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SPEED CONTROL VALVE FOR HYDRAULIC MECHANISM

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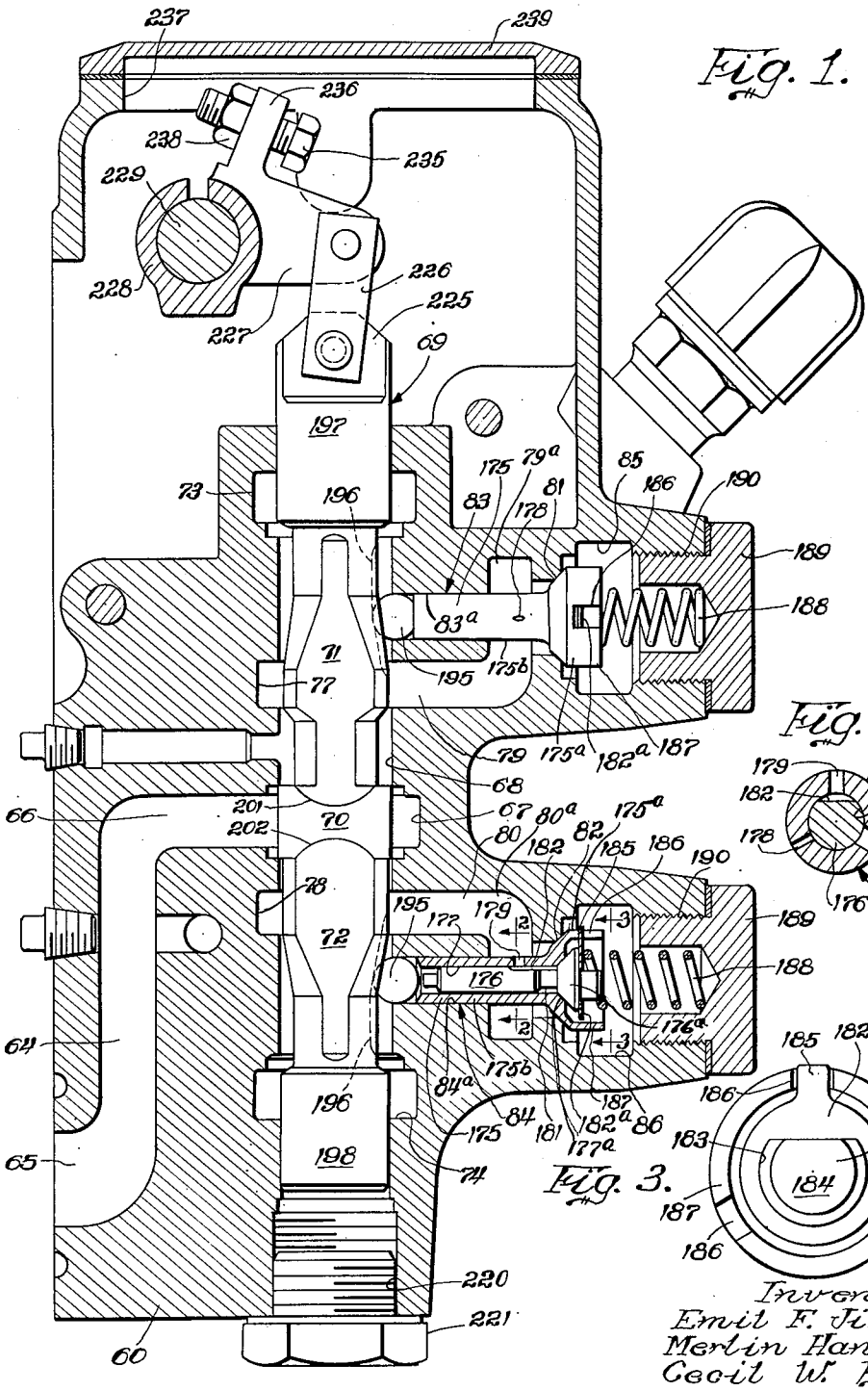

Fig. 1.

Fig. 2.

Fig. 3.

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SPEED CONTROL VALVE FOR HYDRAULIC MECHANISM

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5 Claims. (Cl. 277—43)

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This invention relates to hydraulic apparatus and more specifically to means for providing a plurality of operating means for such apparatus. The present application is a division of our copending application, Serial No. 626,626, filed November 5, 1945 now U. S. Patent 2,532,552.

