

Oct. 6, 1953

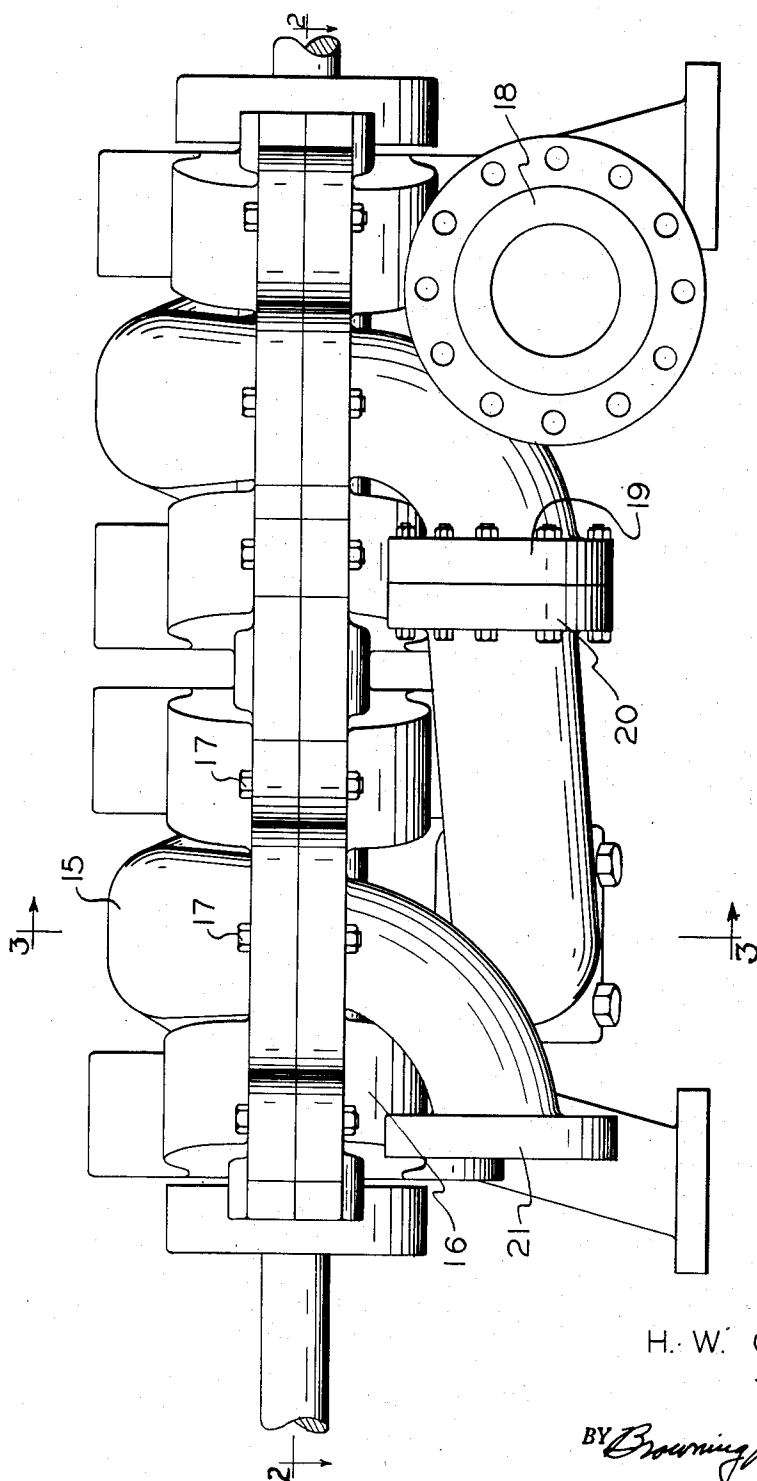
H. W. OLSEN

2,654,322

PUMP

Filed Sept. 15, 1948

