

June 18, 1968

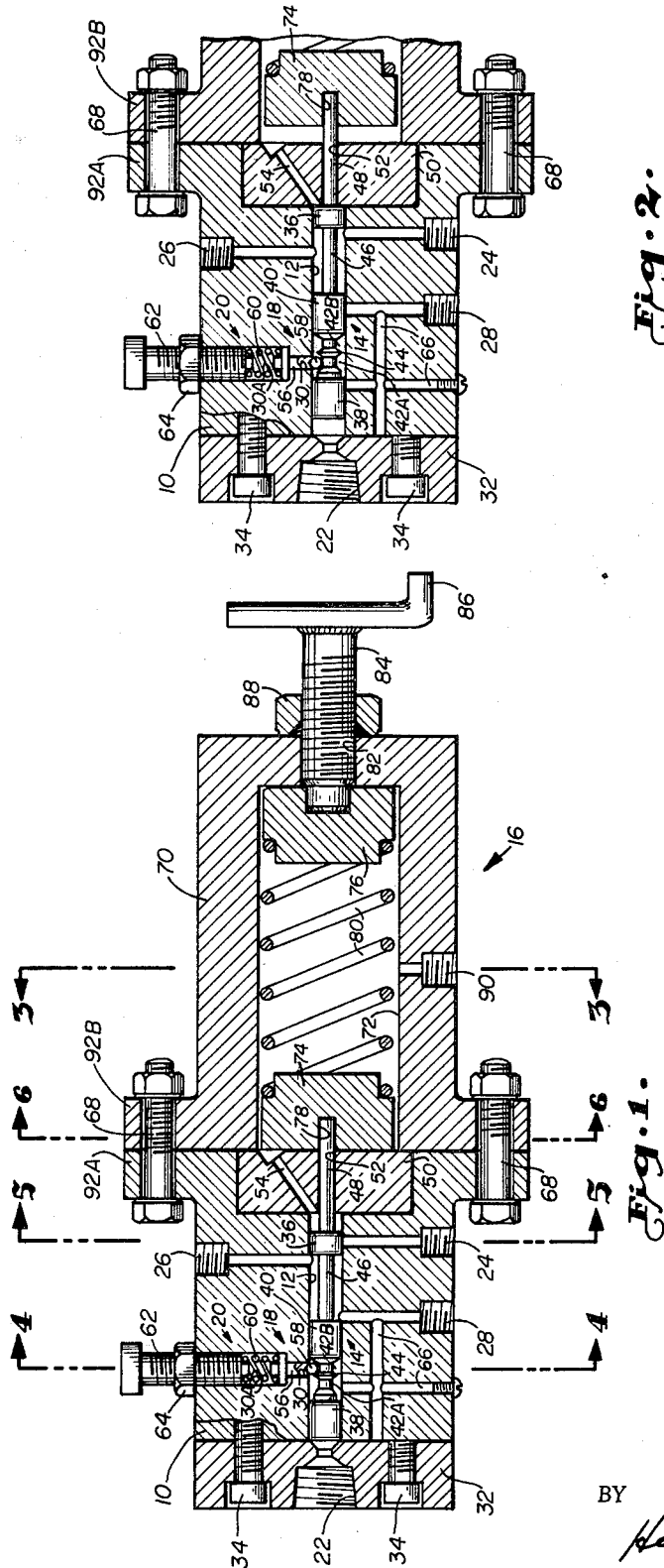
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3,388,721

HYDRAULIC SIGNAL CONTROL VALVE

Filed Aug. 26, 1965

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

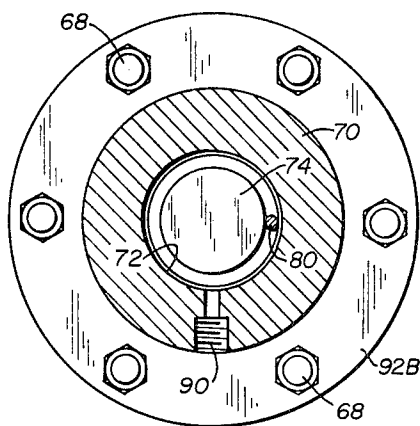


Fig. 3.

