

Dec. 18, 1934.

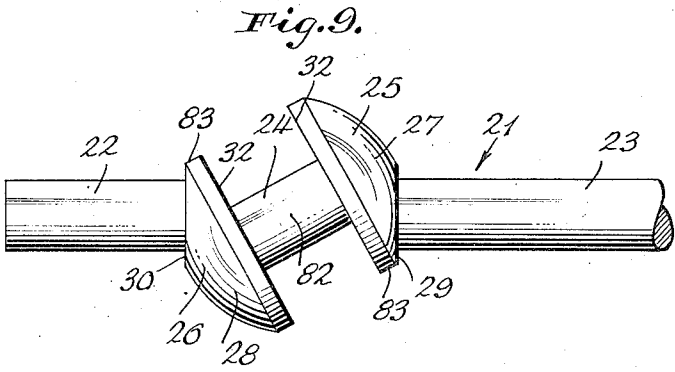
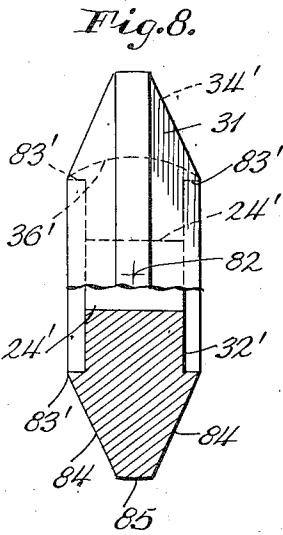
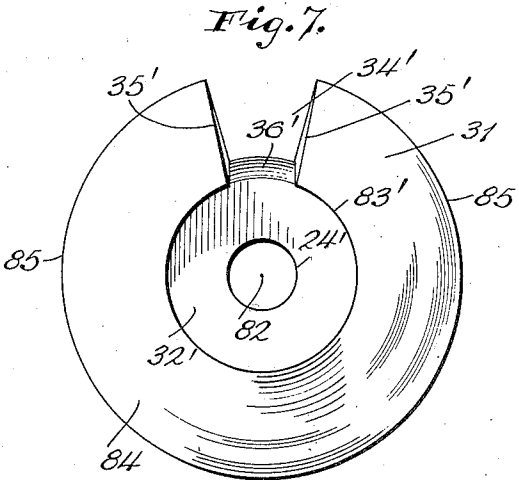
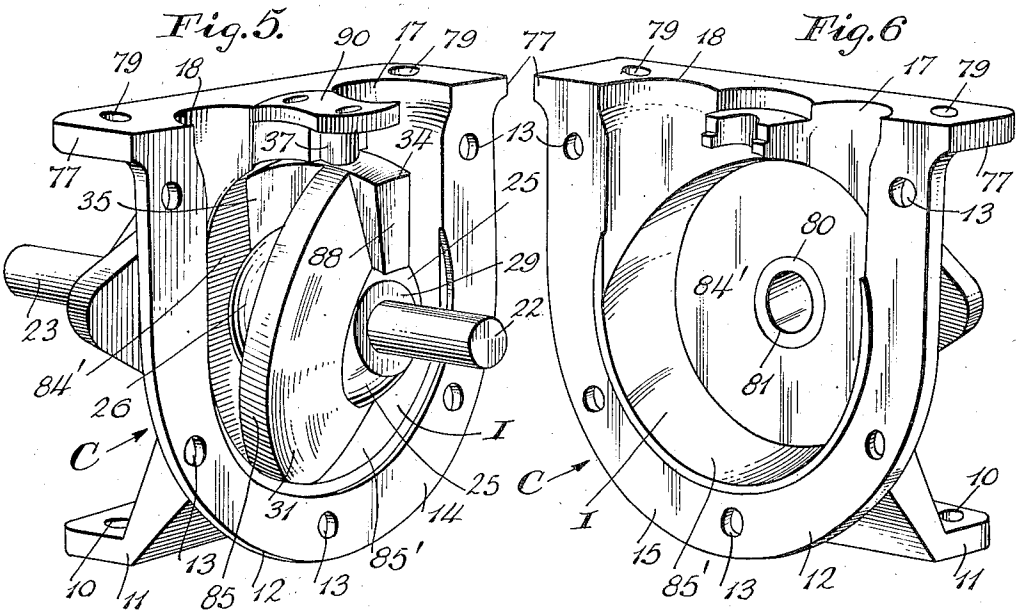
A. WICHA

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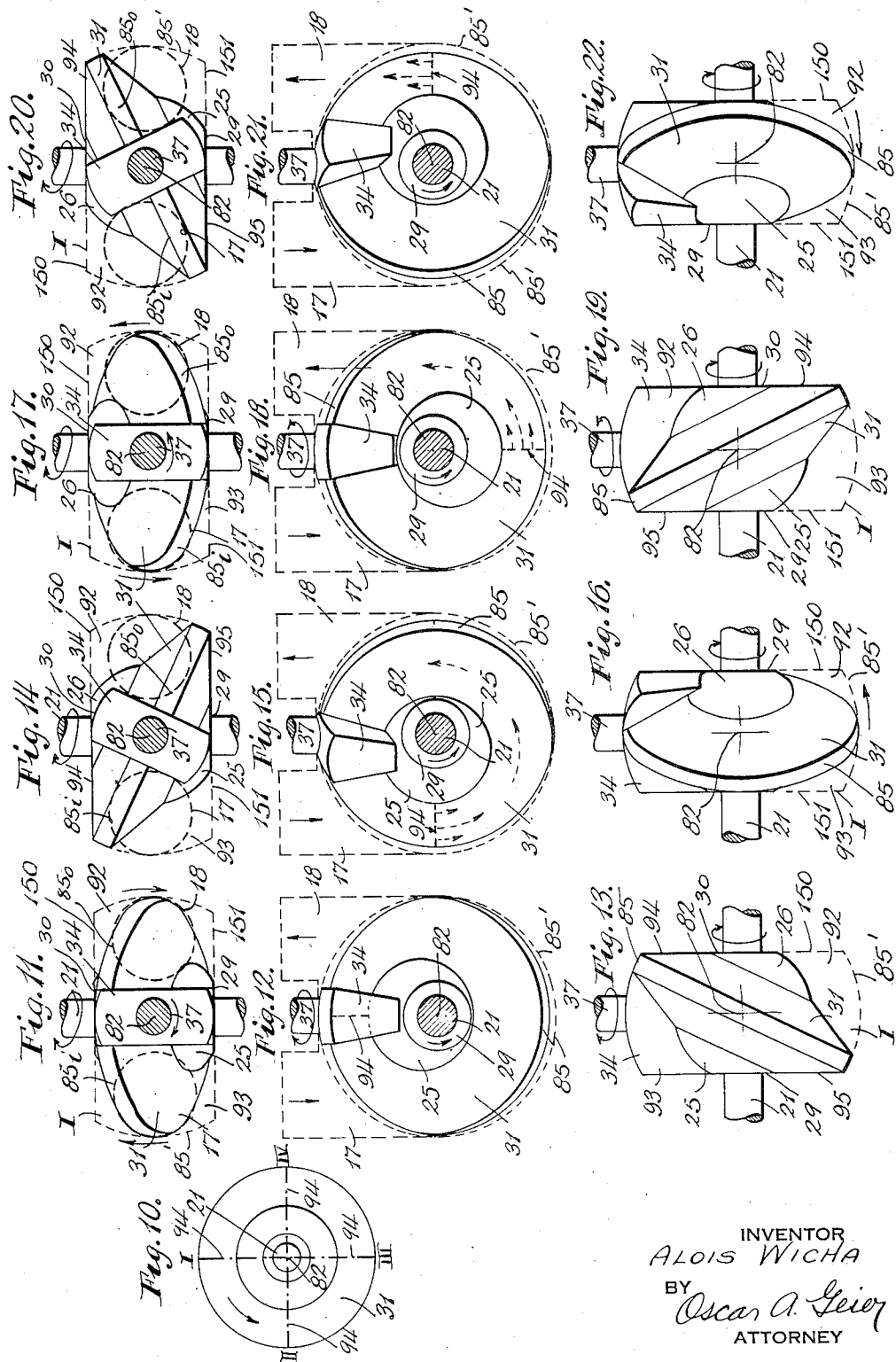
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7 Sheets-Sheet 3



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Fig. 23.

