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HYDRAULIC TIMER

2,742,918

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2 Sheets-Sheet 1

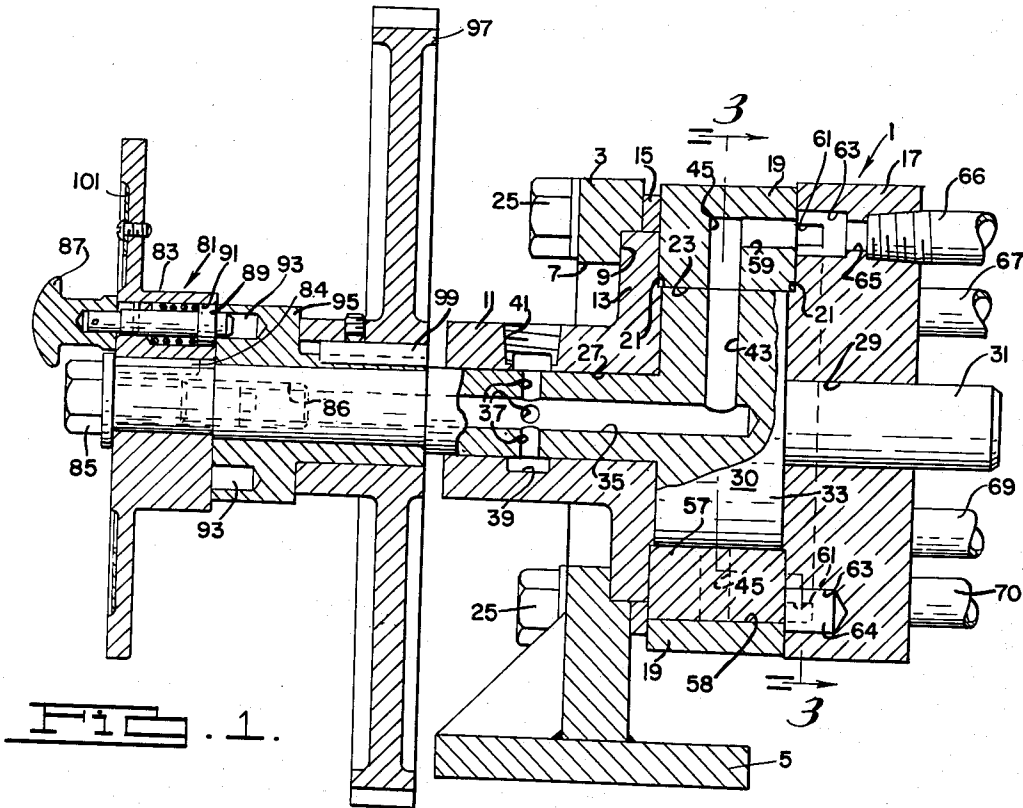


Fig. 1.

