Feb. 17, 1953

C. D. BRANSON

2,628,489

HYDRAULIC CONTROL

Filed June 3, 1947

4 Sheets-Sheet 1

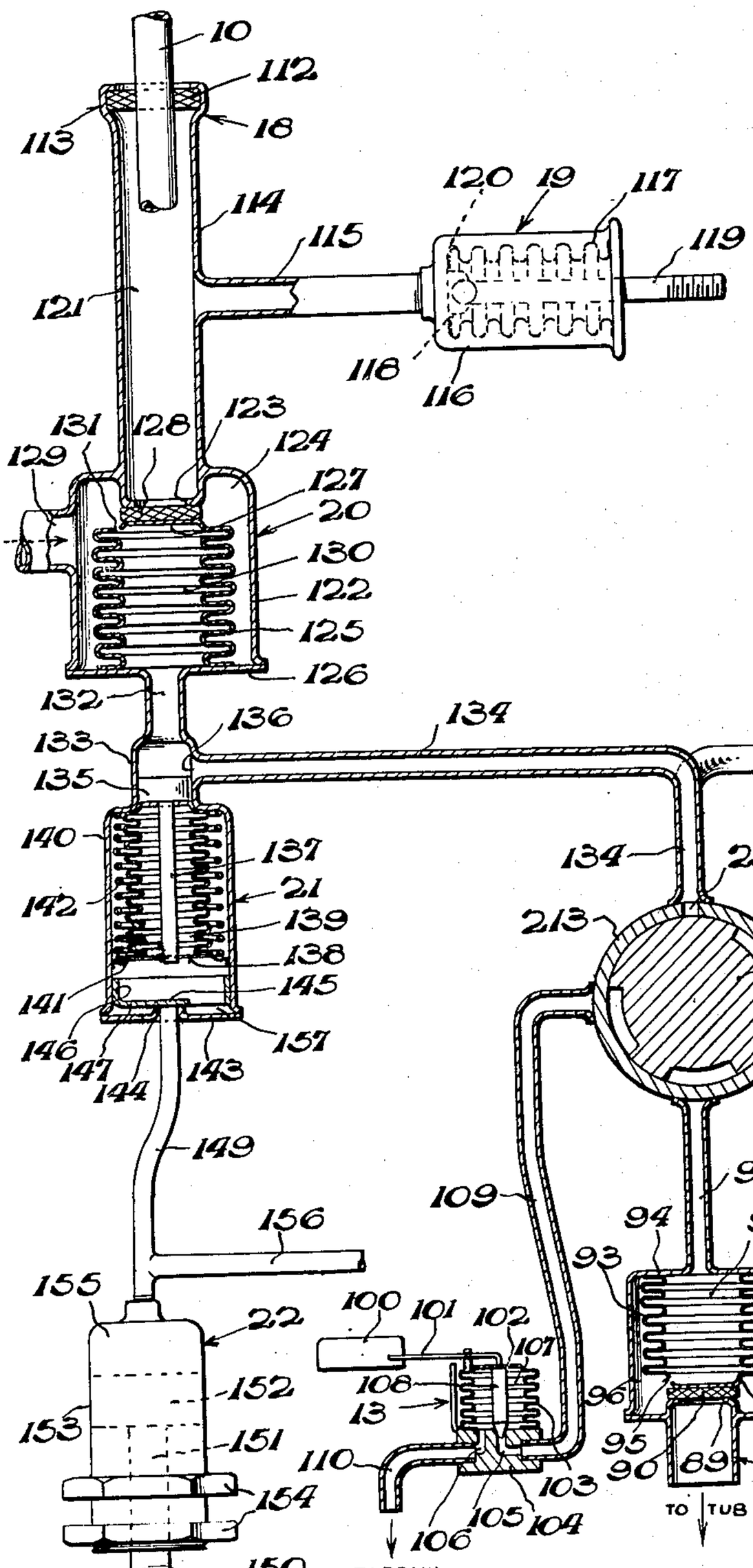

Fig. 1.

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HYDRAULIC CONTROL

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Fig. 5.

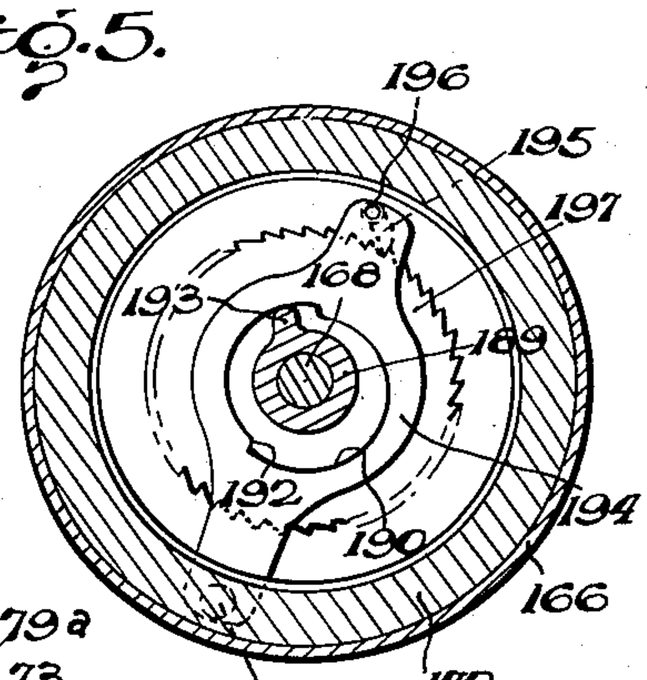

Fig. 2.

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Fig. 4.

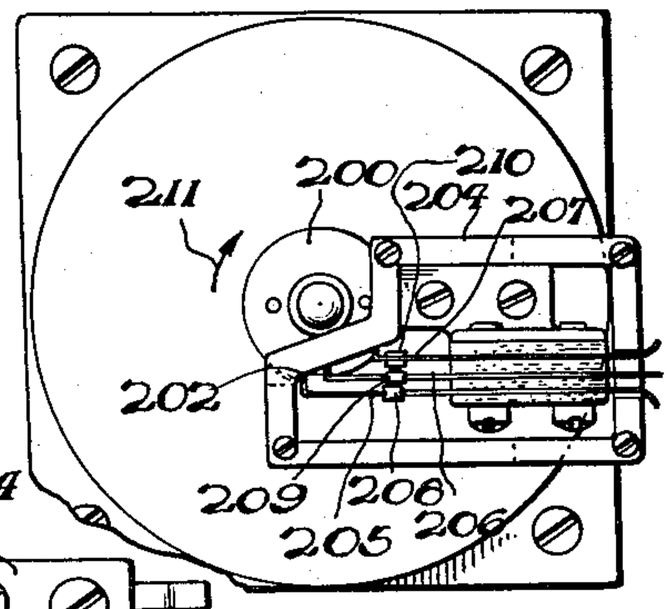

Fig. 3.

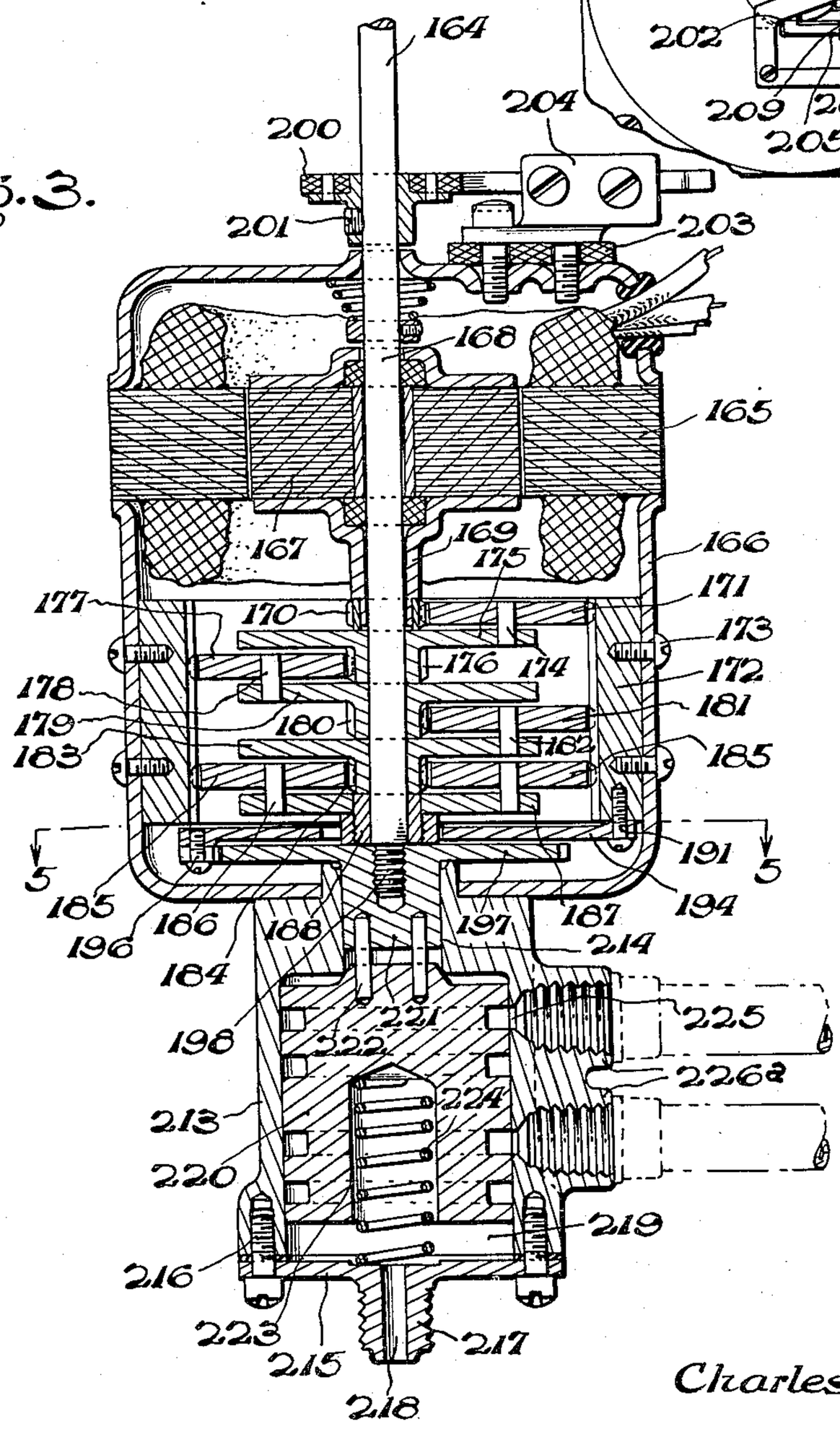

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Fig. 11.

