Nov. 4, 1958 L. D. ETHINGTON ET AL 2,858,803

FLUID PRESSURE CONTROL SYSTEM

Filed Dec. 6, 1956 2 Sheets-Sheet 1

FIG. 1

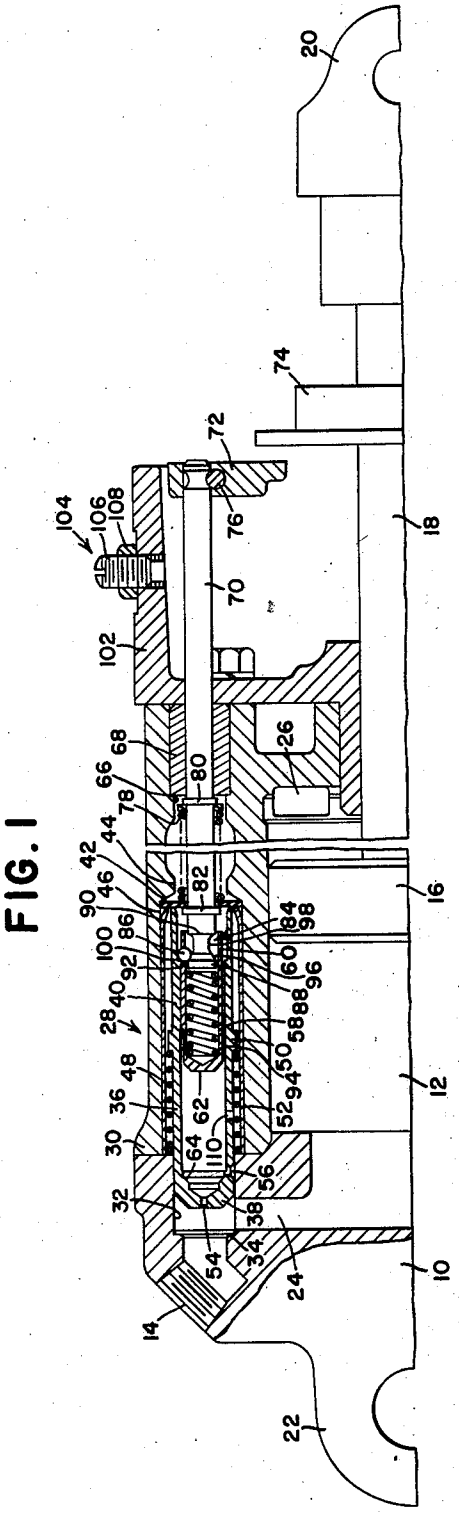
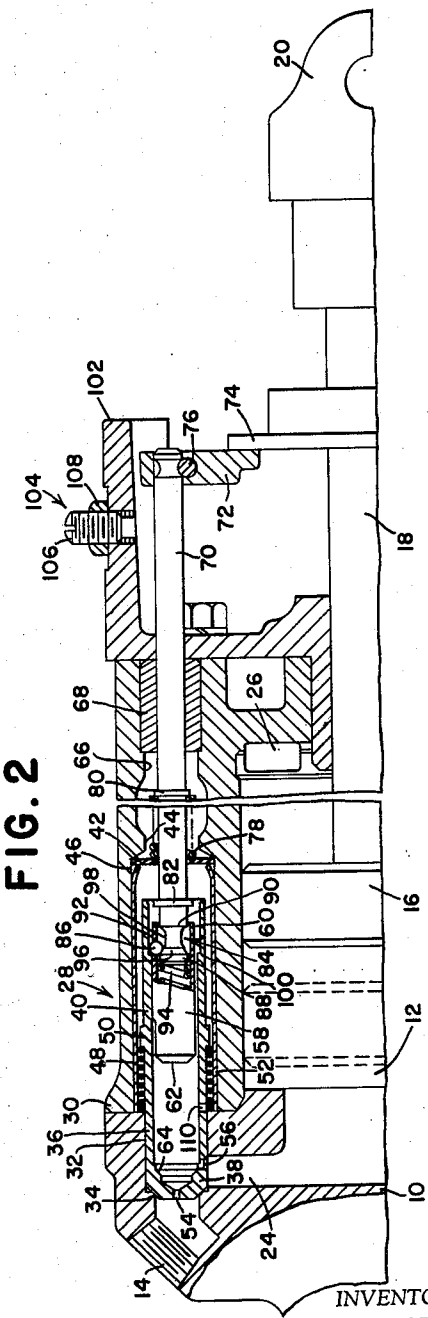


