Dec. 7, 1937. E. A. CUNY 2,101,428

ROTARY FLUID DISPLACEMENT DEVICE

Filed May 1, 1935 2 Sheets-Sheet 1

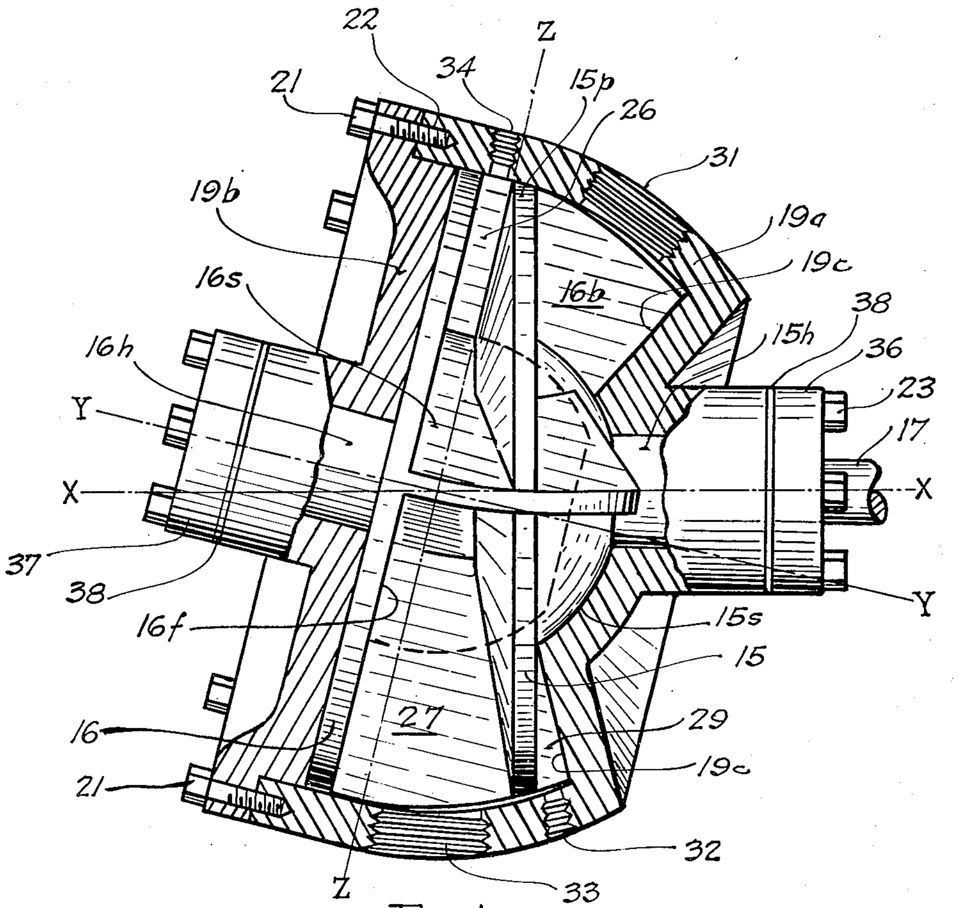

FIG. 1.

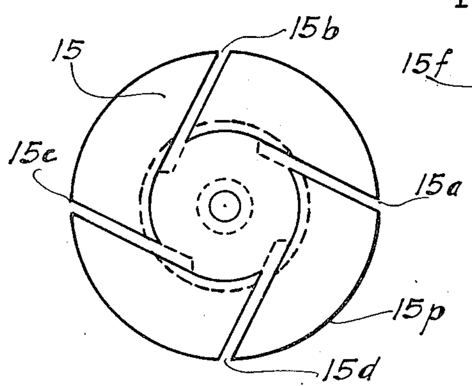

FIG. 6.

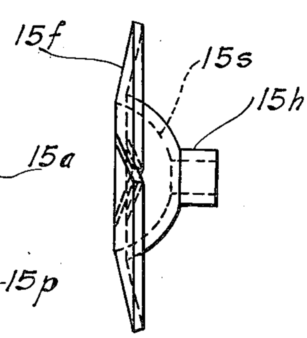

FIG. 5.

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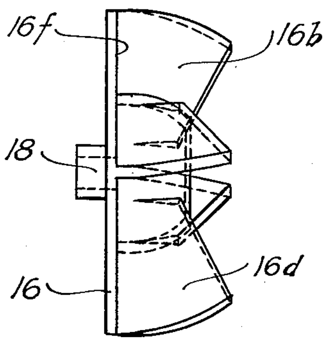

FIG. 3.

