Dec. 19, 1967 D. M. COHEN ETAL 3,358,964

SEAT ASSEMBLY FOR BALANCED PRESSURE REDUCING VALVE

Filed Dec. 16, 1964 2 Sheets-Sheet 1

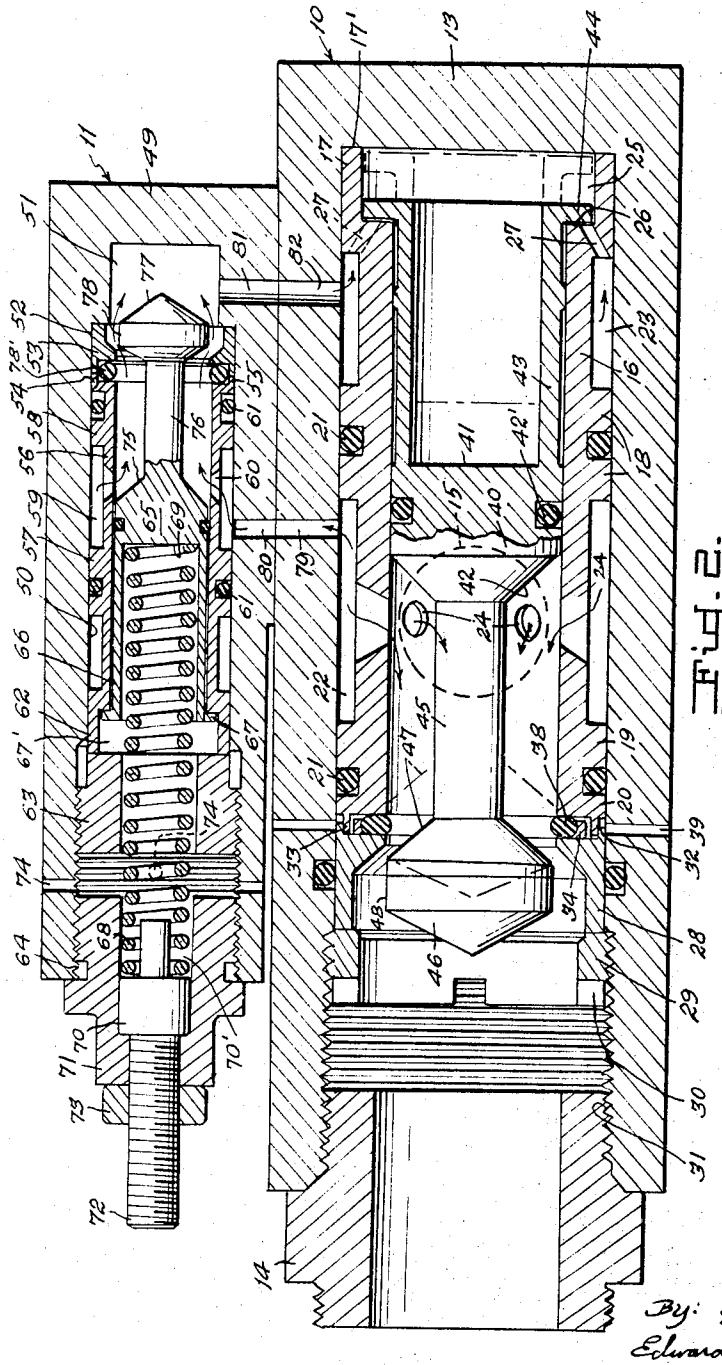

Fig. 2.

