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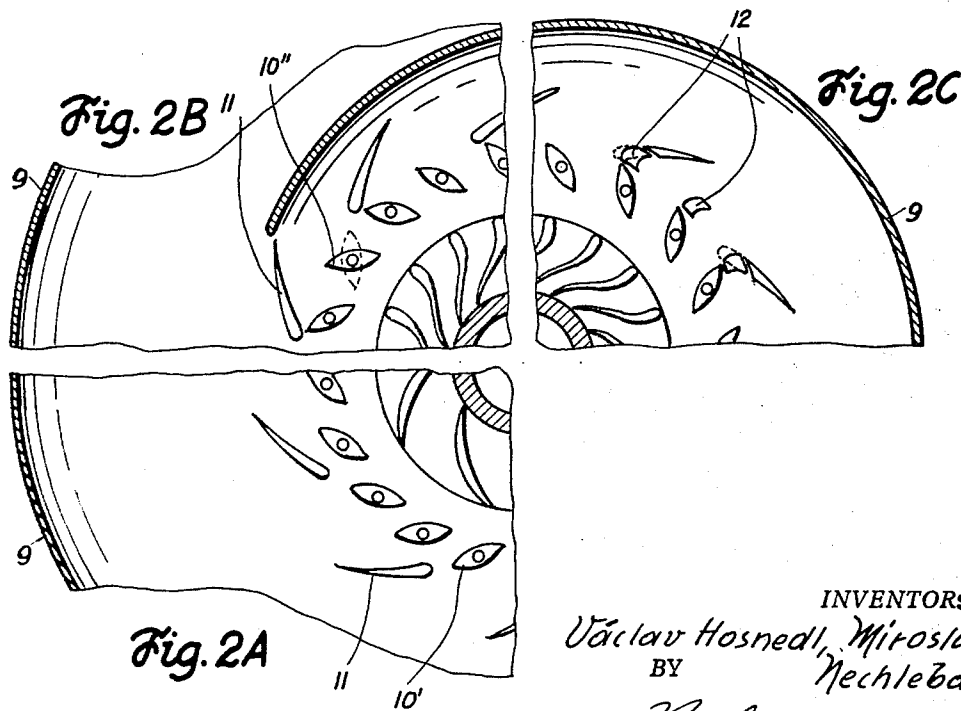
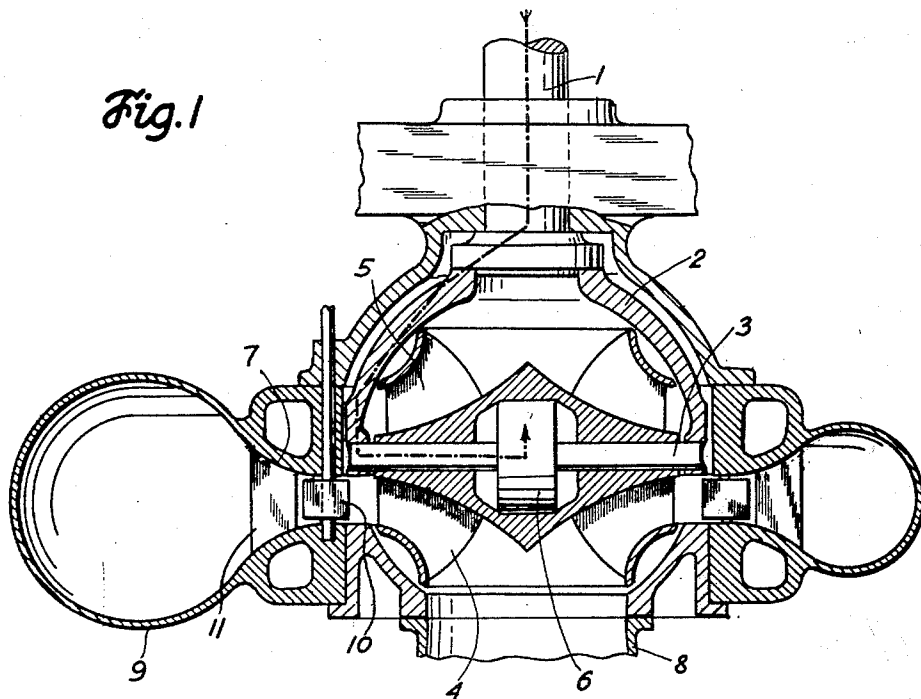
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3,433,165

