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HYDRAULIC PUMP, MOTOR, AND LIKE APPARATUS.

APPLICATION FILED FEB. 2, 1912.

1,081,810.

Patented Dec. 16, 1913.

4 SHEETS—SHEET 1.

Fig. 5

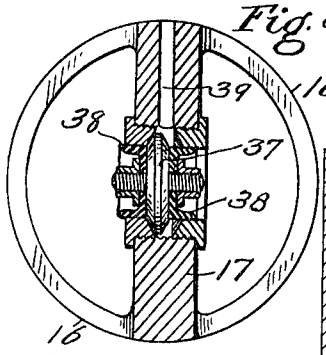

Fig. 1.

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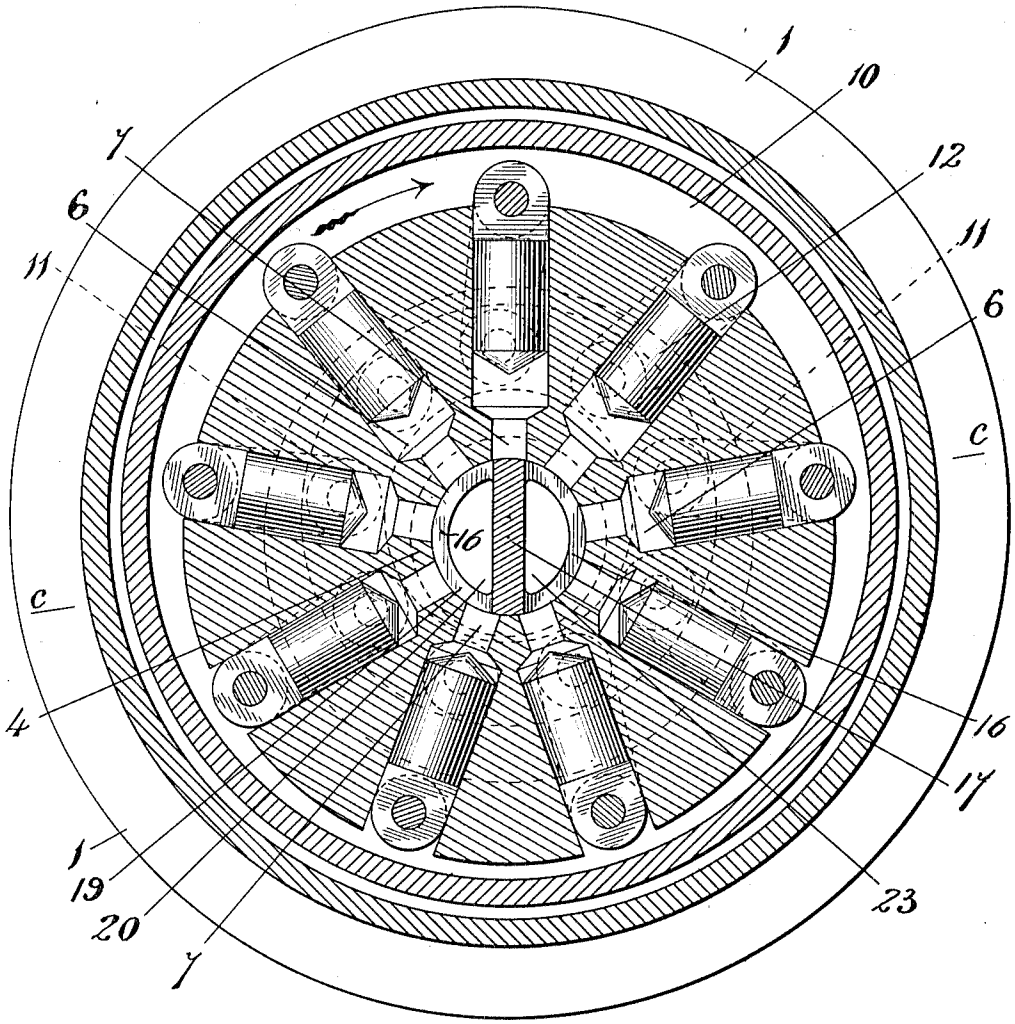
Fig. 2.



