H. LENTZ.

FLUID CHANGE AND REVERSING GEAR.

APPLICATION FILED OCT. 21, 1914.

1,156,015.

Patented Oct. 5, 1915.

3 SHEETS—SHEET 1.

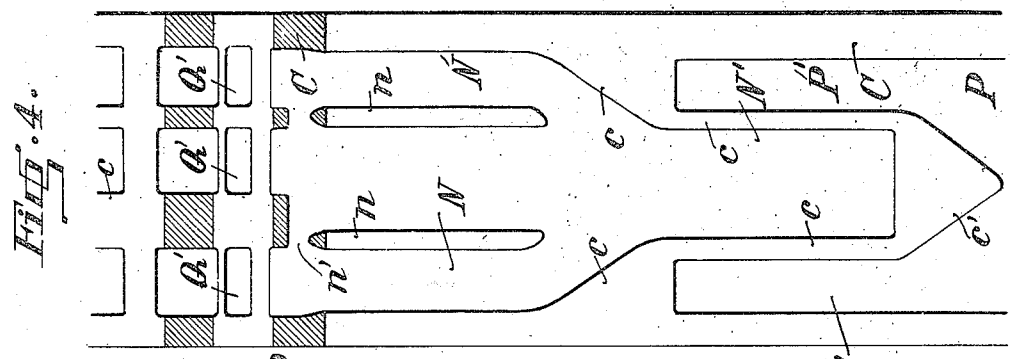


Fig. 4.

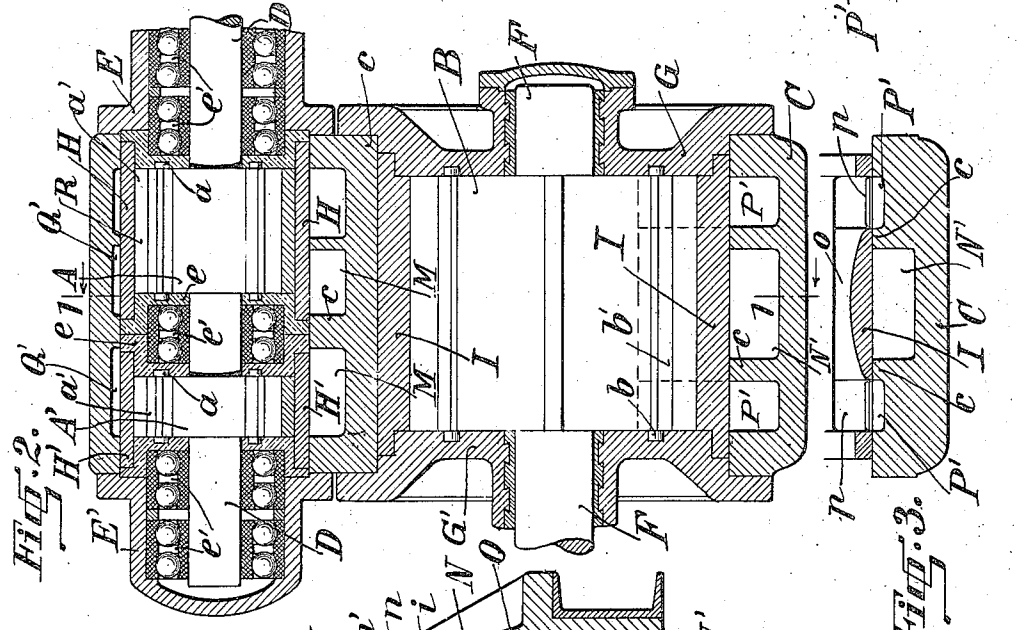


Fig. 2.

Fig. 3.