HYDRAULIC APPARATUS

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Sheet 1 of 2



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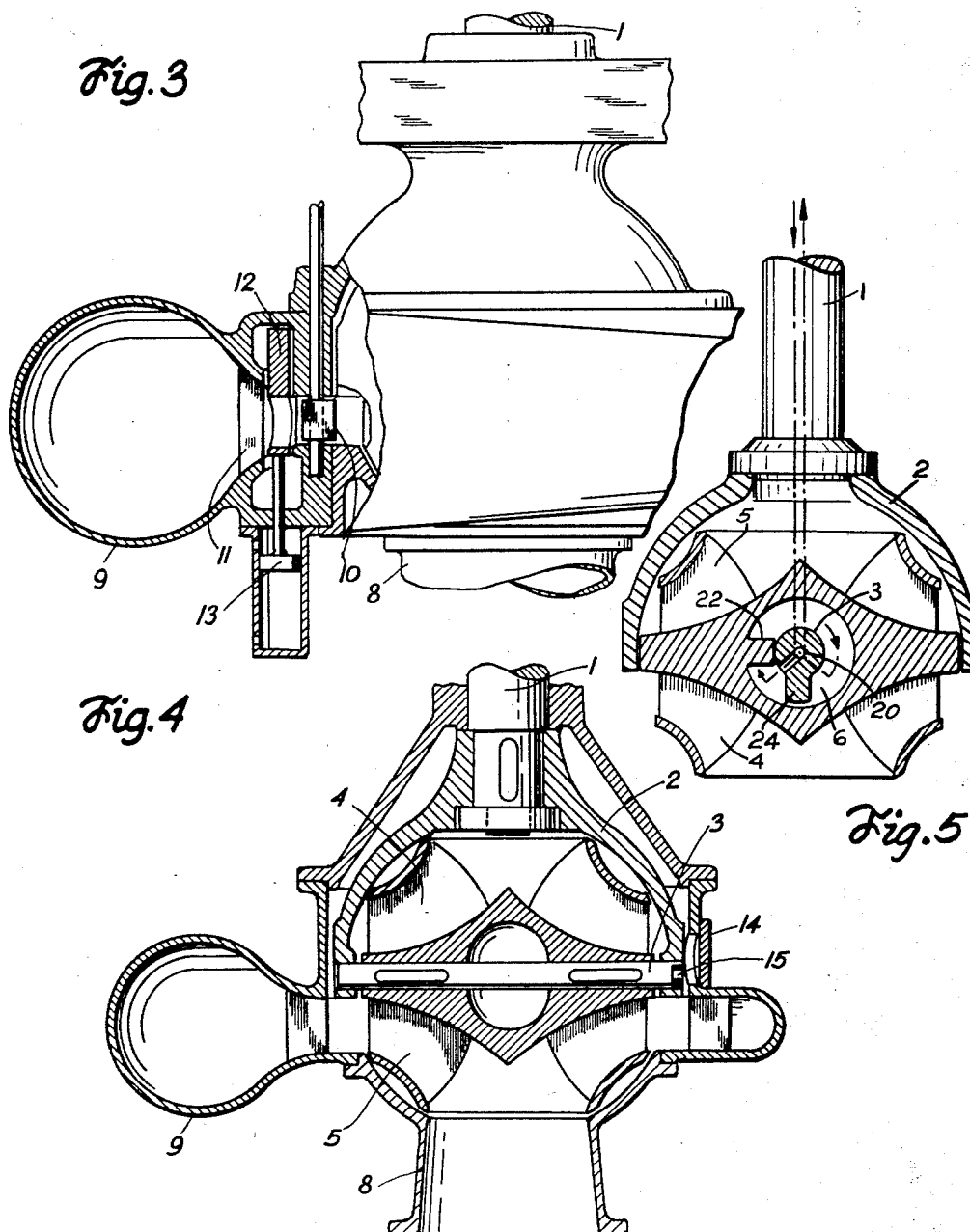
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Sheet 2 of 2



