May 30, 1961 W. E. RENICK 2,986,161

FLOW CONTROL VALVE MECHANISM

Filed June 27, 1957 2 Sheets-Sheet 1

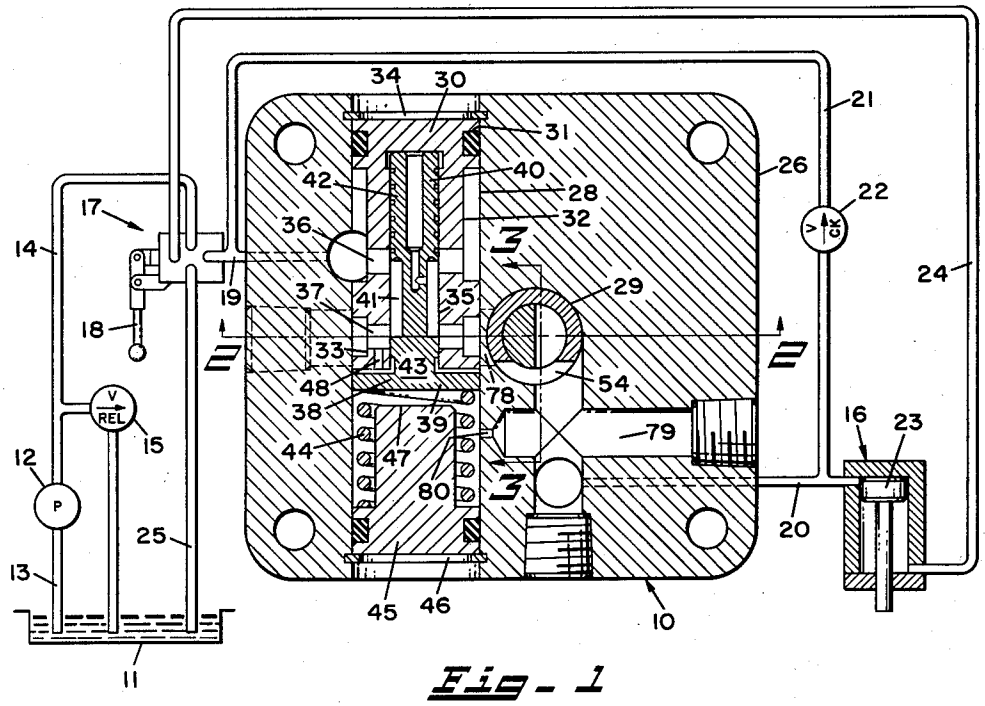

Fig - 1

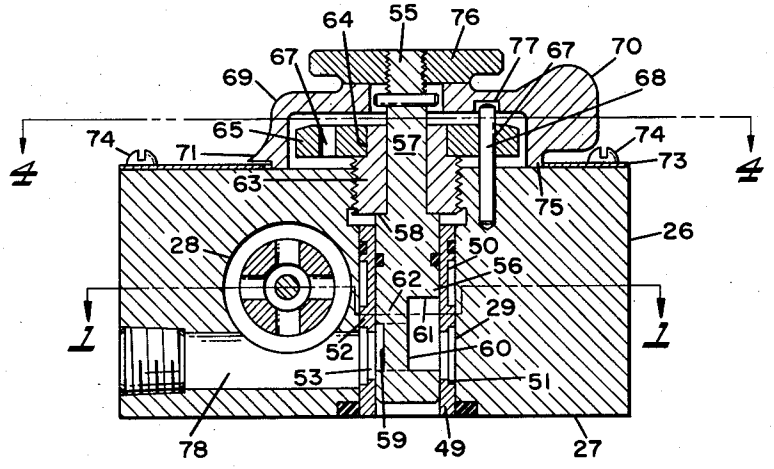

Fig - 2

INVENTOR.
WENDELL E. RENICK

BY Donald J. Detrick,
AGENT.