5 Sheets-Sheet 1



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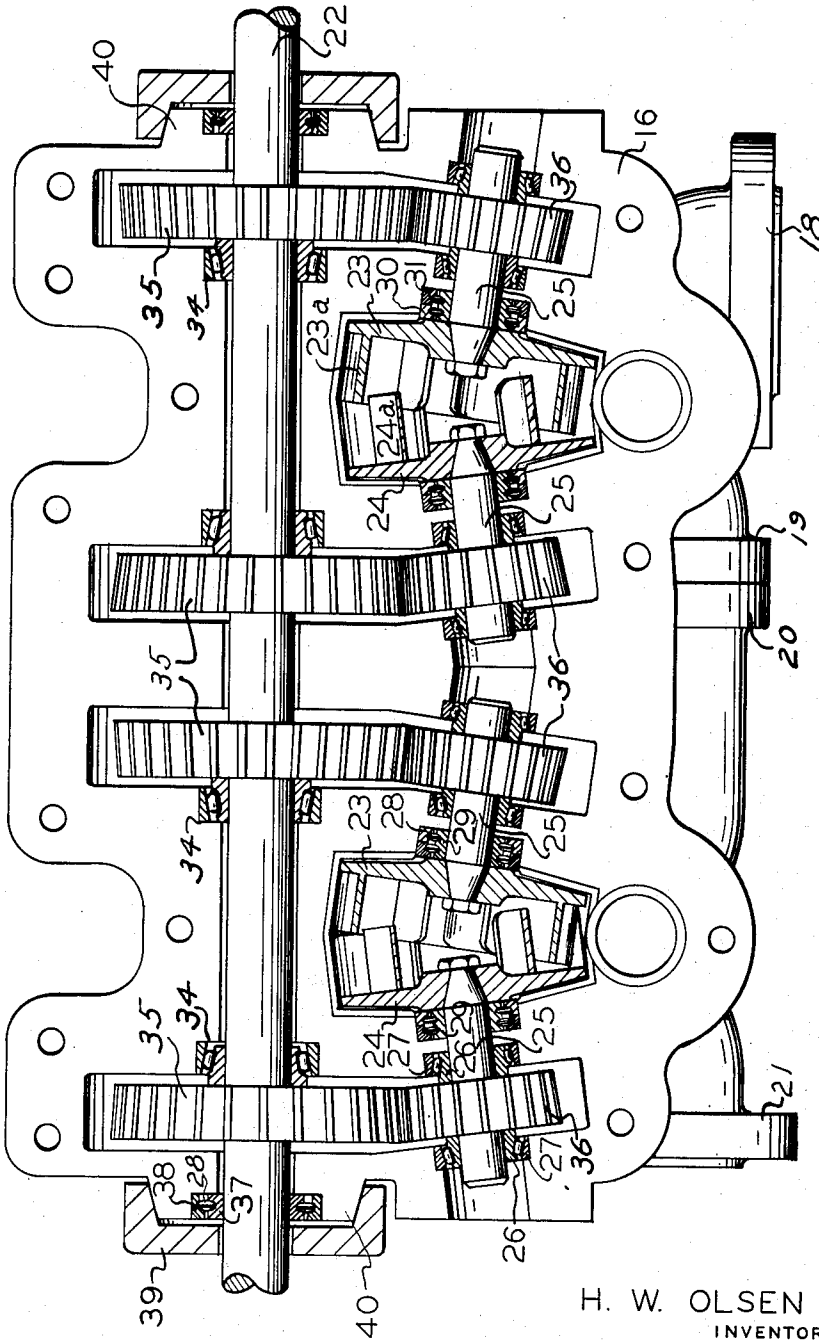


Fig. 2.