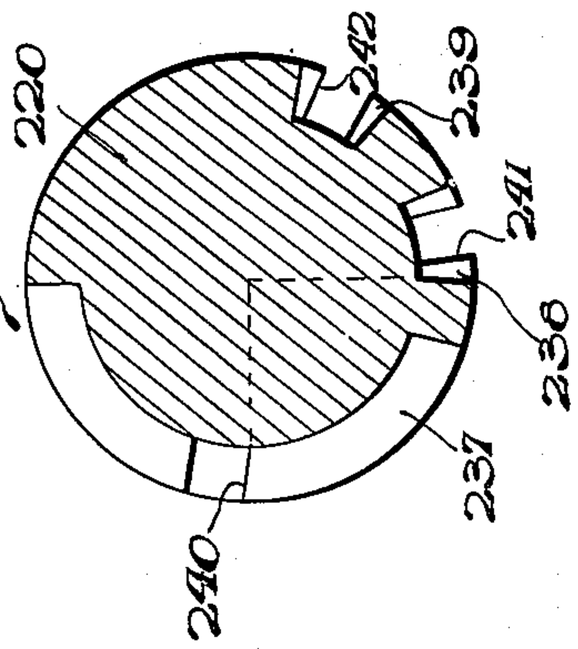


Fig. 12.

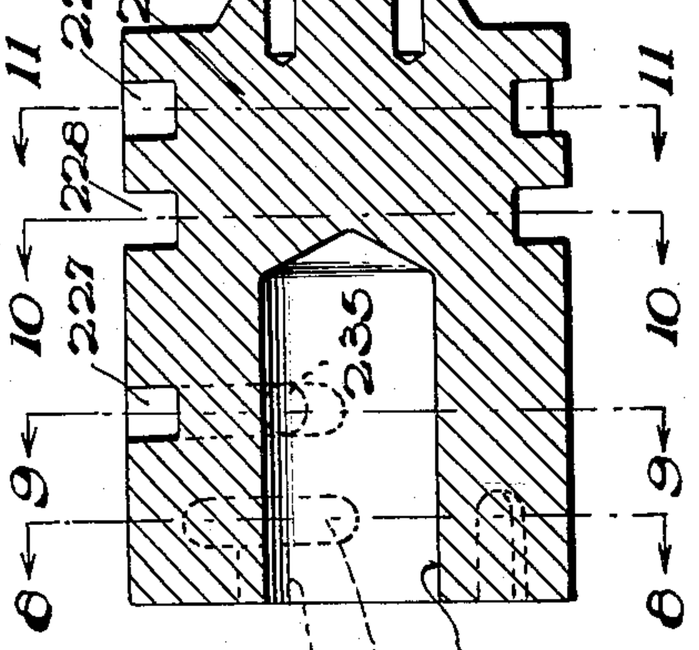


Fig. 6.

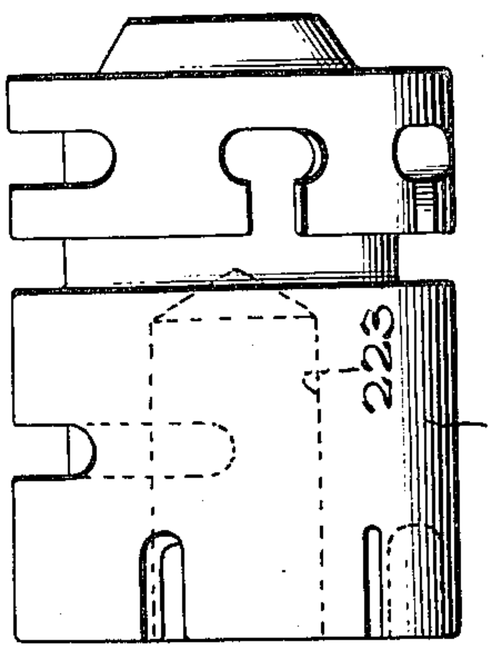


Fig. 7.

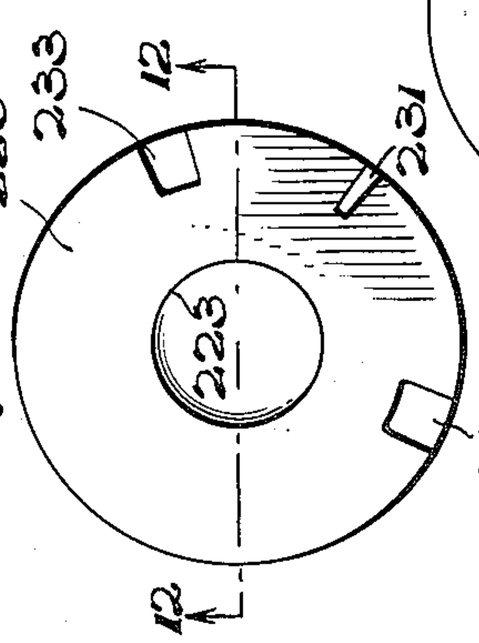


Fig. 10.

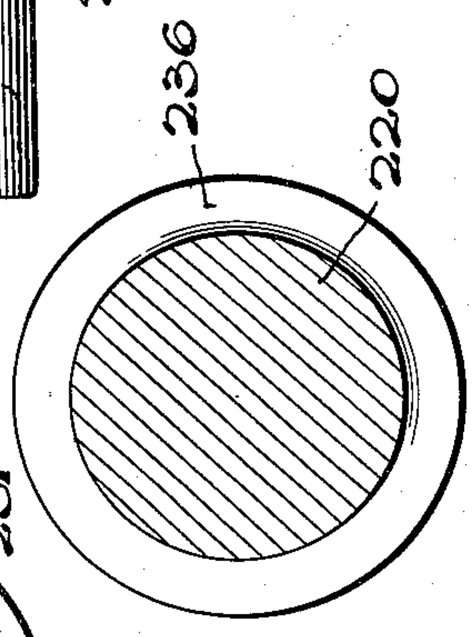


Fig. 9.

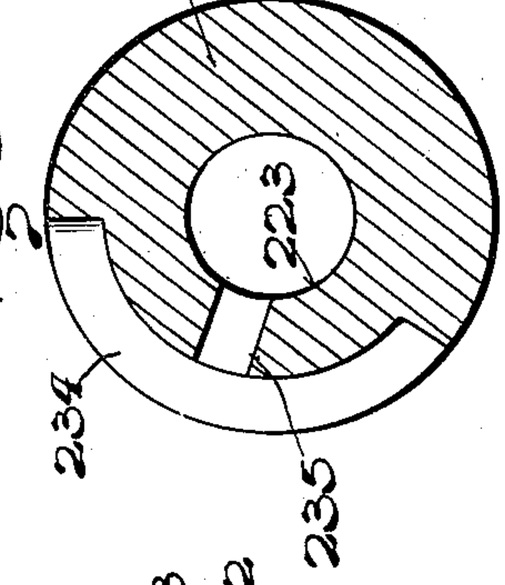
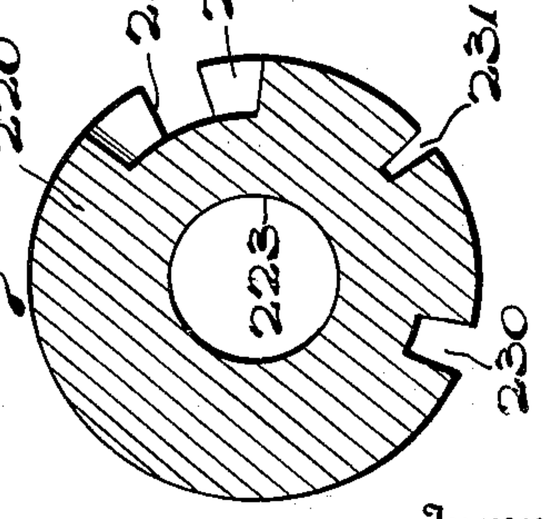


Fig. 8.



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Patented Feb. 17, 1953

2,628,489

UNITED STATES PATENT OFFICE

2,628,489

HYDRAULIC CONTROL

Charles D. Branson, Knoxville, Tenn., assignor to Robertshaw-Fulton Controls Company, a corporation of Delaware

Application June 3, 1947, Serial No. 752,233

30 Claims. (Cl. 68—12)

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This invention relates to hydraulic controls, and more particularly to hydraulic devices which are adapted to control the operation of automatic washing machines, although certain of the subcombinations used in the control, while possessed of particular utility when embodied in a control for an automatic washing machine, have wider utility and are capable of use in other relationships as will be apparent to those skilled in the art.

It is an object of this invention to provide an improved control which is wholly hydraulic in its operation except that the motor employed to drive the same may be of any suitable character such as an electric motor, although a hydraulic motor could be used if preferred.

Another object of this invention is to provide an improved hydraulic control which may use any suitable source of liquid under pressure, such as water from the usual water main, for determining the beginning and the end of each of the steps constituting the automatic cycle to be effected.

Another object of this invention is to provide an improved hydraulic control for automatic washing machines whereby one or more of the steps in the automatic cycle of the machine may be readily omitted while assuring against reverse operation of the control.

Another object of this invention is to provide an improved control wherein each of the steps of the automatic cycle of the machine is initiated and terminated by the use of a pilot valve, thereby avoiding the complexity introduced by solenoid valves and other electrical systems for effecting the control.

Another object of this invention is to provide an improved control of the type just characterized wherein the several steps of the automatic cycle are under the control of a motor-driven pilot valve which can be readily manipulated to predetermine which of the steps of the automatic cycle of the machine shall be performed.

Another object of this invention is to provide an improved mixing valve which is automatically operated at predetermined times to adjust the valve so that fluid can be delivered at a lower temperature for a predetermined period.

Another object of this invention is to provide an improved thermostatically controlled mixing valve for washing machines wherein the mixing valve, as for example during a rinsing period, can be so operated under the control of a pilot valve that colder rinse water may be delivered by the mixing valve.

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Another object of this invention is to provide an improved hydraulic control which is simple and compact in construction, composed of fewer and more directly connected parts than prior comparable controls, and positive in action.

Another object of this invention is to provide an improved hydraulic control which assures that no injury will occur to the parts even though there may be wide variations in the water pressure available for operating the machine.

Another object of this invention is to provide an improved hydraulic control including an improved pilot valve which not only exactly predetermines the sequence of operations but also effects rapid transition from stage to stage so as to avoid the sluggish action incident to a gradual change in pressure.

Another object of this invention is to provide an improved timing mechanism which exactly predetermines the beginning and end of the respective steps in the automatic cycle to be effected and avoids sluggish transition from one step to another.

Another object of this invention is to provide an improved pilot valve and operating mechanism therefor for predetermining the actuation of a plurality of devices controlled by fluid pressure.

Another object of this invention is to provide an improved operating mechanism for timing the actuation of a pilot valve.

Another object of this invention is to provide an improved hydraulic control for washing machines which includes means whereby an unbalanced condition in the operation of the washing machine will initiate an operation whose purpose is to remedy the cause of such unbalance.

Another object of this invention is to provide a control as last characterized wherein the remedial operation will be repeated as long as the cause for unbalance persists.