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HYDRAULIC APPARATUS

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ABSTRACT OF THE DISCLOSURE

A hydraulic apparatus including a plurality of impellers of different characteristics. One of the impellers can be selected to be situated in an operative position so as to provide a predetermined type of operation determined by the selected impeller which is placed in the operating position. In particular, a pair of impellers are provided, these impellers having a common turning axis and being joined to each other so as to form a single unitary structure, while at the same time the pair of impellers are respectively located on opposite sides of a predetermined plane which extends perpendicularly across their common turning axis. An inner housing means is provided for accommodating in its interior one or the other of the impellers, and a support means carries this inner housing means and supports the impellers for turning movement about a positioning axis situated within this predetermined plane and extending perpendicularly across the common turning axis of the impellers, so that one or the other of the impellers may be selected to be located in an operating position at the exterior of the inner housing means.

Background of the invention

The invention relates to hydraulic apparatus.

In particular, the present invention relates to hydraulic pumps or motors. It relates primarily to hydraulic apparatus provided with a plurality of impellers so that different types of operation can be achieved by placing a selected impeller in an operating position.

Thus, the invention relates to a hydraulic apparatus which has a pair of impellers enabling the apparatus to operate either as a pump or motor, although, if desired, the apparatus may operate exclusively as a pump with the pair of impellers giving the possibility of different types of pump operations, or exclusively as a motor with the pair of impellers giving the possibility of different types of motor operations.

Known apparatus of this type have been provided with impellers having rotary blades and with a fluid guide having swivelling blades, or there are known structures where a pair of impellers and a pair of fluid guides are used always but for one type of operation, while special closures and admission of air and the like are relied upon to prevent operation of the non-selected components. The disadvantages of these known structures resides in the intricacy of the impeller turning mechanism and in the fact that the operation derived from the pump or motor is determined only by a single impeller characteristic. This same disadvantage is encountered in the case of reversible hydraulic motors where it is not possible to achieve required operating characteristics in both directions of rotation. In addition, the known structures have the disadvantage of requiring exceedingly complex valves and very heavy machines inasmuch as a pair of independent impellers are required and the losses resulting from admission of air are considerable.

Summary of the invention

It is accordingly a primary object of the present invention to provide a construction which will avoid the above mentioned disadvantages.

More particularly, it is an object of the invention to provide a hydraulic apparatus with a pair of impellers which are firmly joined together and attached to the apparatus by way of a common supporting structure.

Another object of the invention is to provide a construction which will enable a non-selected impeller to be reliably maintained separated from the operations in a manner where no particular disadvantages result from this latter feature, while at the same time the operation with a single selected impeller can be carried out in a highly efficient manner.

Thus, it is possible with the structure of the invention to adapt each of the impellers, according to its particular construction, to the desired operations, such as the desired rates of discharge, and to desired operating heads for different types of motor or pump operations.

With the structure of the invention, inasmuch as there is only a single unitary structure including both of the impellers, the total amount of work required for operating the motor or pump is reduced and at the same time the weight of the entire apparatus is reduced and the cost of the apparatus is not very high. Because of the fact that the non-selected impeller which is not operating is situated within a given enclosure where it is reliably separated from participation in the operations there are no losses which otherwise would result from admission of air in connection with the non-selected impeller. Furthermore, with the apparatus of the invention there is the advantage of providing only one direction of rotation for both types of operation.

With the structure of the invention it is possible to provide either two different types of pump operation, two different types of motor operation, and a single unitary impeller assembly which can be adapted to the different desired operations.