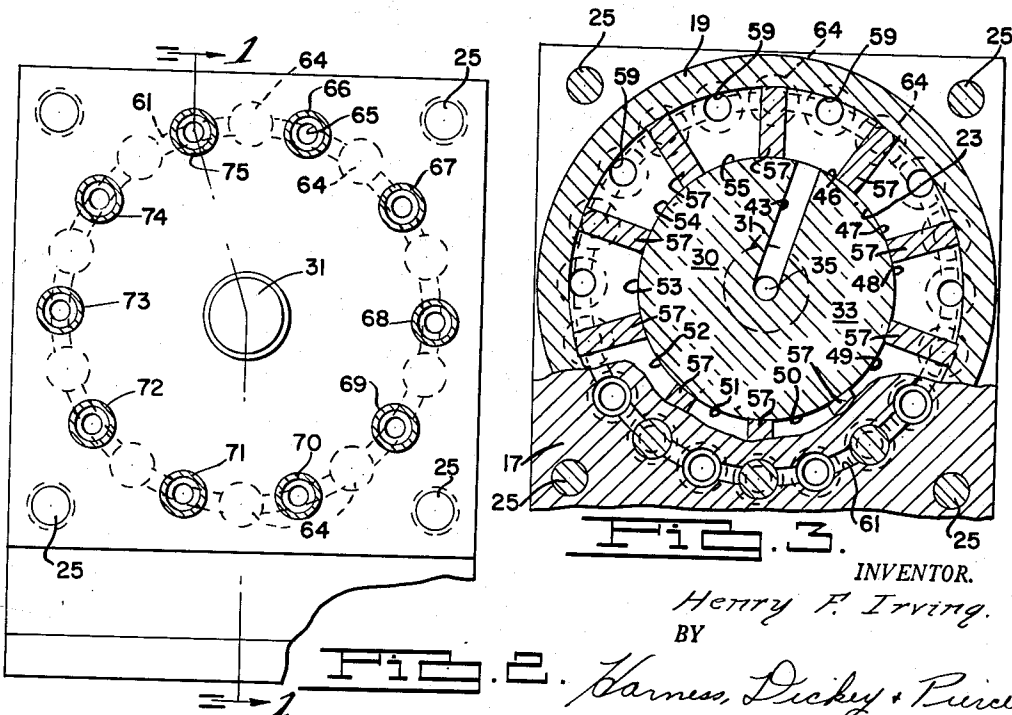


Fig. 3.

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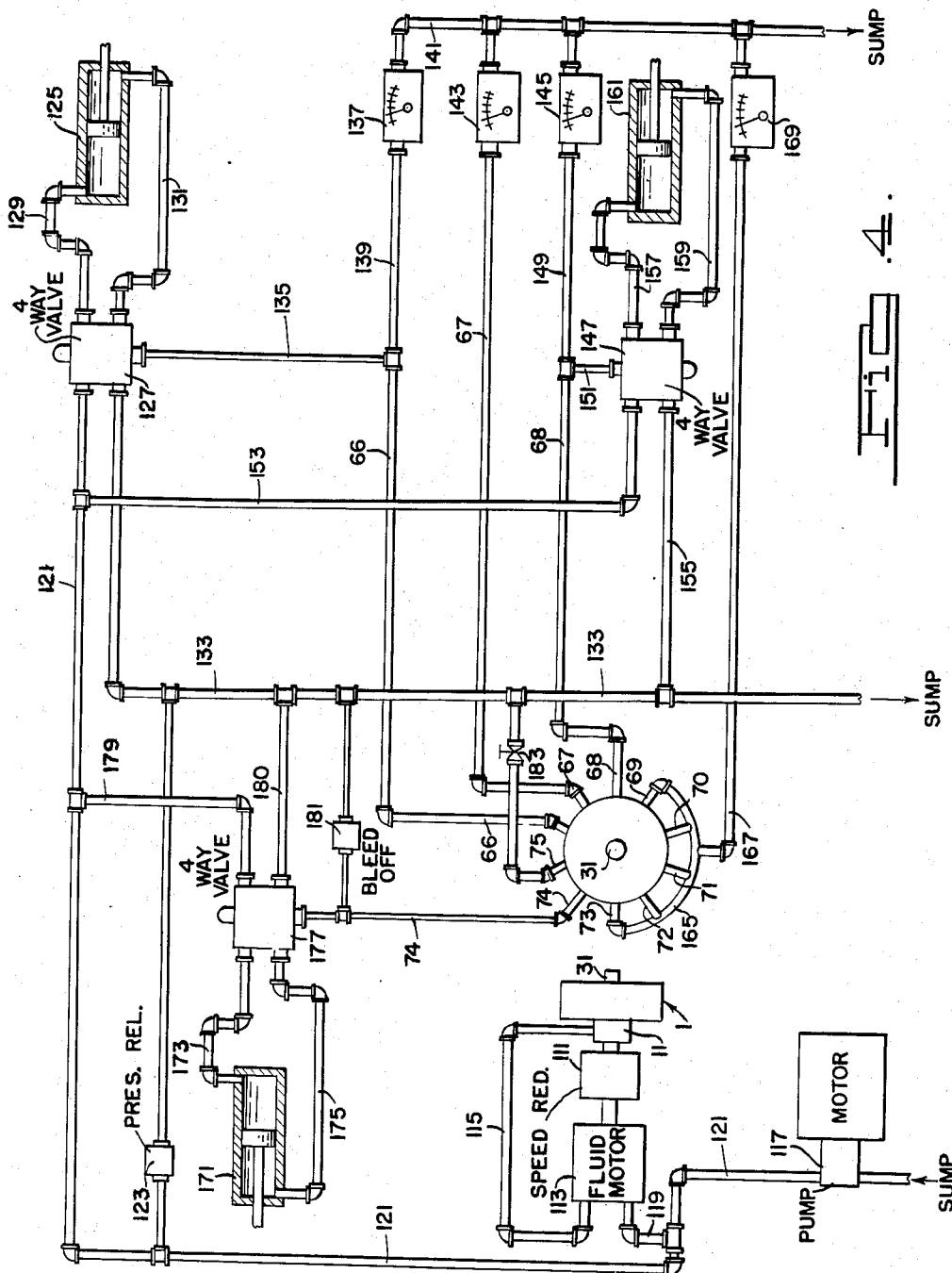
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1

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HYDRAULIC TIMER

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This invention relates to hydraulic or pressure fluid controls and, in particular, refers to a distributor and timer for controlling pressure fluid systems.