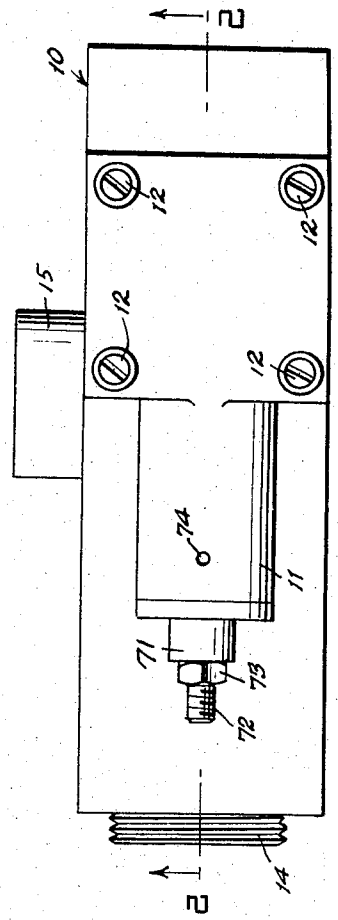

Fig. 1.

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Fig. 3.

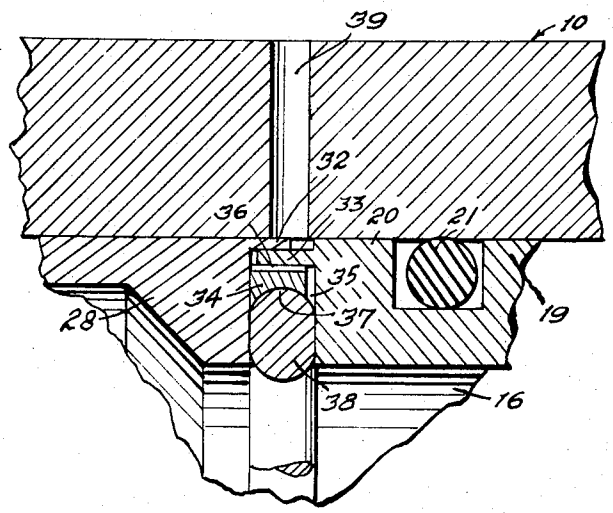


Fig. 4.

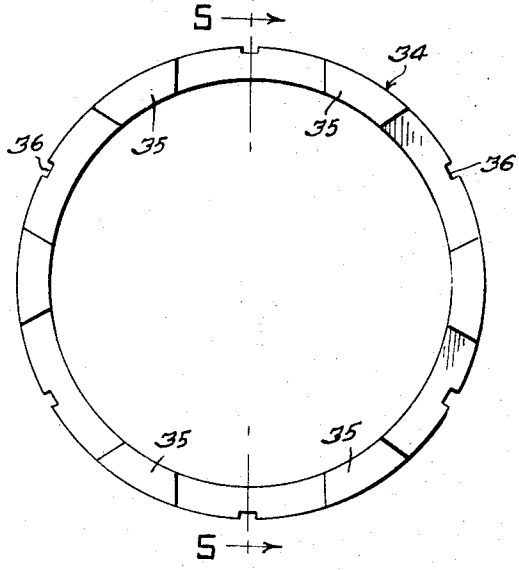
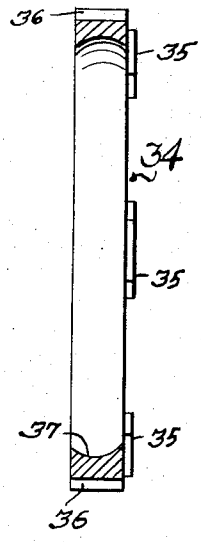


Fig. 5.



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SEAT ASSEMBLY FOR BALANCED PRESSURE REDUCING VALVE

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4 Claims. (Cl. 251—324)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

The invention relates to balanced pressure regulating reducing valve of the type which transmit at reduced pressures fluids received at high pressures. More particularly, the invention relates to such a valve which is fluid balanced rather than spring balanced. The valve is specifically useful in controlling high gas or air pressures required to operate a military flame thrower, but is, of course, applicable to other uses requiring the control of other fluids under high pressure, particularly gaseous fluids.

Such devices, particularly when used by military personnel for military purposes, as when used as a part of the flame thrower aforesaid, must be exceptionally strong and well made to withstand the necessary rough treatment to which a flame thrower is subjected. It must be light enough so as not to increase the weight of the flame thrower enough to bar its being transported by one person; it must be efficient and reliable in operation under adverse temperature, climatic and weather conditions; and, finally, it must be simple to operate, maintain and repair so that replacement parts may be easily applied by relatively unskilled personnel using simple tools and under adverse light and climatic conditions.