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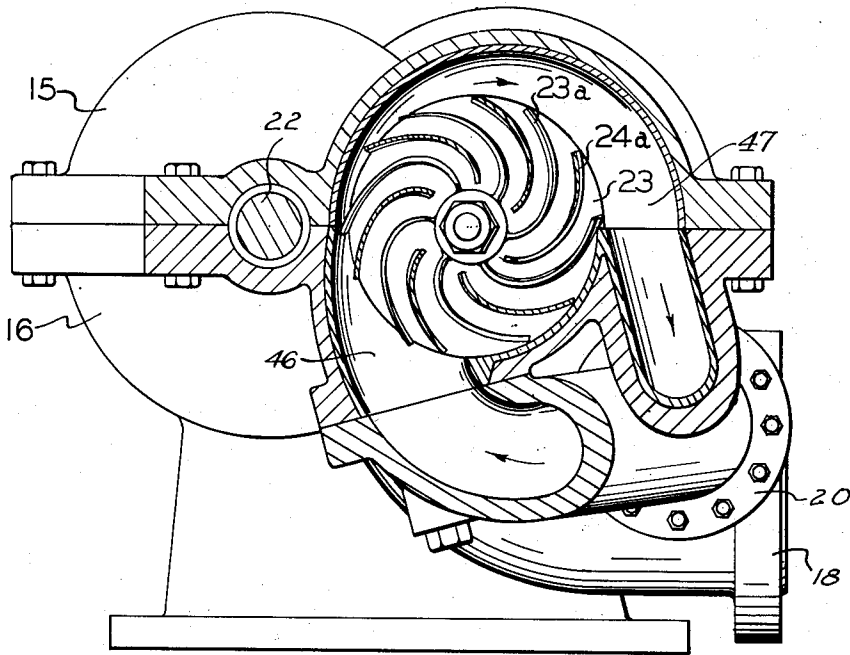


Fig. 3.

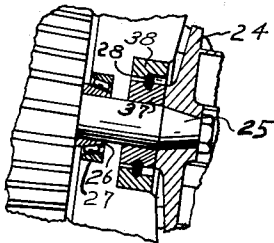


Fig. 4.

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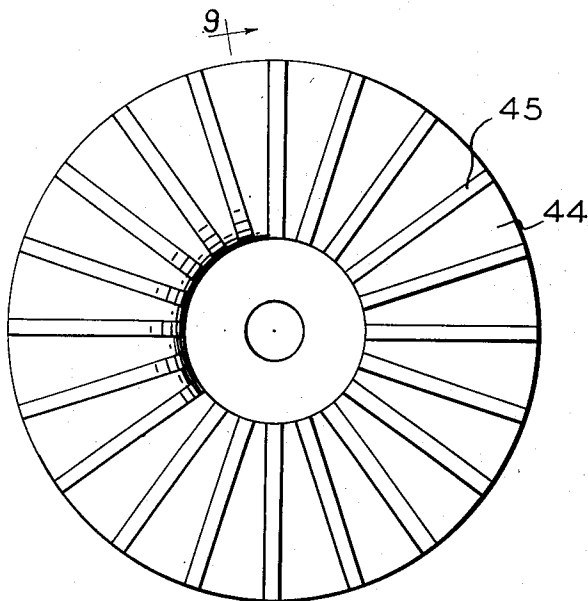
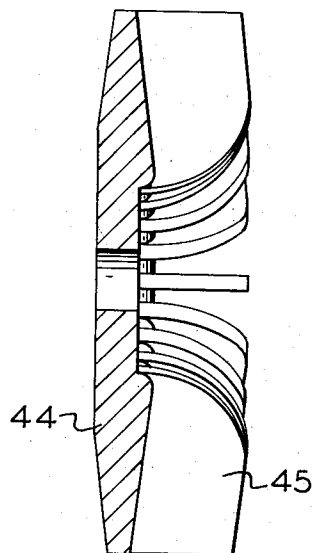