Many cyclic hydraulic systems include several individual work circuits that are operated at different parts of the cycle and often for different lengths of time. The present invention provides a distributor and timer that automatically controls the sequence of operation as well as the length of operation of the individual circuits in a hydraulic system and may also be used to provide idle periods between operation of the circuits.

In its preferred form, the present timer includes an improved distributor valve that has a plurality of separated chamber spaced angularly about the axis of a rotor. The rotor carries pressure fluid and has an outlet for it which communicates with less than all of the chambers at a time and preferably with only one of them. The angular or rotary position of the rotor therefore determines which of the chambers is to receive pressure fluid. The chambers are connected respectively to the various individual work circuits so that presence of fluid in the chamber actuates the circuits in the desired sequence. Deactuation of each circuit takes place when the rotor outlet passes beyond its respective chamber so that the control or pilot pressure is cut off.

The length of the period that the circuit operates is the time that it takes the rotor outlet to pass by the control chamber for the circuit. The present invention contemplates intracyclic controlled variation of the angular speed of the rotor so that the length of time it takes to pass through each chamber, and thus the length of time each circuit is operative, may be regulated. A preferred means for obtaining rotor speed control employs a hydraulic motor to drive the rotor. The motor discharges pressure into the rotor and thus into the chambers. The outlet lines for the chambers, which are operatively connected to the individual circuits, also contain flow control valves which determine the rate at which the pressure fluid can flow to the sump. These valves therefore control the rate of discharge of the motor and by adjusting them to the desired settings the rotor speed through the various chambers can be varied in the necessary way to secure the required periods of circuit operation.

The invention is illustrated in the accompanying drawings, in which:

Figure 1 is an axial cross section through the improved distributor valve of this invention taken along the line 1—1 of Fig. 2;

Fig. 2 is a side elevation taken from the right of Fig. 1;

Fig. 3 is a cross section taken along the line 3—3 of Fig. 1; and

Fig. 4 illustrates a hydraulic system embodying the distributor and timer of this invention.

The central element of the control unit provided by this invention is the distributor valve 1 shown in Figs. 1-3. The distributor 1 has a suitable base or support member 3 which may be secured by way of a suitable flange 5

2

in various desired positions and for reasons which will appear later it is preferably mounted in the sump or on the tank or fluid reservoir. The upright side of the support member 3 has an aperture 7 which is surrounded on the inner face of the member by a counterbore 9. A hub 11 has a radial flange 13 that is received in the counterbore 9 and extends axially beyond the end face of the base 3 and may itself be surrounded, if desired, by a washer 15. The distributor 1 has a right-hand end plate 17 and a casing ring 19 is clamped between the faces of this plate and the flange 13, both of which may be provided with slight reliefs on their radial faces to form annular shoulders 21 that serve to locate the ring 19 by engagement with its inner periphery 23. Bolts 25 shoulder on the outer face of the supporting member 3 and thread into the end plate 17 to clamp the parts together. The hub 11 and the end plate 17 have bores 27 and 29 which support the rotary shaft or bearing portions 31 of the rotor 30. The rotor 30 has a central disk or radial circular flange 33 that fits in a non-leak-proof joint between the opposing end faces of the hub flange 13 and the end plate 17 and which rides upon and rather loosely fits the inner periphery 23 of the ring 19 so that leakage around the joint may readily take place. The left-hand bearing portion 31 has an axial fluid passage 35 formed therein which extends into the portion of the rotor that is mounted in the hub 11 and which terminates at approximately the center of the disk 33. Fluid flows into the passage 35 by way of radial passages 37 formed in the bearing portion and to permit this the passages 37 communicate with an annular groove or chamber 39 in the hub 11. Fluid flows into the groove 39 through a threaded opening 41 in the side wall of the hub which is adapted to receive a conduit or the like. The fluid received in passage 35 from the radial openings 37 flows outwardly in the disk 33 through preferably a single radial passage 43 that preferably opens into the outer periphery of the disk but which obviously may open into one of its radial faces. An annular groove 45 is formed in a central part of the ring 19 and opens into the periphery 23 so that it receives fluid from the passage 43 in the disk. The annular groove 45 is subdivided into a plurality of preferably equi-length chambers 46, 47, 48, 49, 50, 51, 52, 53, 54, and 55 by a series of radial dividing walls 57. The walls 57, which preferably are at least as wide as the passage 43, are conveniently provided by forming slots extending axially through the entire length of the ring 19 and opening into the periphery 23 and then sweating or otherwise securely fastening plates 57 in these slots. The inner end faces of the plates lie, of course, on the periphery 23. It is evident that as the rotor 30 rotates fluid is continuously admitted to the passage 35 through the annular groove 39 and radial passages 37 but that fluid is discharged from passage 43 into only one of the chambers 46-55 at a time.