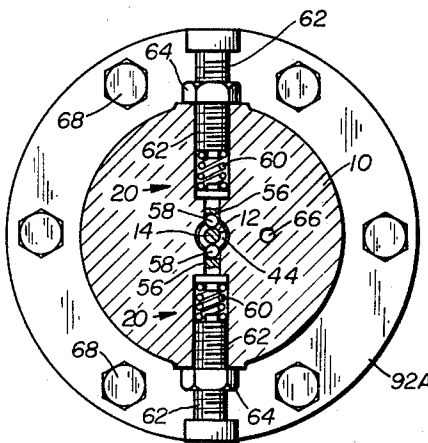


Fig. 4.

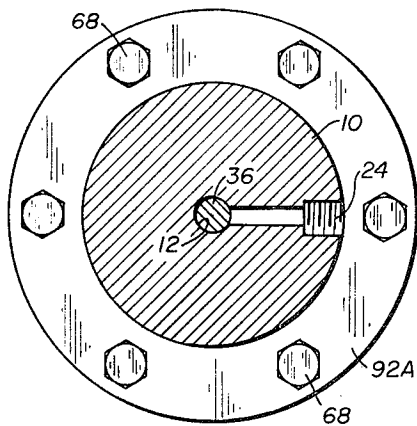


Fig. 5.

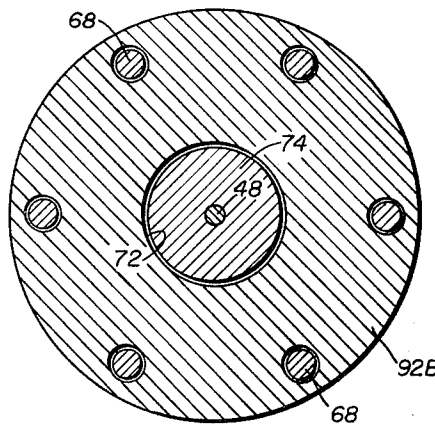


Fig. 6.

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3 Sheets-Sheet 3

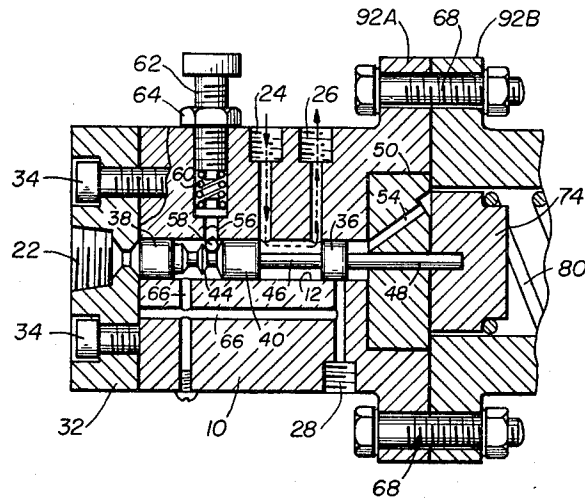


Fig. 7.

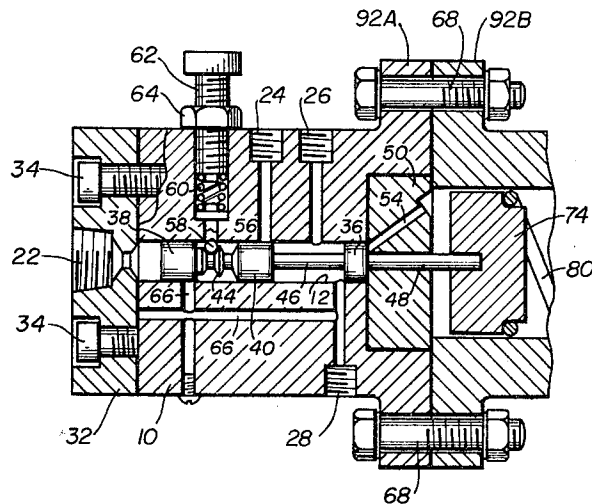


Fig. 8.

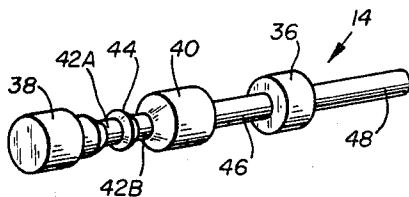


Fig. 9.

