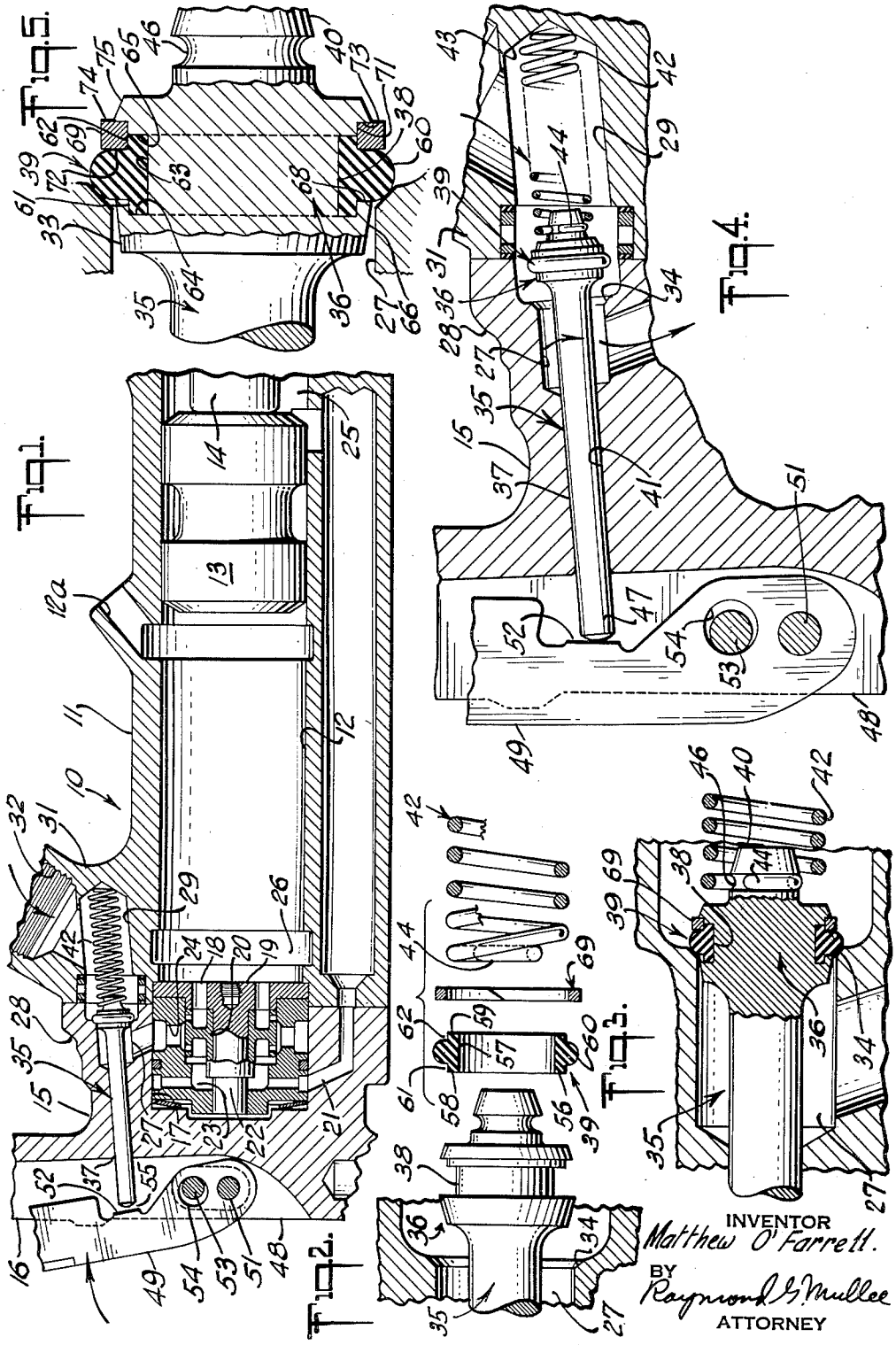
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THROTTLE VALVE FOR PNEUMATIC PERCUSSIVE TOOL

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THROTTLE VALVE FOR PNEUMATIC PERCUSSIVE TOOL

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This invention relates to throttle valves for pneumatically powered devices; and it has for its general object the provision of an improved, practical and efficiently operating throttle valve.

