

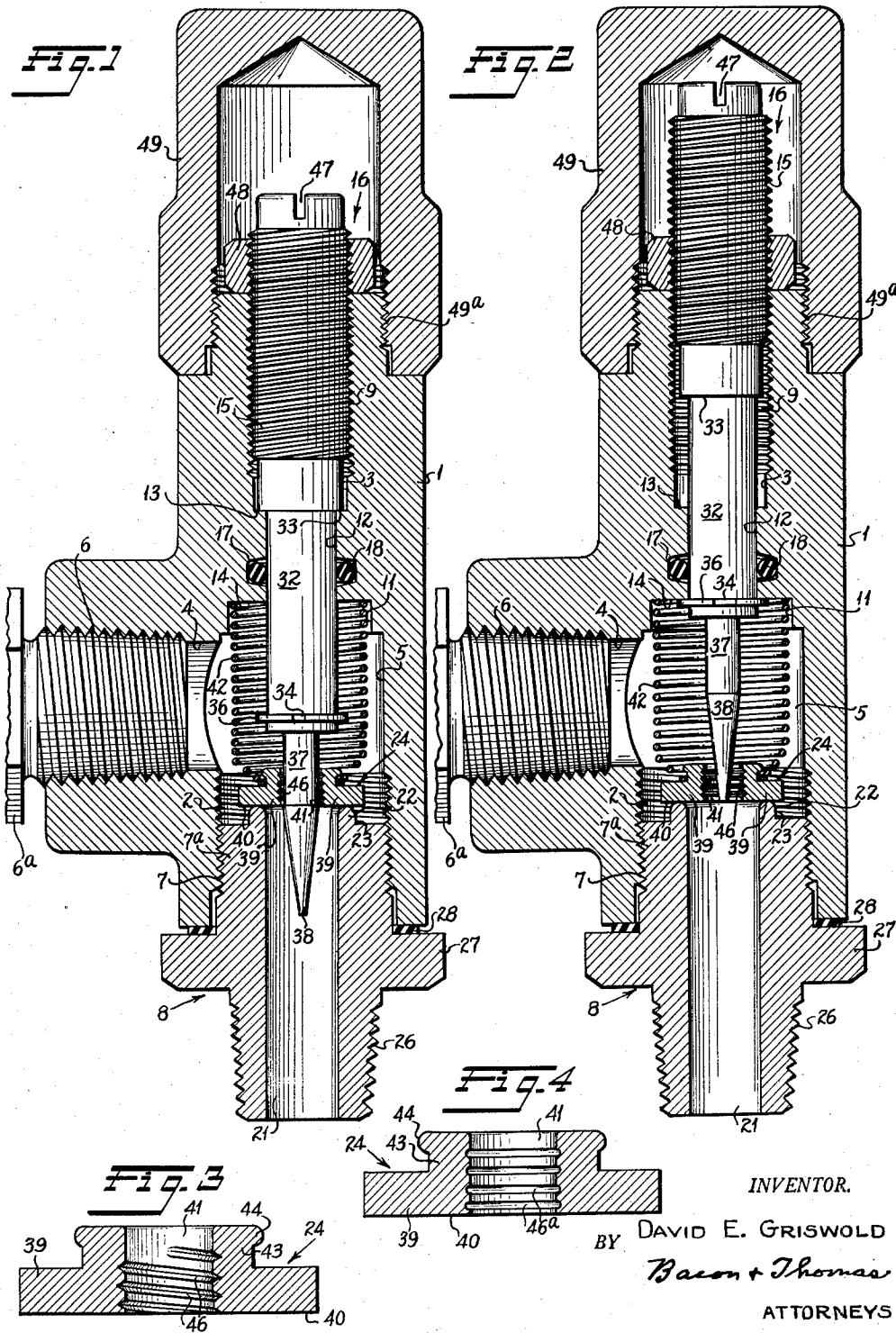
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COMBINATION ADJUSTABLE NEEDLE AND CHECK VALVE

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COMBINATION ADJUSTABLE NEEDLE AND CHECK VALVE

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The present invention relates to a combination needle and check valve and more particularly to a valve of this type which is very sensitive and adapted for extremely fine and accurate adjustment.