Each chamber 46-55 has an outlet opening 59 formed therein preferably midway between the adjacent boundary walls 57. The passages 59 are preferably parallel to the axis of the shaft 31 and thus open out of the radial end face of the ring 19 into an annular groove 61 that is formed in the end plate 17, the groove 61 preferably being somewhat narrower than the outlet opening 59. The groove 61 is divided into a series of separated chambers that are counterparts of the chambers 46-55. The subdivision of groove 61 is conveniently accomplished by drilling holes 63 in the radial face of the end plate 17 which are in alignment with the dividing walls 57 and then filling these holes with a suitable fitting or plug 64. Each of the chambers that is thus formed in the end plate 17 is provided with an outlet passage 65 ex-

tending parallel to the axis of the shaft 31, and preferably wider than the groove 61, which is threaded at its outer end to receive conduits 66, 67, 68, 69, 70, 71, 72, 73, 74, and 75. The conduits 66, 67 . . . 75 are therefore, respectively, the outlet connections for the chambers 46, 47 . . . 55. It is evident that the angular position of the rotor 30 and passage 43 determines which of these conduits will be carrying fluid.

The rotor 30 is, of course, adapted to receive torque and, if desired, a manually operated clutch 81 may be provided between the source of power in the shaft so that the rotor 30 can be manually turned to any desired angular starting position or, indeed, rotated by hand through the entire cycle if it is not desired to automatically control the length of operation of each circuit as herein-after described. The clutch 81 includes a disk 83 that is connected by way of a key 84 and axial bolt 85 to bearing portion 31, it being observed in Fig. 1 that the bolt may fit into an enlargement of the passage 35 which is closed by the plug 86. The disk 83 carries a knob 87 that is secured to a pin 89 which reciprocates in bore 91 along an axis parallel to the axis of the shaft 31. The end of the pin 89 is spring pressed to project beyond the end of the disk 83 but may be withdrawn into the disk by manually pulling the knob 87. The end of the pin 89 is received in one of a plurality of holes 93 formed in a hub 95, the number of holes 93 being the same as the number of chambers 46-55. The sleeve hub 95 is rotatable upon the shaft portion 31, but when the pin 89 is fitted in one of the holes 93, it is connected to the disk 83 so that the two rotate together and with the rotor 30. Power is fed to the rotor by suitable means such as a gear 97 that is keyed at 99 to the hub 95. It is evident that by pulling the knob 87 to disconnect the pin 91 from the hub 95, the disk 83 and rotor 30 may be rotated to align the passage 43 with any of the chambers 46-55. If desired, the disk 43 may be provided with an index scale 101 that has calibrations designating each of the chambers 46-55, it being evident that when the gear 97 is connected to a power source the disk 83 can be indexed in no smaller increments than the angular spacing between the chambers and, hence, the scale 101 will designate which of the chambers is connected to the passage 43.

The distributor 1 will thus operate to deliver fluid to any one of the chambers 46-55, and it is evident that by connecting the pipes 66-75 to various work circuits sequencing is automatically obtained. In accordance with the invention means are combined with the distributor to vary the time that any particular circuit is connected to fluid pressure in the passage 43 and this, of course, can be accomplished by varying the angular speed of the rotor 30 as it progresses from one chamber or series of chambers to another. A preferred means for accomplishing this variation in speed is shown in Fig. 4 which illustrates a typical system in which the present invention may be embodied.