Brief description of the drawings

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a fragmentary schematic sectional elevation of one possible embodiment of a structure according to the invention, the plane in which the section of FIG. 1 is taken containing the common turning axis for the pair of impellers;

FIGS. 2A-2C fragmentarily and schematically illustrate in plan views different types of blade assemblies for coacting with the impellers;

FIG. 3 is a fragmentary schematic sectional elevation showing an adjustable blade structure corresponding to the structure shown in FIG. 2C, the section of FIG. 3 also being taken in a plane which contains the common turning axis of the impellers;

FIG. 4 is a schematic sectional elevation of another possible embodiment of a structure according to the invention, the section of FIG. 4 also being taken in a plane which contains the common turning axis of the impellers; and

FIG. 5 is a schematic transverse section of part of the structure of FIG. 1, taken in a plane passing centrally through FIG. 1 perpendicularly to the latter to illustrate positioning structure.

Description of preferred embodiments

In the embodiment of the invention which is illustrated in FIG. 1, there are a pair of impellers 4 and 5 which are

joined so as to form a unitary structure. These impellers are respectively a pump impeller 4 and a motor impeller 5. The impellers have a common turning axis which extends vertically in FIG. 1 and coincides with the axis of a rotary shaft 1 which is indicated at the upper part of FIG. 1 in a fragmentary manner. The impellers 4 and 5 are respectively situated at opposite sides of a predetermined plane which extends perpendicularly across their common turning axis, and the impellers respectively have their blades situated at opposite sides of and directed away from this predetermined plane. This latter plane contains the axis of a shaft 3 which is shown in FIG. 1. This shaft extends through a bore of the unitary structure formed by the impellers 4 and 5 so that the latter are turnable about the shaft 3.

The shaft 3 forms a support means to support the impellers for turning movement about a positioning axis which is formed by the axis of the shaft 3 to a position where a selected one of the impellers is in an operating position. In the position of the parts shown in FIG. 1 it is the pump impeller 4 which has been selected to be located in the operating position, while the motor impeller 5 is situated in an inoperative position.

An inner housing means 2 is fixedly connected with the rotary shaft 1 for rotation therewith and carries the support means 3 which has its ends fixed to the inner housing 2, as illustrated in FIG. 1. This inner housing is of a substantially hemispherical configuration and has a hollow interior which is large enough to accommodate either the impeller 5 or the impeller 4. Thus, whichever one of the impellers is not selected for operation will be situated in the interior of the inner housing means 2 so as to be separated thereby from participation in the operation.

The inner housing means 2 together with the support means 3 and the impellers 4 and 5 are situated within an outer housing means 7. This outer housing means is provided with a passage means for directing the liquid along a path of flow with respect to the impeller which is selected for operation. This passage means includes an axial duct 8 whose axis coincides with the axis of the shaft 1, and a peripheral duct 9 which is a conventional involute duct and surrounds the housing 7. The peripheral duct or passage 9 is situated in a second plane in which the operating impeller 4 is situated, this latter plane being parallel to the predetermined plane which contains the positioning axis of shaft 3.

In order to place a selected impeller in its operating position, a positioning means 6 may be provided, as schematically illustrated in FIGS. 1 and 5. This positioning means 6 may take, for example, the form of a servomotor acted upon by suitable fluid under pressure which communicates with the servomotor through suitable non-illustrated passages formed in the shaft 1 and housing 2, and the passage 20 in shaft 3. The servomotor 6 is driven by a conventional means whereby only sufficient fluid under pressure is supplied to the servomotor 6 to turn the same through an angle of 180 degrees in one direction or the other. For example, the servomotor 6 may include a housing which surrounds, and is turnable with respect to, the shaft 3 but is fixed to the connected impellers 4 and 5, this housing having in its interior a vane 22 which coacts with a vane 24 that is fixed to the shaft 3 and extends also into the interior of the housing of the servomotor 6, so that in accordance with the delivery of fluid under pressure to one or the other sides of the stationary blade which is fixed to the shaft 3, the servomotor will turn together with the impellers through 180 degrees to situate one or the other of the impellers in its operating position. The passages which communicate with the servomotor are controlled through suitable valves so that in one direction of turning of the impellers the pressure fluid is drawn out of the servomotor from one side of the stationary vane and introduced at the other side thereof, and, of course, through the reverse operations reverse

turning may be provided so that in this way it is possible to place a selected impeller in its operating position.

