Dec. 9, 1952 J. M. TOWLER ET AL 2,620,777

HYDRAULIC CONTROL SYSTEM FOR HYDRAULIC PISTON TYPE CONTROL VALVES

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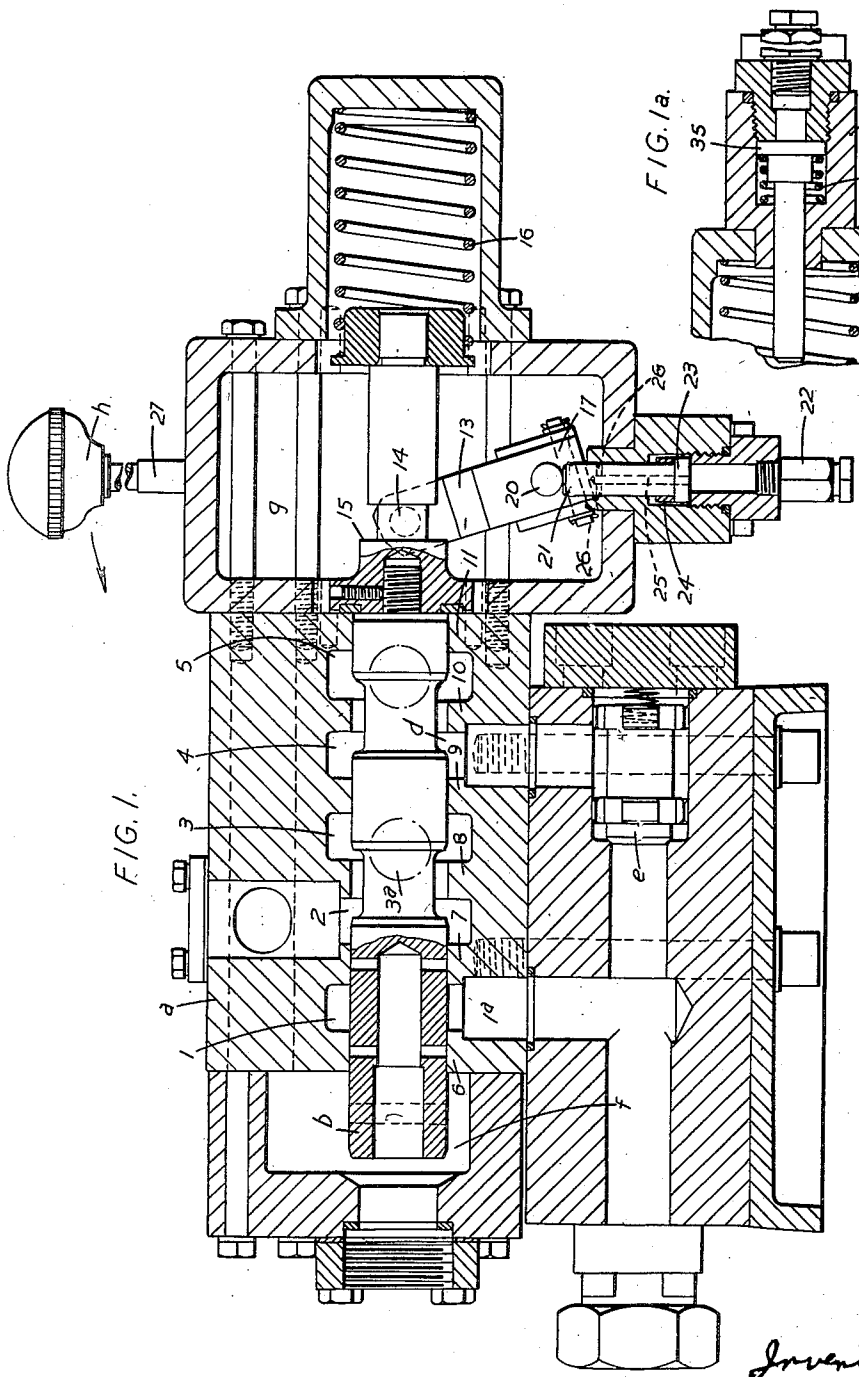


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HYDRAULIC CONTROL SYSTEM FOR HYDRAULIC PISTON TYPE CONTROL VALVES

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FIG. 4.