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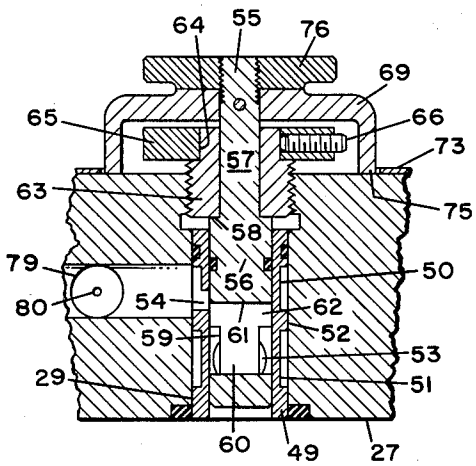

Fig - 3

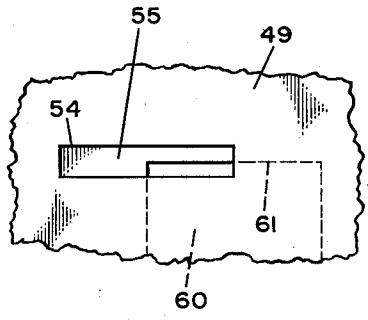

Fig - 5

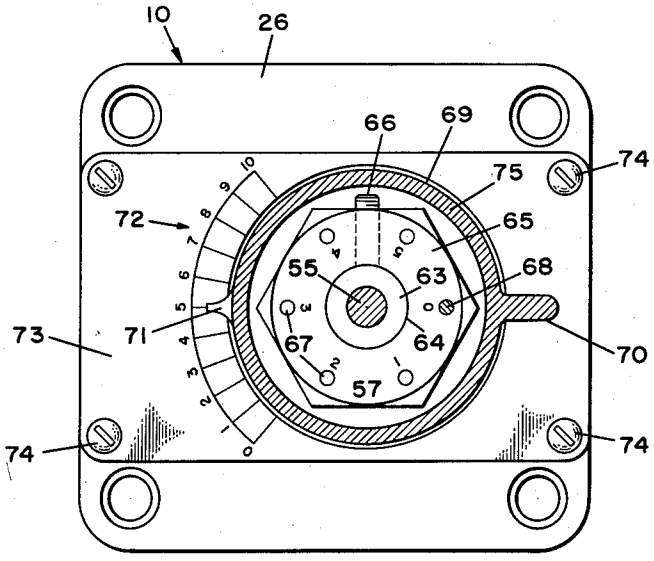

Fig - 4

INVENTOR.
WENDELL E. RENICK

BY
Donald J. Detrick,
AGENT.

United States Patent Office 2,986,161
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FLOW CONTROL VALVE MECHANISM

Wendell E. Renick, Columbus, Ohio, assignor to American Brake Shoe Company, New York, N.Y., a corporation of Delaware

Filed June 27, 1957, Ser. No. 668,429

9 Claims. (Cl. 137—556.6)

This invention relates generally to fluid control devices and its main object is to provide improvements in the arrangement and structure of the adjusting mechanisms of such devices.

Another object of the invention is to provide an improved construction and arrangement of the adjusting means in a device of the type set forth by which the area of an adjustable orifice therein may be adjusted in two directions, namely width and length.

Another object of the invention is to provide improved adjusting means in a device of the type set forth whereby the area of an adjustable orifice therein may be adjusted in two directions and in one direction independently of the adjustment in the other direction.

Another and more specific object of the invention is to provide improved adjusting mechanism in a fluid flow control valve in which one adjusting mechanism adjusts one dimension of a variable orifice therein to predetermine the range of flow, for example in gallons per minute through the valve, and another adjusting mechanism adjusts another dimension of the orifice to determine the flow of fluid in the range determined by the first adjusting mechanism.

Another object of the invention is to provide improved adjusting mechanism in a flow control valve as set forth in the foregoing objects wherein access to one of the adjusting means is prevented by an element which serves as a part of the other adjusting means.