It is often necessary in hydraulically controlled systems to provide for full flow of liquid through a conduit in one direction and restricted flow therethrough in the reverse direction. The present valve device is ideal for this purpose.

It is the primary object of the present invention to provide, as a single compact unit, a combination valve device which will act as a check valve to permit substantially unobstructed flow of liquid in one direction, and which will also function as a needle valve to permit a regulatable, restricted flow in the opposite direction.

Another object is to provide a combined needle and check valve wherein the needle valve has no tendency to clog at the region of greatest restriction, which is an inherent fault of present needle valves.

Still another object is to provide a combined needle and check valve in which the needle valve will be automatically cleaned through the normal operation of the check valve.

A further object is to provide a combined needle and check valve in which the needle valve will have its most sensitive adjustment when the need therefor is most critical, namely, at its point of maximum flow restriction.

A still further object is to provide a combined needle and check valve in which the check valve closure member will seat firmly and with great rapidity.

Yet another object is to provide a combined needle and check valve in which the needle valve may be easily adjusted and firmly locked in adjusted position.

Another object is to provide a combined needle and check valve which can be economically manufactured and assembled.

Other and further objects of the invention will be apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a vertical sectional view showing the stem of the needle valve in its position of maximum restriction;

Fig. 2 is a similar view showing the stem of the needle valve in its position of minimum restriction;

Fig. 3 is an enlarged sectional view showing the construction of the disk which serves as the check valve; and

Fig. 4 is a similar view showing a modified form of disk.

The combined needle and check valve of the present invention comprises a housing 1, preferably cast of brass or bronze in a generally T-shaped configuration. The housing 1 is provided with aligned bores 2 and 3 at the ends thereof and with another bore 4 in its stem portion extending normally to the aligned bores 2 and 3. Bores 2, 3 and 4 all communicate with a valve chamber 5 within the housing 1.

Bore 4 serves as an outlet or inlet, depending upon the direction of liquid flow through the housing 1, and is internally threaded as at 6 for the reception of a fitting

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6a for connection with a suitable conduit (not shown) of the hydraulic system in which the valve is being employed.

Bore 2 is internally threaded as indicated at 7 for the reception of a correspondingly threaded portion 7a on a fitting designated by the numeral 8, which fitting will be described in detail hereinafter.

Bore 3 includes axially spaced, enlarged portions 9 and 11, and a relatively restricted intermediate portion 12, which provides shoulders 13 and 14, the purpose of which will also be explained later.

Enlarged portion 9 is threaded for the reception of a correspondingly threaded portion 15 of a needle valve stem, generally designated by the numeral 16. The specific construction of this stem will be set forth at a later point herein.

The portion of the valve housing 1 forming the restricted portion 12 of bore 3 is provided with an annular groove 17 for the reception of a conventional O-ring 18, which may be formed of rubber, either natural or artificial, and which engages the needle valve stem 16 to form a seal therewith.

The fitting 8 is provided with a central passage or bore 21, which constitutes a port for the flow of liquid in either direction. Fitting 8 is provided at its upper or inner end with a valve seat 22 formed by relieving a portion of the face of the inner end, as at 23. The valve seat 22 is rounded to provide for substantially line contact with the closure member of the check valve, which is generally designated by the numeral 24 and will be described in detail later. The outer end of fitting 8 is threaded as at 26 for connection with a conduit (not shown) in the hydraulic system in which the instant combined needle and check valve is to be employed.

An enlarged portion 27 is provided on the fitting 8 intermediate the threaded end portions 7a and 26 and conveniently may be shaped to be engaged by a tool for screwing the fitting 8 into position. A gasket 28, preferably of soft metal, such as copper, is inserted between the enlarged portion 27 and the adjacent end of the valve housing 1 to prevent leakage.