While the throttle valve of the present invention is subject to application in a wide variety of pneumatically powered devices, it is especially suited to pneumatic percussive tools of the demolition type, such as pavement breakers. In this type of tool, during the time the throttle valve is held open, a slide hammer piston is automatically repeatedly reciprocated by pneumatic pressure fluid to pound an anvil against a work steel. When the throttle valve is released to shut-off position, reciprocation of the piston normally stops; but if there is leakage past the throttle valve valuable air power is wasted. It is essential, therefore, in this type of tool that the throttle valve will not leak after it has been released to shut-off position.

An earlier type throttle valve had a metal to metal type seated condition in the tool. This type of valve required careful and expensive lapping of the valve seal and of the valve seat to avoid leakage when the valve was closed. Unless carefully lapped, valves of this construction would become pitted or deformed, and cause scoring of the valve seat with consequent leakage. The damaged valve and the scored seat would have to be reground, if feasible, or replaced.

The operation of a pneumatic demolition tool is such that often the throttle valve is caused to be forcefully seated when suddenly released to shut-off condition. This rough treatment causes damage and early wearing of the throttle valve seal. Conventional type valves are of a unitary or integral nature, so that upon wearing of the valve seal the entire valve is required to be replaced. Such valve structures accordingly increase the operating expense of the tool.

A further object of the present invention is to provide a throttle valve arrangement in a demolition tool providing safeguards against damage to the valve when any forceful seating action occurs.

Another object of the invention is to provide in a pneumatic percussive tool a throttle valve having a readily replaceable seal, so that when the latter is worn or damaged the entire throttle valve need not be replaced.

A still further object of the invention is to provide in a pneumatically powered percussive tool a throttle valve which when released, effectively seals off flow of pneumatic operating fluid to the piston, and has a long lasting and readily replaceable valve seal.

In accordance with the invention a pneumatic flow control throttle valve is provided having a readily replaceable resilient valve seal.

The foregoing and other objects and advantages of this invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein an embodiment of the invention is illustrated. It is to be expressly understood that the drawings are for purposes of illustration and description, and they are not to be construed as defining the limits of the invention.

In the drawings:

FIG. 1 is a longitudinal section through a tool embodying the invention, the tool being broken away to avoid unnecessary detail;

FIG. 2 is an exploded view of the several components of the throttle valve and of an associated portion of the housing of the tool;

FIG. 3 is an enlarged view of the throttle valve in seated condition;

FIG. 4 is an operative detail showing the trigger element actuated and the throttle valve in unseated condition; and

FIG. 5 is an enlarged detail of the valve head.

For a more detailed understanding of the invention reference is now directed to the several figures of the drawing wherein is disclosed a pneumatically powered percussive tool of the demolition type. It includes a housing generally designated **10** having a body portion **11** defining a piston chamber **12**. In the latter a heavy solid slidable hammer piston **13** reciprocates to pound an anvil **14** against a work steel, not shown. A backhead **15** mounted fast to the rear end of the body portion **11** by the usual side bolts, not shown, provides at its rear a transverse grip handle **16** for manually handling the tool. In the forward end of the backhead is an annular chamber **17** in which is housed a cylindrical shift valve casing **19**. An annular inner pneumatic flow chamber **27** in the wall **28** of the backhead communicates by passage means **24** with a valve chamber **23** of a shift valve **20**. The latter has axial slidable movement on a shaft **22** relative to the passage means **24**, and controls flow of pneumatic fluid through the latter from chamber **27** to the valve chamber **23**. In a forward position of valve **20**, as in FIG. 1, pneumatic fluid from passage **24** enters the valve chamber and flows through a connected passage **21** to the forward end **25** of the piston chamber to drive the piston **13** rearwardly away from the anvil **14**; and in a reverse position of valve **20** pneumatic fluid from passage **24** enters the valve chamber **23** and flows through ports **18** to the rear end **26** of the piston chamber to drive the piston forwardly against the anvil. Pressure air spent in driving the piston in one direction or the other exhausts through a vent **12***a* as the piston overruns the latter. Air trapped in the forward end **25** of the piston chamber as the piston terminates its forward stroke is forced over the passage **21** to shift the valve **20** to its forward position; and air trapped at the rear end **26** on a return stroke of the piston forces the shift valve to its reverse position.