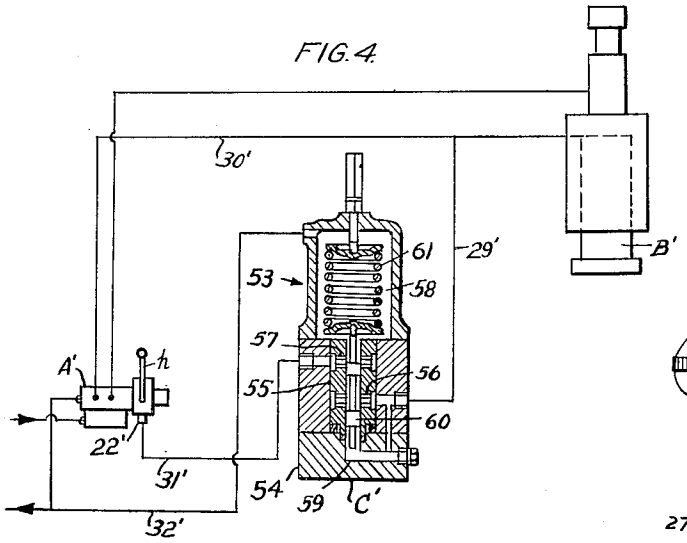
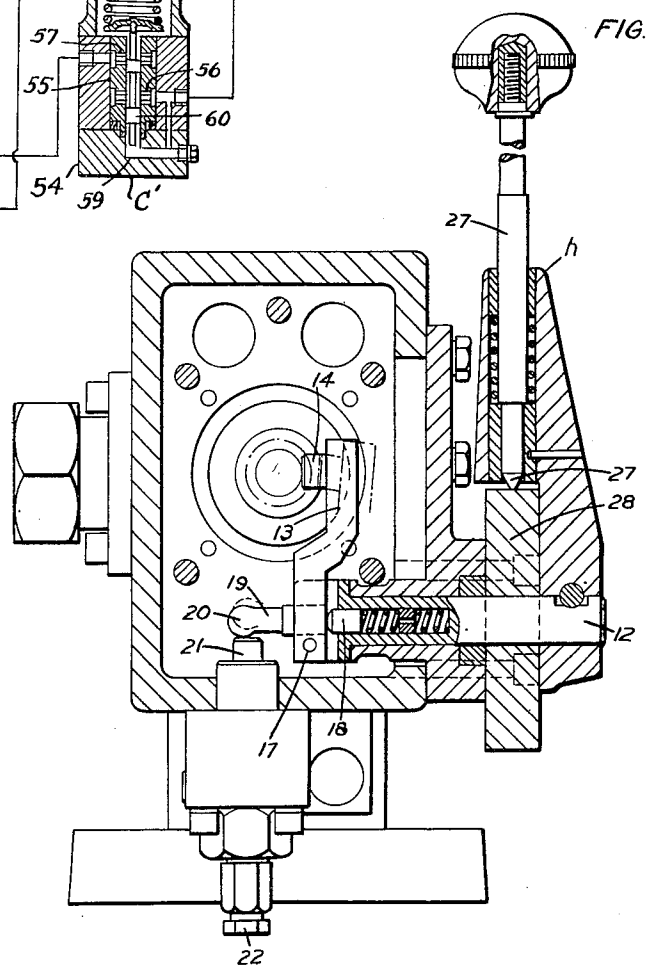



FIG. 2.

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HYDRAULIC CONTROL SYSTEM FOR HYDRAULIC PISTON TYPE CONTROL VALVES

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FIG. 3.