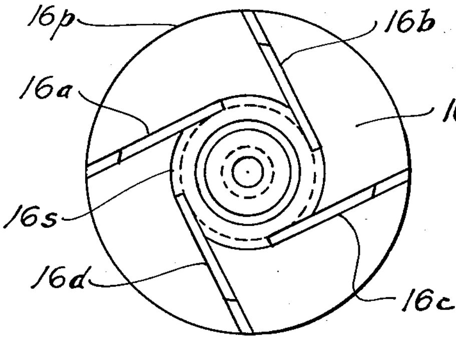

FIG. 4.

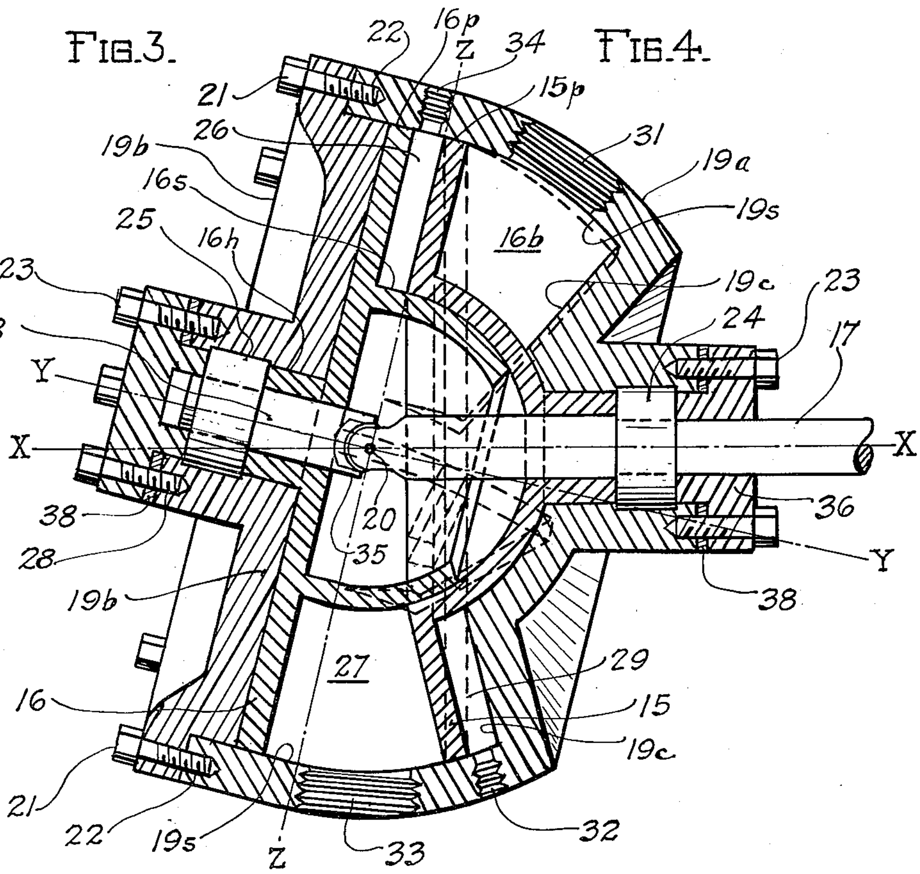

FIG. 2.

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UNITED STATES PATENT OFFICE

2,101,428

ROTARY FLUID DISPLACEMENT DEVICE

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Application May 1, 1935, Serial No. 19,191

10 Claims. (Cl. 103—127)

This invention relates to rotary fluid displacement devices.

It is desirable in compressing, delivering, or exhausting gases, in pumping liquids or in creating and maintaining vacuums, that a machine producing these results be of the positive-acting rotary type, simple and economical in construction with a minimum of moving parts, relatively free from friction, noise and wear, efficient in operation over a wide range of rotational speeds, and adapted to be direct-connected to a motor or other power drive source at the standard operating speed of the latter without the need of intermediate speed reduction means.

A considerable number of designs have been proposed for rotary compressors, pumps and the like, but none have met with any degree of success due principally to the fact that when they are operated at even moderate speeds the friction developed causes excessive heating and for this reason they are usually required to be run in oil and are accordingly limited to those applications where the use of oil is not objectionable. My invention overcomes these objections and obtains all of the above mentioned desirable results.