FIG. 2



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FIG. 3

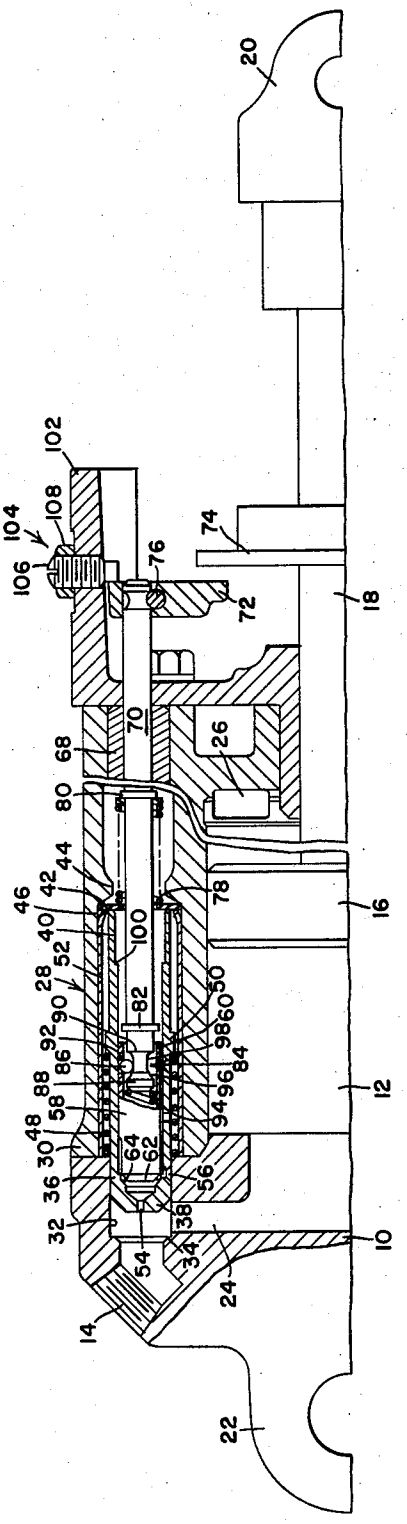
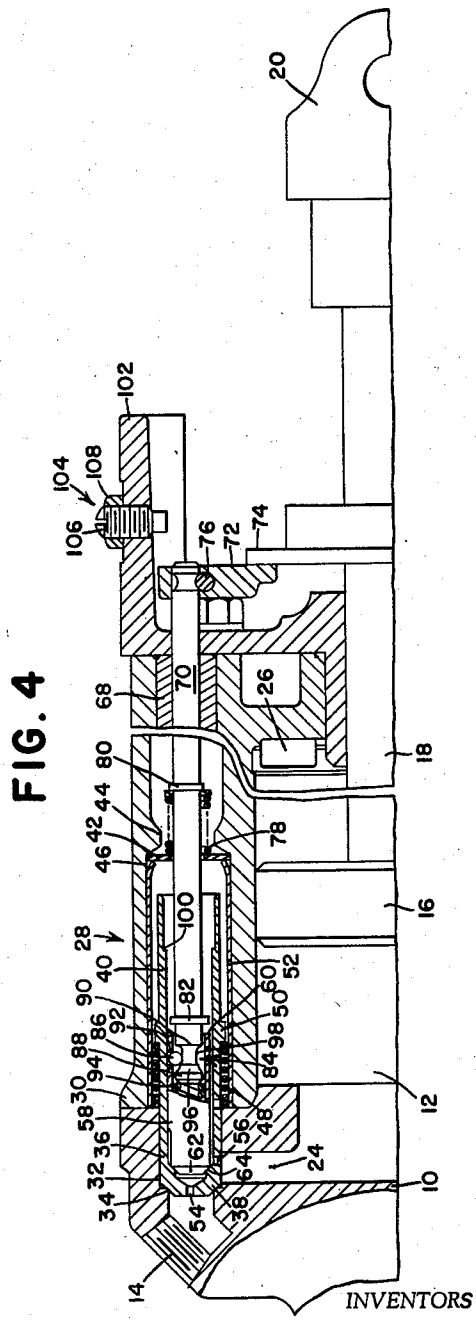


FIG. 4



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2,858,803

FLUID PRESSURE CONTROL SYSTEM

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Application December 6, 1956, Serial No. 626,708

13 Claims. (Cl. 121—38)

This invention relates to a fluid pressure control system and more particularly to improved valve mechanism for obtaining selective control.

The invention finds particular utility in a background organization such as that disclosed in the U. S. Patents to Fletcher 2,615,430, 2,546,831 and Re. 23,537. As depicted primarily in Fletcher 2,615,430, an agricultural tractor is equipped with a hydraulic power control system including a tractor-mounted control valve and a remotely located cylinder mounted on an implement, for example, connected to the tractor. Without more, manipulation of the control valve will extend and retract the cylinder but, as an adjunct to the flexibility of the system, means is provided for limiting the stroke of the cylinder in at least one direction irrespective of whether the control valve is held open for a longer interval. The stop means operates fundamentally on the basis of the principle that fluid flow from the cylinder is blocked or reduced to such an extent as to cause return of the control valve to its neutral position as a result of the abnormal rise in pressure. In the system there disclosed, the first action of the stop means is one to reduce the fluid flow for incurring return of the control valve to its neutral position, but the means whereby the fluid flow is restricted or reduced rather than being blocked completely affords a restricted orifice through which overtravel beyond the stop position may be had by forcibly opening the control valve again.

The present invention pertains to a modification of the foregoing structure by the superimposition of selector means for cutting out the provision of overtravel of the stop when desired. It is a significant feature of the present invention to provide a structure which may be substituted for that of the prior patents for effecting the conversion of existing remote cylinders.

Specifically, it is an object of the invention to utilize a dual-valve arrangement in which the valves are normally movable respectively through different distances and to modify this arrangement so as to shorten the distance through which one of the valves is movable whereby sooner to achieve the ultimate position of said one valve. The invention improves the former structure by the provision of means enabling overtravel at high speed rather than at slow speed; the provision of improved drive means between the two valves and between at least one of the valves and the control member that causes movement of the valves; and such other features and objects as will appear in greater detail from the ensuing specification and accompanying sheets of drawings, the several figures of which are described immediately below.

Fig. 1 is a longitudinal half section of a cylinder and piston assembly, showing the valve mechanism just before it is actuated.