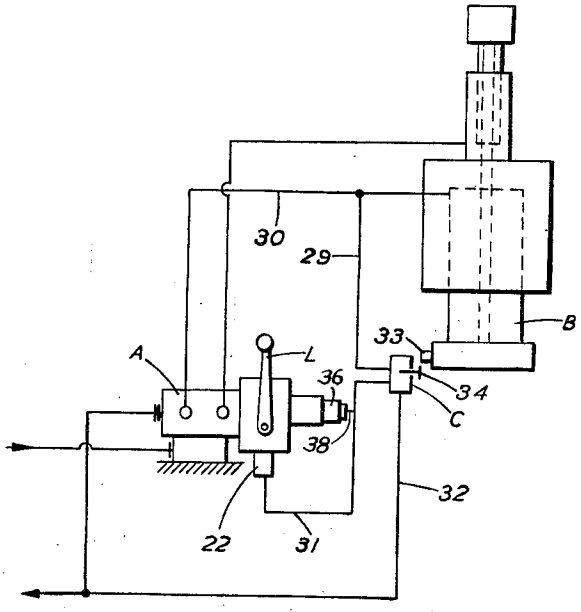
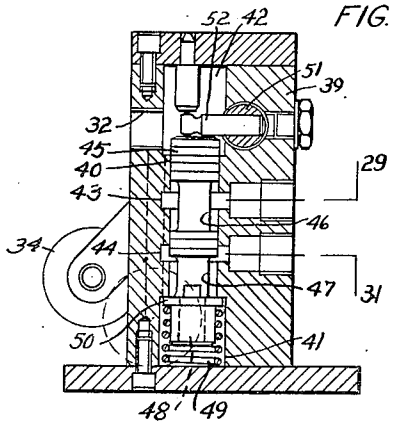



FIG. 3a.

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# UNITED STATES PATENT OFFICE

2,620,777

## HYDRAULIC CONTROL SYSTEM FOR HYDRAULIC PISTON TYPE CONTROL VALVES

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Application January 15, 1946, Serial No. 641,300
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7 Claims. (Cl. 121—38)

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This invention relates to hydraulic control systems for control valves of the piston type for controlling the supply of pressure liquid to the hydraulic cylinder or cylinders of a hydraulic press.

One object of this invention is to provide means whereby such a control valve can be made to operate a hydraulic press on an automatic cycle so that when the operator moves the valve lever into the operative position, the press ram makes an operating stroke and when it comes into contact with the work the pressure in the press cylinder builds up to a predetermined pressure at which the valve lever is tripped or when the press ram reaches a predetermined position it strikes tappets which actuate the trip either hydraulically or mechanically and the valve spindle or plunger is automatically reversed so as to terminate the delivery of pressure liquid to the press cylinder and connect it to exhaust and admit pressure liquid to the return cylinders or annulus in order to effect the return stroke of the press ram.

A further object of this invention is to provide means whereby the movement of the control valve spindle or plunger shall be completely controllable by the operator until such time as the predetermined pressure or predetermined stroke is reached so that the press ram can be inched on the operative stroke or reversed by the operator before the trip comes into operation. This invention may be applied with equal facility to a single acting piston type control valve for controlling the supply of pressure liquid to a press cylinder so that when a predetermined pressure is reached the supply of pressure liquid to the cylinder is terminated and the cylinder is connected to exhaust so that the return stroke of the press ram can be effected by means of springs or draw-back weights or a constant pressure push-back ram or annulus.

Broadly the present invention consists of an hydraulic control valve of the piston type wherein the valve piston is operable manually against an opposing spring or other pressure to admit pressure liquid to a press or other hydraulic cylinder and wherein automatically operating means is provided to disconnect the manual operating means from the valve plunger when either a predetermined pressure in the press cylinder is reached or a predetermined stroke of the press ram has taken place to permit the opposing spring or other pressure to move the valve plunger in the opposite direction to a neutral or other position for returning the press ram or other operation.

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In order that the invention may be clearly understood and carried into effect an embodiment of the same, as applied to the control valve illustrated in Figs. 1 and 2 of the U. S. Letters Patent 2,361,801 of October 31, 1944, will now be described, by way of example, by aid of the accompanying drawings in which:

Fig. 1 is a longitudinal section through the valve which is constructed for use in connection with a double-acting hydraulic cylinder.

Fig. 1*a* is a detail hereafter to be described.

Fig. 2 is a transverse vertical section taken at right angles to Fig. 1.

Fig. 3 is a diagram illustrating one arrangement in which the operating lever of the control valve is tripped when the hydraulic ram of a press or other mechanism reaches a predetermined position in its stroke.

Fig. 3*a* is a longitudinal sectional view of a valve operated by the press ram.

Fig. 4 is a diagram similar to Fig. 3, but illustrating a modified arrangement in which the control valve is tripped when a predetermined pressure is attained in the ram cylinder.