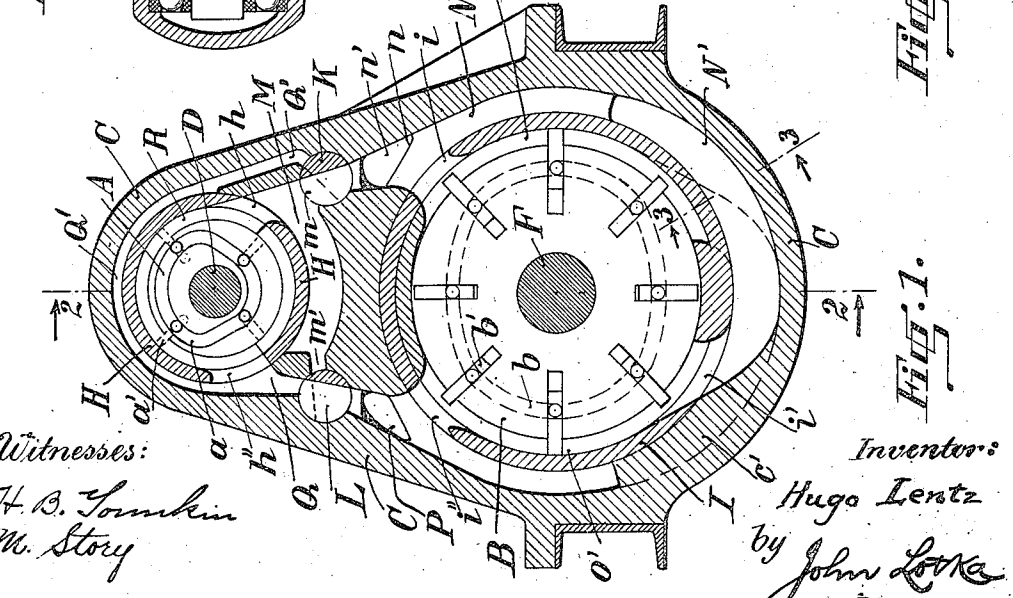


Fig. 1.

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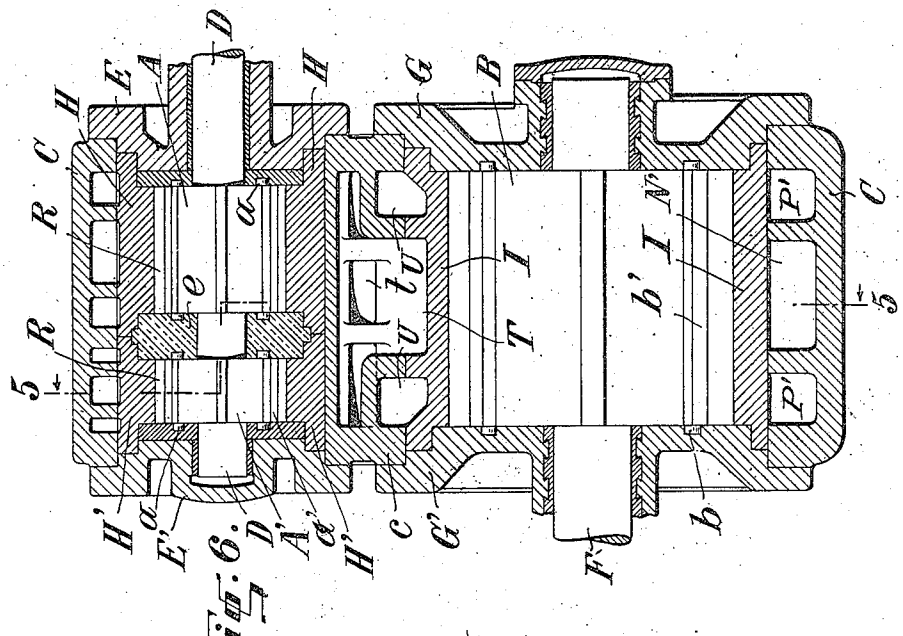


Fig. 6.