Fig. 2 is a similar view showing the valve mechanism in an intermediate stage.

Fig. 3 is a similar view showing actuation of the selector means to reposition the internal valve.

Fig. 4 is a similar sectional view showing the relationship of the inner and outer valves at the stroke-limiting position thereof.

The basic arrangement of the disclosure of the above-identified patent to Fletcher 2,615,430 may be taken as representative of the background in which the present invention finds particular utility; although, obviously, the invention is not thus limited. Likewise, such expressions as "front," "rear," etc. are used here as well as in the claims as terms of convenience and not of limitation.

With the foregoing in mind, the basic element in which the valve structure is mounted is a first element or cylinder **10** formed with a chamber **12** to and from which fluid is conducted by means of a passage **14**, it being understood that the passage **14** is connected to a remote control valve such as that identified in the above-mentioned patent. A piston **16** represents a second element comprising an internal part movable back and forth in the cylinder chamber **12** and having a piston rod **18** representing an external part which of course reflects movement of the piston **16**. The free end of the piston rod has a clevis **20** thereon which cooperates with a clevis **22** at the opposite end of the cylinder **10** for mounting the cylinder-piston assembly between a pair of parts capable of relative adjustment by extension and retraction of the cylinder.

It will be understood that the cylinder can be of the two-way type in which fluid supplied through the passage **14** and a continuation passage portion **24** extends the cylinder-piston assembly by forcing the piston **16** to the right, and that another passage, not shown, is capacitated to introduce fluid under pressure at the right hand end of the piston, as via a passage portion **26**, to contract the assembly by forcing the piston **16** to the left. As an incident to extension of the cylinder, fluid to the right of the piston will be expelled through the passage **26** and retraction of the cylinder will result in exhaust of fluid from the left hand side of the cylinder through the passage **24—14**.

The control valve mechanism, identified generally by the numeral **28**, is instrumental in controlling the flow of fluid from the chamber **12** through the passage **24—14**; although, the valve mechanism will, of course, open to admit fluid to the chamber **12** from the passage **14**.

A supporting portion **30**, integral with or otherwise connected to the cylinder **10**, affords a fore-and-aft valve bore **32** which intersects the passage **14—24** at a valve seat **34**. The valve bore **32** carries therein for advance toward the seat **34** a first valve **36** having a forward head **38** and a rear tubular part **40**. The valve **36** has a normal rearwardly stopped position (Fig. 1) which is effected by stop means including a washer **42** at a necked-down portion **44** of a rearward enlarged extension chamber **46** of the valve bore **32**; and biasing means in the form of a coiled compression spring **48** operates between the front end of the valve-housing chamber **46** and a shoulder **50** on the valve **36** to urge the valve rearwardly to the stopped position just identified. A sleeve **52** abuts the forward portion of the chamber **46** and also abuts the washer **42** to prevent forward displacement of the washer.

When the valve **36** is advanced from its normal rearwardly stopped position as shown in Fig. 1, its head **38** seats on the passage-control seat **34** and would block fluid flow through the passage **14—24** except for the provision in the head of orifice means comprising a pair of restrictive holes or ports **54** and **56** which, as shown in Fig. 2, for example, enable flow of fluid at a reduced rate through the passage **14—24**. The reduction in rate is sufficient, however, to create an abnormal pressure rise in the control system sufficient to actuate the main control valve (not shown) as in the Fletcher patents identified above. Also, the fact that a reduced flow is available enables

remanipulation of the control valve to exhaust fluid at said reduced rate so that the piston **16** can have overtravel to the left of the position shown in Fig. 2, the amount of which overtravel is determined by the time of closing of an internal or second valve **58**.

In the preferred construction illustrated, the tubular rear part **40** of the large or outer valve **36** coaxially carries the inner valve **58** which itself is tubular to have a rear tubular part **60** and a closed front end or head **62** which is adapted to seat, upon advance of the valve **58**, on a rear or inner seat **64** formed interiorly of the valve **36** in controlling relationship to the orifice means provided by the restrictive openings **54** and **56**. In short, when the valve **58** seats on the seat **64**, the orifice means is blocked and the aforesaid reduced flow of fluid is stopped completely.

It will be apparent from the foregoing that if the valve **36** is made responsive to the position of the piston **16** and if the orifice ports **54** and **56** are eliminated, the valve **36** when closed would provide a positive stop limiting the stroke of the piston and having no provision for overtravel, such as is available by incorporating the ports **54** and **56** and the second valve **58**. However, experience with the former Fletcher designs has evidenced the broad desirability of the provision for a limited stop supplemented by provision for overtravel. On the other hand, further experience has shown that in enough instances to warrant utilization of the present invention there is need for a system in which the provision for overtravel can be cut in or cut out at will, and this is here accomplished in a manner to be presently described.

A coaxial continuation of the valve mechanism housing **46**, here comprising a bore **66**, is equipped with a combination seal and bushing **68** which carries a fore-and-aft movable control member or rod **70** which has at its free or outer rear end one-way means **72** engageable by a selectively adjustable stop **74** movable with the piston rod **18** as an indication of the position of the piston **16** and settable to determine the amount of travel of the piston **16** to the left in the cylinder chamber **12**. For present purposes, the means **72** need not be considered as anything more than a lug affixed to the free end of the rod **70** as by a cross pin **76**, and the member **74** may be mounted on the piston rod **18** in a manner such as that illustrated in the Fletcher Patent 2,615,430, mentioned above.