We have disclosed in that patent a hydraulic system in which a manually operated valve selectively controls the admission of fluid pressure to and the exhaust of fluid from a fluid motor of the cylinder and piston type. According to a preferred embodiment of the invention, fluid pressure is used to move the piston for the purpose of accomplishing the adjustment—primarily the raising—of an agricultural implement. In such systems, the lowering of the implement is achieved by exhausting the cylinder, the piston and implement moving by virtue of the weight of the implement in returning to its previous position. The system disclosed in the application referred to also shows the application of this type of control means to a cylinder of the two-way type, in which instance fluid pressure is optionally supplied at either end of the cylinder to accomplish adjustment of the implement in either of two directions. In either instance, the speed at which the piston moves is controllable by positioning of a valve. A further regulation of the speed of operation of the piston may be accomplished on the low pressure side of the system by regulating the transmission of fluid during the exhaust of the cylinder.

According to the present invention, it is a principal object to provide improved means for regulating the low pressure side of a hydraulic system. More particularly, it is an object of the invention to provide means that may be selectively positionable to vary the resistance to flow of fluid. It is a feature of the invention to provide this means in the form of a check valve having an adjustable portion provided with orifices of different sizes, the portion being positionable so that an orifice of a certain size may be selected according to the speed of operation desired. Still further, it is a feature of the invention to provide an improved check valve of the poppet type, preferably comprising a first valve having a hollow stem and a second valve having a stem fitting in the hollow stem of the first valve, the stem of the second valve including a flat selectively communicable with orifices of different sizes provided in the hollow stem of the first valve.

The foregoing and other desirable objects and features of the invention will become apparent to those versed in the art as a complete disclosure

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is made of a preferred form of the invention as described in the following detailed specification and as illustrated in the accompanying sheet of drawings in which:

Figure 1 is a sectional view of a control housing showing a control valve in conjunction with regulating check valves constructed according to the invention;

Figure 2 is an enlarged transverse sectional view taken substantially on the line 2—2 of Figure 1; and

Figure 3 is an end view of the check valve structure, as viewed along the line 3—3 in Figure 1.

The complete hydraulic system is shown in our patent referred to above, and only so much of such system as is necessary to illustrate the present invention has been shown and will be described here. Accordingly, the present disclosure is limited to that portion of the main invention including a control housing 60 which is provided wtih a cored high-pressure passage 64 having an intake port 65 which may be connected in any suitable manner to a source of fluid under pressure, as shown in our copending application. The passage 64 extends upwardly from the port 65 and turns rearwardly at 66 to an enlarged port 67 in a vertically disposed valve cylinder 68, within which is a vertically slidable valve plunger 69. The valve plunger 69 is provided with a centrally disposed piston or spool 70 disposed within the annular port 67 and substantially coextensive therewith.

The laterally opposite sides of the valve plunger 69 and the upper edges of the piston 70 are ground off, as indicated at 71, to provide flat portions along which the fluid can flow. Similarly, the laterally opposite sides of the valve plunger 69 below the piston 70, and the lower edge of the latter, are ground off as indicated at 72, to provide passages for the flow of fluid. Hence, in the neutral or inactive position of the plunger 69, as shown in the drawings, the fluid flowing upwardly through the passage 64 and into the port 67 divides between the upper and lower flat portions 71 and 72 and flows therealong through the valve cylinder 68 to a pair of upper and lower annular ports 73 and 74, which are exhaust ports communicating with a reservoir (not shown) within the interior of the control housing 60. Thus, when the control mechanism is inactive, the pump (not shown) furnishes a continuous flow of fluid upwardly through the passages 64 and 66 and along the flats 71 and 72 respectively to the ports 73 and 74 and thence to the reservoir (not shown).

A pair of annular ports 77, 78 are spaced axially above and below the central inlet port 67 in the valve cylinder 68 and these ports are connected to a pair of passages 79, 80, respectively, the outer ends of which are turned upwardly and downwardly at 79a and 80a, respectively, and having valve seats or ports 81, 82 communicating therewith. Poppet-type valves 83, 84, shiftably carried in valve bores 83a and 84a, are adapted to seat respectively in the valve seats 81, 82. The bores 83a and 84a open at their inner ends to the actuating member 69. These check valves are respectively in controlled communication with a pair of cylinder-supply ducts 85 and 86, which are connected by passages (not shown) which in turn may communicate with opposite ends of a fluid motor, as shown in our patent identified above.