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## HYDRAULIC SIGNAL CONTROL VALVE

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8 Claims. (Cl. 137—625.66)

### ABSTRACT OF THE DISCLOSURE

This invention relates to a hydraulic signal valve. More particularly, the invention relates to a hydraulic signal valve including a body member having a spool member, a supply pressure port and signal port intersecting the spool opening, one end of the spool having a pilot port therein, a longitudinally displaceable spool positioned in the spool opening forming a piston displaceable by pressure at the pilot port, the spool being longitudinally positionable between a nonactuated and an actuated position, and spring biasing means compressibly biasing the spool towards the pilot port, the spool being movable by hydraulic pressure at the pilot port against the bias to the actuated position, the spring bias being adjustable by means externally of the valve so that the pressure at the signal port required to move the spool to the actuated position is thereby adjustable. The valve further includes detent means to insure that the valve spool, when moved from the nonactuated to the actuated position and vice-versa, moves quickly from one position to the other.

This invention relates to a control valve for hydraulic systems. More particularly, the invention relates to a signal control valve responsive to hydraulic pressure.

Modern mechanisms utilize hydraulics extensively for both power and control functions. This invention provides a simple, yet highly effective, device for monitoring hydraulic fluid pressure and is responsive to furnish a hydraulic signal when the monitored pressure exceeds a selectable predetermined point. The hydraulic signal is provided either as an opened or closed fluid path. In a more restricted sense, the control valve of this invention provides a first signal, such as an open fluid path, when monitored pressure exceeds a selectable predetermined point and a second signal, such as a closed fluid path, when monitored pressure falls below a predetermined point.

Throughout this description the expression "open fluid path" means that direct fluid coupling is provided between supply pressure port and a signal port. The expression "closed fluid path" means that the fluid coupling between supply pressure port and a signal port is blocked and, at the same time, according to the precepts of this invention, the signal port is tanked.

The invention may be described, in a general sense but not in a limiting sense, as a hydraulic signal valve consisting of the basic elements of a body portion, a spool member, a means biasing the spool member against movement, and a detent pin biased against movement. The body member is provided with a main cylindrical opening, closed at one end, and a pilot port opening communicating with the cylindrical opening adjacent the closed end, a supply pressure port opening communicating with the cylindrical opening intermediate the ends thereof, a signal port opening communicating with the cylindrical opening intermediate the ends thereof and spaced from the signal port opening, and a detent pin opening intersecting the main opening. The spool member is slidably positioned in the main opening in the body member and has one end

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extending out the open end of the main opening. The spool member has four integral portions, that is, (1) a full diameter valve portion normally closing communication between the body portion supply pressure opening and the signal port opening, (2) a reduced diameter portion adjacent the valve portion providing communication between the supply pressure port and the signal port when the spool member is longitudinally displaced, (3) a full diameter piston portion adjacent the body portion pilot port opening, and (4) adjacent detent grooves providing a detent peak therebetween. The detent pin engages the spool member at one or the other of the detent grooves. The spool member is limited in movement by the detent pin to rapid longitudinal displacement providing either open or closed communication between the body portion supply pressure and signal port openings.

A primary object of this invention is to provide a control valve for hydraulic systems.

A more particular object of this invention is to provide a signal control valve responsive to hydraulic fluid pressure.

A still more particular object of this invention is to provide a signal valve for monitoring the pressure of a hydraulic system, the valve functioning to provide a hydraulic signal when the monitored hydraulic pressure exceeds a selectable predetermined point.

Another object of this invention is to provide a signal valve for monitoring the pressure of a hydraulic system, the valve functioning to provide a hydraulic signal in the form of an open fluid path when the monitored pressure exceeds a selectable predetermined point.

Another object of this invention is to provide a signal valve for monitoring the pressure of a hydraulic system, the valve functioning to provide a hydraulic signal in the form of a closed fluid path when the monitored pressure exceeds a selectable predetermined point.

Another object of this invention is to provide a signal valve for monitoring the pressure of a hydraulic system, the valve functioning to provide a quick change hydraulic signal when the monitored hydraulic pressure exceeds a selectable predetermined point.

Another object of this invention is to provide a signal valve for monitoring the pressure of a hydraulic system, the valve functioning to provide a first hydraulic signal, such as an open fluid path, when the monitored pressure exceeds a selectable predetermined point, and a second hydraulic signal, such as a closed fluid flow path, when the monitored pressure falls below a predetermined point.