Still another object of the invention is to provide improved locking or interlocking means whereby the adjusting mechanisms set forth in the foregoing objects may be held against movement once their positions have been determined or set.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the accompanying drawings:

Fig. 1 is a diagrammatic showing of a hydraulic system for operating a hydraulic motor or ram, the showing including a view in section taken on line 1—1 of Fig. 2 of a hydraulic fluid flow control valve which includes the features of the invention, the view of the valve showing particularly the pressure differential operated pressure compensating mechanism of the valve;

Fig. 2 is a view in section of the valve described in Fig. 1, the view being taken on line 2—2 thereof and showing particularly the mechanism thereof which forms an adjustable orifice in the valve and the adjusting mechanism by which this adjustable orifice is adjusted in two directions and is held in the position to which it is adjusted;

Fig. 3 is a view in section, the section being taken on line 3—3 of Fig. 1;

Fig. 4 is a view in plan of the control valve seen in Figs. 1 and 2 with parts in section, the section being taken on line 4—4 of Fig. 2, and

Fig. 5 is a diagrammatic view for illustrating the manner in which the adjustable orifice of the valve is adjusted in two directions, namely width and length.

In Fig. 1 of the drawings, there is shown a hydraulic circuit or system which includes an adjustable volume constant flow control valve 10 which includes the features of the invention. This hydraulic circuit includes a reservoir or tank 11 for hydraulic fluid, a pump 12 which receives fluid from the tank 11 through a conduit 13 and discharges fluid under pressure into a conduit 14. Conduit 14 is connected to tank 11 through a relief valve 15. The tank, pump, etc. thus far described constitutes a source of fluid under pressure by which a hydraulic ram or motor 16 is operated.

The high pressure conduit 14 is connected to the inlet port of a manually operated directional flow control valve 17. Valves similar to the valve 17 are well known in the art and, therefore, this valve is not shown in detail. The valve 17 illustrated includes a manual control handle or lever 18. When the lever 18 is in the position shown, the conduit 14 is blocked at the valve 17 and the entire output of fluid from the pump 12 is by-passed through the relief valve 15 to tank 11. When the lever 18 is shifted in one direction from the position illustrated, the conduit 14 is connected to a conduit 19 leading to valve 10 and fluid will flow through this latter valve to a conduit 20 connected to the top of the ram or motor 16. Conduits 19 and 20 are interconnected by a by-pass conduit 21 which includes a check valve 22 that prevents fluid from flowing from the conduit 19 to conduit 20 but which permits substantially free flow in the opposite direction, that is, from the conduit 20 to the conduit 19. The purpose of this by-pass 21, 22 in the reverse direction is fully set forth hereinafter.

Hydraulic fluid under pressure which is directed to the top of the cylinder of the ram or motor 16 forces the piston 23 thereof downwardly and displaces hydraulic fluid from the bottom of the cylinder. The displaced fluid flows through a conduit 24 to the valve 17 and through a conduit 25 to the tank 11.

When the lever 18 is shifted in the opposite direction from the position illustrated, conduit 14 is connected to conduit 24 and conduit 19 is connected to tank. Under these conditions, hydraulic fluid from the source of pressure flowing in conduit 14 flows through conduit 24 to the bottom of the ram or motor 16 and forces the piston 23 thereof upwardly displacing fluid from above the piston and through the conduit 20, the by-pass conduit 21 and check valve 22 to the valve 17 from which it is directed through the conduit 25 to tank 11. The conduit 21 and check valve 22 may be, and preferably are, contained within the body 26.

From the foregoing, it will be seen that hydraulic fluid flowing to the top of the ram or motor 16 must flow through the adjustable volume constant flow control valve 10 but that when the direction of flow is reversed, the hydraulic fluid flowing from the top of the ram or motor 16 can by-pass the valve 10 at low pressure by passing through the conduit 21 and check valve 22.

The adjustable volume constant flow control valve 10 is included in the hydraulic circuit or system for causing hydraulic fluid to be admitted to the top of the ram or motor at a constant volume at any of its volumetric adjustments regardless of fluctuations either in the high pressure supply conduit 19 leading thereto or in the conduit 20 leading therefrom and to the top of the ram or motor 16.

The adjustable volume constant flow control valve 10 includes a body 26 in the form of a rectangular block having a base or bottom surface 27 adapted to be mounted, as by clamping, upon a sub-plate mount, not shown. It may be mentioned that it is now common practice

in the art to mount valves, motors, pumps, etc. by the sub-plate method and that one of the numerous advantages of such mounting is found in the fact that it permits the expedient connection of the inlet and outlet ports of the devices to corresponding ports or passages in the sub-plate with only the need of simple sealing means which may be in the form of O-rings or flat gaskets therebetween.