Another object of this invention is to provide a control as last characterized wherein the remedial operation is initiated by fluid pressure generated by the unbalanced operation of the machine.

Another object of this invention is to provide an improved control utilizing hydrostatic pressure which is composed throughout of parts that may be readily standardized, that are relatively inexpensive to manufacture, that are easy to assemble and service, and that are certain and efficient in operation.

Other objects will appear as the description of the invention proceeds.

The present invention in certain of its aspects is an improvement on the system disclosed and claimed in my application Serial No. 712,643, filed November 27, 1946, now Patent Number 2,607,207, issued August 19, 1952, for Hydraulic Controls for Automatic Washing Machines, some portions of the system herein disclosed being the same as employed in the system disclosed in said application. Therefore, in the interest of brevity illustrated parts which are the same as fully disclosed in my aforesaid application will be summarily described herein, sufficiently for a full understanding of the operation of the complete system of the present invention, and cross reference is made to said earlier application for further details of construction and operation.

The present invention is capable of receiving a variety of mechanical expressions only one of which has been illustrated on the accompanying drawings, and it is therefore to be expressly understood that the drawings are for purposes of illustration only, and are not to be construed as a definition of the limits of the invention, reference being had to the appended claims for that purpose.

Referring in detail to the accompanying drawings, wherein the same reference characters are used to designate corresponding parts in the several figures,

Fig. 1 is a diagrammatic view to illustrate the component parts of an hydraulic control embodying the present invention laid out without regard to the spatial relationships of the functioning elements actually existing in a washing machine embodying the present invention;

Fig. 2 is an axial section through a preferred form of automatic mixing valve;

Fig. 3 is an axial section through a preferred form of pilot valve and its motor-driven timing mechanism;

Fig. 4 is a plan view of the automatic switch controlled by said timing mechanism;

Fig. 5 is a cross section on line 5—5 of Fig. 3;

Fig. 6 is an elevation of a preferred form of pilot valve;

Fig. 7 is an end view of the valve of Fig. 6;

Figs. 8, 9, 10 and 11 are cross sections of the pilot valve of Fig. 6 taken on the lines 8—8, 9—9, 10—10 and 11—11 of Fig. 12; and

Fig. 12 is an axial section of said pilot valve taken on the line 12—12 of Fig. 7.

Referring first to the diagram of Fig. 1, 10 designates the driving shaft of a washing machine of any suitable character and construction which may be driven in any suitable way to impart any appropriate motion or motions to the movable elements within the tub or casing of the machine to effect the operations embraced within the cycle of the machine. While any suitable motor, as for example an hydraulic motor, may be used, it will be assumed for purposes of exemplification of the present invention that an electric motor is employed. As this motor and the elements driven thereby constitute no part of the present invention, they have not been illustrated in the interest of simplicity.

The tub of the washing machine is supplied with water through a suitable conduit or passage, a fragment of which is illustrated at 11, after passing through a flow control valve generally indicated at 12. Valve 12 is operated by fluid pressure, partly under the control of a float valve in or associated with the tub and generally indicated at 13. The water passing through the flow control valve first passes through a mixing valve generally indicated at 14 which is supplied with hot and cold water from any suitable sources through conduits or passages connected to the nipples 15 and 16, respectively. The admission of water to the tub, as well as the performance of other steps in the automatic cycle of the machine, is under the control of a pilot valve generally indicated at 17, operated by a timing mechanism shown more particularly in Fig. 3. The timing mechanism also operates the mechanism, here assumed to be a switch and shown more particularly in Figs. 3 and 4, for starting and stopping the motor which drives the mechanism associated with the tub and also the motor which drives the timing mechanism and therefore the pilot valve, but while said timing mechanism and pilot valve are shown as driven by an electric motor they may be driven by any other suitable motor, such as a hydraulic motor.

Associated with the shaft 10 is a Hemmeter valve of any suitable construction, generally indicated at 18, and operatively associated therewith is a brake operator, generally indicated at 19, for operating any suitable brake mechanism associated with the mechanism which determines when spinning of the clothes shall be initiated to effect the drying operation. Valve 18 and operator 19 are under the control of a flow control valve generally indicated at 20, and said last named valve is in turn controlled by a pressure operated valve generally indicated at 21 in the line connecting the valve 20 with the pilot valve 17, pressure operated valve 21 in turn being under the control of fluid pressure devices, one of which is generally indicated at 22, associated with the legs of the washing machine so as to develop a pressure for operation of the valve 21 in the event of a predetermined condition of unbalance in the operation of the machine. The main drain valve operator is generally indicated at 23 and is also controlled by the pilot valve 17.

Referring now to Fig. 2, which shows the details of the mixing valve generally indicated at 14 in Fig. 1, a casing 25 of any suitable construction, form and material is provided with the aforesaid inlet nipples 15 and 16 for the hot and cold water, respectively. Each of these inlet nipples is preferably provided with a filter 26 to prevent scale or other foreign matter from entering the hydraulic system hereinafter described. Any suitable sources of hot and cold water may be connected with said nipples 15 and 16, respectively, as the building's system for supplying hot water to various outlets, as conventionally provided, and the cold water main of the building. The passages through the nipples 15 and 16 communicate with hot and cold water chambers 27 and 28, respectively, and said chambers in turn communicate with an intermediate mixing chamber 29 through ports 30 and 31, respectively, provided in any suitable way but here shown as merely apertures in the walls dividing the chambers 27 and 28 from the chamber 29, although suitable members providing ported valve seats may be used in said apertures if preferred. To facilitate manufacture, the portion of the casing including the chamber 27 may be made separate from the portion containing the chambers 28 and 29, and the two portions may be connected in any suitable way, with or without interposed packing as shown at 32. Disposed in the chamber 29 for cooperation with the valve ports 30 and 31 is a balanced valve 33 of any

suitable construction, here shown as a single member provided at its opposite extremities with beveled seating surfaces 34 and 35, respectively, for cooperation with the ports 30 and 31 and thereby proportioning the flow of hot and cold water into the mixing chamber 29. Mixing chamber 29 communicates through any suitable passage or passages in housing 25 (not shown) with a thermostat chamber 36 separated from the cold water chamber 28 by a partition 37 in which is an aperture 38.

Disposed in chamber 36 is a thermostat of any suitable construction here shown as having an external cup-shaped wall 39 provided with a flanged open end 40 and a portion of reduced diameter 41 at its opposite end. End wall 42 of said cup-shaped wall 39 is provided with an aperture 43, and hermetically sealed to said end wall at said aperture is an expansible and collapsible corrugated tubular wall or bellows 44. The movable end wall 45 of said bellows 44 has attached thereto in any suitable way a valve stem 46, here shown as a hollow stem 46 which passes through the apertures 43 and 38 and is attached to the valve member 33 in any suitable way. The passage 47 through said stem opens at one end into the chamber 27, but its opposite end is closed by the movable end wall 45. Where stem 46 extends through the aperture 38 in the partition 37 a flexible wall, shown as an expansible and collapsible corrugated tubular wall or bellows 48, has one end secured in any suitable way to the valve stem 46 at 49 while its opposite end is secured in any suitable way to an annular plate 50 mounted on the partition 37 around the aperture 38 with interposed packing if desired. As shown, said plate 50 is shaped to provide a seat 51 in which a yieldable annular pad 52 is disposed and against which the end wall 42 of the thermostat is seated when the flange 40 of the thermostat is mounted on the flange 53 of the casing 25, flange 40 being secured in position in any suitable way as by an annular plate 54 that in turn is held in position by the flange 55 of a bonnet member 56 hereinafter described, with packing 57 interposed between said members 53, 54 and 55 if preferred. Said members 53, 54 and 55 may be connected together in any suitable way as by bolts and nuts, screws, etc., which have been omitted from the drawings in the interest of simplicity.

With the parts assembled as shown, end wall 42 of the thermostat presses pad 52 onto its seat 51 and thereby presses plate 50 against the partition 37 so that leakage of water between chambers 28 and 36 is prevented. Bellows 48 has the same effective area as valve port 31 so that variations in the cold water pressure are balanced out. On the other hand, the chamber inside of the communicating bellows 44 and 48 is in communication with the passage 47, as through one or more apertures 47', and as passage 47 communicates with the hot water chamber 27, bellows 48 is subjected on its opposite sides to the pressures of the hot and the cold water. Thereby valve 33 is balanced against pressure variations in and pressure differences between the hot and cold water.

Spaced inwardly from the flange 40 of the cup-shaped wall 39 is an interior flanged member 58 secured to the wall 39 in any suitable way, and attached to the inner periphery of said flanged member 58 is an expansible and collapsible corrugated tubular wall or bellows 59 which extends into the chamber 60 constituting the expansible and collapsible chamber of the thermostat. The opposite and movable end wall 61 of said bellows 59 is engaged by but unattached to a cup-shaped member 62 having in its bottom wall an aperture 63, and extending through said aperture 63 in slidable relation therewith is a post 64 having a head 65, while the opposite end of said post has attached thereto in any suitable way a flange member 66 providing a spring seat. A coil spring 67 extends between the flange member 66 and the flanged extremity of said cup-shaped member 62, and normally holds the cup-shaped member 62 in engagement with the head 65 or the movable end wall 61 of bellows 59, but if the pressure in the chamber 60 continues to increase after valve member 33 has engaged its seat at port 31, the bellows 59 may be contracted by the increasing pressure, lifting member 62 against the tension of spring 67, member 62 sliding on post 64. The depth of the depression in the cup-shaped member 62 is such that the head 65 will not be engaged by the end wall 61 under the maximum displacement contemplated.

Attached to the annular plate 54 in any suitable way is one end of an expansible and collapsible corrugated tubular wall or bellows 68 whose opposite end is formed as or attached in any suitable way to a reentrant cup-shaped movable wall 69 having therein a bleed opening 70 leading to the expansible and collapsible chamber between bellows 68 and wall 69. The end wall 71 of cup-shaped wall 69 engages the flange member 65 heretofore referred to, and a coil spring 72 reacts between said bottom wall 71 and a stationary member 73 formed by or carried on the end wall 74 of the bonnet member 56 heretofore referred to. Member 73 as shown has an inwardly extending tubular portion 75 internally splined for cooperating with a similarly splined enlargement 77 mounted on or formed integrally with a stem 78 which at its inner end 79 extends into contact with the end wall 71 of the cup-shaped member 69. Stem 78 is here shown as provided with a packing gland 79a which may be of any suitable construction, or if preferred a packless construction may be employed instead. Stem 78 extends outwardly to any suitable distance where it is provided with any suitable manually operable means for moving the stem in the direction of its axis, or the stem 78 could be made rotatable and the elements 75, 77 be provided with cooperating threads to provide the axial movement of the inner end of the stem 78. In the case of a washing machine the mechanism for effecting movement of the stem 78 manually in the direction of its axis would be located where it would be easy of access and preferably would have associated therewith any suitable indicating means calibrated in temperature so that by reference thereto the operator will be able to set the position of the stem 78 and therefore predetermine the temperature of the wash water to that which is suitable for the goods being washed. The chamber 79' within the bonnet member 56 is in communication with a conduit or passage 80 leading to the pilot valve generally indicated at 17 in Fig. 1 for a purpose to be explained.