With the foregoing in view, it is an object of the invention to provide an improved balanced, pressure-regulating reducing valve of the class described.

Another object of the invention is to provide in combination with a novel valve and valve seat, novel fluid controlled means for balancing the valve.

A further object of the invention is to provide a novel seat for the valve.

An additional object of the invention is to provide a novel seat for the valve which includes an O-ring providing the seal together with novel means mounting such O-ring and novel means for bleeding trapped air from the seat or mount for the O-ring.

Still a further object of the invention is to provide in combination with the O-ring mount, a novel valve for such mount.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings, forming a part of this application, and in which like numerals are employed to designate like parts throughout the same—

FIGURE 1 is a side elevational view of a valve according to the invention;

FIGURE 2 is an enlarged horizontal sectional view taken substantially on the line 2—2 of FIGURE 1;

FIGURE 3 is a fragmentary sectional view in the plane of FIGURE 2, but on a still larger scale and showing the O-rings and vent holes;

FIGURE 4 is an end elevational view of the back up ring employed in the invention; and

FIGURE 5 is a sectional view taken substantially on the line 5—5 of FIGURE 4.

In the drawings wherein for the purpose of illustration is shown a preferred embodiment of the invention, the numeral 10 designates generally a hollow casing or housing for the valve which has secured thereto at one side

thereof a second smaller housing 11. Housings 10 and 11 may be permanently secured together or, as shown, may be readily detachably secured together by any suitable means such as the machine screws or the like 12. Housing 10 has a closed back end 13 and an open front end to which may be threadedly attached any suitable tubular fitting outlet nozzle 14 for connecting the outlet in the implement with which the valve is to be used, such as a flame thrower (not shown). Fluid under high pressure, such as compressed air is admitted to the interior of the housing 10 through an inlet port 15. Any suitable fitting, not shown, connects the inlet port 15 to a source of fluid under high pressure.

A cylinder 16 is disposed within the housing 10 and is generally of small diameter but is freely slidable therein by virtue of a belled rear flange 17 and annular pairs of shoulders 18 and 19, 20. Between each pair of shoulders is provided a seat for an O-ring 21 which seals off two cylindrical spaces 22 and 23 which surround the cylinder 16. A circumferential series of ports 24 extend through the wall of the cylinder 16 between shoulder 19 and the nearest shoulder 18 which define the cylindrical space 22, and provides means for admitted air under high pressure from the inlet port 15 to the interior of the cylinder 16. The belled rear flange 17 of the cylinder 16 has a rear free edge 17' which bears against the closed back end 13 of the housing 10 to provide a space 25 between the latter and a rearwardly facing annular shoulder 26 of the flange 17. The shoulder 26 is pierced with a series of ports 27 which are in open communication with the rearward cylindrical space 23 defined by flange 17 and the rearmost annular shoulder 18. The purpose of this structure will be apparent hereinafter.

The cylinder 16 is held against the closed back end 13 of the housing 10 by a retainer ring 28 which is slidable within the housing 10 and bears against the front end of the cylinder 16. Ring 28 is releasably secured in position by a screw threaded tubular plug 29 which is threaded into its holding position along the internal screw threaded portion 31 of the housing 10 by a screw driver or the like which engages in the cross slots 30 of the plug 29. As best seen in FIGURE 3, the retainer ring 28 includes a rearwardly extending cylindrical flange 32 which telescopically overlaps a forwardly directed like flange 33 formed on the foremost annular shoulder 20. The free edges of the flanges 32, 33 are prevented from abutting the end edges of the cylinder 16 and retaining ring 28 respectively by a metal back-up ring 34 best seen in FIGURES 4 and 5.