The control member or rod **70** is urged rearwardly to a normally stopped rear position by biasing means comprising a coiled compression spring **78** which encircles that portion of the rod **70** within the necked-down portion **44** and bore extension **66**, one end of the spring seating against the stop washer **42** and at the other end seating against a stop afforded by a ring and washer assembly **80** on the rod **70**. Rearward extension of the rod **70** under action of the biasing means **78** beyond the position shown in Fig. 1 is prevented by a forward stop **82** which engages the washer **42** from in front. From the description thus far, it will be seen that the lug or one-way means **72** on the free end of the rod **70** depends into the path of the adjustable but fixed stop **74** on the piston rod **18**, so that as the piston **16** and rod **18** move to the left, the stop **74** ultimately engages the lug **72** from behind and moves the control member **70** forwardly against the action of its biasing spring **78**. As will be brought out below, this action of the control member **70** is utilized to effectuate either sequential or simultaneous closing of the valves **36** and **58**.

For this purpose, the forward end portion of the control member **70** extends into the rear tubular part **60** of the inner valve **58** to afford a lost-motion connection **84** which includes a detent ball **86** and front and rear stops afforded by fore-and-aft spaced apart shoulders **88** and **90**, respectively, on the forward portion of the rod **70**. The ball **86** is retained in an aperture **92** in the wall of the tubular part **60** of the inner valve **58** and since the ball is retained fore-and-aft between the shoulders **88** and **90** the lost-motion connection effects drive means between the rod **70** and the valve **58**. The lost-motion connection is biased by a compression spring **94** contained within the valve **58** and acting to take up the lost-motion by normally urging the valve **58** forwardly relative to the rod **70** so that the detent is engaged with the front shoulder **88**, on the back of which is formed a front cam surface **96** which, together with a rear cam surface **98**, cooperates with the detent **86** to effect a drive connection with the outer or larger valve **36** by means of an abutment or annular shoulder **100** on the inner tubular wall of the latter. Since the biasing spring **94** within the valve **58** normally urges the valve **58** forwardly, it seats the detent ball **86** on the front cam **96** and therefore urges the ball radially outwardly into engagement with the annular shoulder **100** on the valve **36**, thus effecting the drive connection just referred to. If the valve **58** is moved rearwardly relative to the control rod **70**, compressing the spring **94**, the detent **86** will drop down onto the rear cam surface **98** and thus will retract or disengage from the abutment afforded by the annular shoulder **100**. In the preferred construction illustrated, the front and rear shoulders on the front end of the control rod **70** are annular, as are the front and rear cams **96** and **98**; although, the same results could be otherwise accomplished.

The rear end of the cylinder **10** carries a support in the form of a bracket **102** which mounts selector means **104** operative to establish for the valve **58** a second rear position ahead of the rear position it normally occupies when the rod return spring **78** returns the rod **70** to its maximum rear position. The means **104** is here shown as comprising a set screw **106** and lock nut **108** and is operative to be extended into or retracted from the path of the one-way lug **72** on the control rod **70**; although, other means of accomplishing the same result will readily suggest themselves. Figs. 1 and 2 show the retracted position of the means **104** and Figs. 3 and 4 show the extended position of the means.

A vent hole **110** (Figs. 1 and 2) in the forward part of the large valve **36** prevents entrapment of fluid between the two valves **36** and **58**.

Operation—Stop and overtravel

In this phase of operation, the conditions are that the piston rod stop **74** is fixed to the piston rod in a selected position, the stop means **104** is retracted and the cylinder piston assembly is extended as shown in Fig. 1 so that the rod **70** is fully extended to its maximum limit and the valves **36** and **58** are open or unseated.

As the main control valve (not shown) is manipulated to supply fluid under pressure through the passage **26** to the right hand side of the piston **16** and to exhaust fluid from the left hand side of the piston via the passage **24—14** past the open valve seat **34**, the piston **16** and piston rod **18** move to the left, the piston rod stop **74** approaching the lug **72** on the control rod **70**. As engagement is effected between the stop **74** and the lug **72**, the rod **70** is advanced to the left (Fig. 2). The biasing action **94** which affects the lost-motion connection **84** is extended to retain the ball **86** on the front cam **96** and therefore in engagement with the valve **36** via the annular abutment shoulder **100**. Since the ball **86** is retained in the aperture **92** in the valve **58**, the connection between the control member **70** and the valve **58** is permanent. Hence, as the piston rod stop **74** picks up the control rod **70**, the now activated drive connection **84—86—100** causes advance of the valves **36** and **58** in unison until the head **38** on the valve **36** seats at the valve seat **34** to block the passage **24** except for the reduced fluid flow permissible through the orifice means **56—54**. As stated above, the reduction in flow is sufficient to cause in the hydraulic system an abnormal rise in pressure effective to return the main control valve to neutral. Consequently, the piston **16** is automatically stopped in the

full-line position of Fig. 2 and the positions of the valves **36** and **58** remain unchanged, as does the position of the control rod **70**.

