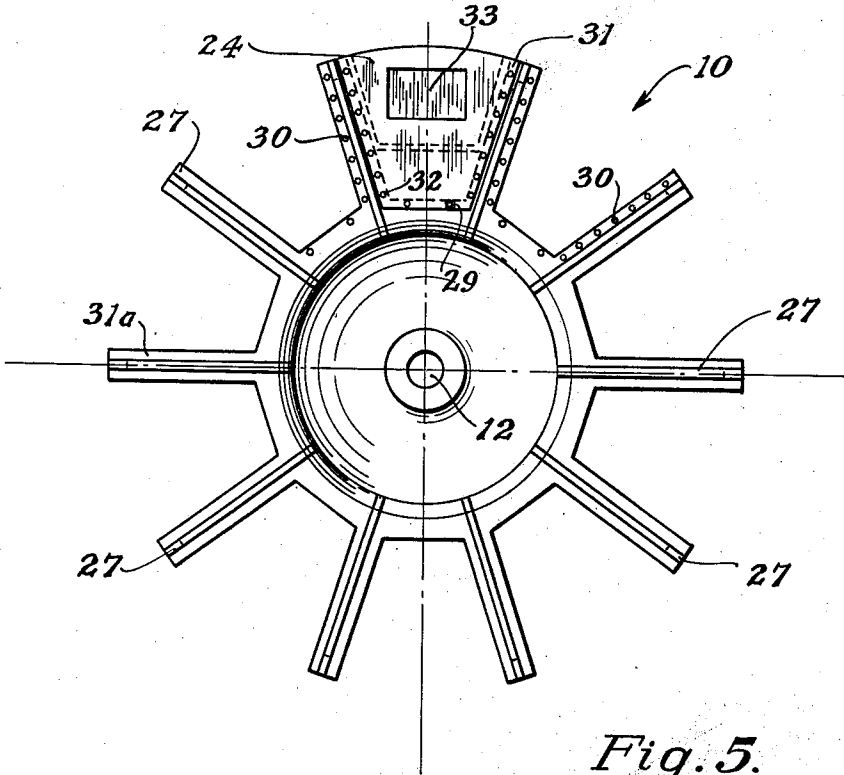


Fig. 5.

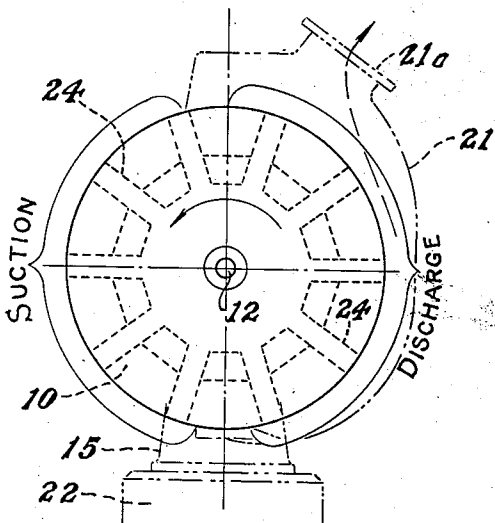


Fig. 6.

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UNITED STATES PATENT OFFICE

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ROTARY BLOWER

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12 Claims. (Cl. 230-168)

The present invention relates to fluid displacement devices and more particularly to an improved rotary bellows type blower.

A number of prior attempts have been made to provide rotary blowers based upon the positive displacement effect of collapsible bellows units mounted between elements which rotate upon angularly inclined shafts such that the bellows-carrying units alternately approach and recede from each other during each revolution. A number of these prior devices have not proven commercially satisfactory for such reasons that the bellows were subjected to unusual operating conditions, no provisions were made for their ready removal for repair or replacement, the porting and manifold arrangements were not efficient or satisfactory, and for numerous other reasons. The present invention relates to such bellows type rotary blowers in which an improved arrangement of the bellows unit and their carrying elements as well as to an improved manifold; and other features are provided which eliminate substantially all of the previous objections and attain an improved result.