Back-up ring 34 has a rear face which is formed with integral rearwardly directed and spaced projections 35 which bear against the front edge of the cylinder 16 so as to provide radially directed spaces between such projections. As illustrated, the projections 35 are generally keystone-shaped and are relatively widely spaced. Other shapes and spacings are contemplated. The periphery of the ring 34 is formed with a number of axially extending grooves or notches 36 which correspond to the number of spaces between the projections 35 and the grooves 36 open into the spaces. The inner periphery of ring 34 is formed with a groove 37 which has an arcuate cross section for the reception therein of an O-ring 38. As the O-ring 38 is normally wider than the back-up ring 34, it is squeezed between the adjacent end edges of the retainer ring 28 and the cylinder 16. This deforms the ring 28 slightly and forces it into sealing engagement with the back-up ring 34 as well as with the adjacent end edges of the retainer ring 28 and cylinder 16. Any air which is trapped behind the back-up ring 34 is bled off between the axial projections 35 into the grooves 36, around the end edges of the flanges 32, 33. (which do not have an

air tight fit) and is vented from the housing **10** through a series of vent holes **39** formed therethrough. The vent holes **39** open into the interior of the housing **10** in alignment with the composite groove formed by the back-up-ring-spaced ends of the retainer ring **28** and the overlapped flanges **32, 33**. The O-ring seat **38** provides the seal of the balanced valve of the invention and the mount therefor which has just been described is an important feature of the invention.

O-rings normally cannot be used for high pressure seals of this kind because the high pressure will normally roll it out of its seat and blow it downstream, or alternatively, it is ruptured and destroyed. However, in the structure described and shown, the O-ring is clamped under tension so it cannot be flexed or rolled out of the composite groove. By venting it from the rear no air under pressure can get behind it to force it out of its mount or seat particularly because of its seat in the groove **37** of the back-up ring **34**. As the O-ring **38** is under three-way tension it has a close fit in the groove **37** and any air in the composite groove can only get behind the back-up ring **34** where it is bled harmlessly outwardly of the same. It follows, therefore, that the mount of the O-ring **38** is capable of withstanding extremely high pressures without damage to or loss of the O-ring.

A piston head **40** is slidable inside the cylinder **16** and includes a rear face **41** and a frusto-conical front face **42**. Any suitable means, such as the O-ring **42'** shown, may provide a seal between the piston **40** and the cylinder **16**. A cylindrical piston skirt **43** extends rearwardly of the piston head **40** and terminates in a radially outwardly directed flange **44** which is disposed in the space **25** between the closed back end **13** of the housing **10** and the shoulder **26** of the cylinder **16** to provide fixed stops limiting reciprocal movement of the piston in the cylinder. The flange **44** is of a smaller diameter than inner diameter of the flange **17**. A valve stem **45** extends forwardly of the piston head **40** axially thereof and integral therewith. The forward end of the stem **45** is enlarged to provide a valve head **46** which includes a frusto-conical rear face **47** which corresponds in size and shape to the front face **42** of the piston head **40** for a purpose to be apparent hereinafter. Valve head **46** has a cylindrical periphery **48** which has a sealing fit with the O-ring **38** when the piston head **40** is retracted to the rearmost position shown in broken lines in FIGURE 2. As will appear, the valve head and piston are normally located in the full line position of FIGURE 2, wherein the valve head **46** is in forwardly spaced relation to its O-ring seat **38** to permit passage of fluid or air under high pressure outwardly of the housing **10** through the outlet fitting **14**. The valve is normally held in this open position by a means now to be described.

The smaller housing **11** has a closed front end **49** with a main cylindrical bore **50** separated from a reduced cylindrical chamber **51** by an annular shoulder **52** adjacent the front end **49**. A retainer ring **53** (generally like the ring **28**) is seated against the shoulder **52** by a cylinder **56** which is generally similar to the cylinder **16** aforesaid. Ring **53** and the cylinder **56** have opposing flanges **54** and **55** respectively. If desired, flanges **54** and **55** may be telescoped like the corresponding flanges **32, 33** in the housing **10**. Annular shoulders **57** and **58** are formed on the periphery of the cylinder **56** and are longitudinally spaced to define a cylindrical space **59** around the cylinder **56**. The cylinder wall between the annular shoulders **57** and **58** is formed with a plurality of ports **60** which provide access to the interior of the cylinder **56**. O-rings **61** positioned outwardly axially of the shoulders **57** and **58** seal off the space **59**. The opposite, or rear end, of the cylinder **56** is belled to provide a flange **62** which is engaged by the tubular nut **63** or the like which is threaded in the threaded portion **64** of the housing **11** to secure the assembly in position similarly to the like assembly in the housing **10**.