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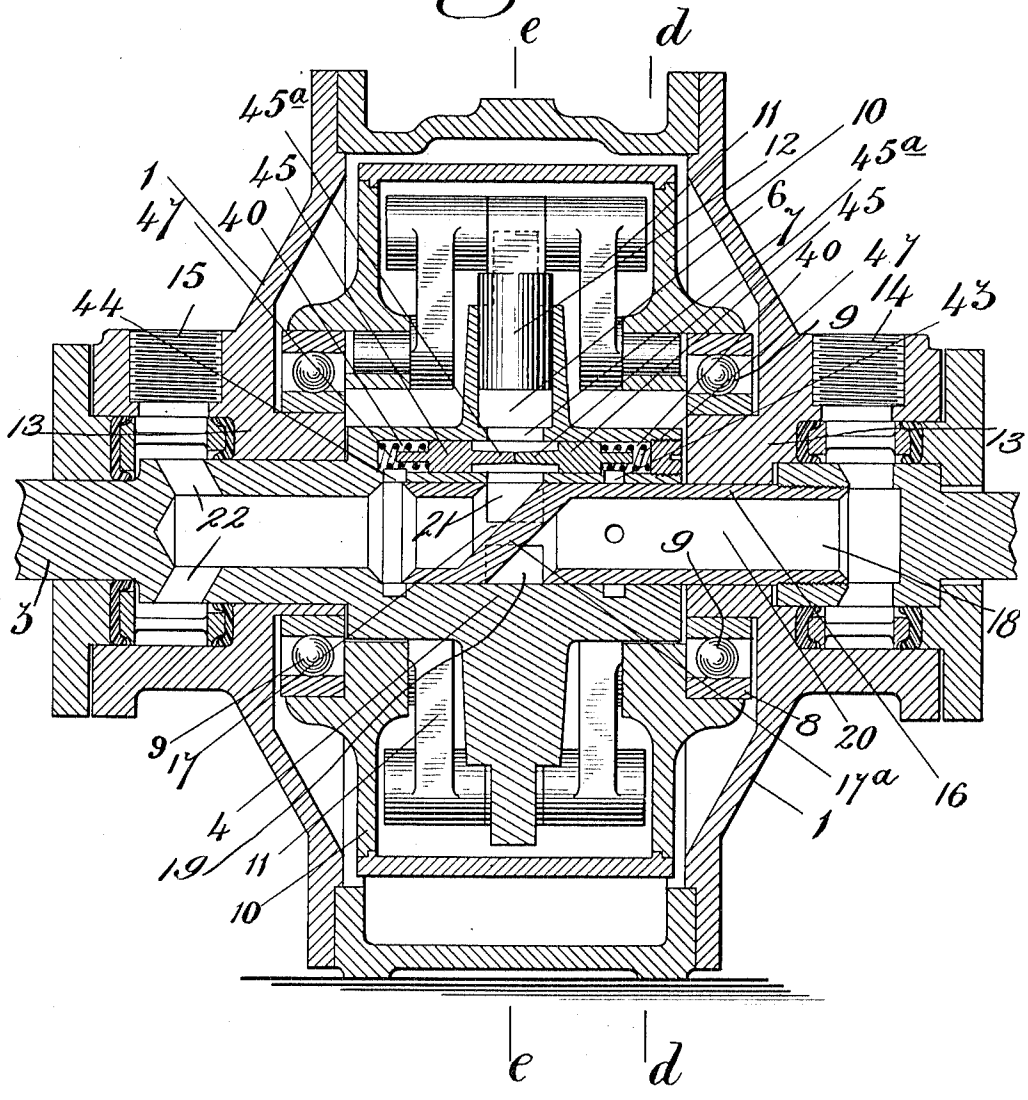
4 SHEETS—SHEET 3.