In this system, the pressure in certain of the distributor chambers is used as pilot fluid to operate various work circuits. The distributor 1 is driven through a suitable speed reducer 111, which may include the gear 97 (not shown in Fig. 4), by a fluid motor 113, which is preferably a piston type constant displacement hydraulic motor available on the open market. In the system illustrated, the clutch mechanism 81 is omitted to simplify the drawings. The outlet of the fluid motor is connected by way of a pipe 115 to the inlet 41 of the distributor hub 11 and thus furnishes pressure fluid to the distributor passage 43 in the rotor disk 33. The fluid motor receives fluid under pressure from the pump 117, which is preferably a vane type constant delivery pump available on the open market, by way of a conduit 119 which is connected in parallel with the outlet line 121 of the pump. The outlet line 121 of the pump 117 furnishes pressure fluid to six different circuits in the illustrative embodiment of Fig. 4. The maximum pressure in line 121 may

be controlled in a conventional manner by a pressure relief valve 123 connected between the line 121 and the sump line 133.

The first circuit, which is pilot operated by the chamber 46 in valve 1, includes a work cylinder 125 that is controlled by a pilot-operated, spool type, spring return, four-way valve 127 which connects with opposite ends of the cylinder by means of conduits 129 and 131. The four-way valve is connected in series with the line 121 and exhausts to the sump by way of the conduit 133. The pilot chamber of the four-way valve 127 is connected by a pilot line 135 to the outlet conduit 66 of the chamber 46 in the distributor 1 so that pressure in this chamber operates the valve to allow pressure from line 121 to flow to the desired side of the work cylinder. Connected in parallel with the line 135 and the four-way valve is a metering-out flow control valve 137, which is of a conventional type that maintains a constant rate of flow regardless of pressure variations and of less capacity than the pump 117. It receives fluid through pipe 139 from the conduit 66 and exhausts fluid to the sump through a conduit 141 and is the principal source of initial back pressure in the pilot circuit through the motor 113 and valve 1. The flow control valve 137 may be manually set to vary the rate of flow through it and thus the rate of discharge of the motor 113 during the period that the passage 43 communicates with chamber 46. Thus, the setting of the flow control valve 137 determines the speed or rotation of the fluid motor 113 and therefore the angular speed of the rotor 30 which is driven by the fluid motor. This, of course, determines the time in seconds or minutes that the passage 43 communicates with the chamber 46 and thus the length of the period that pressure is furnished to the work cylinder 125.

After the rotor 30 has passed by chamber 46, the pressure in pilot line 135 is relieved so that the valve 127 is returned to spring biased position to cut-off pressure to the work cylinder. Pressure relief may be provided by a bleed-off port in the valve 127 which connects the pilot chamber to the exhaust line, this being a conventional construction. It may also be provided by a bleed-off valve in line 135. It is also provided by the aforementioned loose fit of the rotor 30 in the housing provided by the casing 19, the hub 11, and end plate 17, which allows pressure to escape. Since the valve 1 is intended to leak, it is preferably mounted in the sump or on the reservoir tank, or is enclosed in a housing which drains to the tank. It may be noted that the permissible leakage tends to balance the pressure on the rotor as well as lubricate it so that binding does not occur, the pressure drop being sufficient to prevent untimely operation of the other circuits.

A simpler circuit is controlled by the pressure fluid discharged from chamber 47 through the pipe 67. This is illustrated as merely an idling circuit; that is it is desired during the period that the passage 43 connects with chamber 47 to have no useful work performed by the hydraulic system. This is accomplished by connecting the outlet line 67 directly to only the flow control 143, the flow control being connected on its outlet side to the sump line 141. Adjustment of the flow control setting will therefore determine the length of time that pressure fluid is available in chamber 47 for the idling period.

The chamber 48 is connected by way of its outlet pipe 68 to another circuit which is similar to the above described work circuit that includes the cylinder 125. The circuit of pipe 68 includes a flow control valve 145 and a four-way valve 147 which are connected in parallel with the line 68 by pipes 149 and 151, respectively. The four-way valve receives operating pressure from line 121 by means of the line 153 which it exhausts through line 155 to the sump line 133. Lines 157 and 159 connect the four-way to opposite sides of the work cylinder 161. It is evident that this circuit operates in the same way as the circuit controlled by chamber 46 so that the length

5

of its period of operation is determined by the setting of valve 145.

Another idling circuit is connected to the chambers 49, 50, 51, 52, and 53. The outlet pipes 69-73 for these chambers are connected to a common manifold 165 and a pipe 167 receives fluid from the manifold and discharges it into the sump line 141 through the flow control valve 169. It is evident that the setting of the valve 169 will control the rate at which the rotor 30 moves past chambers 49-53.