The cup-shaped wall 39 is also provided with one or more apertures 81 in the area between the flanged member 58 and the flange 40 so as to provide a means of communication between the chambers 82 and 83 interiorly of the bellows 59 and 68, respectively, and the chamber 36, so that the pressure of the water in the chamber 36 is transmitted to the chambers 82 and 83. In

chamber 83 said pressure acts on the end wall of the cup-shaped member 69 attached to the movable end of bellows 68 so that normally said end wall is held in contact with the end 79 of the stem 78. When, however, by reason of the operation of the bleed opening 70 the pressure is equalized on opposite sides of the end wall 69, spring 72 may contract the bellows 68 for a purpose to be explained.

The valve member 33 is preferably urged toward its seat at port 31 by a suitable spring 84, here shown as a coil spring reacting between the member 33 and a suitable spring seat formed in the wall of the hot water chamber 27. The chamber 60 within the thermostat is charged with any suitable thermosensitive fluid, preferably filled with a suitable thermosensitive liquid, so that under the influence of the temperature in the chamber 36 it will expand on contract, contracting or expanding the bellows 44, to move the valve member 33 toward one or the other of its seats at the ports 30 and 31, to the end that the temperature of the mixture within the chamber 36 may, under normal thermostatic control, be kept at approximately the desired temperature. Chamber 36 has a suitable outlet nipple 85 leading therefrom and through which the mixture of hot and cold water flows from the chamber 36.

Explaining the operation of the mixing valve as so far described, hot and cold water flow respectively into the chambers 27 and 28, and assuming that the valve member 33 is in an intermediate position, the hot and cold water flow through the ports 30 and 31, respectively, to the mixing chamber 29. From chamber 29 the mixed hot and cold water flows into the chamber 36 where it is in intimate heat interchanging relationship with the exterior wall 39, 41 of the thermostat chamber 60. If desired, any suitable baffling means may be provided in chamber 36 to assure flow of the mixture into intimate contact with the thermostat. From the chamber 36 the mixture flows through the outlet 85.

Assuming a predetermined setting for the thermostat, if the temperature of the mixture rises above the predetermined temperature the thermosensitive fluid in chamber 60 expands to contract bellows 44, bellows 59 with its spring 67 being so constructed as to afford greater opposition to movement under the pressure in the chamber 60 than bellows 44 and spring 84. Contraction of the bellows 44 causes the valve stem 46 to move downwardly as viewed in Fig. 2, decreasing the flow through port 30 but increasing the flow through port 31 so as to restore the temperature of the mixture to its predetermined degree. Conversely, if the temperature of the mixture drops below the predetermined temperature the thermosensitive fluid in chamber 60 contracts, and spring 84 acts through the valve member 33 and stem 46 to expand the bellows 44, moving the valve member 33 to decrease the flow of cold water through the port 31 and increase the flow of hot water through the port 30.

If the temperature of the mixture causes the thermostat to engage valve 33 with its seat at port 30, further expansion of the chamber 60 by compression of the bellows 44 is prevented, and if for any reason the temperature of the mixture thereafter rises to increase the pressure in the chamber 60, this pressure acting on the movable end wall 61 of bellows 59 contracts bellows 59, lifting the cup-shaped member 62 off of the head 65, against the tension of the spring 67, until such time as the temperature decreases sufficiently to permit the spring 67 to restore engagement between the cup-shaped member 62 and the head 65 or end wall 61. The apertures 81 permit free circulation of the liquid between the chamber 36 and the chambers 82 and 83, so that the latter are full of liquid at the same pressure as in the chamber 36. If such water as leaks through the bleed hole 70 may flow freely out of the chamber 79' through passage 80, the movable end wall 71 of the cup-shaped wall 69 will be held by the water pressure against the end 79 of the stem 78. However, if water cannot flow freely away through passage 80, pressure will accumulate in the chamber 79' until the pressures at the opposite sides of movable end wall 71 are equalized, whereupon spring 72 will move end wall 71 downwardly away from the end 79 of stem 78, and this movement will be transmitted through the flange 66 and spring 67 to the end wall 61 of bellows 59, thereby tending to contract the chamber 60. With the chamber 60 filled with a thermosensitive liquid, this pressure will be transmitted to bellows 44, contracting the latter and moving the valve stem 46 so as to advance valve member 33 toward its seat at port 30, nearly if not completely closing the latter, whereby predominately cold water is now admitted from chamber 28 through port 31 to chambers 29 and 36 and thence flows through the outlet 85 to effect the rinsing operation.

To adjust the temperature of the mixture flowing out of chamber 36 through outlet 85, stem 78 is moved upwardly or downwardly in the direction of its length by any suitable manually adjustable device as heretofore referred to. If stem 78 is moved downwardly as viewed in Fig. 2, the end wall 71 of cup-shaped member 69 is moved downwardly, moving flange member 66 therewith and, through spring 67, expanding bellows 59 by the pressure applied to its movable end wall 61 by the cup-shaped member 62. This tends to contract the chamber 60, but as the chamber 60 is full of thermosensitive liquid this pressure is transmitted to the movable end wall 45 of bellows 44, causing the valve member 33 to move downwardly so as to decrease the flow of hot water through port 30 and increase the flow of cold water through port 31, thereby maintaining a lower temperature of the mixture in chambers 29 and 36. Conversely, movement of the stem 78 upwardly as viewed in Fig. 2 will cause valve member 33 to approach its port 31 so that a higher temperature will be maintained in chambers 29 and 36. Thereby, by adjustment of the stem 78 in the direction of its length, in one direction or the other, the temperature to be maintained in chamber 36 may be closely predetermined.

The water flowing through the outlet 85 of the mixing valve, whether wash water or rinse water, first flows through any suitable passage or conduit 86 (Fig. 1) to the inlet nipple 87 of a flow control valve generally indicated at 12 in Fig. 1. As disclosed more particularly in my aforesaid application, such a flow control valve includes a casing 88 from which extends the outlet 11 heretofore referred to. Associated with said outlet 11 is a valve port 89 with which cooperates a valve member 90 of any suitable construction. Valve member 90 is carried by the movable end wall 91 of an expansible and collapsible chamber 92 whose peripheral wall is here shown as composed of an expansible and collapsible corrugated tubular wall or bellows 93 having one end formed as or attached in any suitable way to the

movable end wall 91 and its opposite end attached in any suitable way to a stationary end wall 94, here shown as constituting the end wall of the casing 88. Movable end wall 91 is provided with a suitable bleed opening 95 for a purpose to be explained, so that the bellows chamber 92 is in communication through said bleed opening with the chamber 96 in casing 88 that is exterior of the bellows 93. Casing 88 is constructed in any suitable way to provide for the communication of chamber 92 with a conduit or passage 97 leading to the pilot valve generally indicated at 17.

As also shown in Fig. 1, a float controlled valve generally indicated at 13 is mounted in or associated with the interior of the tub so as to respond to the level of the water therein. Any suitable float controlled valve may be used. As shown, a float 100 of any suitable construction is connected through a pivoted lever 101 to a valve member 108 here shown as carried by the movable end wall 102 of an expansible and collapsible corrugated tubular wall or bellows 103 whose opposite end is suitably secured to a fixed block 104 having passages 105 and 106 leading from the chamber 107 in the interior of said bellows. Valve member 108 cooperates with a valve seat at the end of the passage 105. Passage 105 is connected by any suitable conduit or passage 109 with the pilot valve generally indicated at 17, while passage 106 is connected to any suitable low pressure or exhaust conduit or passage 110 such as a passage leading to the drain connections.

To explain the operation of the flow control valve 12 and float controlled valve 13, when the pilot valve 17 is so positioned that passages 97 and 109 are in open communication with the drain passage 110, with float 100 holding valve member 108 away from its seat at the end of passage 105, water may flow freely from the mixing valve 14 through conduit 86 to chamber 96 in the flow control valve and thence through outlet 11, because the pressure of the water in chamber 96 acting on the end wall 91 of bellows 93 holds the valve member 90 away from its seat at port 89 inasmuch as any water entering the chamber 92 through bleed hole 95 is exhausted to the drain 110. When, however, the level of the water in the tub raises float 100 so as to depress valve member 108 into engagement with its seat at the end of passage 105 water accumulating in the chamber 92 can no longer escape to the drain 110. Thereupon the pressure builds up in chamber 92 until the pressure is equalized on the opposite sides of movable end wall 91, whereupon the bellows 93, by reason of its inherent resiliency or a spring could be used therewith if desired, will move valve member 90 into engagement with its seat at port 89, terminating the flow of water through the mixing valve 14 to the tub. As long as the level of the water in the tub holds the float 100 so that valve member 108 closes passage 105, valve member 90 will be held against its seat 89 by the equalized pressures in the chambers 92 and 96, preventing flow of water through the mixing valve 14. Similarly, if the pilot valve 17 is moved so as to interrupt the communication between passages 97 and 109, as when it comes time to empty the tub, the pressure is still retained in chamber 92 so as to hold valve member 90 against its seat at port 89 notwithstanding that the lowering of the water in the tub causes float 100 to withdraw valve member 108 from its seat at the end of passage 105. Therefore, admission of water to the tub is possible only when pilot valve 17 places passages 97 and 109 in communication and the float 100 is also holding the valve member 108 away from its seat at the end of passage 105.

The hydraulic control of the present invention is adaptable to a washing machine of the type wherein the shaft 10 is suitably driven so as to produce a wobbling or other suitable non-centric motion during the washing period, following which, during the drying period, the clothes are spun at an increased speed of revolution. In washing machines of this character, which are now known to the art, if the clothes in the tub at the end of the washing period are not distributed around the axis of spin with fair uniformity, the unbalanced load is productive of vibration, and in machines of this character it is known to provide the driving shaft with what is known as a "Hemmeter valve" for the purpose of permitting water to flow therepast into suitable cavities, chambers, or the like, at such locations as tend to establish a proper balance, a deflection of the shaft in one direction, for example, being effective to pass water into a diametrically opposite chamber as a balancing weight. Hemmeter valves of this character are known to the art and the details thereof constitute no part of the present invention.