Another object of this invention is to provide a signal valve for monitoring the pressure of a hydraulic system, the valve functioning to provide a first signal when the monitored pressure exceeds a selectable predetermined point, and a second signal when the monitored pressure falls below a predetermined point, and wherein the differential pressure between the first and second signals is adjustable.

The invention which fulfills these as well as other objects will be set forth in the following description and claims, taken in conjunction with the drawings in which:

FIGURE 1 is a cross-sectional view of the signal valve of this invention.

FIGURE 2 is a partial cross-sectional view as in FIGURE 1 showing the valve in the actuated position.

FIGURE 3 is a cross-sectional view taken along the line 3—3 of FIGURE 1.

FIGURE 4 is a cross-sectional view taken along the line 4—4 of FIGURE 1.

FIGURE 5 is a cross-sectional view taken along the line 5—5 of FIGURE 1.

FIGURE 6 is a cross-sectional view taken along the line 6—6 of FIGURE 1.

FIGURE 7 is a partial cross-sectional view similar to that of FIGURE 2 but showing an alternate embodiment wherein, under low monitored pressure conditions, an open fluid path signal is provided.

FIGURE 8 is a partial cross-sectional view of the alternate embodiment of FIGURE 7 showing the valve providing a closed fluid path signal when the monitored hydraulic system has exceeded a predetermined pressure.

FIGURE 9 is an isometric view of the spool member.

Referring now to the drawings and first to FIGURE 1, a cross-sectional view of one embodiment of the signal valve of this invention is shown. The signal valve consists of five basic elements, that is, (1) a body portion 10 having a main cylindrical opening 12 therein, (2) a cylindrical spool member generally indicated by the numeral 14 slidably positioned in the main opening 12, (3) means biasing the spool member against longitudinal displacement, such means being generally indicated by the numeral 16, (4) a detent pin generally indicated by the numeral 18, and (5) a detent biasing means generally indicated by the numeral 20.

In the illustrated embodiment, the body portion 10 includes five openings all intersecting the main opening 12. These are (1) a pilot port opening 22 which communicates with the main opening 12 adjacent the enclosed end thereof and preferably, as shown in FIGURE 1, coaxially of the opening 12; (2) a supply pressure port opening 24; (3) a signal port opening 26; (4) a tank opening 28; and (5) a detent pin opening 30. The supply pressure port, signal port, tank and detent pin openings all intersect the main opening 12 substantially diametrically and are all spaced apart from each other. The main opening 12 is closed at one end, such as by means of head member 32 and bolts 34, the pilot port opening 22 being provided in the head member.

The spool member 14 (see FIGURES 1 and 9) is a unitary elongated member which, as previously indicated, is longitudinally slidably positioned within the main opening 12. The spool member is defined by (1) a full diameter valve portion 36 which normally closes communication between the supply pressure port 24 and the signal port opening 26; (2) a full diameter piston portion 38 which functions to receive hydraulic fluid pressure from pilot port opening 12 for longitudinal displacement of the spool member in a manner to be described subsequently; (3) a full diameter fluid sealing portion 40; (4) a pair of adjacent detent grooves 42A and 42B which define therebetween a detent peak 44; (5) a first reduced diameter portion 46 extending between the valve portion 36 and fluid sealing portion 40; and (6) a second reduced diameter portion 48 which extends exteriorly of the body portion 10.

As shown in FIGURE 1, a bushing 50 having an axial opening 52 closes the open end of the body portion 10, the axial opening 52 slidably receiving the second reduced diameter portion 48 of the spool member 14. A pressure relief opening 54 is also provided in the bushing 50 for purposes to be described subsequently.

The detent biasing means 20 consists basically of an elongated detent member 56 slidably positioned in the detent pin opening 30. A detent ball 58 is received by the detent opening 30 and engages the spool member 14 in one or the other of the detent grooves 42A and 42B. The detent member 56 and detent ball could obviously be integrally formed but the preferred configuration is as shown and includes a separate rotatable ball 58.

The outer portion of the detent opening 30, indicated by numeral 30A, is enlarged and receives a detent biasing spring 60. The opening 30A is threaded and receives a threadably positioned bolt member 62 which engages the outer end of the spring 60 and by which variable compression of spring 60 is made. A nut 64 is utilized to maintain the bolt member 62 in the preset position.