The body **26** is provided with two through bores **28** and **29** the axes of which extend at right angles to each other and are spaced apart. The axis of bore **28** is parallel with the bottom or base surface **27** of the body and it contains elements which cooperate to form the pressure compensating means of the valve **10**. These elements include a cylindrical element **30** having spaced circumferential grooves **31**, **32** and **33** formed therein which is inserted into one of the open ends of bore **28** and is retained therein by a snap ring **34**. The cylinder **30** is sealed to the bore **28** by an O-ring contained within the groove **31** which is adjacent the snap ring **34**. Cylinder **30** also includes a central axially extending cylinder or bore **35** which is connected to the grooves **32** and **33** by passages or ports **36** and **37**, respectively.

A compound piston element **38** is also contained within the bore **28** and this element includes a piston head **39** and a small diameter hollow piston portion **40** which extends into and reciprocates in the cylinder or bore **35**. This small diameter hollow piston portion **40** includes a circumferential groove **41** and a pair of lands **42** and **43**. The land **42** cooperates with the ports or passages **36** to form a valve for controlling the flow of fluid through the ports or passages **36** in accordance with the axial position of the sharp peripheral edge of the land **40** which is adjacent the groove **41**. Land **43** functions merely as a guide or bearing for the compound piston element **38** and it never closes the ports or passages **37**. The hollow interior of the piston portion **40** is connected through a lateral drilling with the groove **41** in order that fluid may flow from this groove **41** through the piston portion **40** and to the chamber formed by its free end and the upper closed end of the cylinder or bore **35**.

The piston head **39** is of such diameter as to sealingly slide in the bore **28** in the valve body **26** and the entire piston **38** is urged upwardly to the position shown in Fig. 1 of the drawings by a spring **44** which abuts the piston head **39** and a plug **45**. Plug **45** is inserted into the other open end of bore **28** and is sealed thereto by an O-ring. A snap ring **46** retains the plug **45** in the bore **28**. The plug **45** forms an abutment **47** which limits the downward movement of the piston **38** in the bore **28**. The chamber formed in the bore **28** between the upper face of the piston head **39** and the adjacent end of the cylindrical element **30** is connected with the groove **37** by a passage **48** formed in the cylindrical element and extending from one of the ports or passages **37** to the bottom of the element **30**.

The through bore **29** contains a mechanism which cooperates to form an adjustable or variable orifice by which the rate of flow of fluid to the exhaust port **20** of the constant volume flow control valve assembly **10** is controlled. The elements which cooperate to form this orifice include a liner, sleeve or thimble **49** which is contained within the bore **29** and has a close sealing fit therewith. This liner sleeve **49** is provided with two circumferential grooves **50** and **51** which are separated by a land **52** and its upper end is further sealed to the bore **29** by an O-ring. As seen in the drawings, this O-ring is contained within a groove formed in the liner sleeve **49**. Another O-ring lies in a groove formed in the body **26** which surrounds the liner sleeve. This latter O-ring is retained in its groove by the sub-plate, not shown, and seals the body **26** to the sub-plate.

Groove **51** in linear sleeve **49** is connected at all times to the interior of the sleeve **49** by a pair of bores or holes **53** formed in the walls thereof and groove **50** is connected to the interior of the liner sleeve by a rectangular slot **54** (see Figs. 1 and 3) which is formed in the sleeve as by a milling operation whereby the peripheral surfaces of the slot where it joins the interior of the liner sleeve will be provided with sharp edges.

The interior of the liner sleeve **49** is cylindrical and it receives a valve element **55** which is adjustable therein both axially or longitudinally and rotationally. This element **55** is a shaft having two cylindrical portions **56** and **57** of different diameters separated by a shoulder **58**. The larger diameter portion **56** of shaft **55** fits closely with the interior of the liner sleeve **49** and it is provided with a circumferential groove adjacent the shoulder **58** in which there is an O-ring for preventing the loss of fluid along the shaft **55** toward the shoulder **58**. As seen in the drawings, the lower end of the portion **56** of shaft **55** is provided with a circumferential groove **59** which is open to the bores or holes **53** in the liner sleeve **49** at all times and this groove **59** is intersected by a slot **60** milled in the shaft and extending at right angles to the axis thereof. The depth of slot **60** is such that the bottom of the slot substantially intersects the longitudinal axis of the shaft **55** and the slot is of greater width than groove **59**. As clearly seen in Fig. 2 of the drawings, the lowermost side wall of slot **60** lies in the same plane as the lowermost side wall of groove **59** and the uppermost side wall **61** of the slot **60** lies in a plane above the plane of the uppermost side wall of groove **59** to provide a solid semicircular shaft portion **62** which, upon rotary adjustment of the shaft **55**, serves to adjust the length of the adjustable orifice of the control valve **10** formed by it and the rectangular slot **54** in the manner hereinafter described in detail.