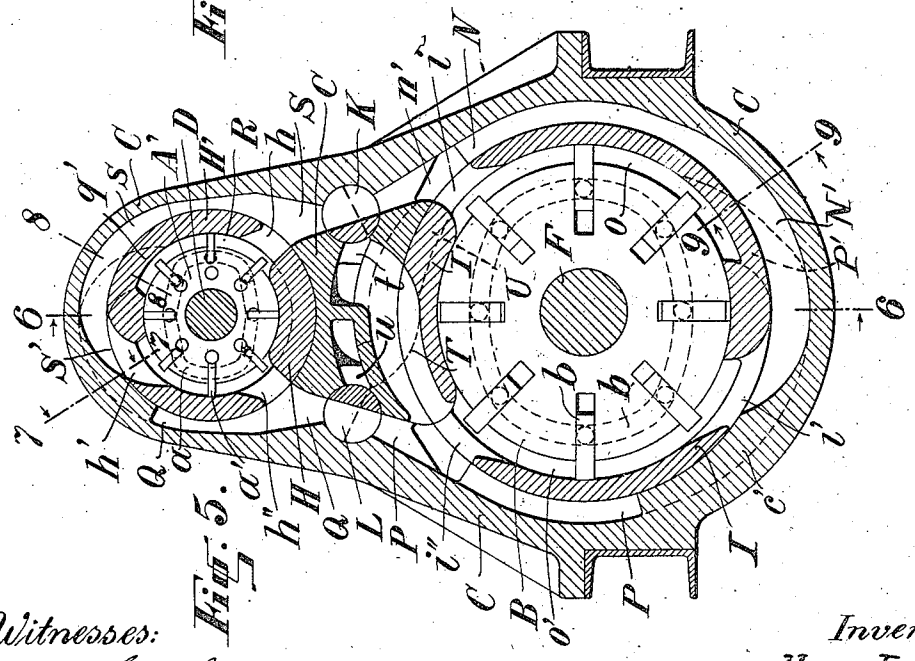


Fig. 5.

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3 SHEETS—SHEET 3.

Fig. 7.

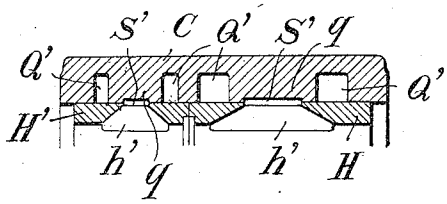


Fig. 8.

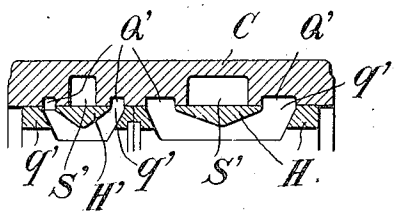


Fig. 9.

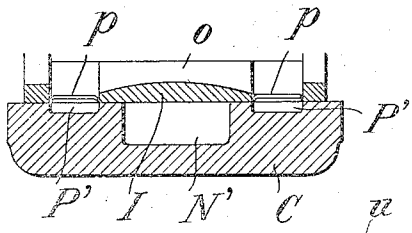


Fig. 10.

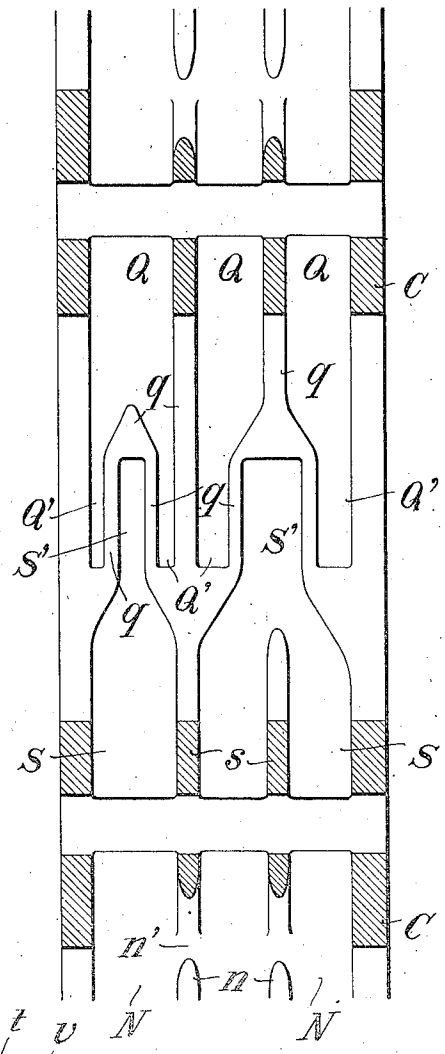
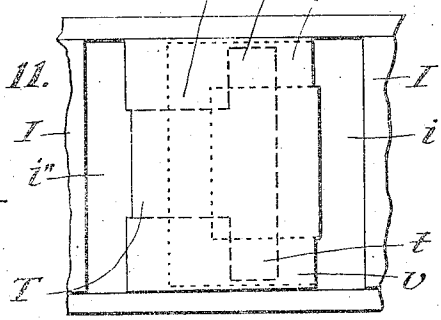


Fig. 11.



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UNITED STATES PATENT OFFICE.

HUGO LENTZ, OF BERLIN-HALENSEE, GERMANY.

FLUID CHANGE AND REVERSING GEAR.