A piston head **65** is slidable in the cylinder **56** and includes a hollow skirt **66** having a flanged free end **67** which fits in the space **67'** defined by the flange **62** and the plug **63**. An expansive coil spring **68** fits into the skirt **66** and bears on the rear face **69** of the piston head **65**. The rear end of the spring **68** is engaged by an adjusting plug **70** which is seated in a hollow recess **70'** of the closure plug **71** which is screw threaded into the housing **11**. A socket head screw **72**, or the like, is threaded through the plug **71** and has a front end which engages the adjusting plug **70** to vary the tension of the spring **68** in a manner readily understood. A lock nut **73** on the adjusting screw **72** holds the same in adjusted positions. Suitable vents **74** may be formed through the threaded rear portion of the housing **11** between the closure plug **71** and the tubular nut **63**.

The front face **75** of the piston head **65** is frusto-conical in form and has a valve stem **76** projecting forwardly thereof. A valve head **77** is formed on the front end of the stem **76** and includes a cylindrical periphery **78** which at times has a sealing seat on the O-ring. However, the spring **68** normally loads the piston head **65** and valve head **77** to a forward position wherein the valve is open as shown. Housing **10** is formed with a port **79** which is aligned with a like port **80** in the housing **11**. Port **79** leads from the high pressure space **22** of the housing **10** and port **80** opens into the space **59** of the housing **11**. Forwardly of valve head **77**, housing **11** is formed with a port **81** which opens from the chamber **51** into an aligned port **82** in the housing **10** which in turn opens into the space **23**.

It should be pointed out that the mechanism contained within the housing **11** is a small capacity pressure reducing valve which serves as a pilot regulator for control of the main-stream high capacity pressure reducing valve contained within housing **10**. Both valves operate in the same manner except the valve head **77** (in the pilot regulator) utilizes the force of the spring **68** to regulate its outlet air pressure which in turn serves as the medium for controlling the output from the larger valve head **46**.

In operation, high pressure air enters the space **22** in housing **10** through the inlet port **15**. Simultaneously, a portion of the high pressure air is by-passed through the ports **79, 80** and **60** into the cylinder **56** ahead of the front face **75** of the piston **65** and around the normally open valve **77** at a reduced pressure. Such by-passed air proceeds into the chamber **51** and through the ports **81, 82** into space **23** in the housing **10**. From there it passes through ports **27** around the outer edge of the flange **44** into the space **25** and into the interior of the skirt **43** of the piston **40** where it loads the rear face **41** of the latter in a forward direction which results in the valve **46** being normally in the open position to permit air to pass through the outlet nozzle **14**. The by-passed airflow from the pilot regulator ceases when the back-pressure sensed on valve face **77** counterbalances the force of spring **68**, thereby causing piston **65** to move to the closed position. The seal is obtained between valve **78** and O-ring **78'**.