A preferred embodiment of this invention comprises essentially two obliquely disposed shafts interconnected and rotatably driven one from the other through a universal joint, one of the shafts carrying a slotted conical disc and the other shaft carrying a flat disc with integral blades perpendicularly disposed thereon and engaging said slots in the first mentioned disc, all being housed within a casing having a substantially spherical chamber and ports through the same, such that rotation of the elements within the casing causes alternate compression and expansion of the chambers defined by the oscillating blades, disc faces and casing thereby resulting in suction and compression of the fluid therewithin. It further provides a second or additional stage of compression, obtained by extending the blade ends through the conic disc slots to positions proximate to a fixed conic surface formed within the casing, this additional stage being operable in series, parallel or independently of the first mentioned stage.

The present invention relates to devices of the type described wherein two rotatable elements are adapted to provide within a single fixed casing two separate stages of compression, the elements being universally but positively coupled such that the blades of one are maintained centrally of the slots of the other, the blades being so disposed that compression of the fluid is augmented by centrifugal effect. My co-pending application Ser. No. 32,371, filed July 20, 1935, being a continuation in part of the present application, relates to improvements in the blades and relative porting and baffling in devices of this type.

It is therefore an object of this invention to provide a positive-acting rotary machine capable of use either as a gas compressor or blower, liquid delivery or a vacuum pump, fluid meter or a like fluid displacement device which is simple and enocomical of construction and with a minimum number of readily accessible parts. It is a further object to provide a machine of the type described which will be relatively devoid of friction, noise and wearing of parts and which will be valveless. It is a further object to provide a device which will be efficient in operation over a relatively wide range of rotational speeds, and operable at the relatively high speeds of the driving motor or other source of power to which it may preferably be direct-connected without the necessity of intermediate speed reduction means.

It is also an object to provide such a machine which requires relatively low starting torque when put into operation against a relatively high pressure on its discharge end or a comparatively low pressure on its suction end. It is a further object to provide a machine which is flexible of arrangement and readily adapted to multi-stage operation both in series relationship for increase in discharge or suction pressures and in parallel relationship for increase in discharge or suction volumes. It is a further object to provide such a machine which is comparatively small in size and space occupied compared with existing similar machines with equal output or capacity. It is a further object to provide a device of this nature, which is self-priming when used as a liquid pump. It is another object to have the device capable of rotation in either direction thereby preventing damage or inoperativeness due to faulty operation.

It is also an object to provide a device of this nature having but two rotating elements within a fixed casing. It is a further object to provide such a device having a second stage of compression between one of the rotating elements and the said fixed casing. It is also an object to provide such a device having a relatively high volumetric efficiency.

Other objects and advantages of this invention will be apparent to one versed in the art in the course of the following description; all of which is understood to be within the scope of this invention and as more clearly enumerated in the subtended claims.

In the accompanying drawings, forming a part of this description, and in which like numerals are employed to designate like or similar parts throughout the same,

Fig. 1 is a plan, cross-sectional in part of a fluid displacement machine embodying this invention, with the rotating elements shown in full;

Fig. 2 is a cross-sectional plan of the same, but with its rotating elements shown in section;

Fig. 3 is a side elevation of the bladed disc element;

Fig. 4 is an end elevation of the same;

Fig. 5 is a side elevation of the slotted conical element; and

Fig. 6 is an end view of the same element.

Referring to Fig. 1, the fluid displacement machine comprises essentially two rotating disc elements, 15 and 16, keyed or otherwise fixedly mounted upon their respective shafts 17 and 18 respectively and adapted to be driven simultaneously and at the same speed within a fixed casing, 19, comprising the two casing portions 19a and 19b. Disc 16 is circular in shape, as more clearly shown in Fig. 4 and has a flat working surface 16f, exposed to the fluid, which surface lies in a plane perpendicular to the axis Y—Y of the shaft 18 to which the disc is attached. Disc 15 is substantially conical in shape as shown in Fig. 5, and has a conical working surface 15f exposed to the fluid, and opposedly positioned with respect to the corresponding surface 16f of disc 16, which working surface 15f of disc 15 forms a portion of a conical surface having an axis X—X corresponding to that of its attached shaft 17, the apex of the said cone coinciding with the said extended axis X—X of shaft 17 at a point where the extended axis Y—Y of the obliquely disposed shaft 18 preferably intersects that of shaft 17. This point of axes intersection 20 preferably forms the normal center of rotation of the universal joint 35, or other flexible coupling means connecting the obliquely disposed shafts 17 and 18 and causing them to rotate in unison when either is driven from any suitable power source outside the casing too well known to those acquainted with the art to be further described. Shaft 17 is journalled in a thrust type roller bearing 24 mounted in the casing 19, and shaft 18 is similarly journalled in a similar bearing 25 mounted in the opposite side of the casing 19b.