The needle valve stem 16 is preferably of stepped construction and comprises the enlarged upper threaded end portion 15 adjustably received in the threaded enlarged portion 9 of bore 3. Adjoining the enlarged portion 15 is a reduced, smooth, intermediate portion 32, which provides a shoulder 33 at its upper end adapted to abut against the shoulder 13 of bore 3 to limit adjusting movement of needle valve stem 16 in one direction. The intermediate portion 32 is provided adjacent its lower end with an annular groove 34 for the reception of a snap ring 36, which is adapted to contact shoulder 14 of bore 3 and limit the travel or adjustment of the needle valve stem 16 in the opposite direction. The diameter of the intermediate portion 32 closely conforms to that of the restricted portion 12 of bore 3, so that it will be contacted by O-ring 18 and effectively sealed against leakage.

Needle valve stem 16 is provided with a further reduced lower end comprising a smooth, cylindrical portion 37 and a tapered or conically-shaped tip 38.

Surrounding the reduced end portion of needle valve stem 16 is the check valve closure member 24, which comprises a relatively thick disk portion 39 provided with a centrally located orifice or bore 41 for this purpose. The disk portion 39 has a lapped lower face 40 which engages the seat 22, and is urged toward said seat by a coil spring 42 bearing at one end against a portion of the shoulder 14, the spring being preferably dimensioned so as to fit with slight clearance within the enlarged portion 11 of bore 3. The other end of coil spring 42 is

secured to disk 39 and for this purpose a portion of the outer periphery of the upper end of the disk is removed to form a raised neck 43 provided with a bead 44 below which a convolution of spring 42, smaller in diameter than the remainder of said spring, is disposed and retains said disk in assembled relation with said spring.

As is best shown in Fig. 3, the circumferential wall defining the bore 41 of check valve member 24 is provided with an interrupted or serrated surface similar to that of a "fluid pack." To accomplish this end, the bore 41 is preferably tapped with a conventional thread tap to provide a shallow helical groove 46 extending substantially the length of the bore, but terminating short of the upper end of said bore. The cylindrical stem portion 37 has a clearance of .001 to .002 of an inch with the cylindrical surface of the bore 41. With this construction, a turbulent flow will be imparted to liquid when flowing from port 4 into passage 21, through the slight clearance space between the wall of bore 41 and the needle valve stem portion 37, which materially reduces the flow rate permitting a very fine adjustment particularly when said stem portion is adjusted so that it occupies the full length of the bore 41 to provide maximum restriction, as illustrated in Fig. 1.

If desired, the "fluid pack" may be obtained by other means. For example, the helical groove 46 may be replaced by a series of spaced, shallow annular grooves 46a, as shown in Fig. 4.

The "fluid pack" as embodied in the present valve represents a new application of the same since it is not embodied herein in the customary manner as a sealing means, but rather as a means to effect a fine adjustment in the rate of flow of liquid through the check valve member 24. Tests have shown that the presence of the serrated surface in the disk bore 41 reduces the volume of flow to about one-half of what it would be without the serrations but with a minimum clearance between the stem portion 37 and the bore 41. The principle involved, and which results in the reduced flow along the stem portion 37, is that the liquid flow is interrupted by the irregularities provided by the helical groove 46, or the annular grooves 46a, which require the fluid to flow from a restricted region at the upper end of the bore 41 into an enlarged zone and then again into a restricted zone, consecutively, and this creates a turbulence or flow resistance that substantially reduces the flow rate along the stem portion 37.

In order to obtain the desired adjustment of needle valve stem 16 by screwing it in or out, the upper end of the stem is provided with a kerf 47 for the reception of a screw driver. A lock nut 48 is provided to maintain the needle valve stem 16 in a selected, adjusted position, a cap 49 is mounted on a threaded extension 49a at the upper end of the housing 1 to enclose and thus protect the adjusting mechanism against damage and unauthorized tampering.

The adjustable mounting of the needle valve stem 16 is such that when it is screwed outwardly the tapered end 38 of said stem increases the clearance between said stem and the bore 41 of the disk 39 and correspondingly increases the flow volume through said disk from port 4 to passage 21, so that any desired rate of flow within the capacity of the device can be effected through the adjustment of said needle valve stem. The present construction of needle valve set and check valve disk provides for extremely sensitive adjustment near the minimum flow capacity range illustrated in Fig. 1; in that the initial decrease in the restrictive adjustment occurs as the cylindrical portion 37 of the needle valve stem 16 is moved outwardly relative to the serrated bore 41 of the check valve disk, thereby reducing the effective length of the minimum clearance passageway between the valve stem and disk and providing a very gradual rate of capacity increases. In other words, an