It is accordingly a major object of the present invention to provide an efficient rotary blower comprising easily replaceable bellows units carried upon rotary elements which rotate on inclined or oblique axes. It is a further object of the present invention to provide such a blower in which the bellows are subjected only to the expanding and collapsing forces necessary for their suction and compression of the air or gases and in which the rotor elements are driven one from the other by means of a universal joint.

It is a still further object of the present invention to provide a rotary displacement device in which the bellows units discharge radially outwardly into an arcuate manifold which encloses the bellows units through an arcuate angle approximating a semi-circle. Another object resides in the provision of a novel mounting arrangement for such a manifold in which it is supported peripherally upon a plurality of hydraulically actuated pin or plunger supports which each urge the manifold radially inwardly with equal pressures toward the rotating bellows units to compensate for wear and for fitting and adjusting purposes.

Other objects and advantages of the present invention will become apparent to those skilled in the art after a reading of the present description and the accompanying drawings forming a part hereof, in which;

Fig. 1 is a transverse sectional view of a preferred form of our rotary bellows device;

Fig. 2 is an elevational view of the said rotary bellows device;

Fig. 3 is a sectional view of a bellows port unit and support taken along the lines III-III of Figure 1;

Fig. 4 is a perspective view of one of the bellows units;

Fig. 5 is a side elevational view of the spider element to which the port units of Fig. 4 are attached to form a flat disc rotor;

Fig. 6 is a diagrammatic view indicating the operating cycle of the present device; and

Fig. 7 is a detailed sectional view of the master cylinder of the hydraulic pressure system.

Referring now to Fig. 1 a flat disc rotor 10 is fixedly mounted upon the horizontal drive shaft 12 in opposed relationship to the part-conic disc rotor 11 similarly mounted by a suitable key or feather upon the inclined or oblique shaft 13. The drive shaft 12 is horizontally supported within the blower device and is driven from any suitable power source about the axis A-B. The inner end of the shaft 12 is keyed to an element of the universal joint 14 and the other element of the universal joint is similarly keyed to the inner end of the inclined driven shaft 13. The universal joint 14, which is indicated diagrammatically, is preferably of the constant velocity type in which the shafts 12 and 13 are rotatably interconnected in precise synchronism throughout each complete revolution without the whip or asynchronous condition developed in the dead-center position in certain types of universals. The latter type of universal imparts a twisting effect upon the bellows units due to the whipping condition referred to and has an undesirable effect upon the life and wear of the bellows.

The rotary device is supported and contained within the two upright frame or support members 15 and 16. Each frame comprises essentially a vertically tapering member converging toward each other at the top of the device and having centrally located hub portions forming the journals 17 and 18 for the shafts 12 and 13, respectively. The frames 15 and 16 are each provided with outwardly tapering arm portions extending from their respective hub portions and converging laterally at the side of the device. In order to take up the outward thrust exerted by the compression between the rotors 10 and 11 there are provided thrust type anti-friction bearings 19 and 20 which in turn bear outwardly against the

hubs of the supports 15 and 16 respectively. The inclined driven shaft 13 rotates about the oblique axis OC, the point O being the center of the universal joint 14 at the intersection of the oblique axis and the horizontal axis A—B.

Referring to both Figs. 1 and 2, it will be noted that the support 15, referred to as providing the journal 17 for the horizontal shaft 12, is a vertically tapering pedestal frame with suitable stiffening ribs 15r, having a flanged base 15b. This frame 15 extends upwardly and outwardly from its base, where it is anchored to a suitable foundation 22 by means of the bolts 23, to its central hub or journal portion 17 from which it has an arm portion extending laterally and inwardly toward the intermediate or side pressure unit 37 to be more fully described below. The frame 15 also continues upwardly and inwardly in a tapering arm portion which terminates adjacent the upper pressure unit 36. The opposite frame support 16 is generally similar to 15 except that it has an arcuate lower portion 16a to accommodate the distended bellows at the bottom of the rotative cycle and extends vertically to its hub portion 18 which provides an inclined journal, at a somewhat higher position than the journal 17, for the accommodation of the oblique shaft 13. From the hub 18 the frame 16 has similar vertically and laterally extending arms which terminate adjacent the corresponding arms of frame 15 to receive the pressure units 36 and 37 respectively.