Referring now to Figs. 1 and 2 of the drawings the valve illustrated comprises a valve body *a*, preferably of hardened steel, having a parallel bore to receive the plunger *b*, which is also preferably of hardened steel. The bore of the valve body, in which the piston is a close sliding fit, is enlarged interiorly to form five chambers, which are numbered from left to right, 1, 2, 3, 4, 5. Thus, the bore of the valve body is therefore divided into six narrow bands, which are numbered 6, 7, 8, 9, 10 and 11, from left to right. The bands 7, 8, 9 and 10 separate the chambers 1, 2, 3, 4, 5 and the bands 6 and 11 are disposed at each end of the valve body.

Chamber number 1 is connected to the pump through inlet 1*a*, chamber number 2 is connected to exhaust by outlet 2*a*, chamber number 3 is connected by outlet 3*a* to one side of the hydraulic piston and cylinder, chamber number 4 is connected through passage *d* and non-return valve *e* to chamber number 1 in such a way that liquid may pass from chamber number 1 past the non-return valve to chamber number 4, but not in a reverse direction; chamber number 5 is connected to the other side of the hydraulic piston and cylinder through outlet 5*a*. The valve plunger passes right through the valve body and protrudes at each end into spaces *f* and *g* and suitable cover plates are provided to enclose such spaces and these spaces are connected to the exhaust outlet 2*a*, leading back to the pump reservoir, so that the valve piston is at all times

hydraulically balanced, and suitable manually operable means such as lever *h* is provided to move the valve plunger longitudinally.

In the embodiment of the present invention now to be described the plunger *b* is moved longitudinally by turning the lever *h* about its pivot. This pivot consists of a pin **12**, see Fig. 2, on the outer end of which is mounted the operating lever *h*, and on the inner end of which is mounted a short lever **13** the upper end of which is provided with a pin **14** which normally engages within a circumferential groove **15** at the right hand end of the plunger *b*. So far the construction is similar to that employed for operating the valve plunger in the control valve illustrated in the drawings accompanying the aforesaid U. S. Patent 2,361,801.

For the purpose of the present invention this construction is modified so that when a predetermined pressure is reached within the hydraulic cylinder under control the pin **14** is automatically disengaged from the circumferential groove **15** thereby freeing the plunger *b* from its manual control and permitting a spring **16**, arranged to oppose the manual operation of the valve plunger in one direction, to return said plunger to a neutral or other predetermined control position.

The modification thus required, consists, in the illustrated arrangement, in mounting the pin **14** on the end of the short lever **13** and attaching this lever to the inner end of the pivot pin **12** of the lever *h* by means of a pivot connection **17** so that the upper end of the lever **13** is free to swing and move the pin **14** into and out of engagement with the circumferential groove **15**. This freedom of movement is, in practice, restrained by a spring plunger **18** which bears against the pivoted lever **13** at a point just above its pivot so that the plunger **18** tends to force the lever towards the valve plunger and maintain the pin **14** in engagement with the aforesaid groove **15**. The valve plunger is thus free to be moved through its bore, under the control of the lever *h*, thereby to admit pressure liquid to either end of a double-acting hydraulic cylinder.

When the pressure in the hydraulic cylinder reaches a predetermined maximum (Fig. 4) or when its ram reaches a predetermined position in its stroke (Fig. 3) it is the object of the present invention to ensure that the plunger of the control valve shall be freed automatically from its manual control and returned to a neutral exhausting position, or another pressure liquid delivery position, under the influence of the spring **16**.

For this purpose the lever **13** is provided with a projection in the form of a short rigid lever **19** having a ball-end **20** which rests upon the upper end of a vertical hydraulic plunger **21**. Pressure liquid is admitted to the lower end of the plunger through an inlet **22** and the upward movement of the plunger under the pressure of said liquid is limited by a stop comprising an enlargement **23** in the length of the plunger and a dead stop **24** the length of which is suitably adjusted during the testing of the valve. The area of the plunger that is subject to the liquid pressure is such as to enable said pressure to move the plunger upwards and tilt the lever **13** backwards against the restraining action of the spring plunger **18**.