As is recognized by those familiar with the general problem involved here, the purpose of the automatic stop is to permit a repetition of the retracting stroke of the cylinder piston assembly throughout successive operations. As is also recognized, there are instances in which exact repetition is not required and it is therefore desirable or necessary to modify the stroke by permitting overtravel beyond the stopped position. In the present case, overtravel will involve further retraction of the cylinder piston assembly to the dotted-line position of Fig. 2. Overtravel is available with the valves **36** and **58** in Fig. 2 position by further manipulation of the main control valve so that additional fluid under pressure is supplied to the right side of the piston via the passage **26**. Although the fluid at the left hand side of the piston will exhaust slowly through the orifice means **56—54**, overtravel is necessarily accomplished. This overtavel will of course entail further advance of the control rod **70** relative to the stopped valve **36** and since the detent ball **86** is engaged between the stopped valve **36** and the temporarily stopped valve **58**, the spring **94** within the valve **58** will yield upon advance of the control rod so that the rear or reduced cam surface **98** is presented beneath the ball **86**, thereby allowing the ball to retract from its engagement with the abutment shoulder **100** on the valve **36**. This, then, deactivates the drive connection between the two valves and the valve **36** is free to snap back to its normal rearwardly stopped position under action of its biasing means **48**.

Since the valve **36** returns toward its normal position it accordingly becomes unseated at **34—38** and therefore removes the restriction set up by the orifice means **54—56** and consequently overtravel may be obtained at the same speed as the original portion of the stroke before the valve **36** was previously seated. At the same time, since the drive connection between the two valves is now disconnected, because the valve **58** is now "ahead" of the valve **36**, the valve **58** will ultimately pick up the valve **36** via engagement of the head **62** of the valve **58** with the inner seat **64** on the valve **36** and both valves will move simultaneously until the valve **36** is again seated at **34—38**. Since the inner valve **58** is seated at **62—64** the orifice means **54—56** is blocked and fluid flow is cut off forthwith, thereby again incurring pressure rise in the system to automatically return the control valve to neutral. In systems lacking the automatic return of control valve to neutral, the operator will become aware of the stop condition either by chattering of the overload relief valve or simply by noting that the cylinder-piston assembly is at the end of its predetermined retraction stroke.

When it is desired to reextend the cylinder-piston assembly, fluid under pressure is admitted via the inlet **14** and this fluid enters the orifice **54** at a rate sufficient to force the valve **58**, which is seated at **62—64**, back against its lost-motion biasing spring **94**, thereby uncovering the orifice **56** which is at present in register with the passage **24**. Therefore, fluid flow to the left hand side of the piston **16** is available at a sufficient rate to cause the piston **16** to move to the right. As this occurs, the stop **74** also moves to the right and the rod control spring **78** begins to extend the rod **70**, relieving the forward pressure of the rod on the valve means, whereupon the valves continue to open until they ultimately are fully opened and movement of the piston rod **16** to the right may be achieved at its normal rate.

As long as the position of the piston rod stop **74** on the piston **18** is retained, the action described above will be repeated on each retraction stroke of the cylinder-piston assembly. The length of the retraction stroke can, of course, be changed by altering the position of the stop **74** axially of the rod **18**, causing the stop **74** to engage the rod lug **72** either earlier or later, as desired. In any event, the mechanism **28** operates to establish a preliminary stopped position of the piston rod **16** at the end of its predetermined stroke, with provision for overtravel beyond that position by an amount determined by the time it takes the valves **58** and **36** to attain their fully seated positions. In other words, the mechanism is effective to move the valve **36** first to throttle the passage **24—14** and then to move the valve **58** to completely block the passage. To this extent, the mechanism gives substantially the same results as in the above-identified patent to Fletcher 2,615,430, with the significant exception that overtravel may occur at the same speed as the original retraction stroke, since in the present design disconnection of the drive means **86—100** permits the large valve **36** to become unseated, thereby removing the restriction **54—56** from the passage. This result is achieved here by divorcing the valve **36** from the control rod **70** except through the connection **84**. Stated otherwise, once the connection **84** is disconnected at **86—100**, the valve **36** is independent of the position of the control rod **70**, whereas in the Fletcher patent the presently described disconnection is not available.

Operation—Overtravel cancelled

Despite the advantages of the provision for stop and overtravel, as described above, there are, as already indicated, instances in which it is desired to cancel or lockout the overtravel feature. For example, even in those systems in which the control valve is automatically returned to neutral in response to abnormal rise in pressure in the system, the operator may inadvertently hold the main control lever in its operating position and will automatically incur overtravel even though he does not desire it. In some control systems in which no provision is made for automatically returning the control valve to neutral, the system will automatically overtravel beyond the desired position. For the foregoing and other reasons, it is desirable that means such as the selector means **104** be provided.

In the foregoing description of the operation involving stop and overtravel, the selector means was retracted. In the present phase of operation the selector means is extended (Fig. 3). The basic function of the selector means in the Fig. 3 position is to set a new position for the control rod **70**. Since the rod **70** is connected by the lost-motion connection **84** to the inner valve **58**, the selector means also affords a new position for that valve. This new position is materially short of its normal rear position as attainable in Fig. 1, for example. Stated otherwise, and referring now to Fig. 1, it will be seen that the required distance of travel of the valve **36** before it seats is considerably shorter than that required to attain seating of the valve **58** at **62—64**. Hence, the two valves are moved sequentially; that is, although they start out at the same time and move in unison, the connection at **86—100** becomes disconnected when the valve **36** becomes seated and consequently the inner valve **58** is permitted to overtravel relative to the seated outer valve. To convert the system to operate without provision for overtravel is tantamount to cutting down the distance that the valve **58** has to travel, plus disconnection of the drive means **86—100**, which automatically results from stopping the valve **58** in a new rear position forwardly of its normal rear position. This will be readily evident by comparing the positions of the valves **58** in Figs. 1 and 3, wherein it will be seen that in both figures the outer valve **36** is stopped rearwardly against the washer **42**, but in Fig. 1 the connection **86—100** is effected whereas in Fig. 3 the same connection is released. Another comparison may be made on the basis of the axial distance between the head **62** of the valve **58** and the seat **64** of the valve **36** in the two figures, noting particularly in Fig. 3 that the head **62** and the seat **64** are practically in engagement. ,

