April 29, 1969 W. ASLAN 3,441,249

FLOW CONTROL VALVE

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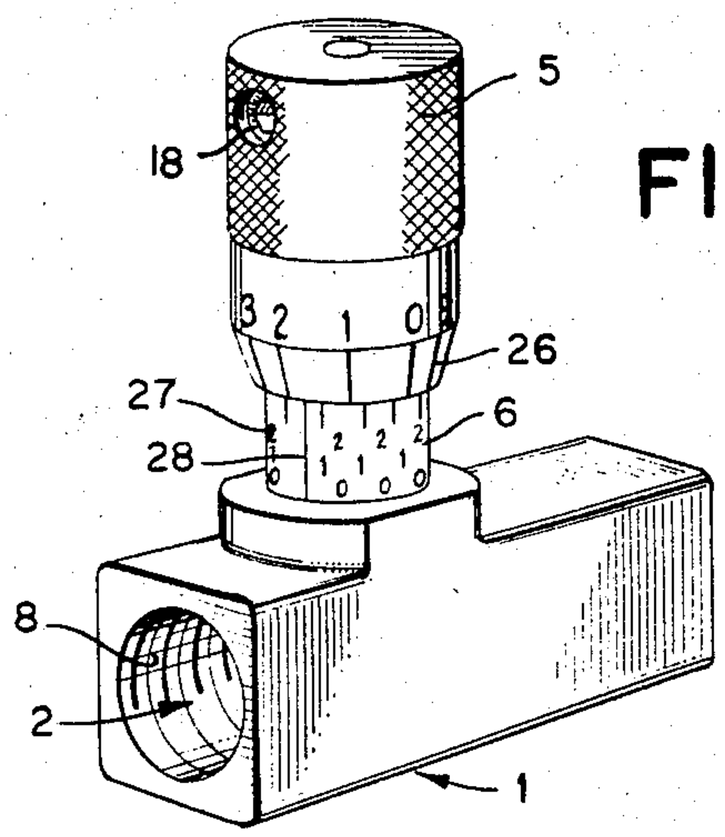