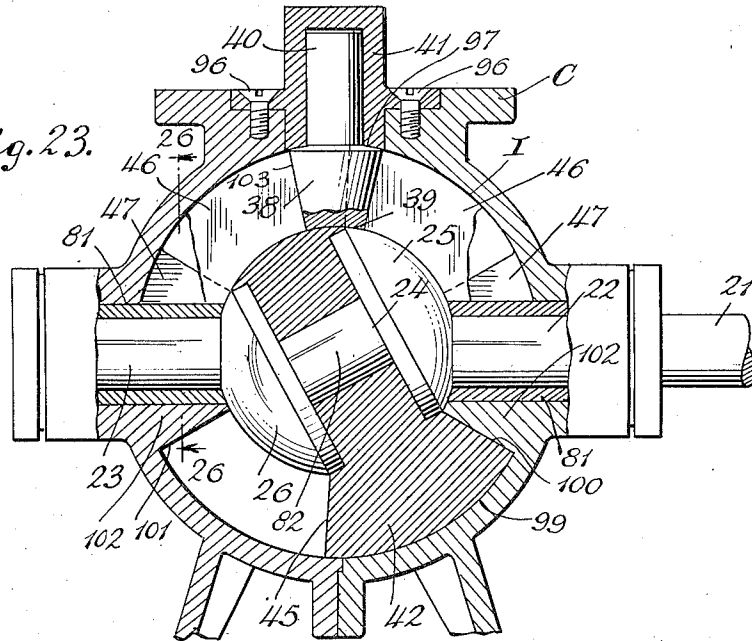


Fig. 25.

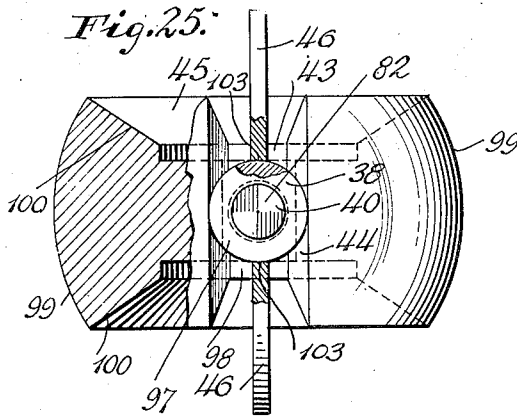


Fig. 24.

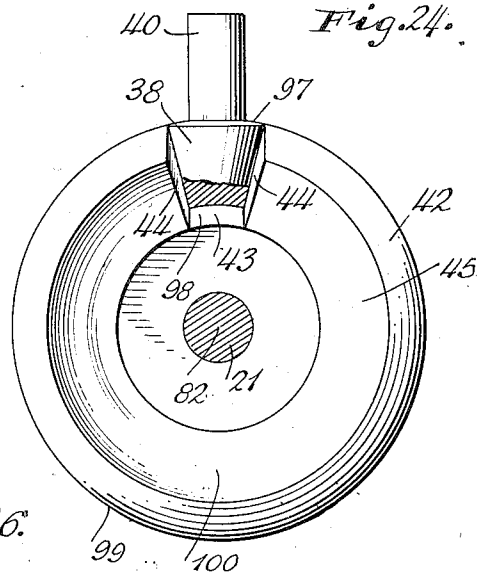
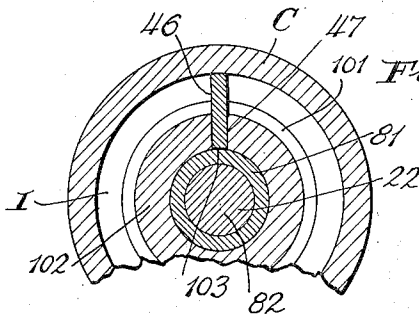


Fig. 26.