extremely fine adjustment can be effected by varying the length of the cylindrical portion 37 that projects into the bore 41 when the valve disk member 24 is in its seated position. Upon complete withdrawal of the cylindrical portion 37 to a position above the bore 41, the flow capacity will be appreciably increased and can be further increased upon adjustment to continue the retraction of the tapered portion 38 from the bore 41. Normal usage of the present valve usually involves a condition where the point of maximum restriction is the most critical and consequently this extremely sensitive adjustment in capacity is a very desirable feature.

It has been found desirable to construct the device so that in one extreme position of adjustment of the needle valve stem 16, the region at which the reduced portion 37 merges into the tip 38 lies in the same horizontal plane as the valve seat 22 (see Fig. 1), and in the other extreme position of adjustment, the point of the tip 38 lies in said plane. (See Fig. 2).

In other words, the length of the conical portion 38 corresponds to the maximum extent of adjustment of the needle valve stem 16. In addition, the parts are so proportioned that the needle valve stem 16 always extends, more or less, into the disk portion 39.

The combined needle and check valve just described may be easily assembled. With O-ring 18 inserted in groove 17, the needle valve stem 16 is screwed into place, and with a suitable tool inserted through bore 2 or 4, the snap ring 36 is positioned in annular groove 34. The check valve closure member 24, with the coil spring 42 attached thereto, is next inserted through bore 2 with the orifice or bore 41 circumscribing the lower end of the needle valve stem 16 and the upper end of the coil spring positioned in the enlarged portion 11 of bore 3. It is then only necessary to screw home the fitting 8 so that valve disk member 39 will engage the rounded valve seat 22. Any desired adjustment can then be made of the needle valve stem 16 to suit the requirements of the system in which the device is to be used. The lock nut 48 is then tightened to maintain this adjustment, and the cap 49 placed over the upper end 49a of the housing 1.

The operation of the assembled valve will be readily apparent. When liquid under sufficient pressure to overcome the force of spring 42 flows into the passage 21 the disk 39 will be lifted upwardly from its seat 22 against the action of coil spring 42 and slide along the needle valve stem 16 so that substantially unrestricted flow of liquid will be permitted into the bore 4.

On the other hand, if the direction of greater pressure is reversed, the check valve member 24 will move to closed position very rapidly under line pressure and the action of coil spring 42, and the surface 40 will quickly seat on valve 22. Flow in the reverse direction is then restricted in accordance with the pre-adjusted position of the needle valve stem 16 relative to the bore or orifice 41 in the disk 39. The disk member 24 seats itself immediately and thus provides quicker action than the conventional spring-pressed ball type of check valve, wherein the ball has a tendency to roll in an orbit before finding its final seating position.

In the normal usage of the device, the adjustment of the needle valve stem 16 is usually close to the point of maximum restriction, which makes the greatly reduced flow produced by the interrupted surface of the bore 41 an important feature of the invention.

Moreover, it should be noted that the relative movement between the check valve disk member 24 and the lower cylindrical end portion 37 of the needle valve stem 16, when the device is acting as a check valve, serves a very important function. Thus, the grooved "fluid pack" formed in the bore of the disk 39 provides tooth-like projections that clean the surfaces of the stem coming in contact therewith and thereby prevent foreign matter from collecting at the point of maximum restriction since such matter is physically displaced as the valve

disk member 24 slides along the needle valve stem 16 during the normal functioning of the device as a check valve.

Thus, it is seen that by the present invention, I have provided, as a single compact unit, a combined needle and check valve, which will permit substantially unrestricted flow in one direction, and accurately adjusted, restricted flow in the opposite direction, and, moreover, one which will possess a self-cleaning action.

It will be understood that variations may be made in the sizes of the valve parts and in the details of construction thereof disclosed herein without departing from the principles of the invention or the scope of the annexed claims.