FIG. 1

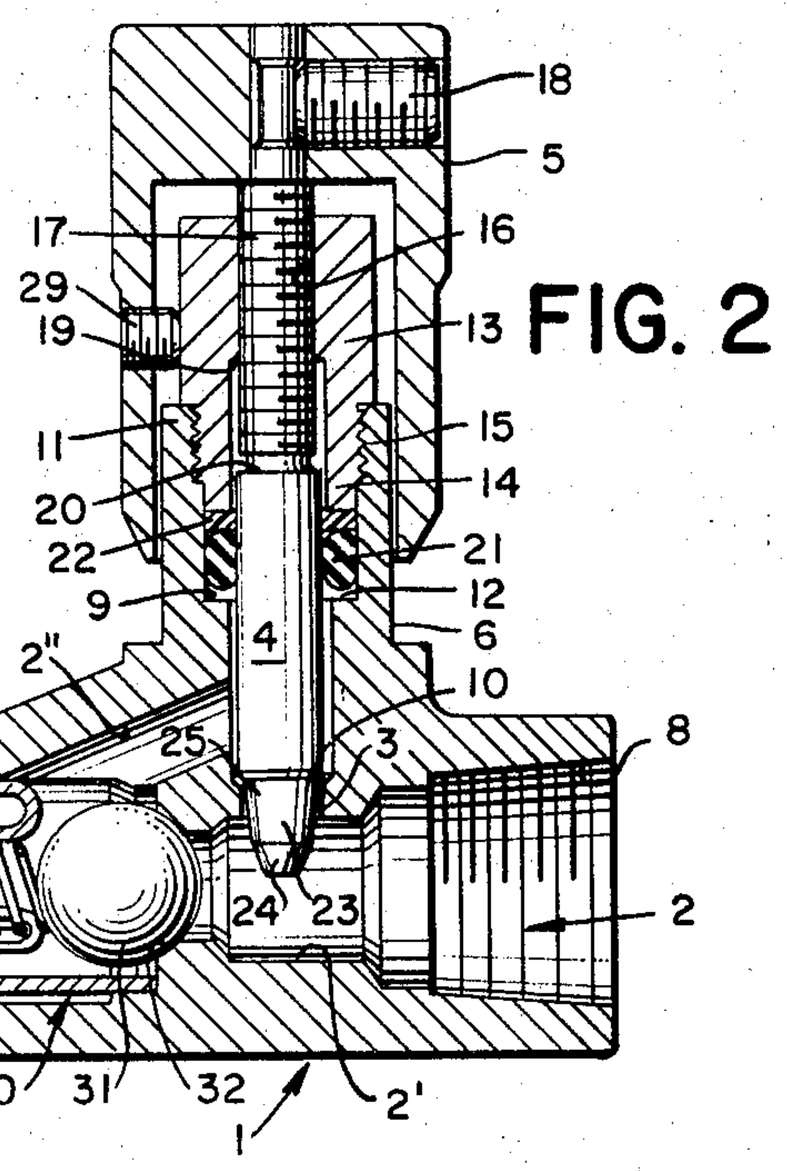
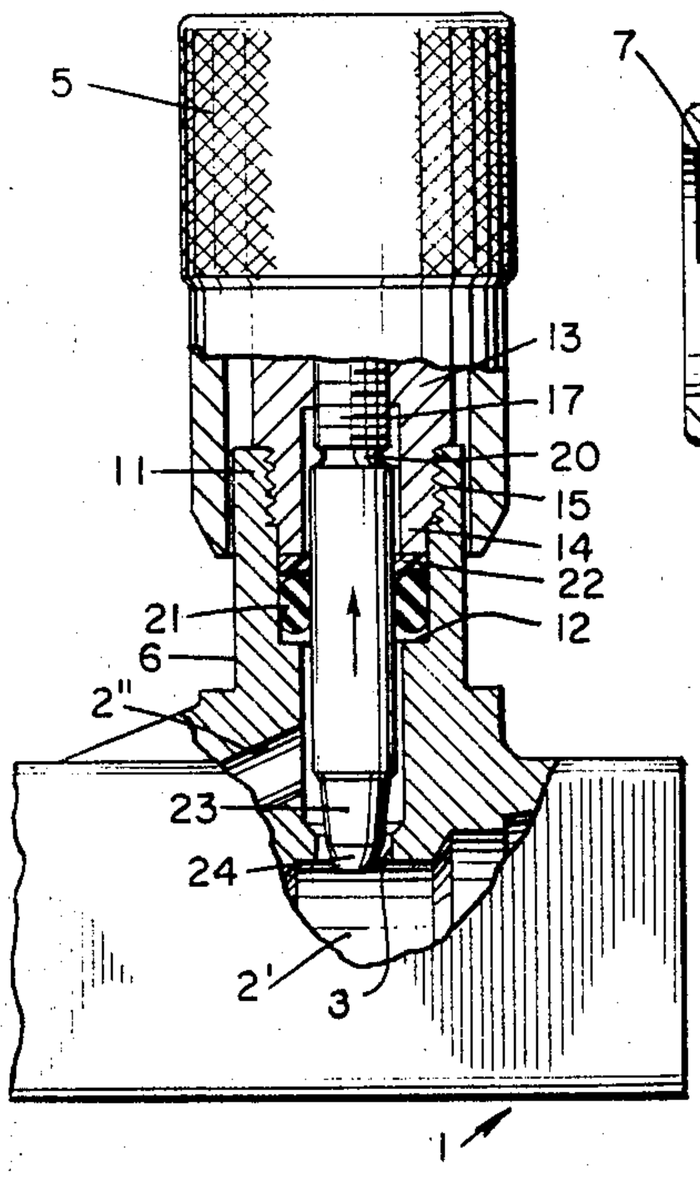


FIG. 2

FIG. 3



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FLOW CONTROL VALVE

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ABSTRACT OF THE DISCLOSURE

A flow control valve having a body member with a passageway extending therethrough, a valve seat in the passageway defining an orifice connecting separate portions of the passageway together; and a metering mechanism for controlling the rate of flow through the orifice comprising a needle valve member movable transversely of the valve seat, said needle valve member having first and second conically tapered metering portions cooperating with said valve seat with the first portion disposed axially outwardly of said second portion and having a taper angle larger than the taper angle of the first portion.

The present invention relates to flow control valves for regulating the flow of fluid and more particularly to a flow control valve of the needle type construction which is compact and inexpensive to produce, one which has a relatively large unrestricted flow area between axially aligned ports and in which the needle, disposed between the ports may be precisely adjusted to vary the rate of flow of fluid through the valve.