Each of the rotors or bellows-carrying units 10 and 11 is constructed in the form of spiders having oppositely curved inner portions to provide clearance for the universal joint 14, and radially extending outer arms defining flat and conic disc surfaces respectively. The flat rotor disc 10 is shown in Fig. 5 and a description of its construction will also suffice for the rotor 11 which differs only in that its faces are part-conic and also with respect to its bellows attachment details. As shown in Fig. 5 the rotor 10 has an outwardly dished inner portion from which extend radially outwardly, in a plane perpendicular to the axis of the shaft 12, a plurality of spider arms 27. These arms are cross-shaped in section and provide flanges 31a and ribs 31 which are suitably apertured as at 30 to accommodate the bolts 29 for fastening the flanges 31 of the bellows attachment units 24 thereto.

The bellows units 26 are preferably formed of rubber, of synthetic rubber, or similar flexible materials being of an accordion or pleated construction to permit rapid extension and contraction and to withstand rapid and continuous flexing with a minimum of fatigue and wear. The bellows units are preferably segmentally shaped in cross-section with radial sides and arcuate peripheries to permit bonding by vulcanizing, cementing or other suitable means for fastening their end faces to the ported attachment unit 24 and to the flat segmental attachment plate 25. The ported attachment units 24 are more clearly shown in the perspective view in Fig. 4 and comprise mainly a radially flanged chamber portion having a radially outwardly facing port 34 and a lateral opening 33 open to the interior of the bellows. The side flanges 31 and the inner edge are suitably drilled as at 32 to align with the matching holes 30 of the spider arms 27 for their attachment by the bolts 29. The opposite end of each bellows 26 is bonded to a flat plate 25 which is similarly drilled and shaped as the opposed ported plate 24, the flat plate 25 being

bolted to corresponding flanged ribs 23 of the conic spider 11. It will be noted from Fig. 1 that the radial lines extending inwardly from the flat plates (of which ten are shown in the preferred embodiment), intersect the oblique axis OC at a point, slightly displaced from center O, and which point is the apex of the frusto-conical spider portion 28 and also the apex of the frustum of the polygonal pyramid formed by the ten flat attachment plates 25, which in effect form a rotor assembly which is herein referred to as part-conical.

Between the side supports 15 and 16 and the periphery of the flat disc rotor 10 there is disposed the manifold 21. This manifold is semi-circular or C-shaped in side elevation and extends from the lower side of the rotor 10 where the rotors are spaced at their maximum around the side adjacent the side pressure unit 37 and terminates at the top where the rotors are most closely spaced in the region of the top pressure unit 36. The manifold 21 has an arcuate portion of minimum radial depth at the bottom closely spaced from the ports 34 of the lower bellows unit and gradually increases in radial depth as it extends around the rotor 10 in a counter-clockwise direction as viewed in Fig. 2. The cross-sectional appearance of the manifold is generally C-shaped with its open slot portion 35 aligned with and closely spaced from the ports 34 of the bellows units 24 as more clearly seen in Fig. 1. The manifold 21 increases to its maximum cross-sectional area in the region of its outwardly extending discharge outlet 21a which is shown flanged in Fig. 2, but may be of any suitable screwed or other type for connection to the piping or duct system. The manifold is maintained in its proper relationship by the fluid-actuated piston pins 41, carried by the hydraulic pressure units 36, 37 and 38, which pistons engage radially disposed cylindrical bores 21a, 21b and 21c located in the outer periphery of the manifold the axes of the upper and lower piston pins 41 are aligned vertically preferably in the plane passing through the centers of the port 35 in the manifold and the ports 34 of the upper and lower bellows port units 24. The axis of the side pin 41 in the pressure unit 37 also preferably lies in the same vertical plane at the elevation of the axis A—B and perpendicular to the vertical axis passing through the upper and lower pins 41.