When the plunger has moved into contact with its stop the pressure liquid acting against its lower end may be automatically released into the space *g* at the end of the valve piston through a passage **25** extending up through the plunger



from its lower end and radial passages **26** serving in the fully raised position of the plunger to provide a communication between the upper end of the passage **25** and the space *g*. This feature is however not essential and may be omitted.

The means for holding the valve lever in the extreme position consists of a detent in the form of a spring plunger **27** extending up through the lever and having a pointed lower end engageable in said extreme position in a notch or recess in the circumference of a quadrant **28**. Here again, this feature is not essential and may be omitted.

If the operation to release the plunger of the control valve is to be dependent upon the attainment of a predetermined pressure in the hydraulic cylinder then the supply of pressure liquid to the plunger **21**, may, as previously explained, be controlled by a "master" control valve **53**, or any other suitable form of control valve but when the release of the plunger of the control valve is to be dependent upon the press or other ram reaching a predetermined position then the control of pressure liquid to the plunger **21** may conveniently be effected by a small valve operated by tappets on the press or other ram.

One suitable arrangement for this purpose controlled by the movement of the ram is illustrated in Fig. 3 in which A indicates the control valve of the present invention, B the press ram, and C the tappet operated valve.

In the illustrated arrangement the valve C is interposed between the press cylinder and the inlet **22** to the small ram **21** of the control valve and said valve is connected by the pipe **29** to the pressure delivery pipe **30** for supplying pressure liquid to the press cylinder, by the pipe **31** to the inlet **22** for by-passing some of the pressure liquid from the delivery pipe **30** to the inlet **22** for operating the plunger **21** and to exhaust by way of pipe **32**. The valve C may be of any suitable character normally adjusted to block the control line **31** from the pressure line **29** and connect it to the exhaust line, and adapted for actuation to block the control line **31** from the exhaust line **32** and connect it to the pressure line **29**. In the form illustrated, the valve C comprises a housing **39** adapted to be supported in fixed position with a pivoted valve actuating tappet **34** thereon disposed in the path of a rigid tappet **33** carried by the press ram B. The housing **39** is formed with a valve bore **40**, chambers **41** and **42** open to opposite ends of the bore and connected to the exhaust line **32**, and axially spaced annular grooves **43** and **44** formed in the surface of the bore and connected respectively to the lines **29** and **31**. A valve plunger **45** of the spool type is reciprocable in the bore **40**, and is formed with two peripheral axially-spaced grooves **46** and **47**, the groove **47** being open through a passage **48** in the plunger to the exhaust end chamber **41**. A compression spring **49** acts against a shoulder **50** on the plunger **45** within the chamber **41** to urge the latter normally into closed position in which the port **43** is blocked and the port **44** is connected through the groove **47** and passage **48** to the chamber. The tappet **34** comprises an arm having a fixed pivot pin **51** rotatable in the housing transaxially of the valve plunger **45**. A radial pin **52** is fixed in the pivot pin **51** and extends therefrom transversely across the end face of the plunger **45** within the chamber **42**. Upon downward actuation of the tappet **34**, the pin **52** will depress the valve plunger **45** against the force of the spring **49** to move the groove **47** out of com-

munication with the port 44 and to connect the latter through the groove 46 with the port 43. The valve C is operated when the rigid tappet 33 carried by the press ram strikes the pivoted tappet 34 forming the operating lever of the valve; in the downward direction to cause pressure liquid to flow to the inlet 22 to effect the release of the plunger of the control valve A from its operating lever by actuation of the plunger 21 and in the upward direction or return stroke of the press ram to connect the inlet 22 to exhaust thereby to permit the operating lever *h* of the control valve A to be reconnected with the plunger of said control valve.

At very high pressures, for example, two to three tons per square inch, it may be found that the valve spindle has a tendency to stick and refuse instantaneously to move under the influence of the spring 16. This, of course, may be overcome by fitting a sufficiently strong spring but to ensure certainty of action a more positive means may be provided. One such means is shown in dotted lines in Fig. 1*a* which is a modification of the right hand end of Fig. 1 and consists of a small hydraulic plunger 35, similar to the plunger 21, which is adapted to give the valve plunger *b* an initial push after the valve lever has been disengaged. The plunger 35 operates in a cylinder 36, which is fitted in the end of the housing for the spring 16, and pressure liquid is supplied thereto, for example from the line 31 through a line 38, at the same time as it is supplied to inlet 22 for the plunger 21. A spring 37 is provided to oppose the inward movement of the plunger 35 and this spring is stronger than the spring acting on the plunger 18 which opposes the inward movement of the other plunger 21 so that the movement of the plunger 35 will occur later than that of the plunger 21, i. e. after the valve lever has been disengaged from the valve plunger *b*.