The flow chamber **27** is an axial extension of a pneumatic supply chamber **29** formed in part in the wall **28** of the backhead and in part in the wall **31** of the body **11**. Chamber **29** has an inlet **32** adapted for connection with a source of pneumatic pressure air, not shown. A shoulder defined by the greater diameter of chamber **29** relative to chamber **28** is beveled inwardly and rearwardly to provide a conical valve seat **34**.

A throttle valve, generally designated **35**, cooperates with the seat **34** to control flow of operating pneumatic fluid from the supply chamber **29** to the inner chamber **27** and the associated valve chamber **23**. The throttle valve includes a cylindrical valve head **36**. The latter is integral with an elongated guide stem **37** of reduced diameter extending axially from its rear, and is integral with a stub portion or pin **40** of reduced diameter extending axially from its forward end. An annular channel **38** formed in the periphery of the valve head contains a resilient seal ring **39**. The latter, having an outer diameter greater than that of the valve head **36** projects in its peripheral area radially beyond the latter. The throttle valve is axially movable relative to the valve seat **34** so as to engage and disengage the peripheral area of the seal ring with respect to the valve seat. The

throttle valve is guided in its seating movement by means of its stem portion 37. The latter extends from the valve head axially through the inner chamber 27, and moves with a slide fit in an elongated bore 41 formed in the wall 28 of the backhead.

A return coil compression spring 42 disposed in the supply chamber 29 abuts at one end against the end wall 43 of the latter, and at its opposite end is anchored by means of a reduced end coil 44 in an annular groove 46 of the stub end 40 of the throttle valve.

The outer diameter of the valve head is less than that of the inner chamber 27, so that a small coned portion 33 of the valve head located to the left or rearwardly of the seal ring is freely received through the seat opening into the inner chamber 27 when the seal ring is engaged upon its seat, as appears in FIG. 5.

A tail end 47 of the valve stem projects from bore 41 into a trigger guide slot 48 of the handle. A manually operable trigger 49 pivoted in slot 48 on a cross pin 51 has a flat 52 on its inner edge. This flat is cooperable with the tail end 47 of the valve stem upon actuation of the trigger to unseat the throttle valve against the load of the return spring 42. A stop pin 53 fixed across the slot and extending freely through a hole 54 in the body of the trigger predetermines the pivotable range of the trigger relative to the throttle valve. Slight play due to a clearance at 55 exists in the released condition of the trigger between the flat 52 of the trigger and the tail end of the valve stem as in FIG. 1. This clearance is desirable in that it permits the throttle valve to move relative to its seat under the load of the return spring sufficiently to carry the seal ring into full and pressed seating engagement with its seat.

In the operation of the tool, the trigger 49 is manually actuated to unseat the throttle valve, and is held actuated during the operation of the tool. Pneumatic operating fluid accordingly flows from the supply chamber 29 through the unseated valve to the inner chamber 27. From the latter it flows under the control of the shift valve 20 alternately through the valve chamber 23 and associated ports 18 and the connected passage 21 alternately to opposite ends 25 and 26 of the piston chamber 12 to effect reciprocation of the piston 13 relative to the anvil 14. As the trigger is released, the throttle valve is returned by spring 42 to its seated condition. In the latter condition the rounded peripheral surface of the resilient seal ring is held pressed against its conical seat under the combined load of the return spring 42 and pneumatic pressure in the supply chamber 29, whereby the seal ring effectively seals out any leakage of operating pressure air to the valve 20 and the associated piston chamber 12.

In the particular type of pneumatic tool described, as the flow control valve shifts to feed operating pneumatic fluid alternately to the opposite ends of the piston chamber, a back pressure is alternately built up and suddenly relaxed in the inner chamber 27 with each stroke of the piston. The back pressure builds up at the end of a stroke after the piston has momentarily stopped moving in one direction; and this back pressure suddenly relaxes as the piston is suddenly driven by the built-up pressure in the opposite direction. If the trigger 49 is suddenly let go or released at a moment when the pressure in the inner chamber 27 is suddenly relaxed, the throttle valve 35 will forcefully engage its seat under the combined forces of the return spring and pneumatic fluid in the supply chamber. Conventional valves having a lapped fit, or disc type valves will under such forceful seating action rapidly deform, score, wear, and generally break down, so as to require constant replacement of the entire valve.