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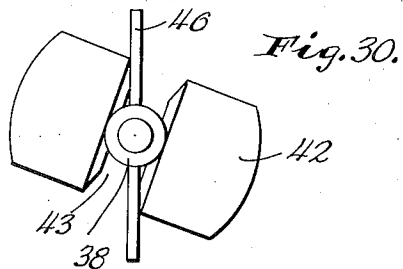
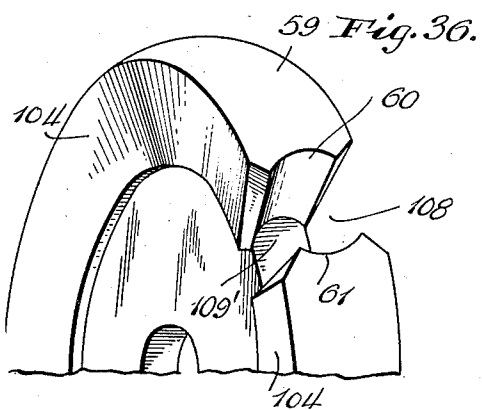
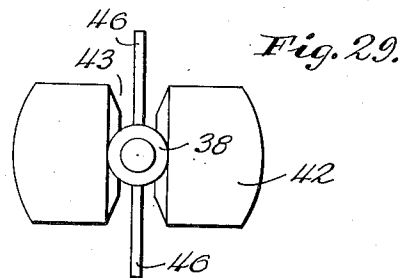
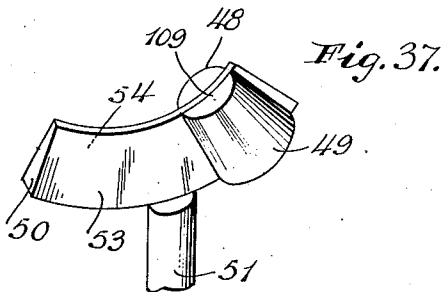
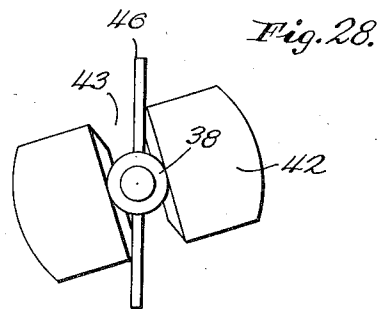
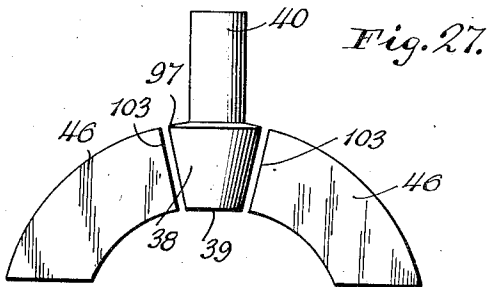
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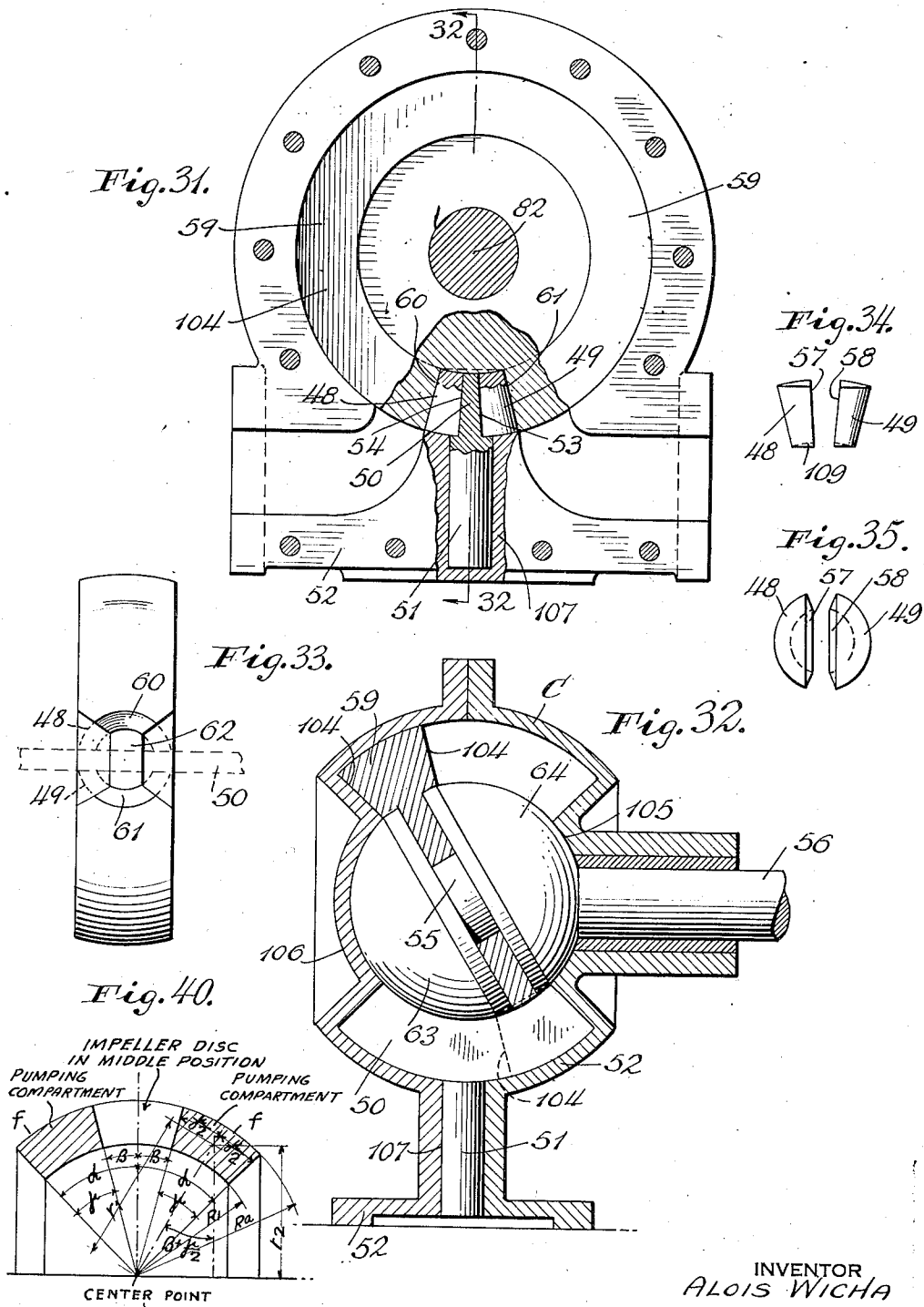
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7 Sheets-Sheet 6



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Fig. 38.

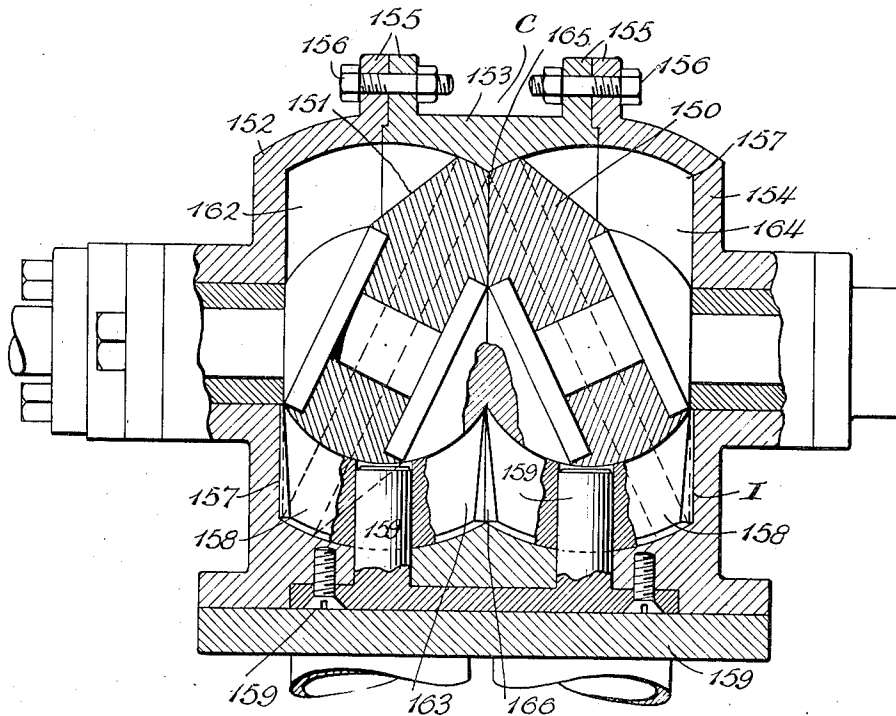
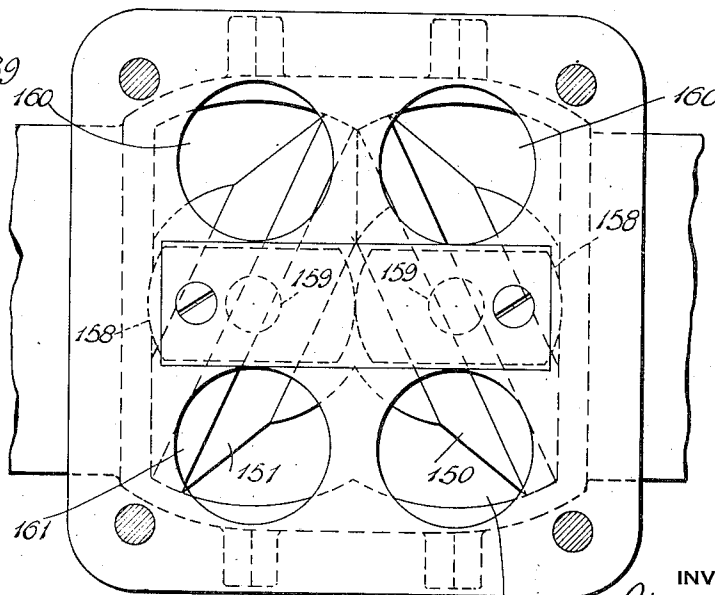


Fig. 39



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UNITED STATES PATENT OFFICE

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Application February 13, 1933, Serial No. 656,637

9 Claims. (Cl. 103—133)

This invention relates to a fluid actuating device and particularly relates to pumps for liquids and gases and to compressors for gases and vapors and other similar apparatus.