For purposes of clarity and exposition, the starting position of the piston **16** is the same as that in Fig. 1, but the position of the stop **74** on the piston rod has been changed so that the stop **74** occupies the same position in Fig. 3, relative to the lug **72**, that it does in Fig. 1. In short, the stop **74** has been advanced on the piston rod by an amount equal to the distance between the fully-rear lug **72** in Fig. 1 and the stopped-short lug **72** in Fig. 3. In this circumstance, the final stop on the leftward stroke of the piston **16** in Fig. 4 will correspond to the position of the piston in Fig. 2. However, whereas in Fig. 2 the piston can have overtravel to the left, because the valve **58** has not seated, such overtravel is not available in Fig. 4, because the valve **58** has seated. If it is desired that the final position of the piston, with the selector means setting of Figs. 3 and 4, coincide with the dotted-line position of the piston in Fig. 2, the stop **74** could retain the setting of Fig. 1 on the piston rod. Of course, other stopped positions of the piston are available according to the setting of the stop **74**. However, as illustrative of the duality of the system, only the one position achieved as in Fig. 4 will be described. That is, the final position of the piston **16** in Fig. 4 corresponds to the first stopped (full-line) position of the piston **16** by seating of the valve **36** at **34** (Fig. 2). Stated otherwise, with the selector set as in Figs. 3 and 4, the piston **16** moves directly to only one position without being first stopped and then re-started.

As previously indicated, when the selector means is extended (Figs. 3 and 4) the control rod **70** is compelled to to occupy a new rear position and this is likewise true as to the valve **58**, hence preventing connection of the drive means **86—100** after the drive means is initially and deliberately disconnected. In the present disclosure, the necessary disconnection may be effected by first manually pushing in on the control rod **70** until both valves **36** and **58** are seated. This will, of course, disconnect the connection at **86—100** and, before the control rod **70** is allowed to return, the set screw **106** is turned in and locked by the lock nut **108** to intercept the control rod **70** by engagement of the inner end of the set screw with the control rod lug **72**. This sets the mechanism in the position of Fig. 3, with the seat **62** on the inner valve **58** just slightly behind the inner seat **64** on the outer valve **36**. Accordingly, when the control rod lug **72** is engaged by the piston rod stop **74**, the inner valve **58** is advanced but slightly until it seats at **62—64**, thereupon picking up the outer valve **36** so that further advance incurs advance of the two valves in unison and effects a blockade of the passage **24—14** without the intervening effect of the orifice means **54—56**.

When it is desired to extend the cylinder, the fluid entering via the inlet **14** can enter through the port or orifice **54** to back up the valve **58** against its spring **94** so as to establish communication between the orifice **56** and the passage **24**, whereupon the piston **16** is capable of moving to the right as described above, ultimately relieving the valve mechanism of the forward force of the control rod so that full-speed extension of the cylinder piston assembly is available.

To restore the mechanism to the condition of Fig. 1, it is necessary only to retract the set screw **106** clear of the control rod lug **72**.

Summary

As indicated, the present disclosure is based upon a preferred embodiment of the invention and obviously contains features peculiar to that embodiment. However, the broad principles disclosed will readily suggest other constructions for attaining the same and additional objects, all of which will readily occur to those skilled in the art without departure from the spirit and scope of the invention.

What is claimed is:

1. In a fluid-pressure control system having a fluid-receivable chamber, a passage for the flow of fluid to and from the chamber, and a part movable back and forth in the chamber, the improvement comprising: means affording a valve bore having a forward end leading to the passage; a normally rearwardly positioned first valve advanceable in the bore through a certain distance to a stopped forward position throttling the passage; a normally rearwardly positioned second valve advanceable in the bore through a normally greater distance to a forward position blocking the passage; a control member advanceable from a stopped rear position and having one-way means engageable by the aforesaid part for advancement of said member by said part; first drive means interconnecting the control member and second valve for advance and return thereof in unison; first biasing means for returning the control member and second valve to their respective rearward positions; second drive means releasably interconnecting the rearwardly positioned valves in the aforesaid spaced relation and operative upon initial advance of the second valve and control member to advance the first valve to its forward position and thereupon releasable to enable further advance of the second valve by the control member to its forward position, said second drive means being reconnectible between the valves upon return of the valves and control member to their respective rearward positions; second biasing means acting on the first valve to return said first valve to its rearward position for conditioning said second drive means for reconnection to the rearwardly positioned second valve; and stop means selectively operative on the control member for limiting rearward return thereof to a position short of its stopped rear position and thereby to hold the second valve in a position intermediate its forward and rearward positions whereby to reduce the distance between said second valve and its forward position and also to preclude reconnection of said second drive means so that the first valve can be moved rearwardly by its biasing means.

2. The invention defined in claim 1, in which: the first and second drive means are combined and comprise a detent maintaining a drive connection between the control member and second valve and biased into engagement with the first valve for yielding to a disconnected position when the first valve advances to its stopped forward position.