Fig. 3.



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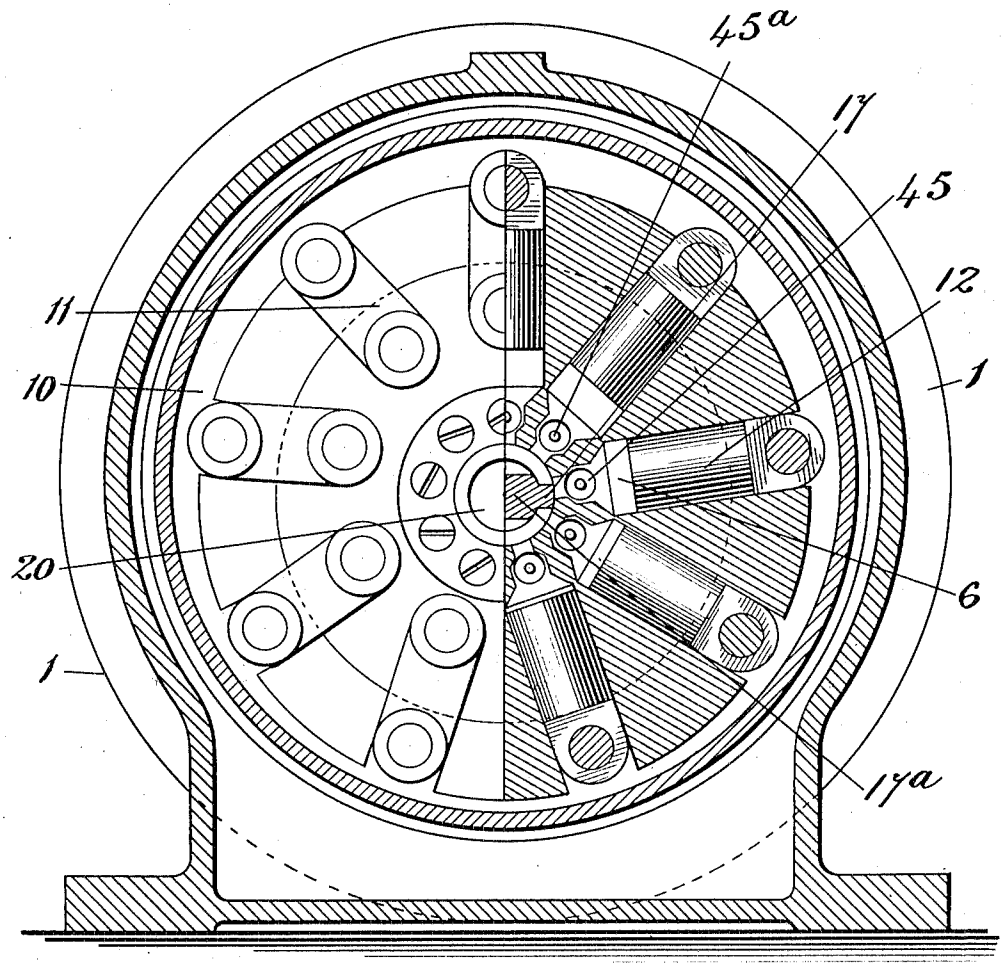
4 SHEETS—SHEET 4.

Fig. 4.



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UNITED STATES PATENT OFFICE.

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HYDRAULIC PUMP, MOTOR, AND LIKE APPARATUS.

1,081,810. Specification of Letters Patent. Patented Dec. 16, 1913.

Application filed February 2, 1912. Serial No. 674,928.

To all whom it may concern:

Be it known that I, ROBERT FALKLAND CAREY, a subject of the King of Great Britain, residing at London, England, have invented certain new and useful Improvements in or Connected with Hydraulic Pumps, Motors, and like Apparatus, of which the following is a specification.