5 Although the present invention will be particularly described in connection with liquid pumps, it is to be understood that it also may be employed in connection with spherical engines or other apparatus where a fluid or liquid is passed
10 into the casing to cause a shaft or a mechanism to be actuated, the flowing fluid or liquid being the source of energy whether it be forced into the spherical casing under substantial pressure and/or removed therefrom under subatmospheric
15 pressure or vacuum.

An object of the present invention is to provide a spherical engine and particularly a durable pump which may be operated directly from a rotating shaft to give a continuous feed and/or to
20 exert a continuous suction, which will be compact, light in weight and relatively inexpensive and which will have very few parts and not require costly lubricating installations or be readily subject to disadjustments.

25 Among the other objects of the present invention is to provide a fluid actuator or a pump, which, although it is directly driven from a rotating shaft, has a very high mechanical efficiency and will have a metering action; which may be
30 driven over a wide range of rotational speeds; which will be devoid of valves; which may be readily reversed; and which will produce both a substantially continuous suction at its inlet and a substantially continuous pressure at its outlet,
35 all without the use of complicated or auxiliary mechanical apparatus, such as air bells, resilient diaphragm devices, and so forth.

Other objects will be sufficiently obvious and will appear during the course of the following
40 specification.

In accomplishing the objects above stated the applicant has devised an altogether novel type of pump consisting of a casing, the interior chamber of which may take the form of a spherical
45 section or segment with a peripheral spherical surface and flat or conical side walls; an oscillating piston or impeller disc, the oscillating movement of which takes place both horizontally and vertically within said casing about a fixed center;
50 a drive shaft which has an eccentric driving bearing for the impeller disc causing said impeller to undergo said movement within the casing resulting in substantially continuous movement of fluid from the inlet to the outlet; and a guide
55 member mounted in said casing and received in a

slot or socket in one edge of the impeller disc preventing the impeller disc from rotating while permitting relative pivotal and sliding movement whereby said impeller will partake of said oscillating movement both laterally and vertically.

The impeller disc, the sides of which may be flat or outwardly converging or diverging, closely conforms to the spherical interior surface of the interior chamber along its entire periphery. As a result the interior chamber will be symmetrically divided into two compartments which will be separated from each other by the impeller. The oscillating movement of the disc will continuously rotate these compartments within the casing.

The guide member is positioned between the inlet and outlet ports of the pump and constructed or associated with other elements, so as to prevent direct communication therebetween. As the compartments pass across the guide member, they will be divided thereby. During this passage they will decrease in volume on the approach or outlet side of the guide member, compressing and/or expelling fluid through the outlet port; and at the same time they will increase in volume on the removal or inlet side of the guide member, sucking fluid in through the inlet port.

As one or the other of the compartments, or both compartments, will be passing across the guide member at all times, a substantially continuous suction will be created through the inlet port, while a substantially continuous discharge will be created through the outlet port.

After a compartment has passed entirely across the guide toward the inlet and has been filled with fluid or liquid, it will be cut off from the inlet by the close adjuxtaposition between the side of the impeller disc and the side wall of the interior chamber. After cut-off from the inlet and before being opened to the outlet, the compartment will not be divided by the guide member. Continued movement will then open the compartment to the outlet and it will remain in communication with such outlet until it has passed onto the other side of the guide member.

This guide member which, as stated before, preferably projects into a slot or socket formed in the impeller disc has a constant sliding and/or rolling contact in respect to impeller disc and considerable friction and strain may be engendered as a result of this frictional contact.

A further object of this invention is to provide a guide member and to so construct the impeller to cooperate with such guide member that the amount of strain and friction will be reduced to a minimum, so that no cocking or biasing effect will

ensue tending to place excessive strains upon either the impeller disc or the guide or to prevent easy relative rolling and/or sliding relative movement of said impeller and guide member.

Another further object of the present invention is to provide a guide member and to form an impeller member to cooperate therewith, so that the oscillating movement of the impeller disc or pump actuator will take place in such a manner as to result in the highest degree of efficiency and substantially eliminate undesirable acceleration and deceleration of the impeller masses during operation of the pump.

In accomplishing these last-mentioned objects it has been found most satisfactory to provide a guide member and a corresponding slot or socket in the impeller disc, the side walls of which will converge and in the preferable embodiment such convergence may take place towards the center point of the casing or the coincident center point of the impeller disc and actuating shaft.

This guide element in one embodiment may take the form of a fragment of an annular spherical section. In another embodiment it may take the form of a truncated cone. When a guide member taking the form of a truncated cone is utilized, a section or sections of an annular plate are utilized in conjunction with the guide member to prevent communication from the inlet to the outlet except through the rotating compartments.

The above and other objects will appear more clearly from the following detailed description when taken in connection with the accompanying drawings, which illustrate a preferred embodiment of the inventive idea.

In the drawings:

Figs. 1 to 22 relate to one embodiment, Fig. 1 being a front sectional view upon the line 1—1 of Fig. 2; Fig. 2 being a side sectional view upon the line 2—2 of Fig. 1; Fig. 3 being a top view in fragmentary section of the casing with the cover removed and the impeller in a different position; Fig. 4 being a top plan view of the guide member, and Figs. 4a and 4b being, respectively, front and side elevations; Figs. 5 and 6 being perspective views of the opened casing showing the impeller disc in position; Figs. 7 and 8 being front and side elevations of the impeller disc, Fig. 8 being in fragmentary section; Fig. 9 being a side elevation of the shaft member; and Figs. 10 to 22 being diagrammatic views illustrating the operation of the pump.

Figs. 23 to 30 show another embodiment, Fig. 23 being a side sectional view; Fig. 24 showing the impeller and guide member in side elevation; Fig. 25 being a top view of the impeller and guide in fragmentary section; Fig. 26 being a fragmentary side sectional view upon the line 26—26 of Fig. 23; Fig. 27 being a diagrammatic exploded view of the guide member with its wing; and Figs. 28 to 30 being diagrammatic views illustrating the operation of the impeller.

Figs. 31 to 37 show another embodiment, Fig. 31 being a side view in fragmentary section of the open casing; Fig. 32 being a side sectional view upon the line 32—32 of Fig. 31; Fig. 33 being a bottom view of the impeller disc; Figs. 34 and 35 being, respectively, side end top views of the split guide; Fig. 36 being a perspective view showing the slot in the impeller disc, and Fig. 37 being a diagrammatic perspective view illustrating the operation of the guide.

Figs. 38 and 39 show still another embodiment, Fig. 38 being a side sectional view, and Fig. 39 being a top view.

Fig. 40 is a diagrammatic view of an embodiment similar to the embodiments of Figs. 23 to 30 and 31 to 37 illustrating the mathematical relationships.

The pump shown in Figs. 1 to 3, 5 and 6 comprises a casing C, the shaft member 21, the impeller disc 31 and the guide member 34.