Such a Hemmeter valve is generally indicated at 18 in Fig. 1 and includes a ring 112 of suitable elastic or resilient material which surrounds the shaft 10 with a nearly fluid-tight contact therewith, said ring being compressible under eccentric motion of the shaft to permit flow of water therepast at 180° from the point of compression, said ring being retained in cooperative relationship with the shaft 10 by a surrounding container 113 attached to or formed as a part of a casing 114. In conformity with the present invention casing 114 is in communication through any suitable conduit or passage 115 with the housing 116 of a brake operator generally indicated at 19, and which may be and preferably is of the construction disclosed in my aforesaid application. As indicated diagrammatically in Fig. 1, casing 116 has interiorly thereof an expansible and collapsible corrugated tubular wall or bellows 117 which has a fluid-tight connection with the casing 116 at its stationary end, while its movable end 118 is connected in any suitable way to a stem 119 that in turn is connected with any suitable brake which controls the initiation of the spinning of the clothes. When the chamber 120 within said casing 116 is pressurized stem 119 is moved to the right as viewed in Fig. 1 for releasing the brake and initiating the spinning of the clothes, whereas when pressure is released from said chamber 120, stem 119 is moved to the left as viewed in Fig. 1, due to the inherent resilience of the bellows 118 or a spring may be used if desired, so as to apply said brake and prevent spinning.

To determine when the chamber 121 in casing 114 and the chamber 120 in casing 116 shall be pressurized to release the brake and condition the Hemmeter valve for operation, or apply the brake and release the pressure in the Hemmeter valve casing, a flow control valve generally indicated at 20 is associated with said casings 114 and 116. As shown in Fig. 1, a casing 122 is suitably constructed so as to provide a valve port 123 in communication with chamber 121. Mounted in the chamber 124 of said casing is an expansible and collapsible corrugated tubular wall or bellows 125 which at its stationary end is suitably secured to

the end wall 126 of said casing, while its opposite and movable end wall 127 is provided with any suitable valve member 128 for cooperation with said port 123. Chamber 124 is in communication through any suitable inlet 129 with a source of water, which may be the cold water line leading to nipple 16. The chamber 130 interiorly of the bellows 125 is in communication with chamber 124 through a bleed opening 131, and said chamber 130 has an outlet 132 formed on or attached to the end wall 126. The passage in outlet 132 at its opposite end is in communication with a valve casing 133 with which communicates any suitable conduit or passage 134 leading to the pilot valve.

Disposed interiorly of casing 133 is any suitable valve member 135 mounted for movement so that it may open and close the inlet 136 to said passage 134. As here shown, said valve member 135 is mounted on a stem 137 that is secured in any suitable way to the movable end wall 138 of an expansible and collapsible corrugated tubular wall or bellows 139 the opposite end of which is secured in any suitable way to a casing 140 surrounding said bellows and here shown as constituting an extension of the casing 133. Movable end wall 138 as shown is provided with an external flange 141 slidably mounted in the interior of the casing 140, and a coil spring 142 extends between said flange and the end of the casing 140 so as normally to urge the valve member 135 into a position wherein the inlet 136 to passage 134 is open.

Casing 140 has suitably secured thereto an end wall 143 in which is a valve port 144, here shown as formed by providing an aperture in said end wall 143 with an interiorly projecting flange. Suitably mounted interiorly of the casing 140 is a flap valve 145 of any suitable form and construction. As here shown, a ring 146, which may be secured to the wall of the casing 140 in any suitable way, is provided with a radially extending resilient or elastic arm 147 carrying said flap valve 145. Valve 145, for a purpose to be explained, is intended to have a predetermined leakage, and to this end it may be provided with a bleed opening or its engagement with the flange surrounding the valve port 144 may be such as to secure the desired leakage. Communicating with said port 144 is a conduit or passage 149 leading to interconnected pressure devices, one of which is generally indicated at 22, that are associated with the legs of the washing machine. As diagrammatically illustrated in Fig. 1, each pressure device includes a foot 150 adapted to rest on the floor, and extending upwardly therefrom is a post 151 terminating in a plunger 152. Mounted on said plunger 152 in surrounding relationship therewith is a cylinder or casing 153 having suitable provisions as nuts 154 for attaching the same to a leg of the washing machine. The chambers 155 in the cylinders 153 above the plungers 152 associated with the several legs are in open communication with each other through suitable cross connections 156 and also in communication with the passage 149.

During the washing cycle pilot valve 17 closes the outlet of passage 134 whereby water entering the chamber 124 flows through bleed opening 131 to chamber 130, thereby equalizing the pressure on the opposite sides of the movable end wall 127, whereby bellows 125, either because of its inherent resiliency or a spring could be used if desired, moves valve member 128 to close the port 123. As there is always a small amount of leakage between the shaft 10 and the Hemmeter valve member 112, chambers 120 and 121 are not under pressure, and therefore bellows 117, either by its own resiliency or a spring could be used if desired, holds stem 119 at its leftward position as viewed in Fig. 1, applying the brake which prevents operation of the means for initiating spinning. At the close of the washing cycle pilot valve 17 opens the outlet of passage 134 so that the pressure in chamber 130 is released. Thereby the pressure in chamber 124 compresses bellows 125, withdrawing valve member 128 from port 123, whereby the pressure of the liquid in chamber 124 is introduced into chambers 120 and 121, releasing the brake to initiate the spinning operation and also conditioning the Hemmeter valve.

If now by reason of improper distribution of the clothes in the tub vibration is set up in the machine, movement of the cylinders 153 with respect to their plungers 152 produces a pumping action, downward movement of each cylinder with respect to its plunger developing a pressure in the chamber 155 which is communicated through the passage 149 to the chamber 157 within casing 140. The flap valve 145 functions as a check valve to largely retain the pressure so developed in chamber 157, and the pressure developed in chamber 157, when of sufficient magnitude, acts on the movable end wall 138, contracting the bellows 139 and moving valve member 135 upwardly as viewed in Fig. 1 until the inlet 136 of passage 134 is closed. This permits pressure to develop in chamber 130 whereupon, when the pressure is equalized on the opposite sides of the movable end wall 127, valve member 128 is moved to close the port 123. This results in a release of the pressure in chambers 120 and 121 by reason of leakage past the Hemmeter valve, whereby the brake operator 119 is again moved to the left as viewed in this figure to apply the brake and discontinue the spinning operation. This causes the mechanism to resume its washing movement so that a redistribution of the clothes will be effected by the wobbling or other suitable movement of such mechanism. After a lapse of a predetermined period of time determined by the leakage or bleeding at the valve 145 the pressure in chamber 157 decreases sufficiently to permit spring 142 to expand bellows 139, moving valve member 135 downwardly so as to reopen the inlet to the passage 134. As the pilot valve at this stage of the cycle is retaining the outlet of passage 134 open, pressure is released promptly from chamber 130, the pressure in chamber 124 contracts the bellows 125 and opens valve member 128, and liquid under pressure is admitted to the chambers 121 and 120 to condition the Hemmeter valve and release the brake for resumption of the spinning operation.

Therefore, the valve generally indicated at 21 operates as a time delay valve for predetermining the period of time during which spinning will be interrupted for redistribution of the clothes in the tub, the fluid pressure devices 22 acting to apply pressure quickly to chamber 157 to effect the closure of the inlet to passage 134 and thereafter, because of the leakage provision, slowly releasing the pressure over a predetermined period of time. If preferred, however, the pressure may be developed slowly and released with the desired rapidity by appropriate construction of the valve mechanism and associated pressure devices generally indicated at 21 and 22.

To control the main drain valve, a second pressure operated device, generally indicated at

23 in Fig. 1, may be of the same construction as disclosed in my aforesaid application or as generally indicated at 19 in Fig. 1 hereof. As shown, the valve operator includes a casing 160 in which is an expansible and collapsible chamber from the movable wall of which extends a suitable stem 161 for connection to and operation of a drain valve of any suitable construction. The chamber in casing 160 is in communication with a conduit or passage 162 which leads to the passage 134 heretofore referred to, because during the washing cycle pressure should be maintained at operator 160 to keep the drain valve closed, but at the end of the washing cycle when spinning is to be initiated the pressure should be released at the operator 23 to open the drain valve at the same time that pressure is released from chamber 130 so as to effect opening of the valve 128 and application of pressure to chambers 120 and 121 in order to release the brake that initiates spinning and simultaneously condition the Hemmeter valve. It will be observed that if the valve mechanism generally indicated at 21 is actuated because of an improper distribution of clothes so as to result in a resumption of the washing movement as heretofore explained, operator 23 is not actuated to close the drain valve because casing 160 is still in communication through passage 162 with passage 134 whose outlet end is open because the pilot valve is now at the spinning stage of the cycle. When the pilot valve is closed, however, the pressure in passage 134 is communicated through passage 162 to the casing 160 and thereby the drain valve is maintained closed.

As is apparent from the description so far given, the automatic cycle of operation referred to contemplates a plurality of steps or stages carried out in sequence. The number and character of steps in such a cycle may be varied, as will be apparent to those skilled in the art. It is desirable, on the other hand, that some one or more of the stages in the sequence be capable of omission if desired, but the sequence must never be capable of reversal. To this end the hydraulic control of the present invention is subject to a manual setting which may skip one or more of the steps in the cycle but the manual control for this purpose is so constructed that the sequence in steps can never be reversed. To move the pilot valve generally indicated at 17 through the sequence of steps or stages constituting the program of the machine, said pilot valve is automatically driven by a timing mechanism associated with said pilot valve, with provision for manually setting the pilot valve, as shown in Figs. 3, 4 and 5. While the timing mechanism and pilot valve now to be described are of particular utility as applied to an automatic washing machine, it is apparent that this mechanism has utility in other relations, and therefore it is to be expressly understood that it is the intention to protect the same as applied to other uses as well as a subcombination of the hydraulic control here disclosed.

Referring now to Figs. 3, 4 and 5, an electric motor 165 of any suitable size and construction has an appropriate casing 166. Armature 167 of said motor is mounted in any suitable way to rotate upon a shaft 168 which extends above the casing 166, as shown at 164, where it may be provided with any suitable knob or other manually operable device for rotating the shaft by hand when one or more of the stages is to be skipped. The armature 167 of said motor is provided in any suitable way with a hub 169 formed as or on which is secured a pinion 170. Meshing with said pinion 170 is a planetary gear 171 which also meshes with a stationary ring gear 172 secured to the casing 166 in any suitable way, as by screws 173. The stub shaft 174 of gear 171 is carried by a disk 175 which is rotatably mounted on the shaft 168 and provided with a hub carrying or formed as a pinion 176. Pinion 176 in turn is in mesh with a planetary gear 177 which also meshes with said ring gear 172. The stub shaft 178 of gear 177 is carried by a disk 179 also rotatably mounted on the shaft 168, and its hub carries or is formed as a pinion 180. Pinion 180 is in mesh with a planetary gear 181 which also is in mesh with said ring gear 172, and its stub shaft 182 is carried by a disk 183 also rotatably mounted on the shaft 168. The hub of disk 183 carries or is formed as a pinion 184 which is in mesh with a pair of diametrically disposed planetary gears 185 that also are in mesh with said ring gear 172. The stub shafts 186 of said gears 185 are carried by a disk 187 also rotatably mounted on said shaft 168.