Fig. 8.
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Fig. 9.
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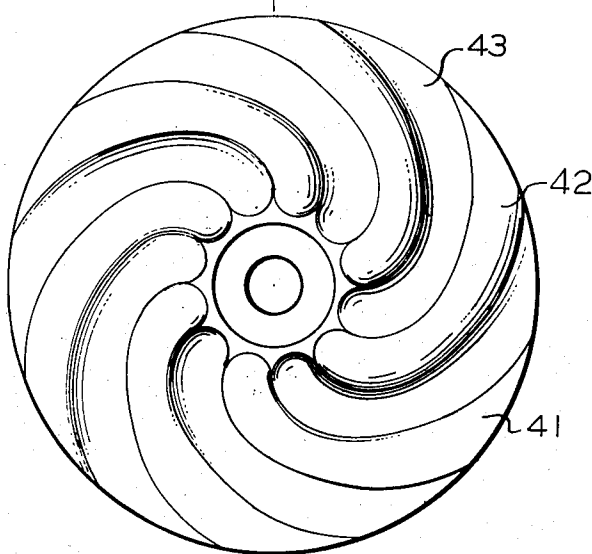


Fig. 5.
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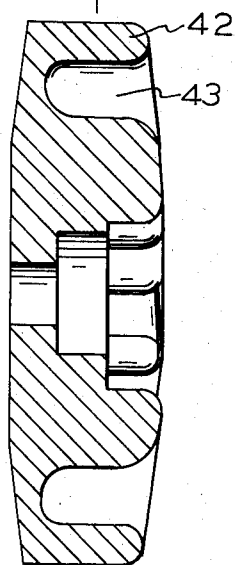


Fig. 6.
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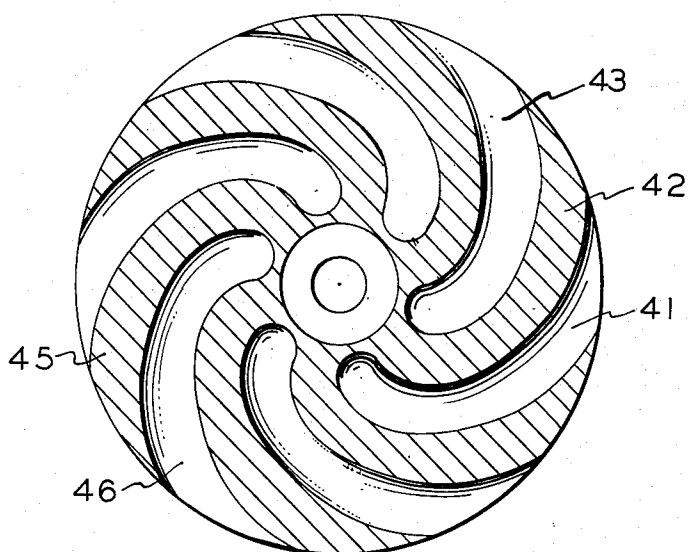


Fig. 7.

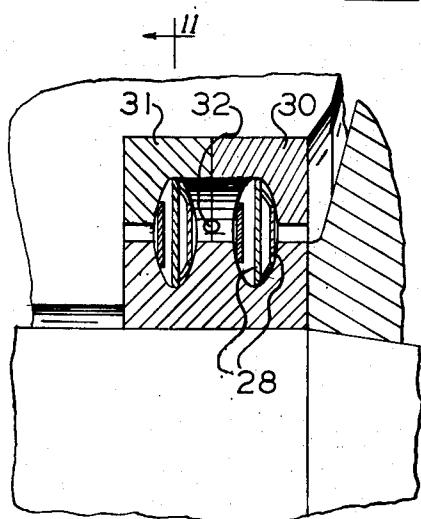


Fig. 10.