The inner surface of the casing 19 designated by 19s exposed to the fluid, and more specifically that portion of the inner surface within which the periphery 15p or edge of disc 15 is caused to rotate, forms a spherical surface the center of which is the center point 20 above referred to. The angle formed by the axes of the shafts 17 and 18, which is determined by the angularity of the conical disc 15, preferably causes the working surfaces 15f and 16f of both discs to be substantially parallel along their laterally extending radial center lines. In other words the sides of the space 26 defined by the tangent portions of the disc working faces are substantially parallel at the horizontal plane through which the section of Fig. 1 was taken, and this relationship is maintained at this point throughout the complete cycle of the rotating assembly. The inner surface of the casing adjacent to the disc 16 is preferably straight or cylindrical as indicated and is tangent to the spherical portion along the line of the plane indicated by Z—Z.

Due also to the oblique relationship of the shafts 17 and 18, the oppositely extending portion of the working face 16f of the flat disc 16 is a comparatively greater distance from the opposed portion of the like face 15f of the conic disc 15 than it is at the upper portion, and forms a comparatively open angle instead of being parallel, resulting in the space 27 being considerably greater in area than the diametrically opposite space 26 and similarly the volumes of the spaces so represented likewise vary considerably.

The flat disc 16 is provided with a cylindrical and spherical hub portion 16s which is spherical and concentric with the surface 19s and has a similarly cylindrical portion adjacent to the disc 16 and having as its axis Y—Y. The disc 16 is further provided with blades 16a, 16b, 16c, and 16d extending perpendicularly from the working face 16f of the disc and tangentially disposed with respect to the cylindrical portion of the hub 16s thereof and equally spaced at angles of 90 degrees from each other. The outer or tip portions of these blades have both cylindrical and spherical surfaces conforming to the particular cross-sectional outlines of the inner faces 19s of the casing portion 19a having also Y—Y for their axis and point 20 for their center. The inner ends of these blades 16a, 16b, 16c and 16d terminate in the hollow spherical hub portion 16s, which is further adapted to form the wall portion of a ball and socket joint of which the hub portion 15s of the conic disc forms the female or socket portion. This ball and socket joint 15s—16s forms a housing for the universal coupling 35 which connects the obliquely opposed ends of shafts 17 and 18 and is adapted to prevent leakage of the compressed fluid into the housing or to prevent the oil or grease with which the coupling 35 may be lubricated from escaping into the fluid spaces indicated by 26 and 27 in addition to forming a contact surface over which the two discs oscillate with respect to each other. Both discs are also provided with hub portions 15h and 16h which are keyed in a suitable manner to their respective shafts 17 and 18 journalled within the casing 19 by bearings 24 and 25.

The conic disc 15 has four slots 15a, 15b, 15c and 15d extending in substantially tangential directions from the spherical part of its hub 15s and through its entire working face portion from the said hub to its circumference or periphery 15p. These slots or openings are positioned and dimensioned in width such that the blades 16a, 16b, 16c and 16d are adapted to reciprocate or oscillate therein with a minimum of friction and fluid leakage between the blade and slot surfaces which clearances are determined by the nature or characteristics of the particular fluid which is to be handled in the device. This reciprocatory movement of the blades within their respective slots is caused by the blades being rotated about an axis which is oblique to the rotational axis of the slots and results in the plane of a given blade face being intersected by the conic surface in a line which is of varying angularity with respect to the working surface 16f of the flat disc 16 depending upon the angular position of the said blade about its rotational axis Y—Y of the attached shaft 18. This angular reciprocation of a given blade within its slot completes one cycle, consisting of one opening and one closing movement of the enclosed chamber 26, during one complete revolution of the shafts 17 and 18. The closed, or compressed relationship of the disc faces represented by the space 26, and their open position indicated by 27, always remain in these relative positions, opposite to each other, and fixed with respect to the casing 19a regardless of the angle of revolution about the rotational shaft axes X—X and Y—Y, because these axes remain fixed.