The casing C consists of two halves 14 and 15 which are connected by the bolts 16 passing through the aligned openings 13 in the contacting peripheral flanges 12. Each half of the casing is provided with a foot 11, provided with openings 10 to receive the bolt 9.

The upper part of the casing C (Figs. 1, 3, 5 and 6) is provided with ports 17 and 18 for the intake and the outlet of a fluid medium which is to be pumped and acted upon by the mechanism. These inlet and outlet ports are formed half in each component section of the casing 14 and 15, so that when these sections of the casing are bolted together, a cylindrical opening will be obtained.

The interior I of the casing C (see Figs. 1 to 3, 5 and 6) takes the form of a spherical section with flat vertical side walls 84' and a peripheral surface 85' connecting said side walls. The inlet ports 17 and 18 intersect said spherical surface 85' to form elongated inlet and outlet openings in the upper portion of the interior I.

The intake and outlet pipes 19 and 20 (see Figs. 1 and 2) are carried by the cover 75, into which they are threaded at 76. The cover 75 is secured to the horizontal flange 77 of the casing C by the bolts 78 passing through the openings 79 (see Figs. 3, 5 and 6).

As shown in Fig. 2, each of the two halves 14 and 15 of the casing are provided with horizontal axial extensions 80' provided with openings 80 into which are fitted the bearing sleeves 81, the bearing sleeves 81 receiving the bearing ends 22 and 23 of the main drive shaft 21 (see also Fig. 9).

As shown in Figs. 2, 5, and 9, the middle oblique eccentric or cam portion 24 of the shaft 21 forms a bearing for the impeller 31 and is positioned so that its center point will at all times coincide with the center point 82 of the casing C and the center of the spherical section I. Connected between the central eccentric cam portion 24 and the end portions 22 and 23 of the shaft are the spherical sections 25 and 26, which are each of the same shape and dimension and are symmetrically positioned within the interior chamber I on both sides of the center point 32. The spherical sectors 25 and 26 are provided with vertical flat surfaces 29 and 30 transverse to the axis of the shaft 21, said flat surfaces 29 and 30 bearing against the sides 84' of the chamber I. The inside faces 32 of the spherical sections 25 and 26 are transverse to the axis of the eccentric. These faces 32, together with the peripheral surfaces 83, bear against the impeller 31.

The impeller disc is shown inside of the casing in Figs. 1, 2, 3 and 5, and removed therefrom in Figs. 7 and 8.

The impeller disc 31 has two outwardly converging truncated or frusto-conical propelling surfaces 84 which at their outer peripheries are joined together by the spherical surface 85 which closely conforms with the surface 85' of the interior of the chamber I (see Figs. 2 and 5).

As shown in Figs. 7 and 8, the impeller disc 31 is provided with the bearing surfaces 24', 32' and 83', which bear upon the correspondingly numbered surfaces on the shaft (see particularly Fig. 9).

This guide member, which with the eccentric 24 controls the oscillation of the impeller 31, is held and bears within the slot 34' in the impeller disc 31. The guide member 34 (see Figs. 4, 4a and 4b) takes the form of a fragmentary spherical segment and has inwardly converging side walls 35 which contact with the side walls 35' of the slot 34' (Fig. 7). The inside surface 36 of the guide member 34, as well as the exterior surface 87 are taken from the surface of a sphere, while the end surfaces 88 of the guide member are taken from the surface of a cylinder.

The cylindrical side surfaces 88 (see Figs. 2 and 3) contact or conform closely with the side walls 84' of the chamber I of the casing C and prevent any communication from the inlet to the outlet across the top of the chamber I. Preferably, the side walls of the chamber I are provided with recesses 88' to receive the ends of guide 34, so that there will be a surface instead of a linear contact or conformation therebetween to prevent liquid or fluid communication.

As shown best in Fig. 2, the spherical surface 87 of the guide closely contacts with the top of the chamber I, while the lower spherical surface 36 contacts both with the correspondingly shaped surface 36' at the bottom of the slot of the impeller disc (see Figs. 7 and 8) and with the spherical surfaces 27 and 28 on the shaft 21. The lateral faces 25 of the guide converge toward the center point 82 of the casing C and of the shaft 21.

The guide member is provided with a central opening 89 (see Figs. 4, 4a and 4b) into which projects the pivot stud 37. This stud is provided with a flange 90 which fits into the recess 90' in the casing and is bolted to the casing C by the screws 91.

The operation of the pump is most conveniently shown from the diagrammatic views, Figs. 10 to 22. Fig. 10 illustrates diagrammatically the turning of the impeller disc and Figs. 11 to 22 show top, front and side views of the impeller disc in each one of the positions designated on Fig. 10, namely I, II, III and IV.

Figs. 11, 12 and 13 are, respectively, top, front and side views of the impeller disc in position I; Figs. 14, 15 and 16 are corresponding views in position II; Figs. 17, 18 and 19 are corresponding views in position III; and Figs. 21, 22 and 23 are corresponding views in position IV.

Figs. 11, 14, 17 and 20 approximately correspond diagrammatically to Fig. 3; Figs. 12, 15, 18 and 21 to Fig. 1; and Figs. 13, 16, 19 and 22 to Fig. 2. As is obvious from a consideration of Figs. 2 to 9 when the shaft 21 rotates, the impeller disc 31 will be caused to sweep backwardly and forwardly both horizontally and vertically across the interior chamber I with the result that the impeller disc 31 will partake of an oscillation. At the same time the axes about which the impeller tends to swing will also tend to rotate about the fixed center point 82 of the casing, impeller disc and the shaft, the horizontal axis of the impeller disc 31 tending to swing in a horizontal plane (see Figs. 11, 14, 17 and 20) and the vertical axis tending to swing in a vertical plane. This last-mentioned vertical plane will also tend to rotate or oscillate about the central vertical axis of the casing (as indicated by the guide member in Figs. 11, 14, 17 and 20).

As a result of this movement, all points on the periphery of the impeller disc 31 removed from the horizontal axis will tend to move along lemniscate curves which become of greater latitude as the point becomes elevated and removed from

the center point 82 so that points at the top and bottom of the disc 31 will move in lemniscate curves of maximum amplitude. These curves will lay in a spherical surface described upon a radius equal to the distance of the point from the center point 82. Because of this movement, substantial acceleration or deceleration forces will not be incurred upon movement of the mass of the impeller disc 31 with the result that the abrupt changes in acceleration characteristic of the reciprocating pump are altogether eliminated.

As indicated in Figs. 11, 12 and 13, respectively, in top, front and side views, the impeller disc 31 will divide the interior I of the casing C into two chambers 92 and 93 which are symmetrically disposed in respect to the center point 82 of the pump.

In Figs. 11, 12 and 13 the chamber 93 occupies the upper half of the casing while the chamber 92 occupies the lower half of the casing. In Figs. 14, 15 and 16 the chamber 92 occupies the right side of the casing while the chamber 93 occupies the left side of the casing. In Figs. 17, 18 and 19 the chamber 92 occupies the top side of the casing while the chamber 93 occupies the bottom side of the casing, and in Figs. 20, 21 and 22 the chamber 92 occupies the left side of the casing while the chamber 93 occupies the right side of the casing.

It is apparent that these chambers, due to the oscillation movement of the impeller disc 31, are caused to move continuously around the interior chamber I of the casing C.