Suitably formed on or secured to the hub 188 of disk 187 is a cam member 189 (see Fig. 5) having a nose 193 which cooperates with the cam face 190 of an opening in a lever 194 pivoted at 191 on a stationary part of the apparatus, here shown as the end of the ring gear 172. Opening 190 is provided with two steps 192 and said lever is urged by any suitable spring so as to hold the cam surface of said opening in cooperative relationship with said cam member 189. Thereby at each revolution of the cam member 189 lever 194 is oscillated twice about its pivot 191. At its end opposite said pivot lever 194 carries a pawl 195 pivoted thereon at 196 and urged by a spring toward the periphery of a ratchet wheel 197. Therefore at each rotation of the cam member 189 lever 194 is actuated once to advance the ratchet wheel 197 the distance of one tooth. By providing the periphery of said ratchet wheel 197 with a suitable number of teeth the desired number of steps required to move the ratchet wheel through one complete revolution may be predetermined, and by suitably selecting the gear ratios of the gear train 170 to 187 the lapse of time required for one complete revolution of the ratchet wheel 197 may likewise be exactly predetermined.

Ratchet wheel 197 is secured in any suitable way, as by a threaded connection at 198, to the end of the shaft 168 so that shaft 168 is driven by said ratchet wheel while said ratchet wheel may be manually rotated by shaft 168 independently of said gear train, but only in the direction in which said ratchet wheel is moved by the pawl 195 during the motor driven operation of said ratchet wheel. Any suitable manually operable knob or other device may be secured or operatively connected to the end 164 of the shaft 168 and with said device may be associated any suitable indicating means for designating the several stages in the operation of the machine.

Shaft 168 is also shown as provided with means for actuating the means which control the operation at both the motor 165 which drives the timing mechanism and also the main motor which drives the washing machine proper, the means here illustrated (see Figs. 3 and 4) being of the same general type as that illustrated and described in detail in my aforesaid application.

As shown, the exteriorly projecting portion of the shaft 168 is provided with a cam 200 secured to the shaft 168 in any suitable way, as by a set screw 201. Cam 200 is circular for the greater part of its circumference but rises to a high point followed by a step at 202. Mounted on any suitable support, here shown as a block 203 carried by the end wall of casing 166, is a frame 204 which carries three spring contact elements 205, 206 and 207, respectively carrying contacts 208, 209 and 210. Contact element 205 is in the circuit leading to the main motor of the washing machine, contact element 206 is in the circuit of the timing motor 165, and contact element 207 is common to both of said circuits.

When the machine stops, the contact elements 205 and 206 are on the high point 202 of the cam but contact element 207 has dropped down the step, whereby the circuits of both motors are opened. When shaft 168 is rotated manually to the station designated "Start" cam 200 is rotated in the direction of the arrow 211 in Fig. 4 to the position where the contact element 206 also drops down the step 202, bringing the contact 209 into engagement with contact 210 and thereby closing the circuit through the timing motor 165. The timing motor drives the shaft 168 through the gear train and ratchet mechanism, and at a predetermined time the cam 200 causes the contact element 205 to drop down the step 202, bringing its contact 208 into engagement with contact 209 so as to complete the circuit through the main motor of the washing machine. Motor 165 drives the ratchet 197 through the reduction gearing heretofore described to advance said ratchet one step at a time through one complete revolution of said ratchet. At the end of said revolution contact element 207 drops down the step 202, separating its contact 210 from contacts 209 and 208 and thereby interrupting the circuits of both motors. At any stage in the operation of the mechanism shaft 168 may be advanced manually in the same direction in which the ratchet is driven by the motor driven reduction gear train, but not in the opposite direction, so as to omit any desired stage or stages in the cycle or program of the machine.

Coming now to the pilot valve generally indicated at 17 in Fig. 1, and shown in detail in Figs. 3 and 6 to 12 inclusive, said pilot valve is shown as including a casing 213 associated with the casing 166 for the timing mechanism in any suitable way, said casing 213 having an opening 214 at its end adjacent to the casing 166, while its opposite end is shown as closed by a closure plate 215 secured to the casing 213 in any suitable way as by screws 216. Closure plate 215 as shown is provided with a nipple 217 having a passage 218 leading from the chamber 219 interiorly of said casing 213, said nipple 217 being adapted to be connected to any suitable low pressure or exhaust conduit or passage such as a passage leading to the drain connections.

Rotatably mounted interiorly of said casing 213 is the cylindrical body 220 of the pilot valve, said body being operatively connected to the ratchet wheel 197 in any suitable way so as to be driven therefrom. As shown, the ratchet wheel has a hub 221 rotatably received in the opening 214 in the pilot valve casing, and it is operatively connected to the end of the pilot valve body 220 in any suitable way, as by a pair of pins 222 received in apertures in said hub and body. Body 220 is shown as provided with an

axially extending bore 223 for a portion of its length, said bore acting as a passage for the escape of liquid as hereinafter explained, and in order to hold the body 220 in driving relationship with the hub 221 a coil spring 224 is disposed in said bore and reacts between the body 220 and the cover plate 215. Casing 213 has a suitable number of ports 225 leading therethrough, and associated with each of these ports is a nipple 226a for connection with the conduits or passages 80, 97, 109 and 134 shown in Fig. 1, only two of such nipples being illustrated in Fig. 3.

Referring now to Figs. 6 to 12, inclusive, the body 220 of said pilot valve member is provided with any suitable number of circumferentially extending passage systems, each including one or more grooves of suitable length and location for the program to be carried out, for registry with the corresponding ports 225 at suitable times during the rotation of said body 220. Figs. 6 to 12 illustrate four circumferential passage systems respectively designated 226, 227, 228 and 229. As shown in cross section in Fig. 8, passage system 226 is composed of three grooves 230, 231 and 232. Grooves 230 and 231 extend to the end of the body member a shown in the end view, Fig. 7, while groove 232 has an axially extending cross groove 233 in communication therewith and also extending to the end of the body member. Thereby all of the grooves in system 226 may drain into the chamber 219 at the end of the body member. Passage system 227, as shown in cross section in Fig. 9, is composed of a single groove 234 with which communicates a passage 235 leading into the bore 223. Passage system 228, as shown in cross section in Fig. 10, is formed as a single groove 236 of 360° extent. Passage system 229, as shown in cross section in Fig. 11, is composed of three grooves 237, 238 and 239 each of which communicates with the groove 236 by cross grooves 240, 241 and 242, respectively.

Passage 134 terminates at the pilot valve in a port 225 in circumferential alignment with the passage system 229. When any of the grooves 230, 231 and 232 are aligned with the port 225 of passage 134 the liquid in said passage may drain into the chamber 219 and thence through the passage 218 to the drain, when pressure is to be released in said passage 234, but when the solid portions of the pilot valve body 220 between said grooves are opposed to the port 225 in communication with passage 134, pressure builds up in said passage to actuate the drain valve operator 23 and the flow control valve 20 as heretofore explained.

Similarly, passage system 227 is circumferentially aligned with the port 225 at one end of passage 80 so that when groove 234 is in registry with said port the pressure in chamber 79' of the mixing valve shown in Fig. 2 is released, the liquid draining through passage 80, groove 234 and passage 235 into the bore 223 and thence through chamber 219 and passage 218 to the drain. When the solid portion of the pilot valve body is opposite the port 225 associated with passage 80, however, pressure builds up in said chamber 79' as heretofore explained, moving the valve member 33 toward the hot water port 30 so that cold water may be admitted for rinsing.

Passage system 228, composed of the single circumferential groove 236, is in circumferential alignment with the port 225 which communicates with the end of passage 109. Passage system 229

is in circumferential alignment with the port 225 in communication with the passage 97 so that when any of the grooves 237, 238 and 239 are in registry with said port the water may drain from passage 97 through said groove, and thence through the corresponding cross passage 240, 241 or 242, respectively, into the groove 236 which is permanently in communication with the passage 109. When the solid portions of body 220 are opposed to the port 225 that communicates with passage 97, however, pressure builds up in the chamber 92 to actuate the flow control valve 12 in the manner heretofore described.

As the operation of the component elements of the system has been explained in detail in connection with the description of the structure of such elements, it will here be sufficient to summarize briefly the operation of the hydraulic control as a system.

The operator first determines the temperature at which the washing should be carried out and by manipulation of the stem 78 associated with the thermostat 39 positions the valve member 33 with respect to its ports 30 and 31 so that a mixture of hot and cold water at a predetermined temperature is maintained in the chamber 36 of the mixing valve 14. The operator then turns shaft 168 to the position designed "Start," whereupon contact element 206 drops down the step 202 bringing contacts 209 and 210 into engagement whereby the circuit through the timing motor 165 is completed. This motor starts to rotate, and through the reduction gearing 170 to 187 and the coaction between the cam 189 and lever 194, the ratchet wheel 197 is started in a step by step motion. The rotation of shaft 168 from ratchet wheel 197, after a proper lapse of time, brings the cam 200 to the position wherein the contact element 205 drops down the step 202 to complete the circuit through the main motor associated with the tub. Rotation of the ratchet wheel 197 also effects rotation of the pilot valve member 220 in the step by step motion heretofore described to determine the cycle of operations constituting the program of the machine. Because of this step by step motion the control grooves in the pilot valve are brought abruptly into and out of communication with their ports 225 so that the gradual building up or release of pressure, as would occur if the pilot valve was rotated continuously and progressively, has been avoided.

Water at the thermostatically controlled temperature in the chamber 36 flows through nipple 85 and passage 86 to the chamber 96 of the flow control valve. At this time the interior of this chamber 96, by reason of the position of the pilot valve, is in open communication, through passage 97, with one of the grooves of passage system 229, groove 236, passage 109 and passage 110 to drain, float operated valve 108 being open because of the absence of water in the tub. The differential pressure applied exteriorly to the end wall 91 of chamber 92 holds the valve member 90 away from its seat at port 89, and the water entering chamber 96 flows through the pipe 11 to the tub and gradually rises therein until the float 100 causes the valve member 108 to close the port at the end of passage 105. Thereafter water flowing through the bleed opening 95 causes a back pressure to build up in chamber 92 until the pressure on movable end wall 91 is equalized, whereupon valve member 90 closes the port 89 and terminates the flow of water to the tub. When the solid portion of the valve member in circumferential alignment with passage system 229 is opposite the port 225 in communication with passage 97 valve member 90 is held closed irrespective of the position of float valve 108.

During the washing step of the cycle the port 225 in communication with passage 134 is opposite the solid portion of valve member 220 that is in circumferential alignment with passage system 226, whereby pressure is maintained on the valve operator 23 to hold the drain valve closed, and pressure is also maintained in chamber 130 to hold the valve member 127 in contact with its seat at port 123. This condition also continues during the rinsing cycle.