This invention relates to that class of hydraulic pumps, motors and like apparatus having a plurality of cylinders and pistons and in which the pressure or quantity of fluid is varied or reversed without varying the stroke of the pistons or plungers or their equivalents by altering the position of a valve or plurality of valves, (termed, hereinafter, for brevity, the "valve-means"), relative to the position of the pistons. The said valve-means governs the opening and closing of the cylinders to the inlet and outlet ports in such a manner that when the position of the valve-means is such that each cylinder delivers throughout its entire incoming stroke into one port and takes fluid through its entire outgoing stroke from the other port maximum capacity is obtained, but when the valve-means is so positioned that each cylinder delivers and takes an equal quantity of fluid to and from each port, the no-work or zero position is obtained. In any mid-position of the valve-means between the no-work or zero and maximum capacity positions, any desired capacity can be obtained by positioning the valve-means so that each cylinder delivers and takes unequal amounts from the same port, the difference between the quantity delivered and the quantity taken being the capacity, while reverse is obtained by positioning the valve-means so that one of the ports is connected to the cylinders of the incoming pistons for the greater period of their stroke, the port thus connected being the delivery port, and the other port being connected to the cylinders of the outgoing pistons for the greater period of their stroke and constituting the intake port. In this class of hydraulic pumps or motors great difficulties have been experienced, (especially when running at high speeds), in the working of the pumps or running of the motor due to the variations of pressure of the liquid or to the fact that there is no give at the points where the ports are shut off as the cylinders change from one port to the other, whereby vibration is set up and undue noise caused in the apparatus and its efficiency materially affected.

The object of my invention, therefore, is to provide or combine with these hydraulic pumps or motors means whereby any excess of pressure due to variation in the pressure in the cylinders, valves or pipes may be relieved and so insure the proper working of the pump or motor.

My invention will be clearly understood from the following description aided by the annexed drawings in which:—

Figure 1 is a section of a hydraulic rotary pump, motor or the like with a rotary valve of one construction, showing means for relieving a cylinder of extreme pressure and passing such released pressure to the valve; Fig. 2 is a section on the line *a a* of Fig. 1; Fig. 3 is a longitudinal section of a rotary hydraulic pump, motor or the like, showing a different construction of the valve arrangements and of the inlet and outlet ports, also a different construction of relief valve; Fig. 4 shows on the left hand half, a section on the line *d d* of Fig. 3, and on the right hand half, a section on the line *e e* of Fig. 3; Fig. 5 is a section of a rotary valve, showing a means of relieving the pressure in a cylinder on either side of the valve.

In Figs. 1 and 2 of the drawings, the apparatus is constructed with multiple pistons and cylinders, the cylinders being formed and revolving with the driving shaft as a pump, or driven shaft as a motor, while the pistons which travel with the cylinders are reciprocated by their carrier being rotated eccentrically to that of the cylinders.

1 is the frame of the apparatus and in which the pistons, cylinders and tracks are situated. The frame 1 has a bearing 2 wherein is journaled the shaft 3, which shaft carries a hollow ring 4 provided on the outside thereof with a number of cylinders 6 having openings 7 leading into the interior of the ring 4. The frame 1 also carries tracks 8, arranged eccentric to the axial line of the shaft 3, and outside these tracks 8 and running on the balls 9 thereon, is a ring 10, to the side walls of which are pivotally connected the links 11 having the pistons 12 attached thereto, with such pistons positioned in their respective cylinders 6. Frame 1 is still further provided with a bearing or bearings 13, having a water in-

let and outlet 14, 15, (in Fig. 1 on one side of the apparatus, and in Fig. 3 on opposite sides of the apparatus), these being connected to the supply or discharge pipes, (not shown). In said bearing or bearings 13, as also in the center of the ring 4, I position the valve 16 which, in the form of the invention shown in Fig. 1, is of tubular construction and has a mid-rib 17 extending practically the whole length of the valve so as to form parallel chambers within the valve. In the form represented in Fig. 3, the rib 17^a extends only a short length of the valve, and is disposed angularly of the valve, to divide the latter into two chambers arranged end on. In each form, however, the valve has openings 18 and 19 on one side of the rib 17 or 17^a leading by the passage 20 from the supply opening 14 to the cylinder openings 7, and also openings 21 and 22, on the other side of said rib leading by the passage 23 from the cylinder openings 7 to the outlet 15. The valve is provided with a hand wheel 24 or other device by which it can be operated.