I claim:

1. A combined variable flow restricting and check valve comprising, a housing having a chamber formed therein and having a pair of ports in communication with said chamber adapted to serve as either inlet or outlet ports depending upon the direction of flow of liquid through said valve; spring-loaded check valve disk means in said chamber insertible into said chamber through one of said ports, said one port being internally threaded and having a fitting including a valve seat at its inner end, removably mounted in said one port, the other end of said fitting being adapted to be connected with a conduit, the other of said pair of ports being adapted to be connected with a conduit, said check valve disk means co-operable with said valve seat to permit substantially unrestricted flow into said chamber when the pressure in said one port exceeds the spring load, said disk means having a central orifice extending therethrough of predetermined uniform size; and a valve stem having a portion of uniform cross section and a portion of varying cross section, to permit a variable restricted flow therethrough from said chamber upon the reversal of pressure conditions, said valve stem including means for adjustment to any position between one extreme position in which only the portion of varying cross section occupies the central orifice to another extreme position in which only the portion of uniform cross section occupies said central orifice.

2. A combined needle and check valve for permitting substantially full flow of liquid in one direction therethrough and restricted flow in the reverse direction, comprising: a valve housing having a chamber formed therein and having a pair of ports in communication therewith adapted to serve interchangeably as inlet and outlet ports depending upon the direction of liquid flow through said valve; one of said pair of ports being internally threaded and having a fitting including a valve seat at its inner end removably mounted in said one port, the other end of said fitting being adapted to be connected with a conduit, the other of said pair of ports being adapted to be connected with a conduit; a check valve member insertible into said chamber through said one port and adapted to seat on said valve seat, said check valve member comprising a disk having a centrally located bore therein; and a needle valve stem projecting into the bore of said disk, said needle valve stem having a cylindrical portion and a pointed portion, means to adjustably mount said needle valve stem in said housing on the same side of said valve seat as said check valve disk, whereby adjustment of said needle valve stem varies the effective area of flow through said bore, and the opening movement of said check valve, resulting from a reverse flow therethrough, increases the extent of projection of the needle valve stem into the bore of said disk, said needle valve stem being adjustable to any position between one extreme position in which only the pointed portion occupies the bore of said disk to another extreme position in which only the cylindrical portion occupies said bore.

3. A combined needle and check valve for permitting substantially full flow of liquid in one direction there-

through and restrictive flow in the reverse direction, comprising: a valve housing having a chamber formed therein and having a pair of ports in communication therewith adapted to serve interchangeably as inlet and outlet ports depending upon the direction of liquid flow through said valve, one of said pair of ports being internally threaded and having a fitting including a valve seat at its inner end removably mounted in said one port, the other end of said fitting being adapted to be connected with a conduit, the other of said pair of ports being adapted to be connected with a conduit; a check valve member insertible into said chamber through said one port and adapted to seat on said valve seat, said check valve member comprising a disk having a centrally located cylindrical bore portion therein of substantially uniform diameter; a needle valve stem mounted in said housing on the same side of said valve seat as said check valve member and having a cylindrical portion and a pointed portion, the cylindrical portion extending into said bore in said disk with very slight clearance to thus provide a minimum clearance space, said needle valve stem being adjustable to any position in which only the pointed portion occupies the bore of said disk to another extreme position in which only the cylindrical portion occupies said bore; and one of said portions having a smooth surface and the other portion having a cooperating interrupted surface for restricting the flow of liquid through said clearance space.

4. A combined needle and check valve for permitting substantially full flow of liquid in one direction and restricted flow in the reverse direction, comprising: a valve housing having a pair of ports adapted to serve interchangeably as inlet and outlet ports; an annular valve seat located in one of said ports; a check valve member adapted to seat on said valve seat, said check valve member comprising a thick disk having a centrally located cylindrical bore therein of substantially uniform diameter; and a needle valve adjustably mounted in said housing, one end of said needle valve extending into the bore of said disk and comprising a portion having cylindrical side walls merging into a conically-shaped tip portion; and means limiting the adjustment of said needle valve in one direction so that the region of the merging of said vertical walls into said conically-shaped tip portion lies substantially in the plane of said valve seat and in the other direction so that the lower end of said tip portion lies substantially in said plane.