In the particular embodiment shown in Fig. 1, selected for illustrative purposes only, all rotational torque for turning the flat disc 16 is derived thereby from its attached shaft 17, which may be driven in the usual manner from any suitable power source, is transmitted entirely through the universal coupling 35, there being no torque or other rotary forces imposed upon the blades of disc 16 by the slotted portion of the disc 15 in the embodiment shown.

The ends of the casing housing the shafts 17 and 18 are sealed or made tight against leakage due to pressure within the casing by means of suitable stuffing box bonnets or end plates 36 and 37 which are additionally provided with suitable gaskets 38 and are attached to casing 19 by the usual tap bolts 23 engaging tapped holes 28 in the hub portions of the casing sections 19a and 19b. The casing halves 19a and 19b are similarly bolted together by means of the tap bolts 21 passing through holes near the circumference of the casing portion 19b and engaging the tapped or threaded holes 22 in the open end of the casing portion 19a. The casing 19a is provided with a suction connection 31 and a discharge connection 32 for supplying and discharging fluid from that stage of the machine defined by the back or concave portion of the conic rotating element 15 and the conic surface 19c of the casing 19a which latter surface 19c has as its axis the extended axis Y—Y of the shaft 18 housed within the other portion 19b. The casing portion 19a is further provided with a suction connection 33 and a discharge connection 34 for supplying and taking the discharged fluid from that stage of the machine defined by the working faces of the two rotating discs 15 and 16.

In operation, we will first consider the compression of the fluid within the single stage portion of the device as defined by the discs 15 and 16 and the four blades or partitioning members 16a, 16b, 16c, 16d. Suction and discharge pipes are suitably connected to the threaded ports 33 and 34 respectively and the fluid is led into and fills the compartment 27. This space or compartment formed between the casing surface 19s and the hub 16s and between the angularly opposed working faces 15f and 16f of the respective discs is at this point in the position of maximum angularity of the disc faces and consequently the position of greatest volume of the compartment 27. As the shaft 17 is caused to rotate in either direction, carrying with it the attached disc 16, and the integral blades and hub of the latter, the space 27 with its enclosed fluid is moved past a point where one of the two blades, depending upon direction of rotation, will pass beyond the inlet port 33 thereby preventing further passage of fluid into or from the compartment 27.

During the first-half revolution the surface 15f moves from its position of maximum angularity with surface 16f, substantially equivalent to twice the angle at which the axes X—X and Y—Y intersect, or twice the angle YOX, to the position diametrically opposite indicated by the space 26, where it is parallel to the face 16f and tangent at the line Z—Z. During this 180 degree angular rotation of the moving assembly, the volume of the space 27 has correspondingly decreased to that of space 26 and the fluid held therewithin between the same two blades or partitioning members has been compressed to a greater pressure than that at which it had entered through the port 33. As the maximum compression is reached the foremost or leading blade passes beyond the discharge port 34 permitting the compressed fluid to be forced into the discharge pipe.

As the rotation continues on the last half of its cycle or complete revolution the compartment gradually increases in volume permitting the residual fluid, which was not discharged, to expand or reduce in pressure until the leading blade again passes beyond the suction port 33 at which point the pressure within the compartment will be less than the pressure prevailing within the suction pipe, thereby causing additional fluid to enter until the two pressures are substantially equal and the trailing blade again cuts off the supply to the compartment at which time the cycle is started again.

In a somewhat similar manner the fluid entering the suction port 31 is compressed between the back or concave side of the disc 15 which also serves as a working face, and the conic surface 19c of the casing portion 19a which latter surface is positioned and shaped to provide the proper clearance for the edges of the blades 16a, 16b, 16c and 16d. In this stage of compression fluid is compressed between a rotating conic disc and a fixed conic disc the blades not being fixed to either. A given point on any given blade surface will follow an oscillating or reciprocating path back and forth from the disc slot of its respective blade, or if near the middle of the blade surface it will pass through the slot twice during each revolution. As in the first described stage the fluid is similarly discharged from chamber 29 through the port 32.

When both of the above mentioned stages are used, compression will be taking place on one side of a given portion of the disc face 15 while expansion will be taking place on the opposite side. The suction and discharge ports 31—32—33—34 have been shown in Fig. 1 within the horizontal plane which passes through both shaft axes, but they can obviously be located either above or below this plane in order to cut off the suction or discharge to suit any particular condition of operation or fluid characteristic for which the device may be designed.