Now in referring to Fig. 2, it will be understood that the frame 1 and the valve 16 have a fixed relation to each other after the positioning of the valve. In this figure, the valve 16 is shown with the mid-rib 17 vertical, in which position the pistons on the left-hand side of the rib are on their suction stroke, drawing the liquid through the passage 20 of the valve, while the pistons on the right hand side of the rib are expelling the liquid previously drawn into their cylinders, through the passage 23. Thus, the pump is delivering its maximum quantity of fluid and the pistons are in such position that the top piston which is cut off by the mid-rib 17 is at the end of its stroke with its crank just positioned ready for a reverse movement of the piston due to the eccentric. Now, if the valve 16 is moved to the horizontal position, the point where the valve cuts off the openings 7 instead of coinciding with the ends of the stroke of the pistons will be approximately at the middle of the stroke of the pistons, and the pistons above and below the mid-rib will be a combination of suction and expulsion, by reason of their movements, and will act in both capacities, so that no pumping is performed. It will be seen that when the valve is in this position, each cylinder is sucking in fluid for part of the time it is connected to either port and is also delivering back into the same port an exactly similar amount of fluid, thus at the end of a revolution no effective work has been done.

As the cylinders are revolved, the mid-rib cuts off each cylinder in succession. Now, if the valve 16 is moved into any position for the mid-rib to be between the horizontal and the vertical position on one side or the other, there will be a long period during which the incoming pistons are delivering into one port and a short period during which the pistons are moving outward and sucking fluid from the same port, the difference between the two giving the effective amount pumped. The opposite port will be connected to the out-going pistons sucking fluid for the long period and to the pistons when incoming and delivering for a short period only. This port, therefore, becomes the suction port. The nearer the position of the mid-rib of valve 16 is to the vertical, the greater is the amount of the fluid delivered by the pump, the speed of the engine remaining constant.

Either port may be made the pressure port or suction port by simply moving the valve one way or the other, without altering the direction of rotation of the cylinders and pistons. The port that is for the time connected for the longer portion of the stroke of the incoming or delivering pistons becomes the pressure port and the port that is connected for the longer period of the stroke of the outgoing pistons becomes the suction port. This capability of varying the quantity pumped and reversing the direction of the flow of liquid through the pump at will, by simply positioning the valve 16, enables the pump to be used in conjunction with a fluid pressure motor of any known type to form a hydraulic transmission or driving gear which will give a mid or stop position with all speeds from zero to a maximum, both forward or reverse. A gear such as this is applicable to motor vehicles, or for any other purposes.

In the above described and similar constructions of apparatus, one cylinder only acting would cause a fluctuating movement of the liquid, but as there are a number of cylinders connected to each port, some may be taking in fluid, and others expelling fluid at the same time, with the result that an exchange of fluid takes place from the expelling to the intaking cylinders and these are very nearly balanced.

To compensate for extra pressure in the cylinders, I may, as depicted in Fig. 5, form a hole 39 in the mid-rib 17 and provide such mid-rib with a double-acting valve 37 held in place by two cup leathers 38, so that any extra pressure in the cylinder will be relieved in passing the mid-rib 17 by such pressure passing down the hole 39 and away by the cup leather on both sides of the valve or on the open side of the valve. Instead of employing a relief valve in the mid-rib I may position one for each cylinder in the cylinder ring, as in Fig. 1, or two for each cylinder, as in Figs. 3 and 4, either being suitable for high-speed pumps or motors.