The particular structure and arrangement of the throttle valve of the present invention avoids this rapid deterioration and consequently provides a throttle valve which is practical, efficient in its operation for controlling intake and shut-off of pneumatic flow to the piston chamber, and is long lasting. It is long lasting in that whatever wear does take place will be primarily in the seal ring 39; but safeguards have been taken to also control this wear to a minimum so that the wearing of the seal ring will be slow and will take place only after long and continuous use of the tool. When the seal ring does eventually become excessively worn it may be replaced, since the entire throttle valve with the exception of the worn seal ring will be in good condition. The seal ring is so arranged upon the throttle valve that it can easily be replaced. A more detailed description of the throttle valve now follows.

The seal ring 39 of the throttle valve is solid in structure, and of resilient compressible or deformable material, here indicated as rubber. The seal ring is T-form in cross section, as appears in FIG. 2. In the latter respect the seal ring comprises an inner annular block or base portion 56. This base has a flat underface 57 defining the inner diameter of the seal ring, and includes opposed parallel side walls 58, 59 of equal height at right angles to the face 57. An annular rib 60 integral with the base 56 and centered about the periphery of the latter divides the surface of the base portion of the seal ring into a pair of flat surfaced arms 61, 62, whereby the T-form of the seal ring is defined. The rib 60 is round in its peripheral surface.

The seal ring is designed to fit snugly in the peripheral channel 38 of the valve head and to be replaceably retained therein. To this end, channel 38 has a floor 63 and side walls 64, 65 respectively complementing the corresponding walls 57, 58 and 59 of the seal ring. An inwardly extending annular flange 66 (FIG. 5) of the valve head overhangs the side wall 64 of channel 38 and overlies the surface of the arm 61 of the seal ring. An inner annular end wall 68 of this flange abuts against the adjacent lower side face of the seal ring's rib 60, as best appears in FIG. 5. Along the opposite side of the seal ring, a split resilient snap ring 69, which is square in cross section, seats in part upon an annular land or step 71 of the valve head adjacent to side wall 65, and seats in part upon the surface of the arm 62 of the seal ring. An inner annular face 72 of the snap ring abuts an adjacent lower side face of the seal ring in opposed relation to the wall 68 of flange 66. A shoulder 73 of the step 71 rises radially relative to the snap ring and abuts the lower portion of the outer face 74 of the latter, whereby the snap ring and the seal ring are retained securely in the channel of the valve head.

The seal ring 39 and the snap ring 69 may be readily assembled to, or disassembled from, the valve head. Since each of these has an inner diameter less than the outer diameter of the shoulder 73 of the valve head, it must be resiliently expanded to pass over the latter. To facilitate this, the valve head has a conical surface portion 75 tapering axially toward the stub end 40. In assembling the throttle valve, the seal ring is freely passed over the stub end 40 and is then forced over the coned surface 75 and shoulder 73 to seat in the groove 38. The seal ring is caused to be seated in the latter in such manner that the arm portion 61 thereof underlies the flange 66. The snap ring 69 is similarly assembled to its proper position. The coned surface 75 of the throttle valve serves to cause expansion of the seal ring and snap ring members as they are passed over this surface, whereupon these elements resiliently restore as they are seated, and are held fast upon the valve head of the throttle valve. Accordingly, the seal ring may, when required, be readily removed and replaced after re-expanding and removing the snap ring.

In the fully assembled throttle valve, the rounded peripheral rib 60 of the seal ring projects radially beyond the outer diameter of the throttle valve head and beyond that of the snap ring as appears in FIG. 5. Further, the overall outer diameter of the fully assembled throttle valve, except for the projecting periphery of the seal ring, is less than the inner diameter, of the valve seat 34 so that at no time in the movement of the throttle valve will any part of the throttle valve head, except for the periphery of

the seal ring, engage the valve seat or adjacent metal areas.

Besides acting to retain the seal ring in the groove of the valve head, the opposed faces **68**, **72** respectively of the flange and snap ring give support to the resilient rib portion **60** of the seal ring over its lower opposed side areas, whereby the crest of the rib is adapted when pressed upon its seat to expand and insure a seal tight engagement of the seal ring with the seat. This supporting arrangement also strengthens the rib of the seal ring at its juncture with its base portion.