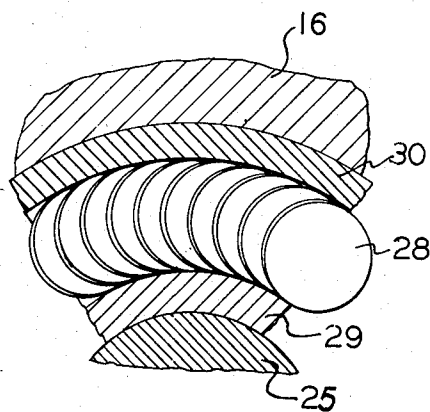


Fig. 11.

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UNITED STATES PATENT OFFICE

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Horace W. Olsen, Houston, Tex.

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7 Claims. (Cl. 103—5)

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This invention refers to improvements in pumps and refers more particularly to pumps employing rotating vaned impellers for imparting energy to fluid and seal assemblies especially adapted for such pumps.

Heretofore, pumps of this type have included centrifugal and turbine type pumps. These two types pumps are satisfactory for many purposes and each has characteristics that are best fitted for particular services. For instance, the centrifugal pumps are useful for handling high volumes and high heads but are not desirable for handling fluids under conditions where high suction is required. On the other hand, turbine type pumps are ideal for high suction lifts and have the highest practical lift characteristic of any of the liquid handling pumps. However, the turbine pump is of small capacity.

An object of this invention is to provide a pump having rotating vaned impellers which combine the characteristics of the turbine and centrifugal type pumps.

Another object is to provide a pump having vaned impellers capable of pulling a high suction at the inlet and also capable of handling high volumes.

A further object is to provide a pump having rotating vaned impellers which at the intake is primarily a turbine type pump and which at the discharge is principally but not entirely a centrifugal pump.

Still another object is to provide a device having rotating vaned impellers that may be used either as a pump or blower.

A still further object is to provide a device capable of acting as a pump or as a blower and employing two vaned impellers mounted for rotation on oblique axes whereby the vanes of one impeller mate closely with the vanes of the other impeller at one location along the peripheries thereof and diverge from this point.

Even another object is to provide in pumps or blowers two impellers having a divergent mounting wherein the vanes of one impeller mate with the vanes of the other very closely at one location along their peripheries and the bodies of the impellers at a point diametrically opposed from the point of close mating of the vanes are at their peripheries substantially two vane widths apart.

Yet another object is to provide a device of the character described having two vaned impellers mounted divergently with their vanes, at least partially mating and having means for maintaining the rotational relationship between the impellers such that vanes of one impeller

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substantially divide the spaces between the vanes of the other impeller.

Yet a further object is to provide a device of the character described having two vaned impellers mounted divergently with their vanes, at least partially mating and having means for maintaining the rotational relationship between the impellers such that vanes of one impeller substantially divide the spaces between the vanes of the other impeller, wherein lubricated mechanical seal assemblies are employed for providing seals about the impeller, the seal assemblies having a low component of sliding friction and a high component of rolling friction to enable the device to handle extremely high pumping fluid pressures with relatively small frictional losses due to the seal assemblies.

Other and further objects of this invention will appear from the following description.

In the accompanying drawings which form a part of the instant specification and which are to be read in conjunction therewith and wherein like reference numerals are employed to designate like parts in the various views:

Fig. 1 is a side elevational view of a pump embodying this invention,

Fig. 2 is a view taken along the line 2—2 in Fig. 1 in the direction of the arrows,

Fig. 3 is a view taken along the line 3—3 in Fig. 1 in the direction of the arrows,

Fig. 4 is a fragmentary view upon an enlarged scale illustrating the mounting of one of the impeller discs in the pump casing,

Fig. 5 is a top plan view of a modified form of impeller which may be used in accordance with this invention,

Fig. 6 is a view taken along the line 6—6 in Fig. 5 in the direction of the arrows,

Fig. 7 is a view taken along the line 7—7 in Fig. 6 in the direction of the arrows,

Fig. 8 is a top plan view of a modified form of impeller,

Fig. 9 is a view taken along the line 9—9 in Fig. 8 in the direction of the arrows,

Fig. 10 is a fragmentary view on an enlarged scale illustrating the seal assembly for an impeller shaft, and

Fig. 11 is a view taken along the line 11—11 in Fig. 10 in the direction of the arrows,

Referring to the drawings, in Fig. 1 the pump is shown in elevation and consists of a casing made up of two parts 15 and 16 having facing flanges held together by bolts 17. In the figures the pump is shown in a plurality or two stages but it is to be understood that the pump may be

constructed with a single stage or additional stages.