When used as a gas compressor at high rotational speeds the clearances between the moving parts may be made sufficiently large to keep friction and heat within reasonable limits and the leakage due to greater clearances is relatively small due to the comparatively large output or delivery.

For use as a liquid pump the angularity of the conic disc 15 and obliquity of the shafts 17 and 18 is made comparatively small and the ports are preferably made oval shaped or longer in the direction of rotation and positioned such that the suction and discharge will take place throughout comparatively longer portions of the operating cycle, and expansion and compression will be reduced to a minimum. In a modification of this device for such use the conic disc 15 is preferably replaced by a flat disc similarly slotted to receive the blades of the other flat disc.

As a gas compressor when it is desired to use but one of the two stages the other stage is preferably plugged at its ports and the gas therein will be alternately expanded and contracted with a minimum expended energy, as the expansion in one compartment assists in the compression in the diametrically opposite compartment. Both stages may be operated in parallel in the same system or independently in different systems.

In a modification of my invention the fluid will first be compressed in the chambers open to suction port 31 and discharged directly into the suction port 33 of the second stage 27—26 for additional compression. The disc 15 is preferably shaped and positioned in this modification such that the volume of chamber 30 is substantially greater than that of chamber 27 in order that excessive expansion does not occur in delivering the gas thereto avoiding excessive pressure drop and maintaining a greater overall pressure differential between the suction pressure at port 31 and the final discharge pressure at port 34.

A modification of my device comprises a rotary fluid meter by substituting any suitable revolution counting device for the rotational means. Rotation of the meter is caused by the flow of the fluid therethrough, the volume of displaced fluid per revolution having computed or measured suitably registered on a dial in a manner well known to the art. It is also contemplated in this and other modifications that each rotating element be alternately slotted and bladed such that each will carry both slots and blades complementary to the opposed element.

My invention is not limited to the embodiment shown which has been merely selected for illustrative purposes only. It may be provided with 3 or more blades and the blade carrying member may be in the form of a conical disc similar to the slotted disc where greater ratios of compression and greater volumetric efficiency is desired. In other modifications both rotating discs may be either flat or plane surfaced, spherical or any spheroid of revolution in shape, or any combination of either of these shapes.

In another modification the universal joint may be dispensed with and the rotational torque transmitted from either disc through the blades engaging the disc slots. In still another modification the discs may be driven separately and at the same speeds from opposite sides of the casing.

While I have shown but one of the many possible modifications of my fluid displacement device, it will be understood that the shape and arrangements of the elements may be varied considerably to suit particular conditions and it is intended that they all be considered as being within the scope and spirit of this invention.

What I claim is:

1. In a fluid displacement device, a rotatable element having blades thereon, a casing having a chamber within which the said element is adapted to rotate, the said casing having a conic portion forming a part of said chamber and opposed to and having the same axis as the said rotatable element such that the edges of the said blades are adapted to rotate contiguously thereto, a rotatable conic element having slots through which the said blades are adapted to reciprocate, the said conic element having a separate axis intersecting the first said axis, inlet and outlet ports in the casing between the said conic portion thereof and the said conic element, inlet and outlet ports between the first said element and the said conic element, and means adapted to rotate the said rotatable elements whereby fluid is caused to be drawn in through the said inlet ports and discharged through the said outlet ports.

2. In a fluid displacement device, a rotating bladed element, a rotating slotted element adapted to have the said blades reciprocate within the slots thereof, a casing having a spherical chamber within which the said elements are journalled and adapted to rotate on separate axes, the said axes intersecting within the chamber, inlet and outlet ports in the said casing, the said blades and slots being tangentially disposed with respect to the said axes of their respective elements, and flexible coupling means positioned at said axes' intersection adapted to cause rotation to be imparted from one of the said elements to the other such that when either element is caused to rotate fluid supplied to the said inlet port is caused to be discharged under increased pressure through the said outlet port.

3. In a fluid displacement device, a rotating bladed element having a hollow spherical hub, a rotating slotted element adapted to have the said blades reciprocate within the slots thereof, the said slotted element having a hollow spherical hub adapted to engage the hub of the first mentioned element, a casing having a spherical chamber within which the said elements are journalled and adapted to rotate on separate axes, the said axes intersecting within the chamber, inlet and outlet ports in the said casing, the said spherical hubs of the said elements being adapted to form a ball and socket joint about which the said elements are adapted to oscillate, the said blades and slots being tangentially disposed with respect to their respective spherical hubs, flexible coupling means positioned at said axes' intersection and within said ball and socket joint, whereby rotation may be transmitted from one of said elements to the other such that when either element is caused to rotate, fluid supplied to the said inlet port is caused to be discharged under increased pressure through the said outlet port.