3. In a fluid-pressure control system having a fluid-receivable chamber, a passage for the flow of fluid to and from the chamber, and a part movable back and forth in the chamber, the improvement comprising: means affording a valve bore having a forward end leading to the passage; a normally rearwardly positioned first valve advanceable in the bore through a certain distance to a stopped forward position throttling the passage; a normally rearwardly positioned second valve advanceable in the bore through a normally greater distance to a forward position blocking the passage, said second valve including a control portion movable with said second valve as an indication of the position thereof, said control portion having one-way means engageable by the aforesaid part for advancement of said portion and second valve; first biasing means for returning the second valve and control portion rearwardly to the aforesaid rearward position of said second valve; drive means releasably interconnecting the rearwardly positioned valves in the aforesaid spaced relation and operative upon initial advance of the second valve and control portion to advance the first valve to its forward position and thereupon releasable to enable further advance of the second valve to its forward position, said drive means being reconnectible between the valves upon return of the valves to their respective rearward positions; second biasing means acting on the first valve to return

said first valve to its rearward position for conditioning said drive means for reconnection to the rearwardly positioned second valve; and stop means selectively operative on the second valve for limiting rearward return thereof to a position short of its aforesaid rear position whereby to reduce the distance between said second valve and its forward position and also to preclude reconnection of said drive means so that the first valve can be moved rearwardly by its biasing means.

4. In a fluid-pressure control system having a fluid-receivable chamber, a passage for the flow of fluid to and from the chamber, and a part movable back and forth in the chamber, the improvement comprising: means affording a valve bore having a forward end leading to the passage and providing a passage-control seat; a first valve in the bore and having a front head seatable on said seat and having orifice means therein operative when said valve is seated to enable reduced fluid flow through the passage and said valve having a rear seat at which said orifice means opens; first means biasing the valve to a rearwardly stopped position spacing said head rearwardly of the passage-control seat; a coaxial second valve normally spaced rearwardly of and adapted to seat on said rear seat to block the orifice means; second means biasing the second valve to a normal rearwardly stopped position spaced behind the rear seat; means for advancing the second valve; releasable drive means connected between the valves in their respective rearwardly stopped positions so that advance of the second valve incurs advance of the first valve until the latter seats, said drive means being thereupon releasable to enable further advance of the second valve until it seats on the rear seat, said first and second biasing means being loaded by said advance to return the valves independently to their respective rearwardly stopped positions to incur reconnection of the drive means; and means for selectively intercepting return of the second valve to stop said second valve at a new position intermediate its seated and normal rearwardly stopped positions to thereby reduce the distance between said second valve and the rear seat on the rearwardly positioned first valve and also to prevent reconnection of the drive means so that subsequent advance of the second valve from its new position first seats said second valve on the first valve rear seat and then advance both valves in unison to seat the first valve.

5. In a fluid-pressure control system having a fluid-receivable chamber, a passage for the flow of fluid to and from the chamber, and a part movable back and forth in the chamber, the improvement comprising: means affording a valve bore having a forward end leading to the passage and providing a passage-control seat; a first valve in the bore and having a front head seatable on said seat and having orifice means therein operative when said valve is seated to enable reduced fluid flow through the passage and said valve having a rear seat at which said orifice means opens; first means biasing the valve to a rearwardly stopped position spacing said head rearwardly of the passage-control seat; a coaxial second valve normally spaced rearwardly of and adapted to seat on said rear seat to block the orifice means; a control member advanceable from a normal rearwardly stopped position for advancing the valves; a fore-and-aft lost-motion connection between the member and second valve normally biased to extend the second valve forwardly relative to the member and yieldable to enable limited forward overrun of said second valve by said member; second means biasing the control member to its normal rearwardly stopped position and operative via said lost-motion connection to retract the second valve to a rearward position spaced behind the rear seat on the first valve; drive means effectuated by the normally biased lost-motion connection to interconnect the two valves in their respective rearward positions so that advance of the control member incurs advance of the valves in unison until the first valve seats to temporarily stop both valves; said lost-motion connection enabling thereupon yielding and forward overrun by the control member to disconnect the drive means for advance of the second valve until it seats; and means for selectively intercepting return of the second valve to hold said second valve in a new position short of its former rear position to thereby reduce the distance between said second valve and the rear seat on the rearwardly positioned first valve and also to prevent reconnection of the drive means so that subsequent advance of the second valve from its new position first seats said second valve on the first valve rear seat and then advance both valves in unison to seat the first valve.

6. The invention defined in claim 5, in which: the first valve has a tubular rear part including an internal rearwardly facing abutment; the second valve is carried within said part and itself has a tubular rear part provided with a radial aperture in substantial radial register with said abutment when both valves are in their respective normal rearwardly stopped position; the drive means includes the aperture, the abutment, a detent retained in the aperture and engaging the control member, said detent being urged outwardly to engage the abutment and retaining engagement with the control member upon biased extension of the lost-motion means and said detent being radially retractible from said abutment upon yielding of said lost-motion means.

7. The invention defined in claim 6, in which: the detent also achieves part of the lost-motion connection, said control member having a recess therein defined by front and rear spaced apart stop portions against the rear one of which the detent is normally urged by the lost-motion connection bias, said recess having a front cam surface adapted to hold the detent normally outwardly into engagement with the abutment and a rear cam surface enabling retraction of the detent upon yielding of the lost-motion connection.