With piston **40** of the main regulator in the open position, high pressure air from **22** proceeds through openings **24** and then through the restricted opening near valve **48** at reduced pressure. When valve face **46** senses a reduced downstream pressure which counterbalances the pressure on piston rear face **41**, piston **40** moves rearward and airflow ceases when valve **48** contacts O-ring seal **38**. However, when a demand is placed upon the main regulator (for example by operation of the flame thrower system), the pressure sensed on valve face **46** will lower thereby causing an unbalance of forces acting respectively on faces **46** and **41**. The higher pressure on face **41** will cause piston **40** to move forward thereby unseating the valve face **48** from O-ring seal **38**. When the downstream demand ceases, piston **40** will again move rearward and airflow will cease. This cycle is continually repeated. It is to be noted that valve faces

47 and 42 within the high pressure chamber are of equal area and opposed to each other and hence have no bearing on the balance of forces which operate the valve. Since O-rings 38 and 42' are of the same diameter, the only forces which operate the valve are those which result from the pressure on rear face 41, sealed by O-ring 42', and from the downstream back-pressure acting against valve face 46, sealed by O-ring 38 and valve 48. Accordingly, this pressure reducing valve, being balanced in the high pressure chamber, will maintain a constant reduced outlet pressure which is dependent only upon the setting of the pilot regulator. The net result is that the high pressure supplied through the inlet port 15 is reduced to a selected and substantially lower working pressure when it passes through the outlet nozzle 14 which enables the flame thrower or other appliance to operate at maximum efficiency for a maximum period of time. When properly adjusted, the valve of the invention can reduce fluid pressure of approximately 3000 p.s.i.g. to a working pressure of approximately 400 p.s.i.g.

Turning now to the valve 78, as soon as the desired pressure is achieved in the skirt 43, the valve 78 is closed and remains closed until a different working pressure is desired. The valve 78 moves rearward and closes when the pressure on the forward face counteracts the force exerted by the spring 68. Adjustments to the valve 78 to achieve specific outlet pressures are made by loosening the lock-nut 73 and turning the screw in one direction to increase the pressure and in the other to decrease pressure. When the desired outlet pressure is attained, the lock-nut 73 is tightened. For maximum sensitivity, vent holes 74 are required to maintain equalized pressure within the skirt 66. By properly adjusting the spring 68, the degree to which the valve 78 is held open, and therefore the pressure of the by-passed air can be regulated with the resultant variance in the amount of back pressure required to close the valve 48. Thus the operating or working pressure can be reduced accurately as required for the best performance.

It follows from the foregoing that the invention provides a fluid balanced reducing valve which is easily adjustable to regulate and reduce high pressures to a variety of selected lower pressures. This result is accomplished by a device which is strong and sturdy in use, which is simple to operate, maintain and repair, and which is highly efficient for the purpose specified.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred embodiment of same, and that various changes in the shape, size, and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

We claim:

1. In a balanced valve including a cylinder, means mounting a valve head for reciprocal movement in said cylinder; the improvement comprising a seat for said

valve having a circumferential groove formed in said cylinder inwardly thereof, said groove having a floor and side walls, said groove being formed with means venting the same, a back-up ring in said groove, said back-up ring being formed with integral projecting means slightly spacing the same from at least one wall of said groove, said back-up ring being formed with axially extending peripheral notches slightly spacing the same from the floor of said groove, said notches and projecting means comprising means for venting said back-up ring, said back-up ring having an inner periphery formed with a circumferential seat having an arcuate cross section, a resilient O-ring seated in said seat, and said O-ring having a portion projecting radially inwardly of said back-up ring and cylinder to provide said seat for said valve head.

2. The structure of claim 1, wherein said notches are disposed intermediate said projecting means.

3. In a balanced valve including a cylinder, means mounting a valve head for reciprocal movement in said cylinder; the improvement comprising a seat for said valve having a circumferential groove formed in said cylinder inwardly thereof, said groove having a floor and side walls, said groove being formed with means venting the same, a back-up ring in said groove, said back-up ring being formed with integral circumferentially spaced means slightly spacing the same from at least one wall of said groove providing means for venting said back-up ring in radial directions, said back-up ring being formed with integral circumferentially spaced means for venting the same axially along the floor of said groove, said back-up ring having an inner periphery formed with a circumferential seat having an arcuate cross section, a resilient O-ring seated in said seat, and said O-ring having a portion projecting radially inwardly of said back-up ring and cylinder to provide said seat for said valve head.

4. The structure of claim 3 wherein said last named venting means are each interposed between two of said first named venting means.

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