Fitting 18 serves as the inlet for the pump and has a flange to facilitate coupling of the pump in a flow line. Fitting 19 is the discharge for the first stage and connects with fitting 20 which is the inlet for the second stage. Fitting 21 is the discharge of the pump.

Referring to Fig. 2 it is seen that the pump may be considered as having a driving section including shaft 22 and a pump section made up of a plurality of vaned impellers. The pump section will be first described.

The pump section of the device is made up of a plurality of vaned impellers 23 which are mounted for rotation in recesses formed in casing members 15 and 16. The impellers closely fit the casing recess walls which may be surface hardened. The two impellers 23 are mounted on stub shafts 25 which are journaled in recesses in the casing sections 15 and 16 by ball bearings including races 26 and 27. To provide a seal between the casing and shaft 25 a novel seal assembly, detailed in Figs. 10 and 11, is used comprising a plurality of thin, wafer-like discs 28 of metal or other suitable material mounted in overlapping relation relative to each other between an inner race 29 and outer races 30. These discs are adapted to roll within the races upon relative rotational movement between the race rings. The outer races 30 have holes or grooves 32 to admit lubricant to the discs. Preferably these lubricant grooves 32 are equipped with Ale-mite fittings or the like to retain the lubricant under pressure higher than the pressures to be developed within the pump. These discs 28 may be fabricated from steel, bronze or the like with thicknesses ranging between .007" to .009". The thinner the discs the more effectively they will seal high pressures, but they are more expensive and the thicker discs are used where possible.

The mounting of impeller 24 is similar to that of impeller 23 and the mounting of the pair of impellers is such that the two impellers are opposed. The axes of these impellers are on oblique lines relative to one another so that the vanes 23a and 24a closely mate at one position along the periphery of the impellers and the peripheral edges of the impellers diametrically opposed to the point of closest approach are substantially two vane widths apart. The vanes 23a and 24a of the impellers are preferably volute vanes as shown clearly in Fig. 3 and the vanes of impeller 23 are preferably held in the center of the spaces between vanes 24a.

The relationship between the divergence of the impellers and the position of the intake and discharge of the pump is best shown in Fig. 3. The impeller 23 is adapted to rotate clockwise as seen in this figure and the point of greatest divergence of the impellers is at the left at the meeting of the sections 15 and 16 of the pump housing. The intake port 46 in section 16 preferably is along a volute line and extends from the point of greatest divergence in a counter-clockwise direction over substantially a quadrant of the impellers. The intake communicates directly with the peripheries of the impellers and the cross-sectional area of the intake diminishes as the divergence of the impellers increases.

The discharge port 47 of the pump unit is also formed in a volute line and extends from a point adjacent the greatest divergence of the impellers to a point adjacent the point of closest proximity between the peripheries of the impellers.

The cross-sectional area of the discharge port increases as the distance between the impellers decreases.

Referring now to the drive for the impellers, a single prime mover not shown in the drawings may be employed to power all of the impeller units of the pump. Also it is contemplated that a plurality of power units may be employed to drive the impellers of the various pump units.

Where the drive for the pump is to be as that shown in the drawings a single drive shaft 22 extends longitudinally through the pump and resides within a longitudinal recess formed between casing sections 15 and 16. This shaft is journaled with a plurality of ball-bearing races 34 and carries a plurality of gears 35. These gears are mounted for rotation within recesses in the casing and mesh with gears 36 carried by stub shafts 25. With this arrangement the rotation of each impeller relative to the other impellers depends upon the ratio of the gearing and for most purposes it is preferred that this ratio be the same in each instance, and in any case the ratio should be the same for the pumps of each unit of the multi-stage pump.