1,156,015. Specification of Letters Patent. Patented Oct. 5, 1915.

Application filed October 21, 1914. Serial No. 867,892.

To all whom it may concern:

Be it known that I, HUGO LENTZ, a citizen of the German Empire, and resident of Berlin-Halensee, Germany, have invented certain new and useful Improvements in Fluid Change and Reversing Gears, of which the following is a specification.

My invention relates to improvements in fluid change and reversing gears, and more particularly in change and reversing gears in which a set of rotary pumps of one or more sections and a rotary motor of similar construction are mounted within a casing in such a way that the motor is driven by the pressure fluid from the pumps, and in which the sets of pumps and motors and controlling members disposed between the same are parallel to one another. Ordinarily the power medium for transmitting the power from the pumps to the motor is a non-elastic liquid. Gears of this class are designed for example on board of ships for transmitting power from the engine to the propeller shaft.

The object of the improvements is to provide an apparatus of this class in which the sets of pumps and motors are mounted within separate bushings and the circumferential passages for the power medium are formed by the said bushings and the casing which for this purpose are provided respectively with apertures or ports and ribs. When constructing the gearing in this way the passages are laid open when removing the bushings from the casing. Therefore the form of the casing is very simple, so that the cost of the manufacture is low, and an easy access can be had to the passages. Therefore I am enabled to have the walls of the passages entirely smooth and thereby to reduce the hydraulic resistances and to increase the efficiency of the gearing, while in gearings now in use the efficiency is considerably reduced because the passages for the fluid are formed by the rough walls of the cast casing. Furthermore the bushings and the apertures or ports formed therein can easily be manufactured independently of the casing. The passages have simple forms and they are made in such a way that the current of the pressure fluid has substantially the form of a uniform oval band. If the passages are made narrower at certain parts than at other parts, yet the cross-section can be made uniform by constructing the passages at such parts with greater depth.

A further object of the improvements is to mount the bushings within the casing in such a way, that there is no loss of fluid between the bushings and the walls of the casing. For this purpose the bushings are pressed into the bores made in the casing under a pressure which is higher than the pressure of the fluid on the bushings.

For the purpose of explaining the invention two examples embodying the same have been shown in the accompanying drawings, in which the same letters of reference have been used in all the views to indicate corresponding parts.

In said drawings Figure 1, is a cross-section of the apparatus taken on the line 1—1 of Fig. 2, the apparatus shown in the figure comprising a set of single acting pumps cooperating with a fluid motor which receives the jet of fluid at two points located diametrically opposite each other, Fig. 2, is an axial section of the apparatus taken on the line 2—2 of Fig. 1, Fig. 3, is a section taken on the line 3—3 of Fig. 1, Fig. 4 shows a development of the inner wall of the casing to illustrate the passages located around the set of motors, Fig. 5, is a cross-section of a modification of the apparatus in which a double set of pumps is provided, the section being taken on the line 5—5 of Fig. 6, Fig. 6, is an axial section taken on the line 6—6 of Fig. 5, Figs. 7–9, are sections taken respectively on the lines 7—7, 8—8, and 9—9 of Fig. 5, Fig. 10, shows a development of the inner wall of the casing of the apparatus shown in Figs. 5 to 9 and illustrating the form of the passages located around the set of pumps, and Fig. 11 is a developed view of the inner wall of the motor bushing, showing certain passages formed partly in said bushing and partly in the casing.

Referring to the example illustrated in Figs. 1 to 4, a set of pressure pumps A, A′ and a set of motors B are inclosed within a common casing C. The set of pumps consists of two single acting pressure pumps A and A′, the pump A being constructed so as to force twice as much fluid as the pump A′, in order to permit variation of the speed of the driven member accordingly. The set of pumps A and A′ is mounted on a shaft D which is supported at its outer ends in ball bearings e′ provided in side walls E and E′

of the casing, and internally of the casing in similar ball bearings e' provided in an annular box e. The pumps are constructed in the form of rotary pumps the blades a' of which are adapted to be shifted in radial direction by means of cam grooves a. The set of motors B is secured to the driven shaft F which is mounted parallel to the shaft D of the pumps and in the covers G and G' of the casing. The motors are likewise constructed in the form of rotary motors, and the blades b' are adapted to be shifted in radial direction by means of cam grooves b.