4. A fluid displacement device comprising two elements rotatable about separate intersecting axes, a casing within which said elements are journalled for rotation, each of said elements having spherical hub portions adapted to form a ball and socket joint, one of the said elements carrying a plurality of blades extending tangentially from its hub portion, the other of said elements having slots tangentially disposed with respect to its hub portion, the said blades being adapted to reciprocate within the said slots upon rotation of the said elements, ports in the said casing, and means for rotating the said elements.

5. In a fluid displacement device, elements rotatable about separate oblique axes, a casing within which said elements are journalled for rotation, each of said elements having spherical hub portions adapted to oscillatably engage each other, one of said elements having a plurality of partitioning members extending tangentially from its hub portion, another of said elements having openings tangentially disposed with respect to its hub portion, the said members being adapted to oscillate within the said openings upon rotation of the said elements, the said axes intersecting at the center of the said engaged hub portions, suction and discharge ports in the said casing, and means to impart rotation to one of the said elements.

6. In a fluid displacement device, elements rotatable about separate oblique axes, a casing within which said elements are journalled for rotation, each of said elements having hollow spheri-

cal hub portions adapted to oscillatably engage each other, one of said elements having a plurality of blades extending tangentially from its hub portion, another of said elements having slots tangentially disposed with respect to its hub portion, the said blades being adapted to oscillate within the said slots upon rotation of the said elements, flexible coupling means connecting the said elements positioned within the said engaged hub portions, ports in the said casing, and means to rotate one of the said elements.

7. In a fluid displacement device, a rotatable element having a plurality of blades tangentially disposed thereon, a casing having a chamber within which the said element is adapted to rotate, the said chamber being defined by an internal spherical portion of the said casing and a portion opposed to the said element, edges of the said blades being adapted to rotate in close proximity to the said casing portions, a second rotatable element having slots through which the said blades are adapted to reciprocate, the said second element being disposed within the said casing between the said opposed portion thereof and the first said element, the two said elements being adapted to rotate on separate intersecting axes, inlet and outlet ports in the casing adapted to form a compression stage between the two said elements, inlet and outlet ports in the casing adapted to form a second compression stage between the second said element and the said opposed casing portion, and means to rotate the said elements whereby fluid may be drawn in through the said inlet ports and discharged through the said outlet ports.

8. In a fluid displacement device, a casing having a chamber defined by spherical and opposed end surfaces, an element journalled for rotation in the said casing adjacent the first of the said end surfaces, a second element having slots and journalled for rotation within said casing intermediate the said end surfaces thereof, blades carried by the first said element and adapted to reciprocate in said slots and rotate in close proximity to the spherical and opposed end surfaces of said casing chamber, ports in the said casing adapted to form fluid compression stages between the said elements and between the second said element and second said end surface, and means to rotate the said elements.

9. In a fluid displacement device, a casing having a chamber defined by spherical and opposed end surfaces, a rotatable element journalled for rotation in the said casing remote from one of the said end surfaces, a second element having slots and journalled for rotation within said casing and being disposed between the first said element and the said remote end surface, the said remote end surface being generated about the extended rotational axis of the first said element, partitioning means extending through the said slots and adapted to rotate with the said elements about the axis of the first said element and in relatively close relationship with the said spherical and remote end surfaces of said casing chamber, ports in the said casing adapted to form fluid displacement chambers on either side of the second said element, and means to rotate the said elements.

10. A fluid displacement device comprising at least two spaced elements rotatable about separate axes, the said axes intersecting at a point intermediate the two elements, the said elements having opposedly disposed blades and slots tangentially arranged with respect to the axis of their respective elements, a casing defined by a concentric outer portion and opposed end portions, the concentric portion having the said point as its center of development, each of the said end portions having one of the said axes as its normal central axis of development, a plurality of inlet and outlet ports extending through the said casing, and means to rotate the said elements whereby the blades of one are caused to oscillate within the slots of the other and fluid displacement is developed from within the spaces between the elements and between at least one of the elements and its adjacent end portion.

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