It is deemed sufficient here to state that the ducts 85 and 86 are connected to opposite ends of a fluid motor, such as a cylinder in which a piston is carried for reciprocation. As previously stated, the valve 69 in its neutral position as shown provides for the circulation of fluid from the pump back to the reservoir. When the valve 69 is moved vertically in one direction, fluid under pressure is supplied through one of the ducts 85, 86 to one end of the cylinder and fluid returns from the other end of the cylinder through the other duct 85, 86. The present invention is concerned primarily with the control of fluid returning through that one of the ducts that is operating as an exhaust or return duct at the time, it being an object of the invention, as stated above, to provide means including an adjustable restriction for varying the resistance to the flow of return or exhaust fluid.

Since both check valves 83, 84 are identical, only one will be described in detail, reference being had to the check valve 83 for a clear view of the external appearance of the valve and reference being had to the valve 84 and the sectional views in Figures 2 and 3 for details of the interior construction of the valve.

Each of the check valves 83, 84 is a dual valve comprising an outer part 175 and an inner part 176. The outer part 175 has a valve head 175a, seatable on and unseatable from the port or seat 82(81), and also has a hollow stem 175b, which provides an axial bore 177 therein. The outer end of the bore 177 forms a secondary valve seat 177a concentric with or encircled by the port 82(81) and valve head 175a. The stem or carrying port of the inner valve part 176 fits closely but slidably within the bore 177 and has at its outer end means in the form of a small valve head 176a which provides a secondary valve element seatable on and unseatable from the secondary seat 177a. The stem 175b of the outer valve part 175 is provided with passage means in the form of three apertures 178, 179, 180, spaced peripherally and extending radially in communication with the passage or bore 177. This construction is best shown in Figures 1 and 2. The stem of the inner valve part 176 is provided with an annular groove 181 under the head 176a and is also provided with passage means by being relieved along one side of the stem, as by grinding a flat portion 182 axially along the stem of the inner valve from the groove 181 to establish communication with any one of the three apertures or orifices 178, 179, and 180. The inner valve part 176 can be rotated about the common axis of the dual valve to place the flat portion 182 selectively in register with any of the apertures

178, 179 or 180, the latter being of relatively different diameters so that the resistance to the flow of oil through the inner valve can thus be adjusted. The two parts 175, 176 are secured in angularly adjusted position by means of a locking washer 182a, the latter having a non-circular aperture 183 therein which fits over a correspondingly shaped lug 184 on the valve head 176a of the inner part 176. The locking washer 182a has a radially extending ear 185 which can be inserted into any of three notches 186 in an axially extending flange 187 encircling the head 175a of the outer valve head 175a, the three notches 186 corresponding to the position of registry of the three apertures 178, 179 and 180. Each of the check valves 83, 84 is urged toward closed position by means of a compression spring 188, which bears against the washer 182a and reacts against a plug 189 screwed into a threaded opening 190 in the outer end of the supply passage or duct 85 (86).

Each of the check valves 83, 84 is actuated by means of a ball 195 disposed at the inner end of the valve, and the balls 195 bear against the splined grooves 196 in the valve plunger 69. The grooves 196 are so inclined that when the valve plunger 69 is moved upwardly, the upper ball 195 is cammed outwardly against the upper check valve 83, while, if the valve plunger 69 is moved downwardly within the valve cylinder 68, the lower ball 195 is forced outwardly to actuate the lower check valve 84. The lengths of the stems of the two coaxial valve parts 175 and 176 are such that the associated ball 195 can engage the inner end of the inner part 176 and shift it outwardly before the ball engages the end of the hollow stem 175b of the outer part 175. This reduces appreciably the amount of effort necessary to open either of the check valves, for, if a single valve were to be used in place of one of the dual valves, the oil pressure against the large head would make it very difficult to raise the valve off its seat; but the area of the small inner valve is so much less than that of a single check valve that the total pressure is greatly reduced. After the inner valve part 176 has been cracked open to unseat the secondary valve 177a, the pressure on the head 175a of the outer valve part is reduced sufficiently to make it comparatively easy to open. The balls are thus used as tappets for opening the inner and outer check valve parts, sequentially, and eliminate a considerable amount of the friction and side thrust on the valve stems that would be involved if the inclined camming surfaces on the valve plunger 69 directly contacted the valve stems.

The valve plunger 69 is provided with a pair of spools or pistons 197, 198 at its upper and lower ends, respectively, the inner edges of which are spaced outwardly from the inner edges of the annular ports 73, 74, thus providing for a free flow of oil along the valve cylinder 68 into the exhaust ports 73, 74 when the plunger is in its neutral position. Movement of the valve plunger 69 downwardly moves the upper piston 197 into the upper end of the valve cylinder 68, thereby closing off the upper reservoir port 73. Similarly, when the plunger 69 is moved upwardly, the valve piston 198 acts against the upper edge of the port 74 to close the latter against flow of oil downwardly into the reservoir.