As previously mentioned, the valve element or shaft **55** is adjusted both axially or longitudinally and rotationally in the liner sleeve **49** and the means for adjusting the shaft in these manners includes a bushing or sleeve **63** which receives the small diameter or stem portion **57** of the shaft **55** and which abuts the shoulder **58** of the latter. The bushing or sleeve **63** is externally threaded to be received by internal threads formed in the body **26** at one end of the through bore **29** and its uppermost end provides a cylindrical surface **64** upon which there is rotationally mounted an adjusting means in the form of a hexagonal index plate **65**. Index plate **65** may be locked to the cylindrical portion of the bushing or sleeve **63** by a set screw **66**. As clearly seen in Fig. 4 of the drawings, the index plate **65** is provided with six equally spaced bores or holes **67** through any one of which a pin **68** may be inserted. The pin **63** is received in a bore in the body **26** and its uppermost end projects above and beyond the top surface of the plate **65** to provide a stop means for a dial **69** which forms a cup shaped cover for the adjusting mechanism just described. While I have shown the index plate **65** as including six of the bores or holes **67**, it is to be understood that more or less of these holes or bores may be provided if desired.

The cup shaped dial or cover **69** is employed to adjust the shaft **55** to different rotational positions and it includes a wing **70** opposite a pointer **71** which cooperates with indicia **72** on a plate **73** which is secured to the body **26** by screws **74**. The dial **69** is mounted upon the stem portion **57** of shaft **55** and is held thereto against rotation by a roll pin which extends through the shaft and is received in a slot in the dial. The circular lip **75** of the dial is flat and it can be clamped against the body **26** by a knurled nut **76** which is threaded on the end of shaft **55**. The uppermost end of pin **63** extends into an arcuate slot **77** formed in the bottom of the dial **69** and the ends of this slot **77** form abutments which engage the pin **68** to determine the limits of rotation of the dial **69**.

As is evident from the foregoing description, the adjustable or variable orifice of the adjustable volume constant flow control valve **10** is formed by the milled rec-

tangular slot 54 in the liner or sleeve 49 and the milled slot 60 in the shaft 55 and the relative positions to which these elements are adjusted determines the effective size or open area of the orifice. These elements are shown diagrammatically in Fig. 5 of the drawings, and, with reference to this drawing, it will be seen that when the upper side wall 61 of the slot 60 is adjusted axially or longitudinally (upwardly or downwardly as seen in Fig. 5) that the effective width of the slot 54 will be changed. It will also be apparent that when the shaft 55 is rotated (moved to the right or left as seen in Fig. 5) that one or the other ends of the slot 60 will function to adjust the effective length of the slot 54.

The width to which the orifice is adjusted determines the range of flow, for example in gallons per minute, through the orifice and the length to which the orifice is adjusted determines the volumetric flow in any of the ranges. For example, assume that the width of the orifice is adjusted or set to permit a maximum flow of five gallons of fluid per minute through the valve, then the length of the orifice may be adjusted to permit any flow of fluid from zero up to the maximum as predetermined by the setting or adjusted width of the orifice.

In the apparatus herein described, the width of the adjustable orifice is, of course, adjusted by shifting the shaft 55 to different axial positions, and in the apparatus illustrated the effective open width of the orifice may be adjusted to any one of different widths as predetermined by the rotation of the bushing or sleeve 63 and the number of holes 67 in the plate 65.