The shaft 22 may be sealed at both ends of the pump casing by any suitable seal arrangement. A novel seal assembly that is especially adapted for this use is similar to that shown in conjunction with the seals for shafts 25. As shown in Fig. 2 this seal assembly includes an inner race 37 and an outer race 38 similar to race 30, a plurality of the seal wafers or discs 28 are mounted within the races and perform in the same manner as described for the seals about shafts 25. Usually the pressures to be sealed against are not great and a single annular arrangement of discs 28 is sufficient to give a satisfactory seal. Covers 39 are provided for the seal and where the shaft extends from both ends of the pump housing the two covers have central apertures to accommodate the shaft. The covers have a tight fit on the annular beveled portion 40 of the casings.

The single row seal assembly is detailed in Fig. 4 and is entirely satisfactory for sealing the journal of a rotating shaft against low pressures.

In operation the pump is connected in a flow line, the intake 18 being connected with the source of material to be pumped and the discharge 21 being connected to the discharge portion of the line. The prime mover, not shown in the drawings, is started and due to a drive connection with shaft 22 the shaft is driven and the impellers in turn are driven by the engaging gears 35 and 36. The direction of rotation of each of the impellers 23 and 24 is the same and impeller 23 shown in Fig. 3 is rotated in a clockwise direction. It has been found that the intake of the pump need not communicate with the center of the impellers but may communicate directly with the peripheries of the impellers. The exact action which takes place within the impellers is not known but it has been found that there is sufficient suction at the periphery to draw the fluid from the intake to the space between the impellers. It is believed that this suction is the result of the vortex created between the rotating impeller blades of the impellers. At the location where the intake communicates with the peripheries of the impellers the impellers are relatively far apart and the action of the impellers impacting the fluid is very similar to that which takes place within the turbine type pumps. At any rate, it has been found that a

comparatively large suction head may be lifted and that the pump need not be primed in operation.

A centrifugal effect is had at the discharge of the pump and due to the volute arrangement of the impeller vanes added impact is given to the fluid imparting energy thereto. Also the divergence of the impellers is such that as the centrifugal effect is imparted to the fluid being pumped the space between the impellers is increasingly diminished and this imparts additional energy to the fluid.

It has been found that the power requirement for the pump as compared to the diameter of the impellers is great as compared to centrifugal pumps. However, this energy input is efficiently used and the pump has a proportionately greater output and may be used in those instances where a relatively great suction head must be lifted. The pump imparts a very high velocity to non-compressible fluids or is capable of compressing elastic fluids, such as vapors or gases, and this is believed in part at least due to the design of the close-mating impeller vanes as they rotate toward the point of closest proximity of the peripheries of the impellers. The effect of this is a progressively closing wedge-shaped space formed between the vanes as the cross-sectional area of the discharge increases.

In Figs. 5 and 6 a modified type impeller is shown at 41. This impeller has a series of volute vanes formed by the volute ribs 42. These ribs have valleys 43 therebetween which are slightly larger than ribs 42 allowing opposing impellers to mate closely at one position along the periphery of the impellers similar to the engagement of the impellers shown in Fig. 2. These modified impellers are especially adapted for use where high velocity is to be imparted to a hydraulic material or where the device is to be used as a compressor.

In the modified impellers 44 shown in Figs. 8 and 9 the vanes 44 extend radially. In this type of impeller many more vanes can be readily provided and this is an advantage in some instances. In any case it is desirable to use as high a number of vanes as possible as this increases the suction pull at the intake.