The lower end of the valve cylinder 68 is threaded, as at 220, to receive a plug 221 in the bottom end of the control housing 60. The

plunger 69 can be removed from the plunger 68 downwardly through the threaded aperture 229 after the plug 221 has been removed. The upper end of the plunger 69 is provided with an upstanding ear 225 which is connected by a short link 226 to an arm 227 cast integrally with a hub 228 rigidly fixed on a control rockshaft 229 which is journaled in the control housing 60. The rockshaft 229 may be provided at a point thereon outside the housing 60 with a suitable control lever (not shown) which may be manually operated to rock the rockshaft 229 and thus control positioning of the valve 69. The upper limit of movement of the plunger 69 is limited by means of an adjustable limit stop comprising a bolt 235 extending through a suitably threaded aperture in an arm 236 preferably formed integrally with the hub 228. The threaded end of the bolt 235 engages a shoulder 237 in the top of the housing 60. A lock nut 238 is provided on the bolt 235 for locking the latter in adjusted position. A cover plate 239 closes the opening defined by the shoulder 237 in the top of the housing 60 and may be removably secured in place by any appropriate securing means. Various other details and refinements of design in connection with the valve 69 and the control thereof are shown in the co-pending applications referred to above and need not be further illustrated or described here.

The operation of the mechanism is as follows: Movement of the plunger 69 upwardly brings the lower piston portion 198 into closing relation with the edge of the exhaust port 74 and simultaneously moves the central piston portion 70 upwardly to cut off the flow of oil upwardly through the valve cylinder 68. This flow is not reduced abruptly, however, in view of the fact that the edge of the piston portion 70 is ground off on an arc 201, with the result that the upward flow of oil to the cylinder 68 is not entirely cut off until the lower point on the curved edge 201 coincides with the upper edge of the central port 67. The lower portion of the piston 70 is similarly provided with a cut-off as indicated at 202.

To continue, during the gradual cut-off of the oil flow to the reservoir, the pressure increases in the high pressure duct 64 and in the lower portion of the valve cylinder 68 beneath the inlet port 67. This causes the oil to flow along the flat portion 72 of the plunger 69 and through the port 76 and passage 80, thereby forcing the check valve 84 away from the seat 82 against the pressure of the spring 188. The oil then flows through the supply duct 86 and thence to whatever kind of fluid motor is utilized with the system.

The upward movement of the valve plunger 69 has also forced the inclined surface of the groove 196 against the ball 195 to open the upper check valve 83. If the cylinder and piston with which the control system is utilized is of the two-way type, fluid returning from the end of the cylinder opposite to that to which fluid pressure is applied through the duct 86 will return through the duct 85 and through the open check valve 83. Since initial movement of the valve 69 upwardly causes the ball 195 to first engage the stem of the inner check valve part 176, the resistance to the flow of oil through the open check valve 83 will be determined by whichever of the apertures 178, 179 or 180 is in register with the flat 182 on the valve part 176. In the drawings, the aperture 179 of medium size is so registered. A similar result is achieved, of course, in the supply of fluid under pressure through the passage 80, check valve 84, and duct 86, since the initial rise of pressure in the valve cylinder below the piston 70 will force fluid through the aperture 179, along the flat 182 and against the head of the inner valve part 176. However, further upward movement of the valve plunger 69 causes the ball 195 to engage the inner end of the stem 175b of the outer valve part 175, thus fully opening the check valve 83 to the exhaust fluid. At the same time, the pressure rise in the valve cylinder 68 below the piston 70 now fully opens the lower check valve 84 against the spring 188, thus imparting full speed operation to the fluid motor that is connected to the control system. Movement of the valve plunger 69 downwardly from its neutral position results in the reversal of the system, the upper duct 85 now being a supply duct and the lower duct 86 constituting a return duct. In the case of a fluid motor of the single-action or one-way type, only one of the ducts 85, 86 is used and whichever one is used serves the dual function of a supply and a return duct. However, the results are similar to those described above.

Either of the plugs 189 can be removed for the purpose of providing for access to the check valves 83, 84, so that the inner valve part 176 may be rotated with respect to the outer valve part 175 to dispose the flat 182 in register with a selected one of the apertures 178, 179 or 180.