In adjusting the relative positions of the elements to predetermine the range adjustments, the bushing or sleeve 63 is rotated to that position wherein it forces the shaft 55 downwardly just to the point wherein the adjustable orifice is closed and no fluid can flow through it. The set screw 66 is then loosened and the index plate 65 is rotated to such position that the pin 68 can be inserted through the hole 67 therein marked 0. The pin 68 is then inserted through this hole into the bore in the body 26 and the set screw 66 is tightened to interlock the index plate 65 and the bushing or sleeve 63. Once the valve has been "zeroed" in the manner described, if it is desired to adjust the orifice to the first range the pin 68 is withdrawn from the index plate 65 and body 26 and the index plate is rotated until the hole 67 therein marked 1 aligns with the pin bore in the body and the pin 68 is replaced. The orifice may be adjusted to any other of the ranges indicated by the holes 67 marked 2 through 5 in the same manner.

It is understood, of course, that since the dial 69 forms a cover for the range adjusting mechanism described that it must be removed from the shaft 55 in order to gain access to the range adjusting mechanism.

After the range adjusting mechanism described has been adjusted to or set in the desired range in the manner described, the dial 69 and nut 76 are placed upon the shaft 55 and nut 76 is tightened to draw the shoulder 58 against the bushing or sleeve 63. In order to adjust the volume in that range to which the orifice has been set, the shaft is rotated to the desired position as indicated by the pointer 71 and indicia 72 and the nut is tightened. Tightening of the nut 76 draws the shoulder 58 of shaft 55 against the end of the bushing or sleeve 63 and it clamps the dial 69 against the body 26 to lock the shaft 55 in its adjusted position.

In operation, the path of fluid flow through the adjustable volume constant flow control valve 10 is from the high pressure conduit 19 to the circumferential groove 32 and from this groove 32 through the passages or ports 36 to the circumferential groove 41 in small diameter piston portion 40 of piston 38. From groove 41, the fluid flows through the ports or passages 37 to groove 33 which is connected to a passage 78 leading to the bores or holes 53 in liner sleeve 49. From the bores or holes 53, the fluid passes into the slot 60 in shaft 55 and upwardly in this slot to the adjustable or variable orifice formed by the slot 54 and groove 60. From this orifice, the fluid flows through a passage 79 to the outlet or exhaust conduit 20 of the hydraulic system.

As previously indicated, when the adjustable volume constant flow control valve 10 is operating, it will maintain a constant volumetric flow at its exhaust port or conduit 20 regardless of pressure fluctuation therein or in its input port or conduit 19. It is the pressure compensator mechanism which is responsible for this action and it is the variable orifice that predetermines what the volumetric flow through the valve shall be.

In the operation of the pressure compensator mechanism, the compound piston element 38 is urged to the position shown in Fig. 1 of the drawings by the spring 44 to open the valve formed by the ports 36 and the sharp bottom edge of the land 42 of the piston portion 40. The fluid flowing through this valve enters the groove 41 and flows to the adjustable or variable orifice. The pressure of this fluid is applied from the groove 41 to the top of the small diameter piston portion 42 and from the groove 41 through the ports 37 and 48 to the upper piston area of the head 39. (For the purposes of this explanation, the total area just described will be assumed to be one square inch.) Assuming that the adjustable orifice is closed and that the spring 44 exerts an upward force of thirty-five pounds upon the compound piston 38, as the pressure builds up in the groove 41 it acts on the total piston area described to compress the spring and close the valve formed by the ports 36 and the lower sharp edge of the top land 42. It will thus be seen that the force of the pressure in the groove 41 will always be equal to the force of the spring 44 plus any force which may assist the spring. In other words, since the piston 38 is pressure balanced and urged in one direction by the spring 44 with a force of thirty-five pounds, the two forces will always be equal. Having assumed that the area of each end of the piston 39 is one square inch, it will be seen that the pressure acting on the pool in opposition to spring 44 will equal thirty-five pounds per square inch.

When the adjustable orifice is opened, fluid will begin to flow through it from the groove 41 and the pressure in said groove will be maintained due to the action of the compensator mechanism. In this action, the spring 44 will move the piston 38 upwardly to open the valve at 36 sufficiently to maintain a pressure in the groove 41 equal to the force of the spring. It is well known that when fluid is forced through an orifice that there is created a pressure drop or difference in pressures between the fluid on the inlet side of the orifice and the pressure of the fluid on the outlet side of the orifice. In the present instance, the higher of these pressures is on the inlet side of the orifice and is reflected to the groove 41. The lower of these pressures is on the outlet side of the orifice and is reflected through a passage 80 to the bore 28 and the bottom of the piston head 39. This lower pressure is applied to the piston head 39 to aid the spring 44 in urging the piston 39 to open the valve at 36.