The detent pin, generally indicated by numeral 18, may be said to consist of the detent member 56 and detent ball

58. The detent biasing means, generally indicated by numeral 20, may be said to include detent spring 60, bolt member 62 and nut 64.

To afford a means of escape of the fluid which may be trapped within the main opening 12 in the area of detent grooves 42A and 42B, a fluid escape passage 66 is provided connecting with tank opening 28.

Affixed to body portion 10, such as by means of bolt 68, is a spool biasing housing 70 which has an axial biasing spring opening 72. Positioned in opening 72 is spool follower 74 and biasing spring follower 76. The spool follower 74 includes an axial opening 78 which receives the second reduced diameter portion 48 of spool 14. Extending between followers 74 and 76 is spool biasing spring 80. A threaded axial opening 82 is provided in spool biasing housing 70 at the end opposite the body portion 10, the opening 82 receiving a threaded bias spring adjusting screw 84 which engages, at its inner end, the bias spring follower 76. Exteriorly of biasing housing 70 and affixed to the outer end of the biasing spring adjusting screw 84 is a handle 86 by which the bias spring adjusting screw is manually, threadably advanced or retarded. Nut 88 keeps the adjusting screw 84 in preset position.

A fluid escape opening 90 is provided in the wall of the spool biasing housing 70 as a means of affording the escape of any fluid which might collect therein.

The spool biasing means, generally indicated by numeral 16, may be said to consist of spool biasing housing 70, spool follower 74, biasing spring follower 76, biasing spring 80, biasing spring adjusting screw 84, handle 86 and nut 88.

Further details of the construction of the illustrated embodiment of the invention will be seen by referring to the cross-sectional views of FIGURES 3, 4, 5 and 6. FIGURE 1 illustrates an embodiment wherein the detent biasing means 20 includes a single detent member 56 with its attendant detent ball, detent biasing spring 60 and bolt member 62. In the arrangement of the cross-sectional view of FIGURE 4, an alternate embodiment is shown wherein the detent biasing means 20 includes two opposed detent members 56, each with its attendant detent ball 58, detent biasing spring 60 and bolt member 62. The embodiment of FIGURE 4 is preferred since this arrangement provides a balanced application of detent biasing against the spool 14, thus substantially relieving any lateral force against the spool member which might ultimately cause wear of the spool member and the main opening 12.

In the illustrated embodiment, the body portion 10 and spool biasing housing 70 are provided with flanges 92A and 92B as a means of assembling the members into fixed end to end relationship. The details of the construction are illustrative only to show one functional and practical embodiment of the invention but such details are not significant of the scope of the invention itself.

#### Operation

The hydraulic signal valve of this invention operates to provide a signal when a monitored hydraulic pressure exceeds a predetermined maximum point. The hydraulic system whose pressure is to be monitored by the valve of this invention is connected to the valve through pilot port opening 22 so that the pressure of the monitored hydraulic system is applied to the piston portion 38 of the spool member 14. A source of hydraulic pressure is applied to the supply pressure port opening 24. Tank opening 28 and opening 90 in the spool biasing housing 70 are both connected to a tank or reservoir source. At opening 26 is provided the hydraulic signal output of the valves and therefore opening 26 may be connected to a hydraulic actuated switch or valve.

When the monitored pressure at pilot port opening 22 exerts sufficient hydrostatic force against the piston portion 38 of spool member 14, the biasing force of spring

is overcome and the spool member longitudinally moves to the right. The amount of hydrostatic force required to move the spool member is dependent upon two factors, first, and primarily, the force imposed by spool biasing means 16, that is, by spool biasing spring 80, and, secondarily, by the resistance to movement of the spool member imposed by detent member 56.

It can be seen from FIGURE 1 that the fluid flow path between supply pressure port 24 and signal port opening 26 is blocked and that, instead, the signal port communicates with tank port 28. When the monitored pressure is sufficient to displace the spool member 14 to the right, the relationship of components is that shown in FIGURE 2. With the spool member moved to the right, direct communication is provided between supply pressure port 24 and signal port 26, furnishing a hydraulic force at port 26 which functions as a hydraulic signal. At the same time communication between the port 26 and tank opening 28 is closed by the spool member sealing action 40.