The next circuit operated by the hydraulic system includes a work cylinder 171 which receives fluid in opposite ends by way of conduits 173 and 175 that are controlled by the four-way valve 177. This valve receives pressure from line 121 through the conduit 179 and exhausts into sump line 133 through the conduit 180. The valve is pilot-operated by pressure in chamber 54 acting through the conduit 74. Adjustment of the time of operation is not directly provided for this circuit. That is, there is no flow control valve to regulate the rate of discharge of the fluid motor 113. A manually operated bleed-off valve 181 is preferably connected between line 74 and sump line 133 to provide a positive control for preventing a pressure lock of the rotor.

The last chamber 55 is connected directly to the sump line 133 by way of its outlet conduit 75 and the rate of discharge may be roughly controlled by means of a hand valve 183. This circuit therefore serves in effect as an idling circuit and it will be appreciated that the total time required for operation of the circuits controlled by chambers 54 and 55 will be the difference between the time required for a complete cycle and the time necessary to complete the previously described circuits which are under the regulation of the flow control valves. In cases where leakage through valve 1 is not enough to prevent a pressure lock of the rotor, the valve 183 serves as means to stop operation of the system at the end of the cycle.

From the foregoing description, it is evident that by means of the distributor 1, in combination with the fluid motor and the flow control valves that have been illustrated, the time and sequence during which each work circuit operates, as well as the time and sequence of idle periods for manual loading operations and the like, may be automatically regulated. For manual regulation, the clutch 81 enables the distributor 1 to be turned by hand or to be set to start at any desired chamber. The construction of the distributor is rather simple and it is relatively free from the possibility of service break-down so that reliable operation is obtained. The distributor valve itself or in combination with the flow control and fluid motor may be used in various ways as those familiar with the art will understand. Hence, it is not intended to limit the invention to the hydraulic system illustrated nor is it intended to limit it to the specific details of construction that have been shown by way of illustration.

What is claimed is:

1. A distributor and timer for hydraulic or pressure fluid systems comprising, in combination, a rotor having a fluid passage with an outlet spaced radially from its axis of rotation, a casing for the rotor having a plurality of separated chambers spaced angularly about the axis of rotation and in communication with said outlet during only a predetermined fraction of the cycle of rotation, said chambers having outlets in said casing, and adjustable means operative within a single revolution of the rotor for rotating the rotor at different speeds as the outlet passes different of said chambers.

6

2. A distributor and timer for hydraulic or pressure fluid systems comprising, in combination, a rotor having a fluid passage with an outlet spaced radially from its axis of rotation, a casing for the rotor having a plurality of separated chambers spaced angularly about the axis of rotation and in communication with said outlet during only a predetermined fraction of the cycle of rotation, said chambers having outlets in said casing, and means for rotating the rotor at different speeds as the outlet passes different of said chambers, said means comprising a fluid motor having a driving connection with the rotor and discharging pressure fluid into said rotor passage and an adjustable flow control device connected to a chamber outlet for controlling the rate of flow therethrough and thus the rate of discharge of said motor.

3. In an hydraulic system, the combination of a distributor having a plurality of outlets and an inlet, a movable valve in said distributor for successively connecting said inlet to each of said outlets, and means for varying the time said inlet is connected with an outlet comprising an hydraulic motor for moving said valve and discharging into said inlet and valve means in the line from at least one of said outlets for varying the rate of flow therethrough and thus the rate of discharge and speed of said motor.

4. A distributor for hydraulic or pressure fluid systems comprising, in combination, a rotor having a fluid passage with an outlet spaced radially from its axis of rotation, a casing for the rotor having a plurality of separated chambers spaced angularly about the axis of rotation and in communication with said outlet during only a predetermined fraction of the cycle of rotation, outlets in the casing for said chambers, a sleeve rotatable on said rotor having a radial face with a plurality of angularly spaced openings therein, a member mounted on the rotor and having a driving connection therewith, a manually actuated element carried by the member and selectively fitting in any of said openings to interconnect the sleeve and member for joint rotation, and means on the sleeve whereby it may receive a driving torque, said element being removable from said opening whereby said member and therefore said rotor may be turned manually.

5. The invention set forth in claim 2 including a plurality of said devices connected respectively in lines from different of said outlets.

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