A modified arrangement controlled by the "master" control valve 53 aforesaid is disclosed in Fig. 4, and, to the extent that it compares with the arrangement of Fig. 3, corresponding ports are identified by the same reference characters but primed. In this arrangement, the "master" control valve 53 may be of any suitable character having the same general functions as the tappet operated valve C, but operable in response to a predetermined pressure in the line 38' rather than by mechanical actuation from the ram B'. More particularly, the valve 53, in the exemplary form disclosed, comprises a housing 54 formed with a valve bore 55 and axially-spaced ports 56 and 57 connected respectively to the lines 29' and 31'. One end of the valve bore 55 opens to a chamber 58 connected to the exhaust line 32, and the other end thereof is connected through a passage 59 to the port 56 and line 29'. A spool type valve plunger 60 is reciprocable in the bore 55, and exposed at one end to the fluid pressure in the passage 59. At the other end, the valve plunger 60 is acted upon by a coiled compression spring 61 located within the chamber 58. The arrangement is such that normally the valve plunger 60 is positioned to block the port 57 and line 31' from the port 56 and line 29', and to connect the port 57 to the chamber 58 and exhaust line 32'. However, upon the attainment of a predetermined pressure in the line 29', this pressure acting upon the end face of the valve plunger 60 will shift the latter in opposition to the spring 61 so as to block the control port 57 from the exhaust chamber 58, and connect the ports 56 and 57. Thereupon, the pressure transmitted from the line 29' to the line 31' will release the control valve A' for movement into reverse position. As soon as reversal of pressure in the lines 29' and 30' is effected to initiate the return stroke of the ram B', the valve 53 will return automatically to normal position.

We claim:

1. An hydraulic control system for an hydraulic control valve comprising a valve body having a bore, a valve plunger slidable in said bore for controlling the distribution of pressure liquid to and from an hydraulic cylinder, manually operable means for imparting longitudinal movement to said valve plunger, said means comprising a hand lever mounted on one end of a pivot pin and a pivoted lever on the other end of said pivot pin, a circumferential groove in the valve plunger, a pin carried by the outer end of said pivoted lever for engagement with said groove, resilient means acting against said pivoted lever to maintain its pin in engagement with said groove, an hydraulically operated plunger for turning said pivoted lever against said resilient means to disengage its pin from said circumferential groove when pressure liquid is admitted to said plunger, valve means operating automatically upon attainment of a predetermined condition to admit pressure liquid to said plunger, and spring loading means for opposing the longitudinal movement of the valve plunger in its bore in one direction and for returning said plunger automatically to its normal position when freed from engagement with said manually operable means.

2. An hydraulic control system for an hydraulic control valve comprising a valve body having a ported valve bore, a valve plunger slidable longitudinally in said bore for controlling the distribution of pressure liquid to and from an hydraulic cylinder, manually operable means for imparting the longitudinal movement to said valve plunger, disengageable means normally connecting said manually operable means operatively to said plunger, actuating means operated hydraulically to act on said disengageable means for effecting automatically disengagement between said manually operable means and the valve plunger, valve means operating automatically upon attainment of a predetermined condition to permit the pressure fluid to said actuating means to cause said disengagement, a load which opposes longitudinal movement of the valve plunger in one direction and which acts automatically when the valve plunger is released to return said plunger to its normal position, and an hydraulically operated plunger operable to give an initial impetus to the valve plunger after release from said manually operable means to prevent the valve plunger from sticking.

3. An hydraulic control system for an hydraulic control valve according to claim 1, wherein the valve plunger after its release from the manually operable means is given an initial impetus by means of a hydraulically operated plunger to prevent the valve plunger from sticking and wherein the plunger for giving said initial impetus to the valve plunger is opposed by a spring that is stronger than the spring which opposes the plunger serving to effect disengagement of the manual operating means from the valve plunger to ensure that said former plunger although receiving liquid at the same time as the other plunger will operate after said disengagement has been effected.