Flow control valves having an adjustable needle member disposed between end ports of the valve are presently available; however, they possess certain inherent characteristics as far as their structure and operation which are undesirable. In these constructions, the needle is adapted to cooperate with a metering orifice disposed internally of the valve to vary the size of the fluid passageway extending through this orifice. This adjustment of the size of flow passageway is effected by moving the needle into and out of the orifice; however, with present constructions, the degree to which the fluid flow is controllable varies as the needle is moved between a fully closed position and a fully opened position. Thus, in some situations, accurate control of the fluid flow may be effected for only low flow rates and not for medium or large flow rates while in other situations where the needle valve is constructed for accurate adjustment of medium and large flow rates, the needle is less sensitive to low flow rates.

Also, with conventional flow control valves of this type, the needle mechanism is typically comprised of a number of separate parts with the connections between these parts in direct communication with the internal pressure created by the fluid passing through the valve. Such a construction gives rise to fluid sealing problems and requires that extra care be taken in assuring that these connections are completely leak proof and this, of course, adds to the expense involved in forming the parts that make up the valve and in assembling them together.

With flow control valves having an adjustable needle for varying the fluid flow through the valve, it is also necessary that there be an outer positive limit to which the needle member may be moved. More specifically, the needle member, once it has moved to a fully opened position, must be prevented from being accidently disconnected from the valve body for this would open the valve to atmosphere. For this purpose, conventional valves of this type incorporate a separate locking mechanism for locking the needle member against movement away from the cooperating metering orifice once a fully opened position has been attained. Due to the fact, however, that these locking mechanisms are separately constructed, they add to the assembly operations necessary in making a complete unit and thus add to its overall expense.

In addition to the fact that steps must be taken to prevent accidenal removal of the needle member in valves of this construction, it is nevertheless sometimes desirable to be able to disassemble the needle member from the valve housing as for example where repairs or replacement is found to be in order. With presently constructed valves of this type, however, this can require that the entire valve unit be first removed from the system in order to gain access to the internal structure of the needle mechanism for releasing the locking mechanism. It is apparent that this can result in excessive down time and as such is undesirable.

In accordance with the teachings of the present invention, the disadvantages encountered with conventional valve constructions of the needle type are eliminated. Generally, the valve of the present invention includes a body member having a flow passageway extending therethrough, a valve seat positioned within the passageway and forming a metering orifice connecting together two portions of the passageway, and a needle valve member mounted on the valve body for movement toward and away from the valve metering orifice to control the rate of fluid flow through the orifice.

For purposes of mounting the needle valve member in operative position with respect to the valve metering orifice, the valve body is provided with a support member formed integrally therewith. The needle valve member is, in turn, received in an opening extending through the support member and retained therein by means of a retainer connected to the support member. The metering end of the needle valve member which is positioned for cooperating with the metering orifice is provided with differently tapered portions so that the rate of flow of fluid through the orifice may be accurately controlled for both low and higher flow rates while the opposite end of the needle valve member extends outwardly beyond the support member and retainer and has connected thereto a control knob. This control knob is adapted to be manually actuated to move the needle valve member axially within the support member to thereby adjust the size of the metering orifice.

To prevent leakage of the fluid through the needle valve support member and in order to disassociate the connection point of the retainer to the support member from the fluid pressure created within the valve body, a seal is effected between the needle valve and surrounding support member at a location disposed between the retainer and the valve fluid passageway. In this way, fluid within the valve is prevented from reaching the point of connection of the retainer and thus, this connection need not be precision made in the sense of being leak proof.

In accordance with a further aspect of the present invention, a positive locking arrangement is provided for preventing accidental disconnection of the needle valve member as it is moved outwardly away from the metering orifice. In particular, the needle valve member intermediate its ends is provided with a flange facing in a direction away from the orifice and the retainer is provided with a cooperating oppositely facing flange. These flanges are oriented with respect to each other so that once the needle valve member is moved axially outwardly of the metering orifice to fully open the metering orifice, they will come into direct engagement with each other and thereby limit the movement of the needle valve member in this direction.

In addition to limiting the outward movement of the needle valve, the stop mechanism of the present invention is constructed so as to be readily accessible by the opera-

tor whereby the metering valve mechanism may be completely disassembled if desired. For this purpose, the retainer member is releasably connected to the support member and since it defines one part of the stop mechanism, its removal will permit full removal of the needle valve member.