The foregoing is based upon a preferred embodiment of our invention. It should be understood, of course, that various modifications and alterations may be made in the preferred form of the invention without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. In fluid pressure mechanism, a dual valve comprising a first poppet type valve having a recess extending through the valve head into the stem thereof, a second poppet valve seated in said recess and having a stem fitting closely but slidably within the recessed stem of said first valve, said second valve stem being relieved axially along one side to provide for the flow of fluid under the head thereof and along the stem, said recessed stem of said first valve having a plurality of peripherally spaced, radially extending apertures of relatively different sizes communicating with the recess in said stem, said second valve being adjustable angularly about its axis to position the axially relieved portion in register with any of said apertures, selectively, and means for retaining said second valve in angularly adjusted position during operation.

2. In fluid pressure mechanism, a dual valve comprising a first poppet type valve having a hollow stem and a head mounted thereon and having a valve seat in said head, and a plurality of peripherally spaced, radially extending apertures of different sizes in the stem communicating with the hollow interior thereof, a second poppet type valve having a head adapted to cover said seat and a stem extending through the hollow stem of said first valve, said second stem having an enlarged portion adapted to block all but one of said apertures and adjustable angularly relative to said hollow stem to select one of said apertures for conducting fluid therethrough, and means for retaining said valve in adjusted position.

3. In fluid pressure mechanism, a dual valve

including a first poppet type valve comprising a stem having a passage extending axially therethrough and a head at one end of said stem, said head being recessed to provide a peripheral flange and provided with a valve seat in one end of said passage, said stem being provided with a plurality of peripherally spaced, radially extending apertures of relatively different sizes communicating with said passage, a second poppet type valve having a head seated in said seat and a stem extending through said passage and fitting closely but slidably and adjustable angularly within the passage, said second valve stem being relieved under the head thereof and axially along one side to provide for the flow of fluid between said seat and one of said apertures selected by angular adjustment of said second valve relative to said first valve about its major axis to position the axially relieved portion in register with any of said apertures, selectively, and a retaining member engageable with said second valve head and rotatable therewith and having an ear extending over said flange in said first valve, said flange having notches adapted to receive said ear in any one of the various positions of said second valve.

4. In fluid pressure mechanism, a dual valve structure comprising a first valve having a body and a head fixed thereto, the head having a seat therein and the body being provided with a hollow interior communicating with the seat, the body further having a plurality of apertures of different sizes spaced angularly about the axis of the body and communicating the exterior of the body with the interior thereof; a second valve having a carrying part and a head part fixed thereto, and arranged with the carrying part in and slidable lengthwise of the hollow body of the first valve and angularly adjustable on the axis about which the apertures are spaced, and with the head part seatable on and unseatable from the seat in the first valve head, said carrying part having a portion thereof within the hollow body of the first valve provided with such cross-sectional shape as to block one of said apertures while leaving another of said apertures open to establish fluid communication via such open aperture between the exterior of the first valve and the seat of the first valve, said second valve being angularly adjustable as aforesaid to re-position said portion to respectively block and open different apertures; and means cooperative between the valves for fixing the second valve in a selected position of angular adjustment.

5. For use in a valve casing having a valve bore including an outer portion providing a primary port and an inner portion opening to a valve-actuating member: a dual valve, comprising, an outer part adapted to be shiftably carried in the valve bore and having inner and outer ends and provided with a through bore communicating said ends, said bore at its outer end providing a secondary valve seat in said part; means at the outer end of said part including a valve head seatable on and unseatable from the aforesaid port, and means at the inner end of said part engageable by the valve-actuating member to effect shifting of said part for causing unseating of said valve head; means at the outer end of said part including a secondary valve element seatable on and unseatable from said secondary valve seat; an inner valve part axially shiftable in the outer part bore but fitting said bore intermediate its opposite ends sufficiently closely to substantially seal said bore against the transmission of fluid between its ends, said inner part having an outer end portion engageable with said secondary valve element, and an inner end normally projecting axially inwardly beyond the inner end of the bore so as to be initially engageable for operational shifting by the valve-actuating member prior to engagement of said member with the inner end of the outer part; passage means in the outer part, and passage means in the inner part; the passage means in the outer part being spaced axially inwardly of the valve head, and the passage means in the inner part opening generally axially to the outer end of the bore and communicable with said outer part passage means; said inner part being constructed for adjustment relative to the outer part other than by said operational shifting thereof and having provision for the projection of an end portion thereof axially inwardly of the inner end of said bore to the same extent as aforesaid to maintain the capacity of the inner part for initial engagement and operational shifting by the valve-actuating member regardless of such adjustment; and the passage means in at least one part being constructed to provide a plurality of different fluid restrictions and selectively cooperative for communication with the passage means in the other part incident to adjustment of said inner part.

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