4. An hydraulic control system for an hydraulic control valve comprising a valve body having a bore, a valve plunger slidable in said bore for controlling the distribution of pressure liquid to and from an hydraulic cylinder, manually operable means for imparting longitudinal movement to said plunger, said means comprising a hand lever mounted on one end of a pivot pin and a pivoted lever on the other end of said pivot pin, a circumferential groove in the valve plunger, a pin carried by the outer end of said pivoted lever for engagement with said groove, resilient means acting against said pivoted lever to maintain its pin in engagement with said groove, an hydraulically operated plunger for turning said pivoted lever against said resilient means to disengage its pin from said circumferential groove when pressure liquid is admitted to said plunger, a tappet valve adapted to be operated when a ram in the hydraulic cylinder has made a predetermined stroke to pass pressure liquid to the hydraulically operated plunger to effect the turning of the pivoted lever, and spring loading means for opposing the longitudinal movement of the valve plunger in its bore in one direction and for returning said plunger automatically to its normal position when freed from engagement with said manually operable means.

5. An hydraulic control valve comprising, in combination, a valve body having a valve bore, a spool valve plunger slidable in said bore in porting relationship therewith for controlling the distribution of pressure fluid, spring means tending to bias said plunger longitudinally in one direction into one distributive position of adjustment, manually operable means disengageably connected to said plunger and being operable to shift said plunger in opposition to said spring means into another distributive position of adjustment, said manually operable means comprising a hand actuator on said body, a latch movable into and out of engagement with said plunger and connected to said actuator for movement thereby to effect longitudinal movement of said plunger when in interlocking engagement therewith, and spring means normally acting on said latch in a direction to effect said interlocking engagement, and hydraulically operable means having a cylinder adapted for connection to receive pressure fluid and a piston therein arranged to act on said latch in opposition to said last mentioned spring means and being responsive to the supply of pressure fluid thereto to effect automatic disengagement between said manually operable means and said plunger for actuation by said first mentioned spring means.

6. An hydraulic control system for an hydraulic control valve comprising a valve body having a bore, a valve plunger slidable in said bore for controlling the distribution of pressure liquid to and from an hydraulic cylinder, manually operable means for imparting longitudinal movement to said plunger, said means comprising a hand actuator mounted on a rock pin and a pivoted lever mounted on said rock pin for swinging movement transversely of said plunger and releasably engageable therewith to slide the latter positively in either direction upon reverse adjustment of said actuator, resilient means acting against said pivoted lever to maintain it in interlocking engagement with said valve plunger, an hydraulically operated plunger for turning said pivoted lever against said resilient means to disengage it from said valve plunger when pressure liquid is admitted to said hydraulically operated plunger, a tappet valve adapted to be operated when a ram in the hydraulic cylinder has made a predetermined stroke to pass pressure liquid to the hydraulically operated plunger to effect the turning of the pivoted lever, and spring loading means for opposing the longitudinal movement of the valve plunger in its bore in one direction and for returning said plunger automatically to its normal position when freed from engagement with said manually operable means.



7. An hydraulic control valve comprising, in combination, a valve body having a valve bore, a spool valve plunger slidable in said bore in porting relationship therewith for controlling the distribution of pressure fluid, spring means tending to bias said plunger longitudinally in one direction into one distributive position of adjustment, manually operable means disengageably connected to said plunger and operable when engaged therewith to shift said plunger synchronously in either direction, including said one direction and also the reverse direction to shift said plunger in opposition to said spring means into another distributive position of adjustment, said manually operable means comprising a rock shaft journalled in said body, a hand actuator secured to said rock shaft, a latch element connected to said shaft for actuation thereby and movable into and out of operative connection with said plunger, and spring means normally acting on said latch element to establish said operative connection, an hydraulically operable means having a cylinder adapted for connection to receive pressure fluid and a piston within said cylinder arranged to act on said latch in opposition to said last mentioned spring means to interrupt said operative connection and being responsive to the supply of pressure fluid to said cylinder, whereby the supply of pressure fluid to said cylinder when said plunger is in said one distributive position will effect automatic disengagement between said manually operable means and said plunger and thereby permit said plunger to be shifted by said first mentioned spring means out of said one distributive position.

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