A more complete understanding of the present invention will be obtained from a reading of the following detailed description thereof with reference being made to the accompanying drawings of which:

FIG. 1 is a perspective view of the flow control valve of the present invention;

FIG. 2 is a cross-sectional view of the valve shown in FIG. 1 with the needle valve shown in one position of adjustment; and

FIG. 3 is a partial cross-sectional view of the valve of FIG. 1 with the needle member shown in a second position of adjustment.

As shown in FIGS. 1 and 2, the flow control valve of the present invention is generally comprised of a valve body member **1** having a flow passageway **2** extending therethrough, a metering orifice **3** positioned intermediate the ends of the passageway, a needle valve metering mechanism **4**, and a control knob **5** attached to the needle valve member for adjusting the position of the latter with respect to the metering orifice.

The body member **1** of the valve is constructed of a one-piece, high tensile strength, brass forging; and as an integral part thereof, an outwardly extending support member **6** is formed for supporting the needle valve metering member **4**. The fluid flow passageway **2** extending through the valve body is generally divided into two portions. One portion **2'** extends axially through the valve body from oppositely disposed valve ports **7** and **8** while the other portion **2''** is defined by a drilled hole extending at an angle relative to the portion **2'**. This drilled hole communicates at one end with the passageway portion **2'** and at its other end with an opening **9** extending through the support member **6**. This opening **9**, in turn, communicates with the metering orifice **3** and through this orifice is connected directly to the portion **2'** of the passageway. A valve seat **10** surrounds the metering orifice and faces in a direction toward the opening **9** of the support member for cooperating with the needle valve member to completely close the orifice as more fully described below. As shown in FIG. 2, the portion **2''** of the flow passageway **2** is aligned with respect to the port **7** whereby the drilling of this portion may be effected through the port **7**.

The support **6** for the needle valve **4** extends outwardly of the valve body and terminates in an internally threaded end **11**. The opening through the support member is enlarged adjacent this end to define a seat **12** facing in a direction away from the metering orifice **3**. The needle valve member **4**, constructed of heat treated, ground and polished 416 stainless steel or the like, extends longitudinally through the support member and is held therein by means of a retainer **13** formed of cold drawn brass. This retainer has an externally threaded neck portion **14** extending downwardly into the enlarged opening of the support member terminating at a position spaced from the seat **12**. The retainer is connected to the support member by threaded engagement therewith as shown at **15** and is provided with a threaded bore **16** through which the needle valve member extends. The needle valve member is, in turn provided with a cooperating threaded portion **17** for threadably connecting it to the retainer.

In assembling the parts of the valve so far described, the needle valve member is threaded through the retainer and the retainer, in turn, threaded to the support member until it is sufficiently tight so as to remain fixed relative to the support member upon subsequent rotation of the needle valve member. The axial position of the needle valve member may then be adjusted relative to the metering orifice **3** by rotation thereof relative to the support member and retainer; and for this purpose, the outwardly

extending end of the needle valve member is provided with the control knob **5** which is locked thereto by means of a set screw **18**.

To prevent accidential removal of the needle valve member as would otherwise occur by its continued movement in a direction away from the metering orifice, the retainer **13** and needle valve member **4** are provided with cooperating positive locking flanges **19**, **20**, respectively. The flange **19** is formed along the bore **16** of the retainer and faces in a direction toward the metering orifice **3** while the flange **20** of the needle valve member faces in a direction away from the metering orifice **3**. With this construction, movement of the needle valve member outwardly of the metering orifice will eventually bring these flanges into engagement with each other and thus prevent further rotation thereof as would cause its complete removal from the support member. The location of the flange **19** of the retainer is so oriented relative to the metering orifice so that when engaged by the flange **20** of the needle valve member, the valve member will have moved to a fully opened position with respect to the metering orifice to allow maximum flow of fluid therethrough.

In accordance with a further aspect of the present invention, leakage of fluid through the support member is prevented by means of an O-ring **21** of resilient material disposed about the needle valve member. This sealing means is positioned with respect to the point of threaded connection **15** of the retainer **13** to the support member **6** so that fluid pressure created within the fluid passageway of the valve will be prevented from reaching this connection. More specifically, the O-ring is positioned within the opening **9** of the support member **6** intermediate the seat **12** of the support and the neck **14** of the retainer and is backed up by an annular washer **22** constructed of Teflon or suitable material positioned adjacent the retainer neck **14**.