It will thus be seen that regardless of the adjustment of the effective open area of the adjustable orifice that the difference in pressures between its high pressure side and its outlet or low pressure side will always be maintained constant and equal to the force of the spring divided by the area of one end of the compound piston 38.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

I claim:

1. In a fluid flow control device, a body; means in said body forming a bore; a valve element in said bore; a valve port in said bore, said valve element cooperating with said port to form an orifice and being adjustable longitudinally and rotationally in said bore to adjust the size of said orifice; means for adjusting said valve element

to different predetermined longitudinal positions and to different rotational positions in any of said longitudinal positions, said adjusting means including sleeve means on said valve element; shoulder means on said valve element engaging said sleeve means; threaded means on said sleeve means engaging threaded means carried by said body for adjusting the longitudinal position of said sleeve means and valve element; means for rotating said sleeve means, said rotating means being carried for rotation on the sleeve means; means for interlocking said rotary means and sleeve means in various relative positions; means for interlocking said rotating means and said body in any of a plurality of predetermined positions, said interlocking means including means forming a plurality of openings in said rotating means, a bore in said body, and removable pin means in said last mentioned bore extending through one of said openings; a dial means on said valve element for rotating it, said dial means forming a cover for said rotating means and having stop means thereon for engaging said pin means to limit rotation of said dial means and valve element and also having means for engaging said body, and means for clamping said valve element, sleeve means, dial means and body together for locking said valve element against rotation.

2. In a fluid flow control device, a body; means in said body forming a bore; a valve element in said bore; a valve port in said bore, said valve element cooperating with said port to form an orifice and being adjustable longitudinally and rotationally in said bore to adjust the size of said orifice; means for adjusting said valve element to different predetermined longitudinal positions and to different rotational positions in any of said longitudinal positions, said adjusting means including sleeve means on said valve element; shoulder means on said valve element engaging said sleeve means; threaded means on said sleeve means engaging threaded means carried by said body for adjusting the longitudinal position of said sleeve means and valve element; means for rotating said sleeve means, said rotating means being carried for rotation on the sleeve means; means for interlocking said rotary means and sleeve means in various relative positions; means for interlocking said rotating means and said body in any of a plurality of predetermined positions, said interlocking means including means forming a plurality of openings in said rotating means, a bore in said body, and removable pin means in said last mentioned bore extending through one of said openings; a dial means on said valve element for rotating it, said dial means forming a cover for said rotating means and having means for engaging said body, and means for clamping said valve element, sleeve means, dial means and body together for locking said valve element against rotation.

3. In a fluid flow control device, a body; means in said body forming a bore; a valve element in said bore; a valve port in said bore, said valve element cooperating with said port to form an orifice and being adjustable longitudinally and rotationally in said bore to adjust the size of said orifice; means for adjusting said valve element to different predetermined longitudinal positions and to different rotational positions in any of said longitudinal positions, said adjusting means including sleeve means on said valve element; shoulder means on said valve element engaging said sleeve means; threaded means on said sleeve means engaging threaded means carried by said body for adjusting the longitudinal position of said sleeve means and valve element; means for rotating said sleeve means, said rotating means being carried for rotation on the sleeve means; means for interlocking said rotary means and sleeve means in various relative positions; means for interlocking said rotating means and said body in any of a plurality of predetermined positions; a dial means on said valve element for rotating it, said dial means forming a cover for said rotating means and having means for engaging said body, and means for clamping said valve element, sleeve means, dial means and body together for locking said valve element against rotation.