These chambers are successively opened and closed to the inlet 17 and to the outlet 18 so that fluid or liquid which is received through the inlet 17 will be carried to the outlet 18. These compartments 92 and 93 will transfer liquid or fluid through the lower half of the casing from the inlet 17 to the outlet 18 and will be prevented from transferring fluid or liquid reversely from the outlet to the inlet in the upper half of the chamber I by the oscillating guide 34.

It will be noted in Figs. 11, 14, 17 and 20 that the compartments 92 and 93 must move through and will be divided by the guide member. As shown in Fig. 11 the compartment 93 is moving to the left and is bisected by the guide 34, while in Fig. 14 both compartments are divided by the guide 34. In Fig. 17 only the compartment 92 is divided by the guide, and as the compartment 92 moves to the left, the greater part of its volume also moves to the left of the guide member 34, decreasing the amount of said volume on the right of the guide member.

As the compartments 92 and 93 move through the guide, they first are opened to the outlet 18. Then the volume of the chamber upon the outlet side of the guide member 34 decreases with the result that the liquid or fluid is then forced or discharged through the outlet. At the same time the volume of the chamber on the inlet side of the guide increases with the result that liquid is sucked in through the inlet 17 to fill the increasing volume on that side. It will thus be apparent that each compartment 92 and 93 as it passes through the guide member 34 has inlet and outlet portions of changing volume, the volume successively increasing in communication with the inlet and decreasing in communication with the outlet. The compartment will be cut off from the inlet after it has completed its passage across the guide member 34 and the lines or areas 94 and 95 between the side surfaces 84 and 84' have passed the inlet port opening.

Then the compartment will be opened to the outlet port 18 and will decrease in volume while in communication with the outlet until all of the liquid or fluid has been then forced out there-
 5 through when the lines or areas 94 and 95 pass across the contact or conformation area of the ends 88 of the guide member 34 with the side walls 84' of the chamber I. This area or line is indicated for the chamber 92 in Figs. 12, 15, 18
 10 and 21 on the rear side of the impeller by the dotted line 94. The area or line 95 is always symmetrically disposed diametrically directly opposite to the area or line 94 in respect to the center point 82.

15 In Figs. 11, 12 and 13 the compartment 92 has just been opened to the outlet 17 by the outlet edge 85o of the impeller disc 31, which is moving away from wall 150, after passage of the line or area 94. The inlet edge 85i is cutting off the inlet
 20 port 17 while still moving toward the wall 150 and it will reverse its movement as the line or area 94 passes. This reversal of movement of the edge 85i will occur simultaneously with the movement of the compartment 92 across the guide 34
 25 and will enable a flow into said compartment 92 through the port 17.

In the position shown in Figs. 11 to 13, the line or area 94 coincides with the contact or conformation of the end walls of the guide 34 with the
 30 wall of the interior I so that the compartment 92 in this position is not divided nor is it decreased in volume by the volume of the guide. To reach this position the compartment 92 has been increased in volume while in communication with
 35 the inlet 17 on the inlet side of the guide 34, with the result that an amount of fluid or liquid equal in amount to the maximum volume of the compartment 92 has been sucked or drawn thereinto.

Then as the shaft 21 continues to rotate and
 40 impeller disc 31 to move from the position of Figs. 11 to 13, to the position of Figs. 14 to 16, namely from position I to position II, as shown on Fig. 10, the edge 85i of the impeller disc 31 will tend to swing away from the wall, increasing the
 45 opening of the inlet port to the position indicated in Fig. 14. At the same time the edge 85o will sweep across the outlet port 18 opening the entire outlet port to the chamber 92.

As this is occurring, the compartment 92 is being moved through the guide 34 so that it is increasing in volume in respect to the inlet 17 and
 50 liquid or fluid is being sucked into the opening portion on the inlet side up to the line of contact 94 (see Fig. 15), while due to the decreasing volume of the compartment 92 on the outlet side of
 55 the guide 34 the corresponding amount of liquid and fluid is being forced outwardly through said outlet.

In the position of Figs. 17 to 19, the compartment 92 is being substantially bisected by the
 60 guide 34 and it is open one-half to the inlet 17 and one-half to the outlet 18 with the volume in communication with the inlet increasing while the volume with the outlet is decreasing. From
 65 this position the outlet edge 85o will tend to swing toward the wall 150 to cut off the outlet port 18, while the inlet edge 85i will continue its movement toward the wall 151.

In Figs. 20 to 22 the area 94 has reached the
 70 position indicated in Fig. 21. In this position the opening of the compartment 92 in respect to the inlet 17 is being completed and the last portions of liquid contained in said compartment on the
 75 outlet side are being forced out through said outlet 18.

As the compartment 92 then continues its movement, the lower edge of the impeller disc will swing outwardly from the wall 150, permitting the incoming liquid to flow to the bottom of the interior of the chamber I. The compartment
 5 92 when it reaches the position of Figs. 11 to 13 will then be filled with liquid, will have been cut off from the inlet port 17 and will be opening to the outlet port 18.

The operation of the other pumping compartment 93 is the same as has just been described, except that all operations take 180° later or
 10 earlier than in the case of compartment 92.

It is, therefore, evident that as the shaft 21 rotates and the impeller disc 31 and the guide 35
 15 oscillate, liquid or fluid will be continuously acted upon and moved from the inlet 17 to the outlet 18 by the compartments 92 and 93. It will be noted that the pump will substantially meter the flow. Except for a small amount of leakage across
 20 the periphery 85 and across the lines or areas 94 and 95, the combined volume of the chambers 92 and 93 will be transferred from the inlet to the outlet upon each complete revolution of the shaft
 25 21.

The volume of these pump compartments may be conveniently calculated, subtracting the volume of the impeller disc and the guide from the
 30 volume of the chamber I. The volume of these compartments control the capacity of the pump and its delivery per revolution and such volume is determined by the diameter of the chamber I and the width of such chamber. The angle of
 35 the eccentric bearing portion 24 of the shaft 21 of course will vary with the width of the chamber I.

The area of the inlet port 17 and the outlet port 18 should be always such that the chambers 92 and 93 may substantially immediately fill
 40 with liquid or fluid as they are increased in volume in communication with the inlet and/or emptied of fluid or liquid as they are decreased in volume in communication with the outlet 18. Otherwise, there would be a tendency for the im-
 45 peller disc, in the case of incompressible liquids, to create a vacuum in the inlet side and to compress liquid on the outlet side, which would reduce the efficiency of the pump.

The velocity of the movement of the impeller disc 31 is substantially uniform at all times, there being no minimum or maximum velocity, merely
 50 a change in direction.

The axis of the eccentric 24, the axis of the pivot of the guide 34, the axis of the impeller 31 and the vertical horizontal axis of the interior I
 55 of the casing, all intersect throughout movement at the point 82. The impeller is preferably so designed that its center of gravity coincides with this central point 82.

By also converging the sides of the guide 34 towards this center point 82, the frictional forces
 60 on the side of the slot on the impeller disc 34' tending to jam or cock the guide and/or impeller are decreased and largely eliminated.

The shaft bearings of the impeller 24', 32' and 33' may be replaced by ball or roller bearings and
 65 may be made similarly converging towards the center of the pump structure as more fully shown in my copending application, Serial No. 656,639, filed Feb. 13, 1933.