During the washing cycle the port 225 at the end of passage 80 is in communication with the groove 234 of passage system 227, so that any water bleeding through the hole 70 can drain off through said groove, passage 235, bore 223 and drain passage 218. When rinsing is to be effected, however, the solid portion of valve member 220 in circumferential alignment with groove 234 comes opposite the port 225 at the end of passage 80, whereby water bleeding through the opening 70 equalizes the pressure in the chambers 79' and 83, whereupon spring 72 moves valve member 33 downwardly as viewed in Fig. 2 to decrease or terminate the inflow of hot water and permit the flow of cold rinsing water through passage 86 to chamber 96, and thence through passage 11 to the tub, passage 97 at this time being in communication with one of the grooves of passage system 229 and passage 105 being open because float 100 has opened valve member 108 when the wash water is drained from the tub. When the rinse water has risen to the proper height in the tub, however, float 100 actuates valve member 108 to close passage 105, whereby the pressure in the chamber 92 again builds up as heretofore explained to close valve member 90 against its seat at port 89.

During the washing and rinsing stages the valve member 128 is held in closed position by the pressure in chamber 130 and drain valve operator 23 holds the drain valve closed, because during the washing and rinsing stages a solid part of valve member 220 in circumferential alignment with passage system 226 is opposite the port 225 at the end of the passage 134. When the clothes are to be spun, either at the end of the washing stage or the rinsing stage, however, a groove in said passage system 226 is brought into registry with the port 225 at the end of passage 134. Pressure is thereby released in both the passage 134 and the passage 162, release of pressure in passage 162 effecting the operation of the operator 23 to open the drain valve and release of pressure in passage 134 causing the unbalanced pressure acting on the end 127 of chamber 130 to open valve member 128. When valve member 128 is opened liquid under pressure is admitted to the chambers 121 and 120, pressure in the former chamber conditioning the Hemmeter valve 18 and pressure in the chamber 120 releasing the brake so as to initiate the spinning operation.

If the clothes are not properly distributed so that undue vibration arises, the plungers 152 and cylinders 153 develop pressure in chambers 155 which is transmitted to the chamber 157, where it is retained by the check valve 145, said pressure when it is developed to the proper magnitude acting on the movable end wall 138 of bellows 139 to move valve member 135 so as to close the inlet 136 to passage 134, but without affecting the

operation of the drain valve operator 23. Closure of the inlet 136 results in pressure building up in chamber 130, whereby valve member 128 is closed, and leakage from the Hemmeter valve 18 causes the pressure in chamber 120 to be released so that the brake controlled by the operator 19 is applied to terminate the spinning operation and restore the movement characteristic of the washing operation so as to effect a redistribution of the clothes. After a predetermined lapse of time, leakage past the valve member 145 or through the bleed opening there provided results in the pressure in chamber 157 being reduced so that spring 142 opens valve 135, whereby chamber 130 is again drained, valve 128 is opened and pressure is reintroduced into the chambers 121 and 120.

If the operator wishes to omit any of the steps in the automatic cycle he observes the indicating mechanism associated with the externally projecting end 164 of shaft 168, and when the step which he desires to omit has been reached, he turns the shaft 168 to the next step, the pawl 195 sliding on the teeth of ratchet wheel 197. In this way as many steps may be omitted as the operator desires, but thereafter the automatic cycle is resumed and continued until cam 200 reaches the position wherein contact element 207 drops down the step 202, and as this is the element common to the circuits of both the timing motor and the main motor, both of these circuits are opened and both motors stop.

By providing appropriate control areas on the valve member 220 the automatic cycle may include any desired number of steps in sequence, and by properly proportioning the grooves in the control areas the instant of application or release of pressure to or from the pressure responsive devices controlling the beginning and end of the respective stages may be exactly predetermined.

It will therefore be perceived that an improved control particularly adapted for use in conjunction with automatic washing machines has been provided wherein all of the control functions are effected by fluid pressure, the pressure used being derived from water which may be taken from the usual water mains. The component elements of the system are so constructed that injury will not be caused thereto even though the pressure in the mains be relatively high or vary from time to time. The control provides for readily omitting desired steps in the automatic cycle of the machine with assurance that the predetermined sequence of steps shall not be upset. The control facilitates predetermining the temperature at which the washing shall be done, but any abnormal rise in temperature in the water will not injure the thermostat. A single valve has been used for controlling both the flow of wash water and rinse water, and the actuation of the mixing valve to admit warm water for washing or cool water for rinsing is under the control of the same pilot valve which effects the control of the other stages of the automatic cycle. The water always rises to a predetermined level in the tub irrespective of how much water may be absorbed by the fabrics therein because the admission of water to the tub is controlled solely by the water level therein. The initiation of the spinning stage is controlled by the same pressure which conditions the Hemmeter valve, and if undue vibration arises from improper distribution of the clothes the spinning is promptly terminated to return to a motion that will redistribute the clothes, and this will recur as long as the improper distribution persists. The complexity incident to the use of electric systems has been eliminated, and undesirable actions incident to the gradual building up or release of pressure, retarding the initiation or termination of particular steps in the cycle, have been avoided. The system is simple and compact, positive in action, and composed of relatively few directly connected parts which are easy to standardize, inexpensive to manufacture, easy to assemble and service, and certain and efficient in operation.

It will also be perceived that while an improved mixing valve, improved timing mechanism, etc., have been provided and which are desirable subcombinations in the hydraulic control of the present invention viewed as an entire system, these and other subcombinations of the system are capable of other applications, and therefore it is to be expressly understood that it is within the contemplation of the present invention that such devices are applicable to wider uses than as parts of the hydraulic control herein disclosed.

While the embodiment of the invention illustrated on the drawings has been described with considerable particularity it is to be expressly understood that the invention is not to be limited thereto, as the same is capable of receiving a variety of mechanical expressions, some of which will now be apparent to those skilled in the art, while within the broader aspects of the present invention one or more of the improved structures constituting components elements of the system may be replaced by other suitable forms of devices to perform comparable functions. Changes may also be made in the details of construction, arrangement, proportion, sizes, etc., some of the improved features may be used without others, the control may be adapted to a smaller or larger number of steps or stages in the automatic cycle of the machine or to effect other steps than herein discussed by way of example, and the control as a whole, while particularly adapted to use with an automatic washing machine, is also susceptible to other applications. Reference is therefore to be had to the appended claims for a definition of the invention.

What is claimed is:

1. In a hydraulic control, in combination with a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors respectively associated with said valve elements, each of said motors including an expansible and collapsible chamber and means providing a chamber exteriorly of said first named chamber and in communication therewith through a bleed opening, each of said motors having a passage individual to and communicating with one of said chambers and means for admitting liquid under pressure to the other of said chambers, means providing a low pressure passage, a single pilot valve associated with all of said first named passages and including means for sequentially bringing the same into communication with said low pressure passage, said pilot valve including a casing having ports respectively in communication with said first named passages and a body movable in said casing and having passages for sequentially establishing communication between said ports and said low pressure passage, and a timing motor operatively connected to said valve body.

2. In a hydraulic control, in combination with

a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors respectively associated with said valve elements, each of said motors including an expansible and collapsible chamber and means providing a chamber exteriorly of said first named chamber and in communication therewith through a bleed opening, each of said motors having a passage individual to and communicating with one of said chambers and means for admitting liquid under pressure to the other of said chambers, means providing a low pressure passage, a single pilot valve associated with all of said first named passages and including means for sequentially bringing the same into communication with said low pressure passage, said pilot valve including a casing having ports respectively in communication with said first named passages and a body movable in said casing and having passages for sequentially establishing communication between said ports and said low pressure passage, a timing motor for moving said valve body, and a driving train between said timing motor and said valve body including a pawl and ratchet mechanism for abruptly bringing the passages in said valve body into and out of registry with said ports.

3. In a hydraulic control, the combination of a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors respectively associated with said valve elements, each of said motors including an expansible and collapsible chamber and means providing a chamber exteriorly of said first named chamber and in communication therewith through a bleed opening, each of said motors including means for admitting a liquid under pressure to one of said chambers and a pressure release passage communicating with the other of said chambers, each of said valve elements including an apertured seat and a valve member connected to one of said expansible and collapsible chambers to be movable relative to said seat by the equalization of pressure interiorly and exteriorly thereof through said bleed opening, and a single pilot valve for controlling the pressure in all of said pressure release passages.

4. In a hydraulic control, the combination of a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors respectively associated with a plurality of said valve elements, each of said motors including an expansible and collapsible chamber and means providing a chamber exteriorly of said first named chamber and in communication therewith through a bleed opening, each of said motors including means for admitting a liquid under pressure to one of said chambers and a pressure release passage communicating with the other of said chambers, each of said valve elements including an apertured seat and a valve member connected to one of said expansible and collapsible chambers to be movable relative to said seat by the equalization of pressure interiorly and exteriorly thereof through said bleed opening, a single pilot valve for controlling the pressure in all of said pressure release passages, said pilot valve including a casing provided with ports respectively in communication with said pressure release passages, means providing a low pressure passage and a rotatable valve body mounted in said casing and provided with passages for sequentially bringing each of said pressure release passages into communication with said low pressure passage, and a timing motor operatively connected to said valve body.

5. In a hydraulic control, the combination of a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors respectively associated with said valve elements, each of said motors including an expansible and collapsible chamber and means providing a chamber exteriorly of said first named chamber and in communication therewith through a bleed opening, each of said motors including means for admitting a liquid under pressure to one of said chambers and a pressure release passage in communication with the other of said chambers, each of said valve elements including an apertured seat and a valve member connected to one of said expansible and collapsible chambers to be movable relative to said seat by the equalization of pressure interiorly and exteriorly thereof through said bleed opening for controlling a port associated therewith, a single pilot valve for controlling the pressure in all of said pressure release passages, said pilot valve including a casing provided with ports respectively in communication with said pressure release passages, means providing a low pressure passage and a rotatable valve body mounted in said casing and provided with passages for sequentially bringing each of said pressure release passages in communication with said low pressure passage, a timing motor for rotating said valve body, and a driving train between said motor and said valve body including reduction gearing and a pawl and ratchet mechanism operated thereby and operatively connected to said valve body to advance said valve body periodically in a step by step motion.

6. In a hydraulic control, the combination of a thermostatically controlled mixing valve for predetermining the temperature of the water to be supplied, said valve including a casing providing a chamber for the mixture of the hot and cold water, hot and cold water passages in communication with said chamber, valve means for controlling said passages, and a thermostat operatively connected to said valve means and subjected to the temperature of the mixture in said chamber, said thermostat including a movable wall, a stem operatively connected with said last named wall for adjusting the thermostat, an expansible and collapsible chamber having a movable wall engaging said stem and in communication with said first named chamber, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating with said latter chamber through a bleed opening, means providing a pressure release passage in communication with said exterior chamber, a valve for controlling the pressure in said pressure release passage, and spring means cooperating with said last named movable wall and operable to move the same away from said stem and actuate said valve means to discontinue flow of water through said hot water passage when said release passage is closed and the liquid flowing through said bleed opening equalizes the pressure on the opposite sides of said last named movable wall.