An enlarged view of the seal for shaft 26 is shown in Figs. 10 and 11. This seal includes three races 29, 30 and 31 having opposed grooves therein forming a space substantially elliptical in cross-section. Lodged within these grooves are a plurality of seal discs which are circular and shown at 28. These discs are relatively thin and upon rotation of shaft 26 are adapted to roll along the groove with their edges contacting the wall of the groove and tend to align in the groove whereby the side surfaces of adjacent discs are held in close abutment one with the other. These discs provide a substantial seal for the journaling of the shaft.

From the foregoing it will be seen that this invention is one well adapted to obtain all of the ends and objects hereinabove set forth together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all

matter herein set forth as shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having described my invention, I claim:

1. A pump comprising a casing, two opposed impellers consisting of discs having vanes rigidly mounted on their adjacent faces, said impellers mounted for rotation within the casing about oblique axes and approaching each other at one point of their peripheries to closely intermesh the vanes, said impellers diverging from each other from said one point to a diametrically opposed point of their peripheries, said impellers being spaced apart at their axes to provide fluid communication between said points, an inlet opening in the casing at the peripheries of the impellers beginning at the point of greatest divergence of the impellers and extending circumferentially over a portion of the impellers in a direction opposite to the impellers' rotational direction, a discharge opening in the casing at the peripheries of the impellers beginning at the point of closest approach of said impellers and extending circumferentially over a portion of the impellers in a direction opposite to the impellers' rotational direction, and drive means for rotating the impellers.

2. A pump as in claim 1 wherein the impeller vanes extend along convolute lines trailing the direction of rotation of the impellers.

3. A pump as in claim 1 wherein the number of vanes approximate that of a turbine impeller.

4. A pump as in claim 1 wherein the vanes are in the form of convolute corrugations.

5. A pump comprising a casing, two opposed impellers consisting of discs having vanes rigidly mounted on their adjacent faces, said impellers mounted for rotation within the casing about oblique axes and approaching each other at one point of their peripheries to closely intermesh the vanes, said impellers diverging from each other from said one point to a diametrically opposed point of their peripheries, said impellers being spaced apart at their axes to provide fluid communication between said points, an inlet opening in the casing at the peripheries of the impellers beginning at the point of greatest divergence of the impellers and extending circumferentially over a portion of the impellers in a direction opposite to the impellers' rotational direction, a discharge opening in the casing at the peripheries of the impellers beginning at the point of closest approach of said impellers and extending circumferentially over a portion of the impellers in a direction opposite to the impellers' rotational direction, the said inlet and discharge openings formed along convolute lines, the inlet decreasing in cross-sectional area in the direction of rotation of the impellers and the discharge increasing in cross-sectional area in the direction of rotation of the impellers, and drive means for rotating the impellers.

6. A pump comprising a casing, two opposed impellers consisting of discs having vanes rigidly mounted on their adjacent faces, said impellers mounted for rotation within the casing about oblique axes and approaching each other at one point of their peripheries to closely intermesh the vanes, said impellers diverging from each other from said one point to a diametrically opposed point of their peripheries, said impellers being spaced apart at their axes to provide fluid communication between said points, the angle between the impeller axes being such that the vanes at the point of closest approach of the impellers

have close tolerance with the discs portion of the opposed impeller and at the point of greatest divergence the discs portions of the impellers are substantially two vane widths apart, an inlet opening in the casing at the peripheries of the impellers beginning at the point of greatest divergence of the impellers and extending circumferentially over a portion of the impellers in a direction opposite to the impellers' rotational direction, a discharge opening in the casing at the peripheries of the impellers beginning at the point of closest approach of said impellers and extending circumferentially over a portion of the impellers in a direction opposite to the impellers' rotational direction, and drive means for rotating the impellers.

7. A pump as in claim 6 wherein a plurality of the pump units recited are interconnected to provide a multi-stage pump, the inlets of all but the first unit connected to the discharge of the preceding unit of the series, the inlet of the first unit and the discharge of the last of the units being connectable to a service line.

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