In Figs. 23 to 30 is shown a somewhat different
 70 embodiment in which the impeller disc 42 has outwardly diverging side walls 45 and is provided with a conical guide 38 having an integral pivotal stud 40. This stud bears in a socket in the hous-
 75 ing 41, which housing is connected by the screws.

96 to the casing C. The truncated conical guide member 38 may be considered as a frustro-conical section taken from a spherical annulus. The outer spherical portion 97 of the guide member 5 contacts with the interior wall of the casing and the inner spherical surface 39 of the guide member slides over the spherical surface 98 at the bottom of the slot 43 in the impeller disc 42.

The sides 44 of the slot 43 contact with the 10 side of the frustro-conical guide 38, said guide rolling or sliding through said slot during the oscillation of the impeller disc upon movement of the shaft 21. The conical surfaces of the guide 38, as well as the walls 44 of the slot 43, converge toward the center point 82 of the mechanism. 15

The oscillating impeller disc 42 with its outwardly diverging walls 45 takes the form of a spherical sector. The interior I of the casing C 20 also takes the form of a spherical section, conical projections 102 being provided at opposite sides of said casing. These projections have central openings to permit of the location of the bearing sleeves 81 for the shaft 21.

As shown upon Fig. 23, the periphery of the 25 impeller disc 42 will contact over a wide area 99 with the interior I of the casing C, with the result that leakage across the periphery disc will be decreased, as compared with the embodiment shown in Fig. 1. The sides of the impeller disc 42 on 30 the other hand will obliquely lay against the sides of the interior chamber I along the conical surfaces 100 on the side of the disc 42 and 101 on the sides of the projections 102.

Since the conical guide 38 does not also contact with the walls of the casing to prevent direct communication between the inlet and outlet ports, it is necessary to provide the wings 46 on either side of said guide 38 (see Figs. 23, 25, 26 and 27). 35 These wings take the form of annular sections and fit into slots 47 in the conical bearing portions 102 of the casing C (see particularly Fig. 26). The inner surfaces 103 of these wings 46 are curved so as to contact closely with the sides 45 of the conical guide 38.

In Figs. 28 and 30 are shown diagrammatically the different relative positions of the impeller disc 42, the wings 46 and the conical guide 38. The operation and fluid actuating movement of 50 the impeller disc 42 is substantially the same as shown in Figs. 10 to 22. The impeller will similarly oscillate both laterally and vertically. The conical guide 38 and the wings 46 will divide the pumping compartments, as they pass through 55 the guide and preventing direct communication from the outlet to the inlet.

Since the contact between the sides of the conical guide 38 and the walls of the slot 43 will be substantially linear, and since the lines of 60 contact will extend towards the center point 82 of the apparatus, the amount of friction will be greatly decreased and the tendency to jam or cock either the guide or impeller will be substantially eliminated.

In the embodiment in Figs. 31 to 36 the impeller disc 59 is also provided with outwardly diverging side surfaces 104. The disc is driven by the eccentric portion 55 of the shaft 56. The shaft 56 terminates within the casing C in the ball element 63-64. The ball element includes the spherical sections 63 and 64, the opposite sides of said sections bearing at 105 and 106 against spherical cavities in the side of the casing. 70

The guide member (see Figs. 31, 34, 35 and 37) 75 includes a plate 50 having a support stud 51,

which stud is received within a cylindrical opening 107 in the bottom of the casing 52 (see Figs. 31 and 32). The guide member also includes the split frustro-conical members 48 and 49, the outer surfaces of which contact with the interior 5 surfaces 60 and 61 of the slot 108 in the impeller disc 59 (see Fig. 36), and the inner spherical surface 109 of which contacts with the spherical surface 109' at the bottom of the slot 108.

The inside faces 57 and 58 of the split conical 10 roller 48 and 49 (see Figs. 31, 35 and 37) contact with the side faces 53 and 54 of the zone sector plate 50 and all of these contacting surfaces converge toward the center point 82.

Fig. 37 diagrammatically illustrates the sliding 15 movement of the split conical members 48 and 49 in respect to the plate 50. As shown, the guide portions 48 and 49 may slide with respect to the plate 50 and will turn with respect to the impeller disc 59. In this embodiment the rotary friction 20 between the guide elements 48 and 49 and the impeller 59 and within the guide between the relatively sliding surfaces 53 and 54, and 57 and 58, will be reduced to a minimum.

In the modification shown in Figs. 1 to 4, the 25 guide member 34 functions as an oscillating wall which has to overcome a considerable pressure caused by the fluid passing through the casing of the pump.

In the modifications shown in Figs. 23 to 30, im- 30 movable walls 46 take the place of the oscillating wall of the first-named modification, and only the center portion of that wall, namely conical guide member 38, continues to oscillate, so that the strain caused by the pressure of the liquid against 35 the guide member is largely eliminated.

In the embodiment of Figs. 38 and 39, there are shown two impeller discs 150 and 151 included in a casing with inlet ports 160 and outlet ports 161 consisting of three sections 152, 153 and 154. The sections 152, 153 and 154 are joined 40 together by the flanges 155 and the bolts 156.

The interior chambers of the casing I include two spherical segments or sections 157, each of which cooperates with one of the impeller discs 45 150 and 151 to form a pump chamber.

The guide members 158 provided with the pivot studs 159 and the impeller discs 150 and 151 function in the manner already described.

In the embodiment of Figs. 38 and 39, it will 50 be noted that there are three pumping compartments 162, 163 and 164. These compartments all function to transfer fluid or liquid from the inlet to the outlet ports, and it is evident that any number of these impeller discs 150 and 151 55 may be connected together as indicated in Figs. 38 and 39 for a multiple pump having as much capacity as desired.

As indicated in 165 and 166, the impeller discs 150 and 151 and the guides 158 roll or move upon each other at their adjacent surfaces instead of 60 rolling and moving over the side wall of the casing.

In considering the operation of the fluid actuating device of the present invention, which operation has been diagrammatically illustrated and described in connection with Figs. 10 to 22, it is to be noted that the impeller 31 in the course of its oscillating movement causes a displacement 65 of fluid both when it moves toward the wall of the casing C and when it moves away from the wall of the casing C. In the former case the fluid is forced out of the casing through the outlet or is forced from one part of the interior chamber 75

of the casing to another part of the interior chamber of the casing.

Since the entire side wall or side surface of the impeller does not move toward the side wall of the interior chamber simultaneously but rather is caused successively to approach said surface so that one portion of the side of the impeller is advancing toward the side of the casing, while another portion of the side of the impeller may be moving away from the same side wall of the impeller, it is evident that the oscillating movement of the impeller will result in moving fluid circularly around within the interior of the casing.

It is thus evident that the displacement action of the oscillating impeller of the present invention differs substantially from the displacement action of the piston of a reciprocating pump in that whereas the motion of the reciprocating piston causes a linear movement of fluid to the end of a cylinder, in the device of the present application on the other hand, the displacement action of the impeller causes a rotational movement of the fluid from the inlet to the outlet along the face of the impeller. The guide with its adjuncts extending between the side walls of the chamber I causes the oscillating action to draw in fluid from the inlet and to force fluid out through the outlet.

The volume for containing fluid or liquid within the casing the device will always be substantially constant since it will be equivalent to the volume of the interior chamber minus the volume of the impeller and the volume of the guide with its adjuncts. As previously described, the impeller will divide the chamber into two symmetrically positioned pumping chambers which, although they are of substantially constant volume throughout operation of the device (except for the volume of the guide or its adjuncts which may project into them) they nevertheless will have portions of varying volumetric capacity in communication with the inlet increasing while the volume in communication with the outlet is decreasing.