7. In a hydraulic control for automatic wash-

ing machines, the combination of a thermostatically controlled mixing valve for predetermining the temperature of the water to be delivered, said valve including a chamber for the mixture of hot and cold water, means providing an outlet passage in communication with said chamber, hot and cold water passages in communication with said chamber, valve means for controlling the flow of water through said hot and cold water passages, a thermostat subjected to the temperature of the mixture in said chamber and operatively connected to said valve means, a valve for controlling the flow of water through said outlet passage, pressure motors operatively connected to said last named valve and to said mixing valve for respectively controlling the flow from said chamber and for adjusting said mixing valve to deliver cold water, each of said pressure motors including an expansible and collapsible chamber and means providing a chamber exteriorly of said expansible and collapsible chamber and in communication therewith through a bleed opening, means providing pressure release passages individual to and communicating with each of said pressure motors, and a single pilot valve for opening and closing said pressure release passages and actuating said pressure motors.

8. In a hydraulic control for automatic washing machines, the combination of a thermostatically controlled mixing valve for predetermining the temperature of the water to be delivered, said valve including a chamber for the mixture of hot and cold water, means providing an outlet passage in communication with said chamber, hot and cold water passages in communication with said chamber, valve means for controlling the flow of water through said hot and cold water passages, a thermostat subjected to the temperature of the mixture in said chamber and operatively connected to said valve means, a valve for controlling the flow of water through said outlet passage, pressure motors operatively connected to said last named valve and to said mixing valve for respectively controlling the flow from said chamber and for adjusting said mixing valve to deliver cold water, each of said pressure motors including an expansible and collapsible chamber and means providing a chamber exteriorly of said expansible and collapsible chamber and in communication therewith through a bleed opening, means providing pressure release passages individual to and communicating with each of said pressure motors, a single pilot valve for opening and closing said pressure release passages and actuating said pressure motors, said pilot valve including a casing, means providing a low pressure passage in communication with said casing, a valve body mounted in said casing and provided with passages for sequentially bringing said low pressure passage into communication with said pressure release passages, and a timing motor operatively connected to said valve body.

9. In a hydraulic control for automatic washing machines, the combination of a thermostatically controlled mixing valve for predetermining the temperature of the water to be delivered, said valve including a chamber for the mixture of hot and cold water, means providing an outlet passage in communication with said chamber, hot and cold water passages in communication with said chamber, valve means for controlling the flow of water through said hot and cold water passages, a thermostat subjected to the temperature of the mixture in said chamber and operatively connected to said valve means, a valve for controlling the flow of water through said outlet passage, pressure motors operatively connected to said last named valve and to said mixing valve for respectively controlling the flow from said chamber and for adjusting said mixing valve to deliver cold water, each of said pressure motors including an expansible and collapsible chamber and means providing a chamber exteriorly of said expansible and collapsible chamber and in communication therewith through a bleed opening, means providing pressure release passages individual to and communicating with each of said pressure motors, a single pilot valve for opening and closing said pressure release passages and actuating said pressure motors, said pilot valve including a casing, means providing a plurality of low pressure passages in communication with said casing, a valve body mounted in said casing and provided with passages for sequentially bringing a low pressure passage into communication with said pressure release passages, a timing motor operatively connected to said valve body, and a float control valve associated with one of said low pressure passages.

10. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, and means for controlling the flow of liquid through said outlet passage to determine whether or not pressure shall be developed through said bleed opening in said expansible and collapsible chamber.

11. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, and means for controlling the flow of liquid through said outlet passage to determine whether or not pressure shall be developed through said bleed opening in said expansible and collapsible chamber, said last named means including a valve controlling said outlet passage and a timing motor operatively connected to said valve.

12. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure

liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, and means for controlling the flow of liquid through said outlet passage to determine whether or not pressure shall be developed through said bleed opening in said expansible and collapsible chamber, said last named means including a pressure responsive device and means operable by vibration to develop pressure in said pressure responsive device.

13. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, a valve for opening and closing said outlet passage, a pressure motor for operating said valve, and means responsive to vibration for developing pressure in said pressure motor and operating said valve to close said outlet passage.

14. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, a valve for opening and closing said outlet passage, a pressure motor for operating said valve, means for developing pressure in said pressure motor, a passage for connecting said last-named means to said pressure motor, and a check valve for controlling said passage and providing for a leakage return to said passage to relieve the pressure in said pressure motor after a predetermined period of time.

15. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing

liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, a valve for opening and closing said outlet passage, a pressure motor for operating said valve, means for developing pressure in said pressure motor, a passage connecting said last named means with said pressure motor, and a time delay valve associated with said passage for predetermining the rate of liquid flow therethrough.

16. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, means providing a low pressure passage, a valve for placing said outlet passage in communication with said low pressure passage, and means responsive to vibration for opening and closing said outlet passage independently of said last named valve.

17. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, means providing a low pressure passage, a valve for placing said outlet passage in communication with said low pressure passage, a second valve for opening and closing said outlet passage, a pressure motor for operating said second valve, and means responsive to vibration for developing a pressure in said last named pressure motor and operating said second valve to close said outlet passage independently of the position of said first named valve.

18. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, means providing a low pressure passage, a valve for placing said outlet passage in communication with said low

pressure passage, a second valve for opening and closing said outlet passage, a pressure motor for operating said second valve, means responsive to vibration for developing a pressure in said last named pressure motor, and a time delay valve interposed between said last named pressure motor and said last named means for predetermining the period of time during which said pressure motor retains said second valve in position for closing said outlet passage.

19. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, a drain valve operator including a pressure motor connected to said outlet passage, and a valve for controlling the flow of liquid through said outlet passage to determine simultaneously whether or not pressure shall be developed through said bleed opening in said expansible and collapsible chamber and whether or not said drain valve operator shall be actuated.

20. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an outlet passage from said expansible and collapsible chamber, a drain valve operator including a pressure motor connected to said outlet passage, a valve for controlling the flow of liquid through said outlet passage to determine simultaneously whether or not pressure shall be developed through said bleed opening in said expansible and collapsible chamber and whether or not said drain valve operator shall be actuated, and means responsive to vibration for closing said outlet passage and operating said first named valve independently of the position of said last named valve.

21. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure liquid to said chamber and motor including a valve, an expansible and collapsible chamber operatively connected to said valve, means providing a chamber exteriorly of said expansible and collapsible chamber and communicating therewith through a bleed opening, means providing an inlet for introducing liquid under pressure into said last named chamber, means providing an

outlet passage from said expansible and collapsible chamber, a drain valve operator including a pressure motor connected to said outlet passage, a valve for controlling the flow of liquid through said outlet passage to determine simultaneously whether or not pressure shall be developed through said bleed opening in said expansible and collapsible chamber and whether or not said drain valve operator shall be actuated, means for closing said outlet passage to operate said first named valve independently of the position of said last named valve including a valve in said outlet passage, a pressure motor operatively connected to said last named valve, and means responsive to vibration for developing pressure in said last named pressure motor.

22. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake opeartor including a pressure motor in communication with said chamber, means for controlling the application of pressure to said chamber and motor including a valve, means for operating said valve, and means responsive to the vibration for actuating said last named means to close said valve and exclude pressure liquid from said first named chamber.

23. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure to said chamber and motor including a valve, means for operating said valve including a pressure motor, and means responsive to vibration for determining whether or not pressure fluid shall actuate said pressure motor.

24. In a hydraulic control for automatic washing machines, the combination of a Hemmeter valve provided with a chamber for liquid under pressure, a brake operator including a pressure motor in communication with said chamber, means for controlling the application of pressure to said chamber and motor including a valve, means for operating said valve including a pressure motor, a valve for controlling the application of pressure to said pressure motor, a pressure motor for operating said last named valve, and a pressure device responsive to vibration for developing pressure in said last named pressure motor.

25. In a hydraulic control, the combination of a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors respectively associated with said valve elements, a pilot valve operatively connected to all of said pressure motors for operating the same in predetermined sequence, and timing mechanism for operating said pilot valve including a motor, a coaxial system of planetary gearing driven by said motor, a pawl oscillated by said gearing, and a ratchet wheel operated by said pawl and operatively connected to said pilot valve.

26. In a hydraulic control, the combination of a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors respectively associated with said valve elements, a pilot valve operatively connected to all of said pressure motors for operating the same in predetermined sequence, and timing mechanism for

operating said pilot valve including a motor, reduction gearing driven by said motor, a cam driven by said gearing, a pivoted lever having a cam-shaped opening cooperating with said cam and carrying a pawl, and a ratchet wheel cooperating with said pawl and operatively connected to said pilot valve.

27. In a hydraulic control, the combination of a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors operatively connected to said valve elements respectively, a pilot valve, and means providing passages operatively connecting the respective pressure motors with said pilot valve, said pilot valve including a casing having ports in communication with the respective passages, a rotatable body in said casing provided with passages for registry with said ports, and means for rotating said valve body including a manually operable shaft connected to said valve body, a motor rotatable around said shaft, reduction gearing driven by said motor and including planetary gearing disposed coaxially with said shaft, and means connecting said reduction gearing with said valve body.

28. In a hydraulic control, the combination of a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors operatively connected to said valve elements respectively, a pilot valve, and means providing passages operatively connecting the respective pressure motors with said pilot valve, said pilot valve including a casing having ports in communication with the respective passages, a rotatable body in said casing provided with passages for registry with said ports, means for rotating said valve body including a manually operable shaft connected to said valve body, a motor rotatable around said shaft, reduction gearing driven by said motor, and means for rotating said valve body from said reduction gearing including a pawl and ratchet mechanism operable to rotate said valve body in one direction and prevent manual rotation of said valve body in the opposite direction.

29. In a hydraulic control, the combination of a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors operatively connected to said valve elements respectively, a pilot valve, and means providing

passages operatively connecting the respective pressure motors with said pilot valve, said pilot valve including a casing having ports in communication with the respective passages, a rotatable body in said casing provided with passages for registry with said ports, means for rotating said valve body including a manually operable shaft connected to said valve body, a motor rotatable around said shaft, reduction gearing driven by said motor, and means for rotating said valve body from said reduction gearing including a cam driven by said reduction gearing, a pivoted lever having a cam-shaped opening cooperating with said cam and carrying a pivoted pawl, and a ratchet wheel cooperating with said pawl and operatively connected to said valve body.

30. In a hydraulic control, the combination of a plurality of valve elements to be controlled including a fluid mixing valve, means responsive to the temperature of said fluid for operating said mixing valve, a plurality of pressure motors operatively connected to said valve elements respectively, a pilot valve, and means providing passages operatively connecting the respective pressure motors with said pilot valve, said pilot valve including a casing having ports in communication with the respective passages, a rotatable body provided with passages for registry with said ports, means for rotating said pilot valve including a manually operable shaft connected to said valve body, a motor rotatable around said shaft, reduction gearing driven by said motor, a pawl and ratchet for driving said valve body from said reduction gearing, said shaft being driven from said ratchet, and means for stopping said motor driven by said shaft.

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