While an embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the design and arrangement of the parts without departing from the spirit and scope of the invention; and it is my intent, therefore, to claim the invention not only as shown and described but also in all such forms and modifications thereof as may be reasonably construed to be within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In combination, a housing having a pneumatic pressure supply chamber, a second chamber of reduced diameter in axial extension of the latter and having lateral communication with a pneumatically powered device, an elongated bore through the housing in axial extension of the second chamber, a coned valve seat separating the supply from the second chamber and tapering into the second chamber, the valve seat and the elongated bore having a common axis; a throttle valve controlling flow from the supply chamber to the second chamber, comprising a cylindrical valve head, an elongated guide stem extending axially from the valve head and extending with a slide fit into the elongated bore, a resilient deformable seal ring means removably mounted upon the valve head, means releasably retaining the seal ring upon the valve head, the valve head having a diameter less than that of the second chamber, the seal ring having a hemispherical annual bead projecting radially from the valve head and the bead having a forward annular face and a rear annular face, the forward face being engageable with the valve seat under axial pressure exerted upon the valve head to seal off the supply chamber from the second chamber, compression spring means in the supply chamber together with pneumatic pressure exerting such axial pressure upon the valve head and a rigid snap ring removably anchored upon the valve head in backing relation to the rear face of the seal ring, the outside diameter of the snap ring being slightly less than that of the seal ring, but greater than the inner diameter of the coned valve seat, whereby the outer portion of the seal ring beyond the valve head is under axial compression between the coned valve seat and the snap ring, and whereby deformation occurring in the seal ring is directed in a radial direction beyond the snap ring and over the surface of the coned valve seat, and the snap ring releasably retaining the seal ring upon the valve head.

2. The subject matter of claim 1, wherein the valve head has a squared channel, the seal ring is of T-form having a base complementing the form of the channel and seated therein and having a peripheral rib defining the hemispherical annular bead about the outer face of the base, wherein the rib is centered about the base of the seal ring whereby a pair of annular arms are defined adjacent opposite sides of the rib, an annular flange formed on the valve head overhangs the channel and seats upon one of the said arms and wherein said annular flange has an inner annular face abutting the forward face of the rib in opposed relation to the snap ring, the outer diameter of the inner face of said flange being less than that of the snap ring, and less than the inner diameter of the coned valve seat, whereby a forward area of the bead is provided for contacting the coned valve seat and the rear area of the bead is resisted against axial displacement by the snap ring.

3. The subject matter of claim 2, wherein the valve head has an annular land adjacent to and level with the outer face of the other arm of the seal-ring and has a shoulder upstanding from said land, and the snap ring is seated in part upon said other arm and in part upon said land, and opposite annular faces of said ring are respectively in abutment with the adjacent rear annular face of the rib and with the said shoulder.

4. The subject matter of claim 3, wherein the valve head has a conical surface portion adjacent said shoulder and tapering rearwardly and down from the shoulder in the direction of the stub pin, the ring is a split snap ring adapted when being assembled to the valve head to be received over the stub pin onto the said conical surface and adapted to progressively expand upon being forced over said surface so as to pass over the said shoulder and to snap to normal condition in its seated position.

5. A throttle valve for controlling flow of operating pneumatic fluid in a pneumatically powered tool of a type wherein the throttle valve is subject at times to being forcefully seated upon a coned valve seat in the housing when suddenly released to shut-off condition, comprising an elongated trigger actuable guide stem designed to have a slide fit in the housing of the tool, a valve head of greater diameter than the guide stem integral with an end of the valve head, the inner diameter of the valve seat being greater than outer diameter of the valve head, a resilient T-seal ring having a rounded periphery projecting radially beyond the valve head and having a rectangular base portion removably retained in a complementary peripheral groove provided in the valve head, the seal ring having a forward annular face engageable with the valve seat, a stud pin of reduced diameter relative to the valve head projecting axially from the opposite end of the latter, the stub pin being adapted to be received axially into an end of a coil compression spring and having a peripheral groove adapted to have a complementing end coil of the spring seated fast therein, and a snap ring having an outer diameter less than that of the outer diameter of the seal ring releasably retaining the seal ring in the groove of the valve head, and the snap ring having a rigid vertical annular face abutting an adjacent major corresponding area of the rear annular face of the seal ring.