The function of the detent pin 18 and detent biasing means 20 is to insure that movement between the actuated and nonactuated position of the valve will be rapid and positive and to establish a switching pressure and width. As shown in FIGURE 1 with the monitored pressure at pilot port opening 22 insufficient to overcome a biasing force of spring 80, the detent pin 56 and its ball 58 are in the detent groove 42B. When sufficient pressure is monitored to move the spool member 14 to the right, the ball 58 and detent member 56 are pushed upwardly compressing detent spring 60 and allowing the detent peak 44 to pass. As soon as the detent peak 44 is passed, the ball 58 immediately enters groove 42A. Thus, whether the valve is moving from the nonactuated to actuated or actuated to nonactuated position, the movement is rapid giving a positive signal indication.

Adjustment of the compressive tension of biasing spring 80, by threaded advancement or retardation of biasing spring adjustment screw 84, provides selection of the exact monitored pressure required to displace the spool member 14. Thus the valve functions to provide a hydraulic signal when the pressure of a monitored hydraulic system exceeds a selectable predetermined maximum. It can further be seen that after such selected predetermined maximum pressure has been reached, causing the spool member 14 to move to the right, and therefore provide a fluid pressure signal at signal port opening 26, a second signal or closed fluid flow signal is given when the spool 14 moves to the left. That is, as pressure at pilot port opening 22 decreases, the spool returns to the nonactuated position. The monitored pressure at which the spool moves left to the nonactuated position will be less than that which moved the spool to the actuated position, the differential pressure being determined primarily by the biasing force applied by spring 60 to the detent member 56. This differential switching pressure or latching band width is adjustable by varying the compression of detent biasing spring 60.

#### *Alternate embodiment*

The embodiment of FIGURES 1 and 2 provides an arrangement where a hydraulic system may be monitored and upon pressure in the monitored system exceeding a selectable maximum a signal is given in the form of an open fluid path between supply pressure fluid port 24 and signal port opening 26. An alternate embodiment shown in the partial cross-sectional views of FIGURES 3 and 8 shows an arrangement wherein the valve of this invention functions in exactly the same way except to provide an opposite phase signal. That is, in FIGURE 7, in the nonactuated position, an open fluid flow path is provided between the supply pressure port 24 and the signal port 26 with the tank or opening 28 being closed. In the actuated position, as shown in FIGURE 8, the signal provided is a no-flow signal between supply pressure port

24 and signal port opening 26 with open communication provided between the signal port 26 and the tank opening 28.

An important feature of the signal valve of this invention is that the signal pressure source connected to the signal port 24 is isolated from the pressure source connected to the pilot port 22. This means that a totally different and independent source of fluid pressure, such as a constant pressure source, may be utilized to provide the hydraulic signal source.

While the invention has been described with a certain degree of particularity, it is manifest that many changes may be made in the details of construction and the arrangement of components without departing from the spirit and scope of this disclosure.

What is claimed:

1. A hydraulic signal valve comprising:

a body having a spool opening therethrough, a supply pressure port and a signal port intersecting the spool opening and in communication with each other through said spool opening, one end of said spool opening forming a pilot port;

a spool positioned in said spool opening, said spool having a piston portion and being displaceable by pressure at said pilot port, said spool axially positionable between a nonactuated and an actuated position, said spool at all times isolating said pilot port from said supply pressure port and said signal port, one end of said spool extending externally of said body member through the end of the spool opening opposite said pilot port;

means with said spool closing communication between said pressure port and said signal port in one of said spool positions and opening communication therebetween in the other position;

a spool biasing housing affixed to said body portion and having an opening therein coaxial with said body spool opening;

a spool follower slidable within said biasing housing opening engaging the said externally extending end of said spool;

a spring follower slidably supported in said biasing housing opening, said spool follower and spring follower being spaced from each other;

a cylindrical coiled spool biasing spring in said opening compressibly positioned between said spool and spring followers;

means on the biasing housing for adjustably positioning said spring follower in said biasing housing whereby the biasing force of said spring may be adjusted, said spool being biased by said spring towards the end of said body having said pilot port therein and being axially displaced from nonactuated to actuated position when the hydraulic force received through said pilot port opening against said spool piston portion overcomes the biasing force of said spring.