The hydraulic pressure units 36, 37 and 38 are each substantially identical and a description of the upper unit 36 as shown in section in Fig. 1 is considered will be sufficient for an understanding of the others. The upper unit 36 comprises a body having an internal fluid chamber 39 in which is disposed an elastic diaphragm or seal 40 embracing the piston 41 and having an outwardly extending flange which is retained within the body 36 by means of the packing lock nut 42. The diaphragm 40 is preferably formed of an elastic synthetic rubber compound such as known by the trade names of Thiokol or Neoprene and the like which are not adversely affected by contact and use with the hydraulic fluid such as the oils which are commonly used in brake and other hydraulic pressure systems and with which oil the system is filled and operated. It will be noted that the pressure units 36, 37 and 38 are each attached directly to the support frame members 15 and 16 by the bolts or attachment screws 43 and that the manifold 21 is supported solely in an inwardly spaced relationship from the enclosing frame and pressure units by the pistons 41

engaging the cylindrical holes 21b, 21c and 21d on which pistons it is floatingly supported by the pressure exerted by the hydraulic fluid.

The fluid chambers 39 of each of the pressure units are in communication by means of the short pipes 44 and the elbow 45 and T's 46 with a fluid feed pipe 47 interconnected by the Y-branch or lateral fitting 63 with the main feed pipe 48 which communicates with the master pressure unit 49 as shown in Fig. 2. The T-fitting 46 adjacent the upper pressure unit 36 is in communication with the capped filling reservoir 64 preferably disposed at the highest point in the fluid system. The master pressure unit 49 is shown in detail in the cross-sectional view in Fig. 7, and comprises a fluid chamber 51 in which is disposed a flexible diaphragm 52 embracing the piston 53 attached at 57 to the inner end of the threaded stem 54 threaded rotatably within the bonnet element 55. This bonnet in turn is screw-threaded into the body 49 and serves to retain the flanged portion of the diaphragm 52 beneath the ring washer 58. A handle 56 is attached to the upper end of the stem 54 for manual operation and it will be seen that rotation of the stem results in increase or decrease in the fluid pressure within the system to adjust the clearance between the inner periphery of the manifold 21 and the outer periphery of the rotating elements. The body of the pressure unit 49 is preferably flanged and drilled as at 61 for fastening by means of the attachment screws 62 to a suitable supporting bracket 50. The pipe 48 is in communication with the fluid chamber 51 and is preferably attached to the lock nut 59 and sealed by the packing 60.

The rotary blower device is operated as follows, after it is suitably mounted as by the foundation bolts 23 upon a suitable concrete or other base 22 and a motor or other suitable power source is coupled to the shaft 12 for the rotation indicated by the arrows in Figs. 1, 2 and 6. As viewed in Figs. 2 and 6 this rotation is counterclockwise, the ports 34 of the port units 24 are open to the atmosphere on the left side of the machine for somewhat less than 180° or almost half of the rotative cycle from the uppermost position where these units emerge from the manifold 21 down to the bottom where they are sealed for a short period by the blanked portion of the manifold at the bottom of the device adjacent the bottom pressure unit 38.

It will be seen from Fig. 1 that as the porting units 24 emerge from the manifold 21 at the top the bellows units 26 to which they communicate have just been completely collapsed and have discharged the remainder of their contents of air or fluid since this is the point in the rotative cycle at which the flat disc rotor 10 and the conic disc 11 approach each other to the closest extent. As each bellows unit is rotated from the top to its lower sealed position the discs 10 and 11 progressively recede from each other, pulling the ends of the bellows apart after the fashion of an accordion and air is sucked into the exposed ports 34. This part of the cycle is accordingly the suction stage and by the time the port 34 enters the closely adjacent sealing portion of the manifold 21 at the bottom the bellows unit has been filled to its extended or maximum capacity by the air sucked in during the preceding 140 to 145 degrees of the suction cycle. As the leading portion of the port 34 passes beyond the sealing position of the manifold the discs 10 and 11 start again to approach each other and compression taking place within the contracting bellows causes dis-