5. A combined needle and check valve for permitting substantially full flow of liquid in one direction and adjustable restricted flow in the reverse direction, comprising: a valve housing having a chamber therein and having a pair of vertically aligned bores and having another bore serving as a port for the flow of liquid in either direction, all of said bores communicating with and extending outwardly from said chamber, one of said aligned bores being internally threaded, and the other of said aligned bores including an upper threaded portion, a relatively reduced intermediate portion forming a shoulder between said upper and intermediate portions and a lower relatively enlarged portion forming a second shoulder between said intermediate portion and said lower portion, said first and second shoulders being vertically spaced; a fitting threaded into said one of said aligned bores, said fitting having a centrally located passage therein serving as a port for the flow of liquid in either direction and having an annular valve seat at its upper end surrounding said passage; a check valve member comprising a disk disposed in said chamber arranged to seat on said valve seat, said disk having a centrally located cylindrical bore; a coil spring having its upper end positioned in said lower enlarged portion of said other aligned bore and resting on said second of said vertically spaced shoulders and having its lower end bearing on said disk, said coil spring constantly urging said disk toward said seat; and a needle valve stem comprising an enlarged upper

end portion adjustably threaded into said upper enlarged threaded portion of said other of said aligned bores; a reduced intermediate portion forming a shoulder between said upper and said intermediate portions of said needle valve stem adapted to contact said first of said vertically spaced shoulders to limit the adjusting movement of said needle valve stem in one direction, said intermediate portion of said needle valve having a close fit with said reduced intermediate portion of said other of said aligned bores and extending therebeyond, said intermediate portion of said needle valve stem having an abutment adjacent its lower end adapted to contact said second of said spaced shoulders to limit the adjusting movement of said needle valve stem in the opposite direction; and said needle valve stem having a further reduced lower end portion axially aligned with and extending into said bore in said disk for restricting flow therethrough and having a cylindrical wall of a diameter smaller than said bore in said disk merging into a conically-shaped tip portion, said housing, needle valve stem and fitting being proportioned so that at one of the limits of adjustment of said needle valve stem the region of merging of said cylindrical wall into said conically-shaped tip portion lies in the plane of the disk-engaging surface of said valve seat and so that at the other limit of adjustment of said needle valve, the lower end of said tip lies in said plane.

6. The combined needle and check valve of claim 5 wherein the bore of the disk has an interrupted surface comprising a relatively shallow helical groove blocked at its upper end but otherwise extending substantially the entire length of said bore.

7. The combined needle and check valve of claim 5 wherein the bore of the disk has an interrupted surface comprising a series of spaced annular grooves.

8. The combined needle and check valve of claim 5 wherein a liquid seal is positioned between the walls of the intermediate restricted portion of said other bore and said intermediate reduced portion of said needle valve stem.

9. The combined needle and check valve of claim 5 wherein said abutment adjacent said lower end of said intermediate portion of said needle valve stem comprises a snap ring positioned in an annular groove in said intermediate portion.

10. The combined needle and check valve of claim 5 wherein a lock nut is applied to the upper threaded end portion of said needle valve stem to maintain said needle valve in adjusted position.

11. The combined needle and check valve of claim 10, including sealing means engaging the intermediate portion of the stem and forming a seal therewith; and a cap enclosing the adjusting nut and serving as a seal in event of failure of said sealing means.

12. A combined needle and check valve for permitting substantially full flow of liquid in one direction and restricted flow in the reverse direction, comprising: a valve housing having a pair of ports adapted to serve interchangeably as inlet and outlet ports; a valve seat located in one of said ports; a check valve member adapted to seat on said valve seat, said check valve member comprising a thick disk having a centrally located cylindrical bore therein of substantially uniform diameter; and a needle valve stem having a conically-shaped tip portion adjustably mounted in said housing on the same side of said valve seat as said check valve member, the maximum diameter of said tip portion being slightly less than the diameter of said bore and merging into a cylindrical portion so that said tip portion and said cylindrical portion may be axially adjusted to any desired position relative to said bore in said disk between one extreme position in which only the conical portion occupies the bore of said disk to another extreme position in which only the cylindrical portion occupies said bore, and means

limiting the adjustment of said needle valve between said extreme positions in both directions.