2. A hydraulic signal valve according to claim 1 wherein said opening in said spool biasing housing is threaded and wherein said means of adjustably positioning said spring follower in said biasing housing includes:

an adjusting screw threadably received in said threaded opening in said biasing housing, one end of the adjusting screw engaging said spring follower and the other end extending externally of said spool biasing housing whereby the adjusting screw may be axially threadably positioned to adjustably position said spring follower to vary the spring bias on said spool.

3. A hydraulic signal valve according to claim 1 wherein said body member has a detent opening intersecting said spool opening and wherein said spool is further defined by adjacent detent grooves providing a detent peak therebetween including:

a detent pin slidably positioned in said detent pin open-

ing and normally engaging said spool at one of said detent grooves; and

a detent biasing means urging said detent pin into engagement with said spool.

4. A hydraulic signal valve comprising:

a body having a cylindrical spool opening therethrough, one end of said opening forming a pilot port opening, a supply pressure port opening communicating with said spool opening intermediate the ends thereof, and a signal port opening communicating with said spool opening intermediate the ends thereof, said supply pressure port opening and said signal port opening being spaced from each other;

a cylindrical spool slidably positioned in said spool opening in said body, said spool having one end thereof extending externally of the body through the end of said spool opening opposite said pilot port, said spool being defined by a full diameter valve portion normally blocking communication between said supply pressure and said signal ports, a reduced diameter portion adjacent said valve portion, a full diameter piston portion adjacent said pilot port opening, said spool isolating at all times said pilot port from said supply pressure port and said signal port;

a spool biasing housing affixed to said body and having an opening therein coaxial with said body spool opening;

a spool follower slidable within said biasing housing opening engaging the said externally extending end of said spool;

a spring follower slidably supported in said biasing housing opening, said spool follower and spring follower being spaced from each other;

a cylindrical coiled spool biasing spring in said opening compressibly positioned between said spool and spring followers;

means on the biasing housing for adjustably positioning said spring follower in said biasing housing whereby the biasing force of said spring may be adjusted, said spool being biased by said spring towards the end of said body having said pilot port therein and being axially displaced when the hydraulic force received through said pilot port opening against said spool piston portion overcomes the biasing force of said spring, the axial displacement of said spool moving said valve portion out of blocking position relative to said supply pressure and signal port opening affording free fluid flow therebetween.

5. A hydraulic signal valve according to claim 4 wherein said opening in said spool biasing housing is threaded and wherein said means of adjustably positioning said spring follower in said biasing housing includes:

an adjusting screw threadably received in said threaded opening in said biasing housing, one end of the adjusting screw engaging said spring follower and the other end extending externally of said spool biasing housing whereby the adjusting screw may be axially threadably positioned to adjustably position said spring follower to vary the spring bias on said spool.

6. A hydraulic signal valve according to claim 4

wherein said body has a detent opening intersecting said spool opening and wherein said spool is further defined by adjacent detent grooves providing a detent peak therebetween, including:

a detent pin slidably positioned in said detent pin opening and normally engaging said spool at one of said detent grooves; and

a detent biasing means urging said detent pin into engagement with said spool.

7. A hydraulic signal valve comprising:

a body having a spool opening therethrough, a supply pressure port and a signal port intersecting the spool opening and in communication with each other through said spool opening, one end of said spool opening forming a pilot port;

a spool positioned in said spool opening, said spool having a piston portion and being displaceable by pressure at said pilot port, said spool axially positionable between a nonactuated and an actuated position, one end of said spool extending externally of said body member through the end of the spool opening opposite said pilot port;

means with said spool closing communication between said pressure port and said signal port in one of said spool positions and opening communication therebetween in the other position;

a spool biasing spring means carried by said body member and having one end thereof engaging said externally extending end of said spool, said spool being biased by said spring means towards the end of said body having said pilot port therein and being axially displaced from said nonactuated position to said actuated position when the hydraulic force received through said pilot opening against said spool piston portion overcomes the biasing force of said spring; and

means externally of said body of adjusting the biasing force of said spool biasing spring.

8. A hydraulic signal valve according to claim 7 wherein said body member has a detent opening intersecting said spool opening and wherein said spool is further defined by adjacent detent grooves providing a detent peak therebetween including:

a detent pin slidably positioned in said detent pin opening and normally engaging said spool at one of said detent grooves; and

a detent biasing means urging said detent pin into engagement with said spool.

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