In the construction shown in Fig. 1, I form a hole 40 at right angles to each pas-

sage 7, and connect such hole by passages 41 and 42 and grooves 43 and 44 arranged around the cylinder ring to both spaces 20, 23, in the valve 16, and inside the hole or smaller cylinder 40, I position two pistons or valves 45 and 46, the valve 45 having a seating against the entrance from the passage 7 and being provided with a stem which abuts against the other valve 46, which latter is controlled by a spring 47 to normally keep the two valves in contact and the valve 45 on its seating. The hole 42 is positioned between the valves 45 and 46 and leads to passage 23 in the valve 16, while the other hole 41 is between the spring-controlled piston or valve and the end of the hole 40 and leads to passage 20 of the valve 16.

Any excess of pressure in any cylinder will operate a piston or valve 45, forcing it slightly back in the hole 40. This valve simply acts as a weighted plunger to give temporary relief while the mid-rib 17 of valve 16 is passing opening 7 and locking the fluid. The valve 45 is automatically weighted to the pressure the pump is working against, and at the time at whichever port happens to be the pressure port, the pressure is at the back of the valve 45 through either hole 41 or 42. Valve 46 really only forms a dividing piston to transfer the pressure from hole 41 to the back of the valve 45 and to prevent the pressure passing from one port 15 to the other. The spring is only quite light to keep the valve up to its work.

According to the construction shown in Fig. 3, I form two holes 40 opposite to each other from the passage 7 and I position in each hole 40 a piston or valve 45, these having stems 45^a projecting into the passage 7 and abutting against each other, being normally kept in this position by the springs 47. Each hole 40 communicates with the grooves 43, 44, one opening into the valve at one side of the mid-rib and the other at the other side, and in this case when there is pressure in either port, the valves 45 are definitely driven over by the pressure and the action of one of the springs, to the exhaust side of the apparatus, until the valve nearest the exhaust side comes against the end of the hole and can move no farther. The valves 45 remain in this position so long as the pressure in the cylinder is equal to, or below the pressure in the pressure port, but should any increase of pressure take place in the cylinder, say when the mid-rib is passing the port opening into the cylinder the pressure will act upon the valve next the pressure side of the mid-rib and move it against the pressure in the pressure port and thus give relief in the cylinder against approximately the same pressure that the machine is working at at the time.

When the apparatus is set in the no-work position, the valves 45 are returned to the mid position, as shown in Fig. 3, by the two springs and any slight fluctuations which occur in the flow of liquid in the two ports are taken up by a slight vibratory motion of the two valves 45 acting together.

What I claim as my invention and desire to secure by Letters Patent is:—

1. A multi-cylinder hydraulic pump, motor or like apparatus of the rotary, radial cylinder type, having an adjustable main-valve, and means for giving temporary relief in each cylinder to prevent undue rise of pressure in each cylinder at the point where it changes from one port to another.

2. A multi-cylinder hydraulic pump, motor or like apparatus of the rotary, radial cylinder type, having an adjustable main valve, and a relief device associated with each cylinder and automatically loaded by the working pressure of the liquid in the apparatus for the time being.

3. A multi-cylinder hydraulic pump, motor or like apparatus of the rotary, radial cylinder type, having an adjustable main valve and having each cylinder provided with means for giving temporary relief to prevent an undue rise of pressure therein at the point where it changes from one port to the other, such means consisting of an auxiliary piston valve working in a cylinder, one end or part of said auxiliary cylinder being connected to the working cylinder and the other end or part to the pressure port in the main valve, thus forming a by-pass containing an auxiliary piston valve automatically loaded by the pressure in the pressure port to the pressure which the machine is working against for the time being, and being capable of a movement or give should the pressure in the cylinder rise above the pressure in the pressure port, and means for returning said auxiliary piston valve to its normal position when the pressure in the cylinder falls to or below the pressure in the pressure port.

4. A multi-cylinder hydraulic pump, motor or like apparatus of the rotary, radial cylinder type, having an adjustable valve provided with means for releasing any excess of pressure in each cylinder at the point where it changes from one port to another, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

ROBERT FALKLAND CAREY.

Witnesses:
P. E. Mattocks,
Wm. O. Brown.