The needle valve member **4**, as shown in FIGS. 2 and 3, is constructed to provide accurate control of the fluid flow through the metering orifice **3** both for low flow rates and for medium and large flow rates. For this purpose, the operative end of the metering valve member is provided with two conically tapered portions **23**, **24**. The portion **23** is tapered at a 3° angle relative to the longitudinal axis of the needle valve member while the portion **24** is tapered at a 15° angle with respect to the axis of the needle valve member. With this construction, the needle valve member when positioned as shown in FIG. 2 for controlling low flow rates will have its finer tapered portion **23** in cooperating relationship with the metering orifice **10** to permit a fine adjustment of the size of the metering orifice. On the other hand, when the needle valve member is retracted to the position of adjustment shown in FIG. 3 for controlling higher flow rates, the coarser tapered portion **24** will be disposed in operative relationship relative to the metering orifice and thus permit a more accurate adjustment of such flow. In addition to the conically tapered portions of the needle valve member, a seat portion **25** is constructed to face the valve seat **10**. Accordingly, a complete closing of the metering orifice may be effected by turning of the needle valve until the portion **25** is seated against the valve seat **10**. As clearly shown in FIG. 2, the seat portion **25** is formed at the upper section of the tapered portion **23**. In other words, the tapered portion **23** has a minimum diameter less than the diameter of the orifice of the valve seat and a maximum diameter larger than the diameter of the orifice.

As an aid in setting the position of the needle valve member to provide the desired opening through the metering orifice **3**, the control knob **5** and support member **6** are provided with cooperating calibrated dials. In particular, the control knob which is generally cup-shaped is provided around its open end with uniformly spaced graduation marks **26** ranging from zero to nine. The outer surface of the support member **6** is, in turn,

provides with a plurality of rows of indicia **27** disposed in cooperating relationship with the graduation marks on the control knob.

As shown in FIG. 1, each row of indicia is comprised of a single set of numbers ranging from zero to five and each row is uniformly spaced from the adjacent row along the axis of the needle valve member. In addition, the support member is provided with an axially extending reference line **28**. The pitch of the threads of the portion **17** of the needle valve member is such that one full rotation of the control knob will effect an axial movement thereof from one row of indicia **27** of the same relative position on the next row of indicia. Accordingly, with this arrangement, it is apparent that the position of the needle valve member relative to the metering orifice may be repeatedly set at the same value by appropriate adjustment of the control knob and the graduation marks **26** relative to the indicia **27** and reference line **28**. A set screw **29** extending through the control knob may be tightened against the retainer member to lock the metering valve in any desired position of adjustment against accidental movement.

A check valve mechanism generally designated at **30** is positioned within the passageway **2** between the metering orifice **3** and the connection of the passageway portion **2''** with the portion **2'**. This check valve mechanism permits the flow of fluid through the valve body to bypass the metering orifice **3** when in a direction to the left as viewed in FIG. 1. When, however, the flow of fluid is in the opposite direction, the check valve will remain closed and the fluid will be caused to flow through the metering orifice and will thus be under the control of the metering mechanism.

The check velve mechanism is generally comprised of a ball member **31** resiliently urged against a check valve set **32** formed in the portion **2'** of the passageway. The ball **31** is held in operative position within the passageway by means of a ball retainer member **33** and spring member **34**. The specific details of the ball check mechanism forms the subject matter of another application, Ser. No. 510,645 filed on Nov. 30, 1965 and reference is made to that application for a complete description thereof.

The above description of the present invention is of the preferred embodiment; however, it is to be understood that various changes may be made thereto without departing from the scope of the invention as set forth in the following claim.

I claim:

1. A flow control valve comprising a body member having a passageway extending therethrough, a valve seat disposed in said passageway and having an orifice therethrough connecting one portion of said passageway to a second portion thereof, a support member disposed on one side of said valve seat and extending outwardly from said body member, and a metering mechanism mounted on said support member for controlling the rate of flow of fluid through said orifice, said mechanism comprising an elongated cylindrical needle valve member mounted for axial movement transversely of said valve seat from a first position disposed within said orifice and seated against said valve seat to close said orifice to a second position spaced axially of said first position on said one side of the valve seat to open said orifice, said needle valve member having two tapered metering surfaces at the free end thereof which are tapered in the direction of movement of said needle valve member from said second position to said first position, said metering surfaces comprising first and second conically tapered portions with the first portion disposed axially outwardly of said second portion, said first portion having a taper angle as measured from the axis of said needle valve member of about 15° and said second portion having a taper angle of about 3° with a minimum diameter less than the diameter of said orifice through said valve seat and a maximum diameter larger than the diameter of said orifice.

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