charge to start into the lower portion of the manifold interior. As the bellows unit continues upwardly past the horizontal center-line of the device discharge takes place progressively into the increasing cross-section of the manifold, this discharge being assisted by the centrifugal effect imposed upon the mass of air within the bellows due to its speed of rotation. The air which is discharged flows along in the direction of the short arrows with a minimum of turbulence and pressure loss due to the progressively increased cross-sectional area of the manifold, as a result of the inertia imparted by the rotation of the bellows units and aided by the relatively great length of the ports 34 in the rotative discharge plane as compared to their width in the axial direction. This air is accordingly discharged under pressure through the outlet 21a beyond which compression within the bellows gradually ceases and changes slightly beyond the top dead center whereupon suction is again initiated at the start of the ensuing cycle. It will accordingly be seen that relatively gradual and progressive suction and discharge stages are afforded the bellows units eliminating any sudden filling or emptying which would have a detrimental effect upon the fatigue and life of the bellows material. This arrangement further provides a smooth and uniform discharge free from periodic blasts or pulsations. Obviously when other than free or ambient air is handled by the device a suitable suction manifold, to which the fluid would be suitably piped or fed, could be utilized. Under certain conditions where it might be desirable to convert the kinetic energy of the flowing mass of air into pressure a suitable series of diffusing vanes can be provided within the discharge manifold in a manner well known in the art. Such an arrangement would be utilized in charge-forming or in the induction systems of internal combustion engine installations where the supercharger is interposed between the carburetor and the engine.

In order to maintain the abutting face of the manifold adjacent its port 35 closely spaced from the corresponding faces of the inlet and discharge ports 34 and to compensate for the wear of these faces, the entire manifold is adjustably or floatingly supported at three points by the hydraulic-actuated piston pins 41 which bear radially inwardly against the manifold. As wear, or the need for adjustment occurs, rotation of the pressure control screw 54 produces increased pressure within the chamber 51 of the master pressure cylinder 49. This pressure is transmitted equally to each of the pressure units 36, 37 and 38 through the conduits 47 and 48 and the branch pipes 44 from the fittings 45 and 46 into the fluid chambers 39 of the pressure units. Since the areas of the pistons 41 and their contacting flexible diaphragms are identical the pressure is maintained and exerted equally in the axial directions of each of the three radially directed pistons. The hydraulic fluid within the system is replenished or filled on release of the control screw 54 by pouring into the capped reservoir 64. A suitable pressure gauge (not shown) can be provided to indicate the pressure within the cylinder at all times. The manifold 21 and the bellows port units are preferably made of the same material, or materials of the desired characteristics such that they will both wear uniformly.

The arrangement of the present device is such that the replacement of any individual bellows is greatly facilitated. It is merely necessary to ro-

tate the moving assembly until the particular bellows is moved outside the supporting frame away from the manifold, preferably in the region of the start of the suction cycle. The attachment bolts 29 are then removed freeing the bellows supporting plates 24 and 25 from their respective spider arms 27 and 28 of the rotors 10 and 11. The bellows 26 may then be collapsed slightly and removed radially outwardly. This procedure is reversed in installing the new bellows unit.

Other modifications of the present invention, for which a preferred form has been shown and described for illustrative purposes only, whether as to general arrangement or specific details, are each intended to come within the scope and spirit of the invention as more particularly defined in the appended claims.

We claim:

1. The combination with a fluid displacement device comprising, a flat rotor, a part-conic rotor, a frame rotatably supporting said rotors for rotation on oblique axes, bellows oppositely attached to said rotors and a manifold adjustably supported between said frame and one of said rotors adapted to conduct fluid displaced from said bellows of hydraulic means supported from said frame adapted to provide said adjustable support for said manifold with respect to one of said rotors.

2. The combination with a fluid displacement device, comprising a transverse flat faced rotor, a part-conic faced rotor, bellows units attached to the opposed faces of said rotors, means for rotating said rotors on oblique axes, porting means communicating with each said bellows and a manifold contiguous to said porting means for receiving fluid displaced by said bellows units of hydraulic means carried by said fixed means movable with respect to one of said axes for the adjustable support of said manifold with respect to said porting means.

3. In a fluid displacement device of the type provided with bellows units carried between rotors having obliquely disposed axes, a manifold having an arcuate inlet closely spaced from the periphery of said bellows units and hydraulic pressure means adapted for the adjustment of said spacing between said bellows units and said manifold inlet.