4. In a fluid flow control device, a body; means in said body forming a bore; a valve element in said bore; a valve port in said bore, said valve element cooperating with said port to form an orifice and being adjustable longitudinally and rotationally in said bore to adjust the size of said orifice; means for adjusting said valve element to different predetermined longitudinal positions and to different rotational positions in any of said longitudinal positions, said adjusting means including threaded means for adjusting the longitudinal position of said valve element; means for rotating said threaded means, said rotating means being carried for rotation on said threaded means; means for interlocking said rotary means and threaded means in various relative positions; means for interlocking said rotary means and said body in any of a plurality of predetermined positions, said interlocking means including means forming a plurality of openings in said rotary means, a bore in said body, and removable pin means in said last mentioned bore extending through one of said openings; a dial means on said valve element for rotating it, said dial means forming a cover for said rotating means and having stop means thereon for engaging said pin means to limit rotation of said dial means and valve element and also having means for engaging said body, and means for clamping said valve element, threaded means and body together for locking said valve element against rotation.

5. In a fluid flow control device, a body; means in said body forming a bore; a valve element in said bore; a valve port in said bore, said valve element cooperating with said port to form an orifice and being adjustable longitudinally and rotationally in said bore to adjust the size of said orifice; means for adjusting said valve element to different predetermined longitudinal positions and to different rotational positions in any of said longitudinal positions, said adjusting means including threaded means for adjusting the longitudinal position of said valve element; means for rotating said threaded means, said rotating means being carried for rotation on said threaded means; means for interlocking said rotary means and threaded means in various relative positions; means for interlocking said rotary means and said body in any of a plurality of predetermined positions, said interlocking means including means forming a plurality of openings in said rotary means, a bore in said body, and removable pin means in said last mentioned bore extending through one of said openings; a dial means on said valve element for rotating it, said dial means forming a cover for said rotating means and having means for engaging said body, and means for clamping said valve element, threaded means and body together for locking said valve element against rotation.

6. In a fluid flow control device, a body; means in said body forming a bore; a valve element in said bore; a valve port in said bore, said valve element cooperating with said port to form an orifice and being adjustable longitudinally and rotationally in said bore to adjust the size of said orifice; means for adjusting said valve element to different predetermined longitudinal positions and to different rotational positions in any of said longitudinal positions, said adjusting means including threaded means for adjusting the longitudinal position of said valve element; means for rotating said threaded means, said rotating means being carried for rotation on said threaded means; means for interlocking said rotary means and threaded means in various relative positions; means for interlocking said rotary means and said body in any of a plurality of predetermined positions; a dial means on said valve element for rotating it, said dial means forming a cover for said rotating means and having means for engaging said body, and means for clamping said valve element, threaded means and body together for locking said valve element against rotation.

7. In a fluid flow control device, a body; means in said body forming a bore; a valve element in said bore; a valve port in said bore, said valve element cooperating with said port to form an orifice and being adjustable longitudinally and rotationally in said bore to adjust the size of said orifice; means for adjusting said valve element to different predetermined longitudinal positions and to different rotational positions in any of said longitudinal positions, said adjusting means including means for adjusting the longitudinal position of said valve element to a plurality of longitudinal positions; means for locking said longitudinal adjusting means in any of said positions; a dial means for rotating said valve element, said dial means forming a cover for said longitudinal adjusting means and having means for engaging said body, and means for clamping said dial means against said body for locking said valve element against rotation.

8. In a fluid flow control device, a body; means in said body forming a bore; a valve element in said bore; a valve port in said bore, said valve element cooperating with said port to form an orifice and being adjustable longitudinally and rotationally in said bore to adjust the size of said orifice; means for adjusting said valve element to different predetermined longitudinal positions and to different rotational positions in any of said longitudinal positions, said adjusting means including means for adjusting the longitudinal position of said valve element to a plurality of longitudinal positions; means for locking said longitudinal adjusting means in any of said positions; rotating means for rotating said valve element, said

rotating means forming a cover for said longitudinal adjusting means and having means for engaging said body, and means for clamping said rotating means against said body for locking said valve element against rotation.

9. In a fluid flow control device, a body; means in said body forming an orifice adjustable in two directions whereby its effective open area may be adjusted, means for adjusting said orifice in one direction, means for adjusting said orifice in another direction, locking means for locking one of said adjusting means in any of a plurality of predetermined positions, and locking means for locking the other of said adjusting means in any of a plurality of positions, one of said locking means forming a cover for the other whereby access to the other can be had only upon removal of the cover.

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