From this point of view it may be considered that the guide is a fixed fluid impelling device which moves relatively through the compartments on opposite sides of the impeller to increase their volume on one side, causing drawing in of fluid from the inlet and to decrease their volume on the other side, causing discharge of liquid through the outlet. This action, however, is quite different from the action of a reciprocating piston pump in which there is a fixed piston and a movable cylinder, in that in the present invention the displacement member or the guide member moves continuously through the compartments, one after the other without the abrupt reversals as occur in all reciprocating pumps.

It is apparent from the foregoing description of the operation, that the shaft may be rotated in either direction, and that as a result of such reverse rotation the inlets and outlets will be similarly reversed. The discharge output of the device is proportional to the speed of rotation of the shaft, while the head or height of delivery is independent of the speed of rotation.

The diagrammatic sketch in Fig. 40 shows the various important dimensions to be determined when calculating the pump with a diverging impeller as shown in Figs. 23 and 33.

For example, with a pump having a speed of 1000 revolutions per minute, a delivery of 334 liters per minute or 20,000 liters per hour, a height of delivery of 100 meters and a rating of 10

horse power, the maximum interior radius of the pumping compartment may be taken 75 mm., while the minimum interior radius may be taken as 57.5 mm. R_a is the interior radius of the chamber I where it contacts with the outer peripheral surface of the impeller, while R_i is the radius of the shaft ball element 25 and 26 of Fig. 23 and 63 and 64 of Fig. 32.

The half angle of the casing α may be taken as 42° while the half angle of the impeller β may be taken as 17° . The half angle of oscillation γ will be equal to the difference or 25° .

It has been found desirable in the embodiment shown to provide a spacing between the periphery of the impeller disc and the periphery of the chamber of about 0.1 mm. in width.

The present application is a continuation in part of my copending application Serial No. 636,295, filed Oct. 5, 1932. According to the present application the guide member is made converging, as is also the slot in the impeller disc and the separating wall and guide member may be combined in one member as shown in Figs. 4, 4a and 4b, or they may be separated as shown in the embodiments of Figs. 23 to 37.

The matter shown and described in the present application, but not claimed herein is covered in my copending applications Serial Nos. 656,639; 656,640 and 656,641, filed respectively February 13, 1933; Serial Nos. 673,244 and 673,245, filed May 27, 1933; and Serial No. 696,944, filed Nov. 7, 1933, and particularly in my copending application Serial No. 656,641, filed February 13, 1933, which is directed to a conical guide and fixed side wall wings utilized in connection with a diverging impeller of the type shown in Figures 27 to 30 of the present application; Serial No. 656,638, filed February 13, 1933, which describes the employment of the device of the present application as a gas or vapor compressor; Serial Nos. 673,244 and 673,245, filed respectively May 27, 1933, which are directed to a fixed separating wall, and a guide member in another part of the casing removed from the separating wall; and Serial No. 696,944 filed Nov. 7, 1933 which respectively show slotted conical and cylindrical guides sliding on a fixed separating wall and also swinging wall guides in connection with space or surface packing or sealing between the peripheral and side surfaces of the impelling piston and the casing chamber involving rotating side walls.

What is claimed is:

1. In a fluid actuating apparatus, a casing, with side walls and with a continuous spherical peripheral wall and an impeller disc therein, means to impart an oscillating movement to said disc about a fixed center point, and a tapered guide engaging said disc to prevent rotation thereof while it is being oscillated by said means, the relatively sliding surfaces of said guide and said disc converging toward the center point of said casing.

2. In a fluid actuating apparatus, a casing with side walls and with a continuous spherical peripheral wall and an impeller disc therein, a shaft on which said disc is mounted, means to drive said shaft to cause said disc to undergo an oscillating movement about a fixed center point, and a guide for said disc, said guide preventing rotation of said disc but permitting relative sliding and pivotal movement of said disc, said guide and disc being so arranged that their relative sliding bearing contact surface will converge toward said center point.

3. In a fluid actuating apparatus, a casing, with side walls and with a continuous spherical peripheral

eral wall and an impeller disc therein, a shaft on which said disc is mounted, means to drive said shaft to cause said disc to undergo an oscillating movement about a fixed center point and having an eccentric bearing portion for said disc, and a guide for said disc, said guide preventing rotation of said disc but permitting relative sliding and pivotal movement of said disc, said guide and disc being so arranged that their relative sliding bearing contact surface will converge toward said center point.

4. In a fluid actuating apparatus, an impeller disc having a transverse slot therein, a shaft with an eccentric element carrying said disc, means to drive said shaft to cause said disc to undergo an oscillating movement about a fixed center point, and a guide located in said slot, said guide preventing rotation of said disc but permitting relative sliding and pivotal movement of said disc, said guide and disc being so arranged that their relative sliding bearing contact surface will converge toward said center point.

5. In a pump, an impeller disc having a slot therein, a shaft with a cam element carrying said disc, means to drive said shaft to cause said disc to undergo an oscillating movement about a fixed center point, and a guide taking the form of a segment of a spherical sector, said guide preventing rotation of said disc but permitting relative sliding and pivotal movement of said disc, said guide and disc being so arranged that their relative sliding bearing contact surface will converge toward said center point.

6. In a pump, an impeller disc having a slot therein, a shaft with an oblique offset portion carrying said disc, means to drive said shaft to cause said disc to undergo an oscillating movement about a fixed center point, and a conical guide member extending into said slot, said guide preventing rotation of said disc but permitting relative sliding and pivotal movement of said disc, said guide and disc being so arranged that their relative sliding bearing contact surface will converge toward said center point.

7. In a pump, a casing, with side walls and with

a continuous spherical peripheral wall and an impeller disc therein having a slot, a shaft having an oblique portion forming a bearing for said disc, means to drive said shaft to cause said disc to undergo an oscillating movement about a fixed center point, the side walls of said slot converging toward said center point of the piston, and a guide fitting in said slot and sliding therein with corresponding contacting converging side walls, said guide preventing rotation of said disc but permitting relative sliding and pivotal movement of said disc, said guide and disc being so arranged that their relative sliding bearing contact surface will converge toward said center point.

8. In a spherical apparatus, a casing having an interior chamber, an impelling piston positioned obliquely therein, means to impart an oscillating movement to said piston about a fixed center point, and a guide engaging said piston to prevent rotation thereof while it is being oscillated by said means, said impeller being provided with a transverse slot and said slot receiving said guide, said guide including a separating wall extending transversely across said chamber at one side thereof and through said slot, the contacting surfaces of said slot and said transverse wall converging towards the center of the casing.

9. In a spherical apparatus, a casing having an interior chamber, an impelling piston positioned obliquely therein, means to impart an oscillating movement to said piston about a fixed center point, and a guide engaging said piston to prevent rotation thereof while it is being oscillated by said means, said impeller being provided with a transverse slot and said slot receiving said guide, said guide including a separating wall extending transversely across said chamber at one side thereof and through said slot, the side surfaces of said separating wall closely contacting with the side surfaces of said slot, said contacting surfaces converging towards the center of the casing and the end surfaces of said wall contacting with the side walls of said interior chamber.

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