One or the other of the impellers will always be in its operating position, while the non-selected impeller will be enclosed within the inner housing means 2 so as to be insulated from the operations and thus prevented from participating in the operations. In the illustrated position of the parts where the pump impeller 4 has been selected for operation, a liquid will be sucked toward the impeller 4 through the inlet 8 and will be driven by the impeller out through the peripheral passage 9 which is of spiral configuration. When the motor impeller 5 is selected for operation, then this impeller will be situated at the exterior of the inner housing means 2 with the pump impeller 4 situated in the interior of the latter and thus prevented from participating in the operations. At this time the liquid which is supplied to the interior of the housing 7 through the passage 9 will drive the motor impeller 5 so as to drive the shaft 1, and the liquid will now discharge out through the axial passage 8.

The outer housing 7 accommodates between the operating impeller and the passage 9 a blade means which includes the stationary blade portions 11, such as those indicated in FIGS. 1 and 2A. Thus, the housing 7 can have along the inner periphery of the spiral passage 9 a passage of inwardly flaring cross section directed toward the operating impeller and fixedly carrying the stationary blades 11 which are positioned as illustrated in FIG. 2A. Between these blades 11 and the operating impeller are situated a plurality of adjustable blade portions 10 which are fixed to pins that extend parallel to the shaft 1, as indicated in FIG. 1, so that through these pins it is possible to adjust the angular positions of the blades 10, and thus these blades 10 are capable of being swiveled to selected adjusting positions. FIG. 2A illustrates the positions 10' for the blades 10, provided in the case where the pump impeller 4 has been selected for operation. When the motor impeller 5 is selected for operation, the blades 10 may be swiveled to the position 10'' illustrated in FIG. 2B so that at this time the inwardly flowing liquid will have its direction of flow changed by the blades 11 and 10 of the blade means, causing the liquid to be directed against the impeller 5, engaging the blades thereof in a manner which will provide a highly efficient motor operation. Because of the adjustable components 10 of the blade means carried by the outer housing 7 between the peripheral passage and the operating impeller it is possible to control the operation of the machine to achieve an efficient operation as well as to regulate its output.

Instead of, or in addition to, the blade portions 10 and 11, it is possible to provide axially displaceable blade portions 12 of the blade means, shiftable in directions parallel to the shaft 1. Thus, either the swivel blades 10 can be replaced by axially displaceable blades, or in addition to the swivel blades 10 it is possible to provide, as shown in FIG. 3, axially displaceable blades 12 respectively connected with servomotors 13 by which the blades 12 can be displaced into operative positions between the blades 10 and 11 or retracted out of operative positions therebetween to an inoperative position. FIG. 2C indicates the operative positions of the axially displaceable blades 12 with respect to the blades 10 and 11 of the blade means.

Thus, by way of these axially displaceable auxiliary relatively short blades 12, adjusted by means of the servomotors 13, it is possible to improve the configuration of the channels formed between the blade assemblies 10-12 so as to improve the efficiency of the apparatus.

FIG. 4 illustrates an embodiment of the invention according to which a pump is provided with two different impeller 4 and 5 which will provide two different types of pump operation, depending upon desired operation characteristics. The different impellers 4 and 5 of FIG. 4 can be designed for operation at different heads to provide different discharges, each with a good efficiency de-

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pending upon the selected impeller. In FIG. 4, the impeller 5 is illustrated as selected for operation.

Except for the construction of the impellers of FIG. 4 and the structure for positioning a selected impeller in its operation position, the structure of FIG. 4 is identical with that of FIG. 1. In the embodiment of FIG. 4 the shaft 3 is turnably supported at its ends by the inner housing means 2 and is fixed, as by suitable keys, to the unitary assembly provided by the pair of impellers 4 and 5. In the illustrated example, if a relatively large discharge is desired, the impeller 4 will be selected for operation while if a smaller discharge is desired, the impeller 5 is selected for operation. Thus, as is evident from the drawing, the impeller 5 is narrower so as to provide a smaller discharge. In order to place a selected impeller of FIG. 4 in its operative position, a plug 14 is removed from the outer housing means so as to give access to the right end of the shaft 3, as viewed in FIG. 4, and this right end of the shaft 3 is formed with a non-circular recess for receiving a suitable wrench, such as a bar of hexagonal or square cross section, enabling the shaft 3 to be turned 180° in a manual manner to place a selected one of the impellers in its operating position. Of course, the positioning of a selected impeller in its operating position takes place when the operation of the pump is stopped.

