United States Patent

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[54] VARIABLE CHOKE VALVE

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[21] Appl. No.: **74,621**

[52] **U.S. Cl.**.....**137/269,** 137/614.17
[51] **Int. Cl.**.....**F16k 47/10**
[58] **Field of Search**...137/269, 329.2, 329.3, 614.17; 251/309, 312, 316, 304; 138/44

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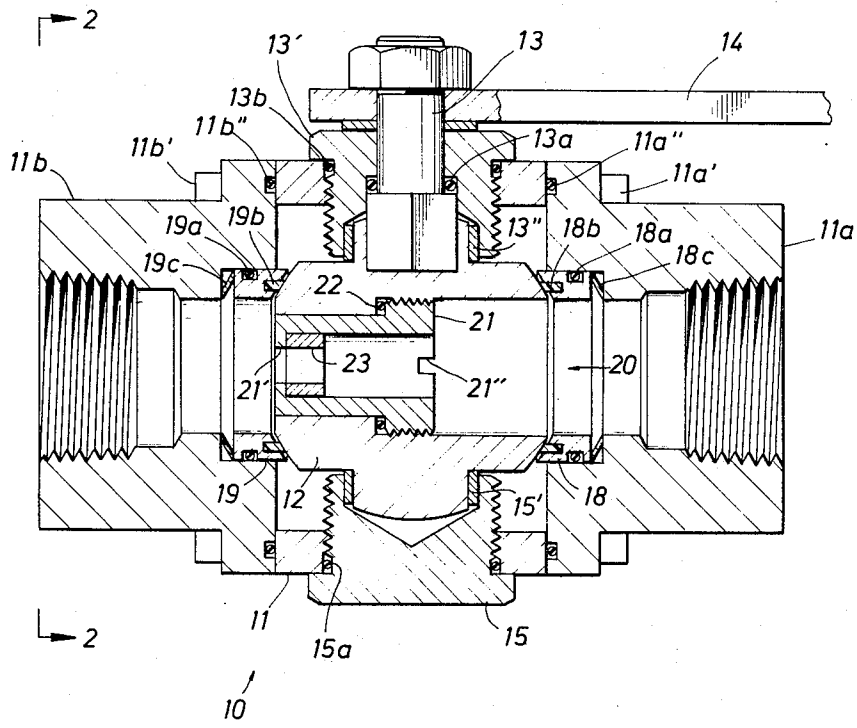
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[57] **ABSTRACT**

A valve of the type having a rotatable closure member with a flow passage which may be moved into and out of communication with flow passages in the valve housing to respectively permit and terminate flow through the housing is provided with removable housing segments whereby direct access to the passage in the closure member is possible through the housing wall when the closure member is rotated out of communication with the housing flow passage. The closure member passage is adapted to carry removable inserts to permit variation in flow passage or choke size. Exchange of inserts is made possible even while the valved fluid is under pressure.

In a modified form, a mechanism is provided for variation of choke size in the closure member without the need for removal of a portion of the housing wall to permit adjustment of choke size in the closure member while fluid is flowing through the valve. The mechanism is removable from the valve housing when the valve is in the off position.