8. In a fluid-pressure control system having a fluid-receivable chamber, a passage for the flow of fluid to and from the chamber, and a part movable back and forth in the chamber, the improvement comprising: valve means for controlling fluid flow through the passage, including a first valve member biased to an open position and movable to a passage-blocking position, said valve member having means affording a restrictive port operative in said passage-blocking position to enable reduced fluid flow through the passage, said valve means further including a second valve member movable relative to the first valve member from a first position clear of the restrictive port to a position blocking the port; drive means releasably interconnecting the two valve members while in their respective open and clear positions for movement in unison to first seat the first valve member, said drive means being releasable in response to seating of the first valve member to enable relative movement of the second valve member to its port-blocking position; means for positively releasing the drive means preliminarily to seating of the first valve member to enable the second valve member to be moved to its port-blocking position; additional means engageable between the valve members when the second valve member is thus moved preliminarily to its port-blocking position to incur movement of said members in unison to the passage-blocking position of the first valve member; and control means engageable by and movable with the aforesaid part and operative through the drive means when connected and through the second valve member and said additional means when the drive means is positively released, for moving the valve members as aforesaid.

9. In a fluid-pressure control system having a fluid-receivable chamber, a passage for the flow of fluid to and from the chamber, and a part movable back and forth in the chamber, the improvement comprising: valve means for controlling fluid flow through the passage, including a first valve member biased to an open position

and movable to a passage-blocking position, said valve member having means affording a restrictive port operative in said passage-blocking position to enable reduced fluid flow through the passage, said valve means further including a second valve member movable relative to the first valve member from a first position clear of the restrictive port to a position blocking the port; control means engageable by and movable with the aforesaid part for incurring sequential movement of the valve members to move the first valve member to its passage-blocking position and then to move the second valve member to its port-blocking position; and selector means operative independently of said port to releasably retain the second valve member in its port-blocking position.

10. In a fluid-pressure control system having a fluid-receivable chamber, a passage for the flow of fluid to and from the chamber, and a part movable back and forth in the chamber, the improvement comprising: means affording a valve bore having a forward end leading to the passage; a normally rearwardly positioned first valve advanceable in the bore through a certain distance to a stopped forward position throttling the passage; a normally rearwardly positioned second valve advanceable in the bore through a normally greater distance to a forward position blocking the passage; a control member advanceable from a stopped rear position and having one-way means engageable by the aforesaid part for advancement of said member by said part; first drive means interconnecting the control member and second valve for advance and return thereof in unison; first biasing means for returning the control member and second valve to their respective rearward positions; second drive means releasably interconnecting the rearwardly positioned valves in the aforesaid spaced relation and operative upon initial advance of the second valve and control member to advance the first valve to its passage-throttling position and thereupon releasable to enable further advance of the second valve by the control member to its forward position; and second biasing means acting on the first valve to return said first valve toward its rearward position upon release of said second drive means whereby to remove said first valve from its passage-throttling position.

11. In a fluid-pressure control system having a fluid-receivable chamber, a passage for the flow of fluid to and from the chamber, and a part movable back and forth in the chamber, the improvement comprising: means affording a valve bore having a forward end leading to the passage; a normally rearwardly positioned first valve advanceable in the bore through a certain distance to a stopped forward position controlling the passage; a normally rearwardly positioned second valve advanceable in the bore through a normally greater distance to a forward position controlling the passage; means for advancing the second valve to its forward position; first biasing means for returning the second valve to its rearward position; drive means releasably interconnecting the rearwardly positioned valves in the aforesaid spaced relation and operative upon initial advance of the second valve to advance the first valve to its forward position and thereupon releasable to enable further advance of the second valve to its forward position; second biasing means acting on the first valve to return said first valve toward its rearward position upon release of said drive means whereby to remove said first valve temporarily from its forward position; and means engageable between the valves whereby the second valve, upon said further advance of said second valve to its forward position, picks up the first valve and again advances said first valve to its forward position.

12. In a fluid-pressure control system having a fluid-receivable chamber, a passage for the flow of fluid to and from the chamber, and a part movable back and forth in the chamber, the improvement comprising: means affording a valve bore having a forward end leading to the passage; normally rearward positioned first valve advanceable in the bore through a certain distance to a stopped forward position controlling the passage; a normally rearwardly positioned second valve advanceable in the bore through a normally greater distance to a forward position controlling the passage; means for advancing the second valve to its forward position; first biasing means for returning the second valve to its rearward position; drive means releasably interconnecting the rearwardly positioned valves in the aforesaid spaced relation and operative upon initial advance of the second valve to advance the first valve to its forward position and thereupon releasable to enable further advance of the second valve to its forward position; and second biasing means acting on the first valve to return said first valve toward its rearward position upon release of said drive means whereby to remove said first valve from its forward position

13. In a fluid-pressure control system having a fluid-receivable chamber, a passage connected to the chamber, and a part movable in the chamber according to the flow rate through the passage, the improvement comprising: a first valve normally biased to an open position and shiftable to a passage-restricting position; a second normally open valve shiftable to a passage-closing position; means operated by said part for moving the second valve to its passage-closing position; and releasable drive means engaged between the valves for incurring shifting of the first valve to its passage-restricting position upon shifting of the second valve to an intermediate position toward but short of its passage-closing position so as to retard movement of said part, said drive means being releasable upon further shifting of the second valve beyond said intermediate position to enable biased return of the first valve to its open position while the second valve is still short of its passage-closing position so that further movement of said part is free of said retarding effect and incurs shifting of the second valve to its passage-closing position without the passage-restricting effect of the first valve.

References Cited in the file of this patent

UNITED STATES PATENTS

2,615,430 Fletcher ---------- Oct. 28, 1952