At diametrically opposed exterior surface portions of the shaft 3 adjacent its right end, as viewed in FIG. 4, this shaft 3 is formed with relatively short axially extending grooves extending inwardly from its right end and matching a groove of the housing 2 so that a pin 15, set screw, or the like, can be introduced into the pair of aligned grooves to fix the shaft 3 either in a position shown in FIG. 4 or in a position angularly displaced by 180° about its axis from the position shown in FIG. 4, so that in this way when a selected impeller has been placed in its operating position it can be fixedly maintained in that position. Thus, with the position of the part shown in FIG. 4, when the shaft 1 is driven, the housing 2, the shaft 3, and the impellers 4 and 5 will be driven so that the impeller 5 will suck liquid in through the inlet 8 and pump it out through the outlet 9.

It should be noted that it is also possible to have different operating characteristics with high efficiency by using impellers of different diameters. Of course, once the structure of FIG. 4 has been adjusted to situate a selected impeller in its operating position, the plug 14 is replaced. Also, it should be noted that the manually operable adjusting structure of FIG. 4 can be used with the embodiment of FIG. 1, if desired.

We claim:

1. In a hydraulic apparatus, a pair of impellers of different characteristics, having a common axis of rotation and being joined to each other and respectively situated on opposite sides of a predetermined plane which is normal to said common axis of rotation, said impellers respectively having blades directed away from said predetermined plane, inner housing means having a hollow interior for accommodating one or the other of said impellers, support means carried by said inner housing means and supporting said impellers for swinging movement about a positioning axis located in said predetermined plane and extending perpendicularly across said common turning axis of said impellers so that said impellers may be turned about said positioning axis to positions where a selected one of said impellers is situated at the exterior of said inner housing means in an operating position while the non-selected impeller is situated in the interior of said inner housing means to be

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prevented from operating by said inner housing means, a rotary shaft fixed to said inner housing means for rotating with the latter and having an axis coinciding with the common turning axis of said impellers when a selected one thereof is in its operating position, said predetermined plane extending perpendicularly across the common axis of said shaft and said impellers when a selected one of the latter is in its operating position, outer housing means surrounding and receiving said inner housing means and said impellers in its interior so that both impellers and said inner housing means will rotate with said shaft within said outer housing means about the common axis of said shaft and the impellers, and passage means coacting with said outer housing means and the selected one of said impellers which is in its operating position to provide for flow of liquid with respect thereto.

2. The combination of claim 1 and wherein said inner housing means is of substantial hemispherical configuration.

3. The combination of claim 1 and wherein said passage means includes an axial passage having an axis coinciding substantially with the axis of said shaft and situated at a part of said outer housing means opposed to said shaft, and a peripheral passage extending around said outer housing means, communicating through the latter with the selected impeller which is in its operating position, and situated substantially in a second plane in which said selected impeller is located, said second plane being parallel to said predetermined plane when a selected impeller is in its operating position.

4. The combination of claim 3 and wherein a blade means is carried by said outer housing means between the selected impeller which is in its operating position and said peripheral passage.

5. The combination of claim 4 and wherein said blade means includes stationary blade portions and adjustable blade portions movable with respect to said stationary blade portions.

6. The combination of claim 5 and wherein said adjustable blade portions are supported for swiveling movement about axes, respectively, parallel to the axis of said shaft to coact with the stationary blade portions and the blade of the selected impeller which is in its operating position.

7. The combination of claim 5 and wherein said adjustable blade portions are axially movable respectively along axes which are parallel to the axis of said shaft to and from operative positions located in and extending perpendicularly through said second plane.

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