4. The combination with a fluid displacement device of the type provided with bellows units carried between rotors having obliquely disposed axes, a frame embracing said rotors and bellows units adapted for their rotatable support, and a manifold adjustably supported from said frame adapted to receive fluid displaced from said bellows units of hydraulic means supported by said frame movable with respect to one of said rotors adapted to provide the said adjustable support for said manifold with respect to said bellows units.

5. In a fluid displacement device of the type provided with a plurality of bellows units detachably carried between opposed elements rotatable upon oblique axes, a frame embracing said bellows units and elements, journals in said frame for the rotatable support of said rotatable elements, each said bellows unit provided with radially outwardly directed ports and manifold means inwardly supported from said frame to receive the radially outwardly displaced fluid in the plane of said outwardly directed ports.

6. In a fluid displacement device of the type provided with a plurality of bellows units detach-

ably carried between opposed elements rotatable upon obliquely disposed axes, a frame having journals for the rotatable support of said rotatable elements, one of said elements having attachment portions lying in a plane normal to its axis of rotation, porting means communicating with each said bellows unit detachably carried upon each said attachment portion and a manifold having an arcuate port contiguous to said porting means for receiving fluid displaced from said rotating bellows units.

7. In a fluid displacement device, a rotor having attachment portions lying in a plane normal to its axis of rotation, a second rotor rotatable on an axis intersecting said first axis having attachment portions inclined to its axis of rotation, a plurality of ported bellows units having their ends attached to the opposed attachment portions of each said rotor, a frame having bearing means for the rotational support of said rotors upon their respective oblique axes, means for rotating said rotors whereby each said bellows unit is compressed and extended during each revolution, and peripherally disposed manifold means contiguous to each said bellows port during substantially all of its compressive cycle.

8. In a fluid displacement device, a rotor having attachment portions lying in a plane normal to its axis of rotation, a second rotor rotatable on an axis intersecting said first axis having attachment portions inclined to its axis of rotation, a plurality of bellows units having their ends attached to the opposed attachment portions of each said rotor, a frame having bearing means for the rotational support of said rotors upon their respective obliquely disposed axes, porting units carried upon said first rotor in communication with each said bellows unit, and a discharge manifold contiguous to said porting units having its inlet lying in a plane normal to the axis of rotation of said first rotor.

9. In a device of the type described, a transverse disc rotor, a part-conic rotor, a frame for the journalling support of said rotors on oblique intersecting axes, individual compression units carried upon the alternately approaching and receding faces of said rotors, an arcuate manifold peripherally disposed adjacent said compression units during their approaching portion of the rotative cycle and a plurality of hydraulic piston units supported upon said frame adapted to urge said manifold toward the periphery of said transversely rotating disc rotor.

10. In a device of the type described, a transverse disc rotor, a part-conic rotor, a frame for the journalling support of said rotors on oblique intersecting axes, individual compression units carried upon the alternately approaching and receding faces of said rotors, an arcuate manifold peripherally disposed adjacent said compression units during their approaching portion of the rotative cycle, a plurality of hydraulic piston units supported upon said frame adapted to urge said manifold toward the periphery of said transversely rotating disc rotor, and a manually adjustable master cylinder communicating with each said hydraulic piston unit for the transmission of equal control pressures to each said hydraulic unit.

11. In a fluid displacement device of the type provided with a plurality of bellows units detachably carried between opposed elements rotatable upon oblique axes, a frame embracing said bellows units and elements, journals in said frame for the

rotatable support of said rotatable elements, each said bellows unit provided with radially outwardly directed ports and arcuate manifold means inwardly supported from said frame to receive the radially outwardly displaced fluid in the plane of said outwardly directed ports, said arcuate manifold means being circumferentially interrupted to permit intake of fluid into said outwardly directed bellows ports.

12. In a fluid displacement device of the type provided with a plurality of bellows units detachably carried between opposed elements rotatable upon oblique axes, a frame embracing said bel-

lows units and elements, journals in said frame for the rotatable support of said rotatable elements, each said bellows unit provided with radially outwardly directed ports and arcuate manifold means inwardly supported from said frame to receive the radially outwardly displaced fluid in the plane of said outwardly directed ports, said bellows ports being open to the atmosphere between the arcuate terminals of said manifold during a portion of their rotational cycle to permit fluid intake thereinto.

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