The sets of pumps and motors are disposed in bushings H, H' and I respectively, which are fitted in bores of the casing C. The said bushings are formed with suitable openings or ports which coöperate with ribs formed on the wall of the casing to provide the passages for the flow of the power medium between the sets of pumps and motors. The passages are controlled by two valves K and L which are located between the sets of pumps and motors and parallel to the shafts D and F, K being the controlling valve which may be constructed in two parts corresponding to the two pumps A and A', so that the pump A or the pump A', or both pumps A and A' can be thrown out of operation according to the position of the valve. The valve L is provided for reversing the current of the power medium and the direction of rotation of the driven shaft F.

The passages provided by the bushings and the casing C are constructed as follows, reference being had at first to the passages located between the valves K and L and around the pressure pump A. Between the bushing H and the drum of the pump A an annular working chamber R for reciprocating blades or pistons a' is provided. The said working chamber communicates through an aperture or port h made in the bushing H with a pressure chamber M and through an aperture or port h'' with the suction chamber Q located between the pump and the valve L. The pressure chamber M extends between the bushing H and the casing C and from the regulating valve K to the reversing valve L, and it communicates according to the positions of the said valves through ports m and m' respectively with a pressure passage N or a suction passage P. Between the controlling valves K and L a by-passage Q' is provided in the casing C, the inner wall of said by-passage being formed partly by the bushing H. The passages which are located around the pump A' are arranged in a similar way, and they are separated from the pump A by a circumferential rib c. For this reason the same letters of reference have been used to indicate the said passages. In a similar way the passages located around the set of motors are provided by the bushing I and the casing C. However, as the motor receives the pressure fluid at two points the passages are disposed in a different way. The circumferential pressure passage N N' which begins from the controlling valve K is passed around the bushing I at one side thereof and between the bushing and the casing C. The first part of the said passage extends over the whole breadth of the casing and it is subdivided only by ribs n which however are formed directly behind the controlling valve K with notches n' through which the current of the pressure medium discharged from the pumps A and A' is directly distributed over the whole width of the pressure passage N. The walls or ribs c which border the pressure passage N at its sides are made tapering toward each other and downward, as is shown in Fig. 4, so that the pressure passage is reduced in width at its lower end, as is shown in Fig. 4 at N'. The end of the passage N' communicates through an opening or port i' made in the bushing I, with the left hand section O' of the working chamber provided between the bushing I and the rotary drum of the motor B. The said section O' of the working chamber is connected through a further opening or port i'' made in the bushing I, with the suction passage P leading to the reversing valve L. Furthermore the pressure passage N communicates at a point located immediately at the rear of the controlling valve K and through an opening or port I with the right hand part O of the working chamber. At its lower end the part O is not connected to the middle passage N' which is located directly below the same, but it is separated therefrom by the solid wall of the bushing I, as is best shown in Fig. 3. But at both sides of the said passage N' which is reduced in width at this part openings or ports p are provided in the bushing I through which the working chamber O communicates with branches P' of the suction passage P, which branches are located at opposite sides of the pressure passage N'. The branches P' are separated from each other by the ribs c and the nose c' provided on the casing C.

The operation of the apparatus is as follows: It may be assumed for the present that only the small pump A' forces pressure fluid (liquid) so that the driven member F rotates at its lowest speed, and that the valves K and L are in the positions shown in Fig. 1, so that the driven member F rotates in forward (clockwise) direction. Under these circumstances the pump A' forces the pressure fluid through the port h and the open controlling valve K into the pressure passage N. Here the pressure fluid is divided into two branches, one part flowing through the port i to the right hand part of the motor B, while the other part

flows through the pressure passage N, N′ and the port *i′* to the left hand part of the motor B. Thereby the pressure on the set of motors is perfectly balanced. After the fluid has developed power within the motor one part of the fluid is discharged through port *i″* and directly into the suction passage P, while the other part flows thereto through the ports *p* and the lateral branch passages P′. The currents of the discharged fluids combine before the open valve L and flow back to the pump through the suction passage Q and the port *h″*. The same circuit is followed by the pressure fluid, when the small pump A′ is thrown out of operation and the large pump A is thrown into operation, so that the medium speed is imparted to the driven member, and also when both pumps are in operation for imparting the maximum speed to the driven member.