6. The combination in a throttle valve, comprising an integral member having a cylindrical valve head, an elongated valve guide stem extending axially from the front end of the valve head, a stub pin extending axially from the opposite end of the valve head, and the pin having a peripheral groove midway thereof, the stem and stub pin being of reduced diameter relative to the valve head, a coil spring having a longitudinal axis aligned with that of the valve head and having a reduced end coil received over the stub pin and seated fast in the peripheral groove, a squared channel about the periphery of the valve head, a T-form resilient seal ring having a squared base complementing the channel and removably seated therein, a rib having a rounded periphery integral with the base of the seal ring and extending centrally about the outer surface thereof whereby a pair of arms are defined by the base adjacent opposite sides of the rib, an annular flange provided on the valve head overlying one of said arms and having an end wall abutting the adjacent side of the rib, an annular land in the valve head adjacent to the other arm and level with the outer surface of the latter, a split snap ring of squared cross section seated in part upon the said land and upon the outer surface on the adjacent arm, the snap ring having an annular face in abutment with the corresponding side of the rib, and a shoulder on the valve head adjacent the land abutting the opposite annular face of the snap ring.

7. In combination, a housing having a pneumatic pressure supply chamber, a second chamber of reduced diameter in axial extension of the latter and having lateral communication with a pneumatically powered device, an

elongated bore through the housing in axial extension of the second chamber, a coned valve seat separating the supply from the second chamber and tapering into the second chamber, the valve seat and the elongated bore having a common axis; a throttle valve controlling flow from the supply chamber to the second chamber, comprising a cylindrical valve head, an elongated guide stem extending axially from the valve head and extending with a slide fit into the elongated bore, a resilient deformable seal ring means removably mounted upon the valve head, means releasably retaining the seal ring upon the valve head, the valve head having a diameter less than that of the second chamber, the seal ring having a hemispherical annular bead projecting radially from the valve head and the bead having a forward annular face and a rear annular face the forward face being engageable with the valve seat under axial pressure exerted upon the valve head to seal off the supply chamber from the second chamber, compression spring means in the supply chamber together with pneumatic pressure exerting such axial pressure upon the valve head, and a rigid snap ring removably anchored upon the valve head in backing relation to the rear face of the seal ring whereby deformation occurring in the seal ring during seating action is resisted in a rearward direction and is forced in an upward direction; wherein a stub pin of reduced diameter relative to the valve head extends axially from the latter and has a peripheral groove therein, and the spring means is of coil form having a reduced end coil received over the pin and anchored fast in the said groove.

8. In a pneumatically powered tool including a housing, a piston pneumatically reciprocable therein, a pressure air supply chamber in the housing, a second chamber in axial continuation of the supply chamber and of reduced diameter, a coned valve seat dividing the supply chamber from the second chamber, and an elongated bore of reduced diameter relative to the second chamber and extending axially from the latter through the housing; a throttle valve having a stem that is slidable in the bore and has a free end projecting from the housing, and having a valve head on the opposite end of the stem cooperable with the seat to control flow of operating fluid from the supply chamber through the second chamber to the piston; a spring load pressing the valve head to seated condition; a manipulative lever pivoted in the housing actuable against the free projecting end of the valve stem to unseat the valve head, the valve head being

adapted under the load of the spring and under pneumatic pressure formed in the supply chamber to forcefully seat upon the valve seat when the lever is suddenly released from operating position, wherein the valve head comprises a body of lesser diameter than the second chamber, an annular squared channel about the periphery of the body, a seal ring having a squared base removably seated in the channel, an annular lip on the body facing rearwardly and overlying a marginal adjacent surface of the squared base, an annular land formed in the body rearwardly of the squared base and level with an upper face of the latter, an upstanding shoulder defined by the body rearwardly of the land, a squared snap ring having an inner annular face seated in part upon the land and in part upon an adjacent marginal surface of the squared base, and an annular hemispherical bead projecting radially from the base above the lip and projecting only slightly above the squared ring, the forward external area of the seal ring being engageable with the seat, and the squared snap ring preventing rearward deformation of the external area of the seal ring and permitting radial deformation of the seal ring upon forceful engagement of the latter with the seat; wherein a stop pin in the housing is cooperable with a slot in the manipulative lever to allow slight free play of the lever relative to the free end of the valve stem so as to permit the lever to be clear of the valve stem in a seated condition of the seal ring; and wherein the spring load is a coil spring axially aligned with the valve head, the spring coil having one end abutting a rear wall of the supply chamber and having a reduced end coil at its opposite end, and wherein the valve head has a stub pin extending from its rear received in the end coil and having a peripheral groove in which the end coil is seated fast.

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