13. A combined needle and check valve for permitting substantially full flow of liquid in one direction and restricted flow in the reverse direction, comprising: a valve housing having a chamber formed therein and having a pair of ports in communication therewith adapted to serve interchangeably as inlet and outlet ports depending upon the direction of liquid flow through said valve, one of said pair of ports being internally threaded and having a fitting including an annular valve seat at its inner end removably mounted in said one port, the other end of said fitting being adapted to be connected with a conduit, the other of said pair of ports being adapted to be connected with a conduit; a check valve member insertible into said chamber through said one port and adapted to seat on said valve seat, said check valve member comprising a thick disk having a centrally located cylindrical bore therein of substantially uniform diameter, said bore having an interrupted surface; and a needle valve stem having an end portion including a smooth cylindrical portion merging into a conically-shaped tip portion of substantial length, said valve stem being adjustably mounted in said housing on the same side of said valve seat as said check valve member so that said end portion can be adjustably positioned in said bore in said disk to any position between one extreme position in which only the conically-shaped tip portion occupies the bore of said disk to another extreme position in which only the cylindrical portion occupies said bore, the arrangement being such that liquid passing between said interrupted surface and said smooth cylindrical portion of said needle valve stem has turbulent flow imparted thereto to reduce the flow rate of said liquid.

14. A combined needle and check valve for permitting substantially full flow of liquid in one direction and restricted flow in the reverse direction, comprising: a valve housing having a chamber formed therein and having a pair of ports in communication therewith adapted to serve interchangeably as inlet and outlet ports depending upon the direction of liquid flow through said valve; one of said pair of ports being internally threaded and having a fitting including an annular valve seat at its inner end removably mounted in said one port, the other end of said fitting being adapted to be connected with a conduit, the other of said pair of ports being adapted to be connected with a conduit; a check valve member insertible into said chamber through said one port and adapted to seat on said valve seat, said check valve member comprising a thick disk having a centrally located cylindrical bore therein of substantially uniform diameter, the surface of said bore being provided with a relatively shallow spiral groove extending substantially the length thereof; and a needle valve stem mounted in said housing on the same side of said valve seat as said check valve member and having an end portion including a smooth cylindrical portion of slightly smaller diameter than said bore merging into a conically-shaped tip portion of substantial length, said end portion of said valve stem being adjustably positioned in said bore in said disk to any position between one extreme position in which only the conically-shaped tip portion occupies the bore of said disk to another extreme position in which only the cylindrical portion occupies said bore, the clearance between the wall of said bore and the exterior surface of the cylindrical portion of the needle valve stem being so small that liquid passing between said spirally grooved surface of said bore and said smooth cylindrical portion of said needle valve stem has turbulent flow imparted thereto to reduce the flow rate of said liquid.

15. A combined needle and check valve for permitting substantially full flow of liquid in one direction and restricted flow in the reverse direction, comprising: a valve housing having a chamber formed therein and having a pair of ports in communication therewith adapted

to serve interchangeably as inlet and outlet ports depending upon the direction of liquid flow through said valve; one of said pair of ports being internally threaded and having a fitting including an annular valve seat at its inner end removably mounted in said one port, the other end of said fitting being adapted to be connected with a conduit, the other of said pair of ports being adapted to be connected with a conduit; a check valve member insertible into said chamber through said one port and adapted to seat on said valve seat, said check valve member comprising a thick disk having a centrally located cylindrical bore therein of substantially uniform diameter, the surface of said bore being provided with a series of spaced annular, relatively shallow grooves; and a needle valve stem mounted in said housing on the same side of said valve seat as said check valve member and having an end portion including a smooth cylindrical portion of slightly smaller diameter than said bore merging into a conically-shaped tip portion of substantial length, said end portion of said valve stem being adjustably positioned in said bore in said disk to any position between one extreme position in which only the conically-shaped tip portion occupies the bore of said disk to another extreme position in which only the cylindrical portion occupies said

bore, the clearance between the wall of the bore and the exterior surface of the cylindrical portion of the needle valve stem being so small that liquid passing between said grooved surface of said bore and said smooth cylindrical portion of said needle valve stem has turbulent flow imparted thereto to reduce the flow rate of said liquid.

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