For reversing the driven member the controlling valves K and L are set in the positions shown in dotted lines in Fig. 1. The direction of rotation of the pump remains the same as before, and the power medium flows through the chamber M, the port *m′*, the valve L and the passage P which now has the function of the pressure passage. From the passage P the fluid is supplied to the working chamber O′ of the piston through the port *i″* and to the chamber O through the branch passages P′ and ports *p*. Therefore the power medium acts on the motor B in the reverse direction. After the power medium has developed power it flows through the ports *i* and *i′* and into the passage N, N′ which before was the pressure passage, and finally through the by-passage Q′ and the suction passage Q to the suction port *h″* of the pump.

In the example shown in Figs. 5 to 10 the apparatus is constructed substantially in the same way as in the example shown in Figs. 1 to 4, the difference residing merely in the construction of the set of pumps A, A′, which are double acting. Therefore, those parts of the apparatus which are constructed in the same way as the corresponding parts of the example shown in Figs. 1 to 4 have received the same letters of reference.

The passages for the power medium forced by the pumps A and A′ are alike and they are disposed as follows: The annular working chamber R which is located between the bushings H, H′ and the pump drums A, A′ communicates with the pressure passage N through ports *h* and *h′* which are provided in the bushings at diametrically opposite points, the communication being either direct or through by-passages S which are subdivided by ribs *s*. The suction chamber Q communicates with the working chamber R through ports *h″*.

As appears from Fig. 10, the by-passages and pressure passages S have not the same width throughout their lengths, but they are reduced in width along the part S′ to the width of the ports *h′*. These parts of the pressure passages S are disposed between bifurcated extensions Q′ of the suction passage Q which is disposed around the left hand section of the bushings H, H′, as is shown in Fig. 10. The passages are separated from one another by ribs *q* made integral with the casing C and the bushings. The ends of the suction passages Q′ communicate with the annular chamber R through openings *q′* which are made in the bushings laterally of the pressure passages S′ at points diametrically opposite to the ports *h″*. Furthermore the casing and the bushing I provide passages T and U. The passage T connects the port *i* and the suction passage P with the controlling valve K by means of which the end *t* of the passage T which communicates with the pressure passage N can be closed or opened. In a similar way passages U lead from the port *i* and pressure passage N to a channel or port *u* controlled by the reversing valve L which connects the suction chamber Q with the pressure passage N, and the two lateral branches or passages U are disposed at opposite sides of the passage T which is reduced in width in comparison with the end portion *t*.

When the valves K and L are in the positions shown in Fig. 5 forward movement is imparted to the driven member by the pressure medium. If one of the pumps or both pumps are in operation the power medium is forced as well through the port *h′* and the passages S, S′, as through the port *h* and the open controlling valve K into the pressure passage N. Here the current is divided in two branches in the same way as has been described with reference to Figs. 1 to 4, and it acts on the motor from opposite sides through the ports *i* and *i′*.

After the fluid has developed power it is discharged from the motor through the suction passage P and the open reversing valve L into the suction passage Q, from which it flows to the pump through the ports *h″* and *q′*. Therefore the pressure on the pump is balanced.

For reversing the apparatus the valves K and L are set in the positions shown in dotted lines, so that the power medium flows through the passage T shown in full lines in Fig. 5 to the opposite side of the set of motors and drives the same in the opposite direction. The discharged fluid is returned to the suction passage Q through the by-passages U. The shape and arrangement of the passages U, *u*, T, *t* is shown best in Fig. 11, where the passages U, *u* are indicated by dotted lines and the passage T, *t* by dashes. The centrally-located relatively narrow passage portion T communicates at

its left-hand end, with the port *i''*, and at its right-hand end with the relatively wide passage end *t* (controlled by the valve K). The right-hand ends of the two narrow passages U communicate with the port *i*, and their left-hand ends with the wide channel or port *u* (controlled by the reversing valve L).

In order to fit the bushings into the casing so tightly as to avoid leakage between bushings and casing, the bushings are given an initial outward tension greater than the separating pressure which would be exerted at the same points by the liquid under pressure.

While in describing the invention reference has been made to two examples in which the pump and motor are made in sections, and in which they are double acting, I wish it to be understood that my invention is not limited to apparatus of such constructions.

Furthermore my invention is not limited to a construction in which the passages for the power medium are disposed in the manner described around both members, that is the pumps and the motors.

Furthermore my invention is not limited to a construction in which the ends S', Q' and N', P' of the pressure and suction passages are disposed on opposite sides of each other. For example the said passages may be reduced at their ends and disposed one beside the other. However, the construction shown in the figures is preferable, because in this case the current of the pressure medium which is in the form of a uniform band is uniformly reduced in width from the outside and inward, and is uniformly branched and can be uniformly combined again over the whole width of the casing at the rear of this part.

I claim herein as my invention:

1. In an apparatus of the class described, the combination with a casing, a pressure pump, and a motor having at least two admission ports and adapted to be operated by the pressure fluid from said pressure pump, of a bushing fitted within said casing and inclosing the operating member of said motor, the passages connecting said pump and motor being provided with circumferential portions located at the contacting surfaces of said bushing and casing, the suction and pressure passages provided between the bushing and the casing being so arranged as to be located with parts of their lengths beside each other and communicating with their ends through ports made in the bushing with the ends of the section of the motor to which the fluid is to be supplied.

2. In an apparatus of the class described, the combination with a casing, a pressure pump, and a motor adapted to be operated by the pressure fluid from said pressure pump, of a bushing fitted within said casing and inclosing the operating member of said pump, the passages connecting said pump and motor being provided with circumferential portions located at the contacting surfaces of said bushing and casing, and one of said passages being bifurcated over a part of its length and so arranged with the bifurcated portion relatively to the other passages as to be located at opposite sides thereof.

3. In an apparatus of the class described, the combination with a casing, a pressure pump, and a motor adapted to be operated by the pressure fluid from said pressure pump, of a bushing fitted within said casing and inclosing the operating member of said motor, the passages connecting said pump and motor being provided with circumferential portions located at the contacting surfaces of said bushing and casing, one of said passages being bifurcated over a part of its length and so arranged with the bifurcated portion relatively to the other passages as to be located at opposite sides thereof.

4. In an apparatus of the class described, the combination with a casing, a pressure pump, and a motor adapted to be operated by the pressure fluid from said pressure pump, of a bushing fitted within said casing and inclosing the operating member of said pump, the passages connecting said pump and motor being provided with circumferential portions located at the contacting surfaces of said bushing and casing, one of said passages being bifurcated over a part of its length and so arranged with the bifurcated portion relatively to the other passages as to be located at opposite sides thereof, and the parts of the passages which are located sidewise of one another being made with greater depths than the main parts of the passages, so that the cross-sections of the passages remain the same over the whole lengths thereof.

5. In an apparatus of the class described, the combination with a casing, a pressure pump, and a motor adapted to be operated by the pressure fluid from said pressure pump, of a bushing fitted within said casing and inclosing the operating member of said motor, the passages connecting said pump and motor being provided with circumferential portions located at the contacting surfaces of said bushing and casing, one of said passages being bifurcated over a part of its length and so arranged with the bifurcated portion relatively to the other passages as to be located at opposite sides thereof, and the parts of the passages which are located sidewise of one another being made with greater depths than the main parts of the passages, so that the cross sections of the passages remain the same over the whole lengths thereof.

6. In a rotary apparatus operating with fluids, the combination of a rotary member,

a stationary bushing in which said member is adapted to rotate, and a casing in which the bushing is located, the bushing being provided with diametrically opposite inlets and with diametrically opposite outlets, and circumferential passages connecting the inlets and the outlets respectively.

7. In a rotary apparatus operating with fluids, the combination of a rotary member and a stationary member in which the first named member is mounted to rotate, said stationary member being provided with diametrically opposite inlets and with diametrically opposite outlets, and with circumferential passages connecting the inlets and the outlets respectively.

8. In an apparatus of the class described, the combination of a pump having a rotary member and a stationary member in which said rotary member is journaled, said stationary member being provided with suction and delivery ports and with a circumferential passage connecting them, a motor comprising a rotary member and a stationary member in which said rotary member is journaled, the stationary member of the motor being provided with diametrically opposite inlet ports, with diametrically opposite outlet ports, and with circumferential passages connecting said inlet ports and outlet ports respectively, passages connecting the circumferential pump passages with the circumferential motor passages, and reversing valves located in said connecting passages and adapted to so direct the fluid from the pump to the motor that either one set of motor ports or the other may act as inlets.

In testimony whereof, I have signed this specification in the presence of two subscribing witnesses.

HUGO LENTZ.

Witnesses:
WOLDEMAR HAUPT,
HENRY HASPER.