7 Claims, 10 Drawing Figures



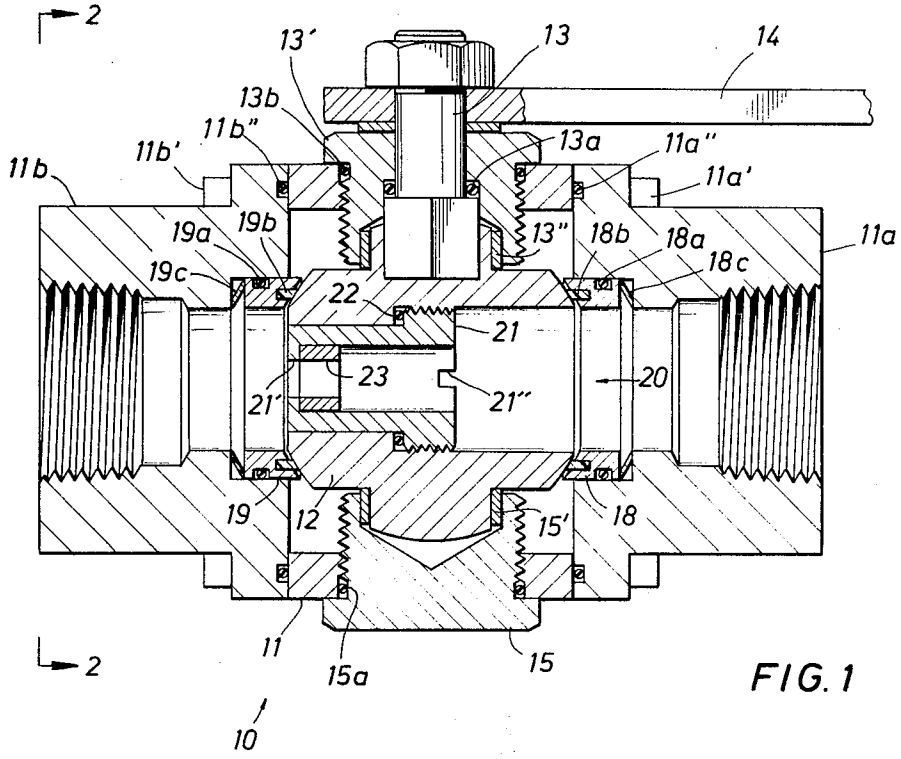


FIG. 1

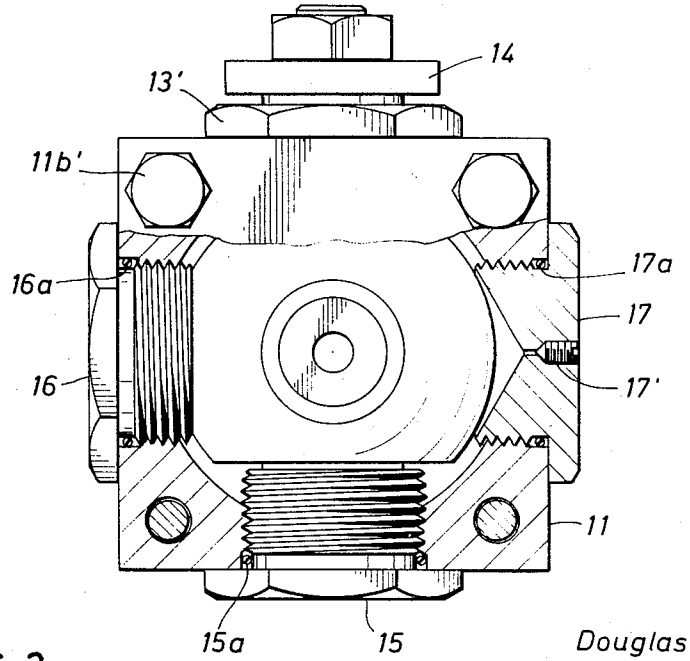


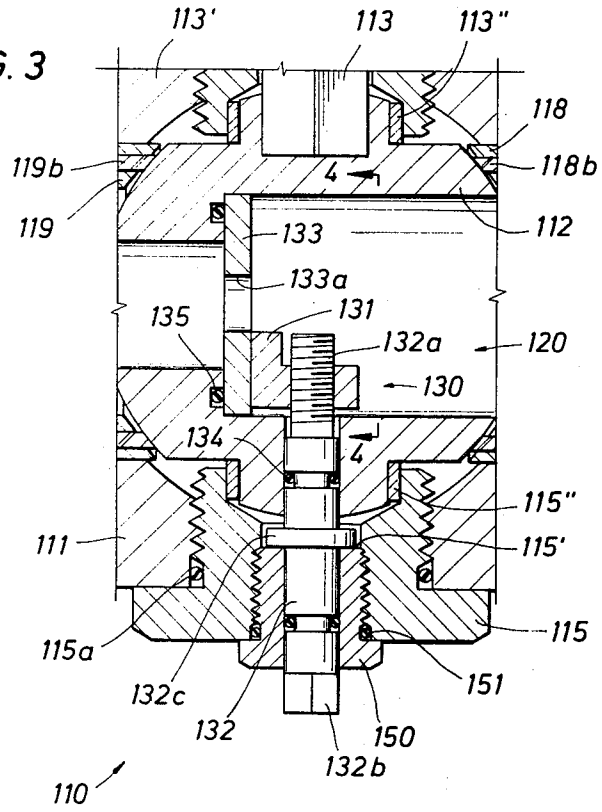
FIG. 2

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FIG. 3



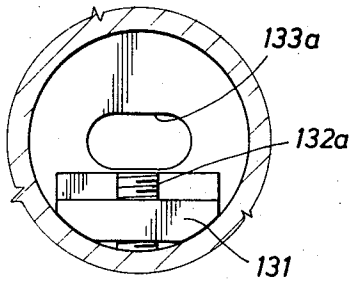


FIG. 4

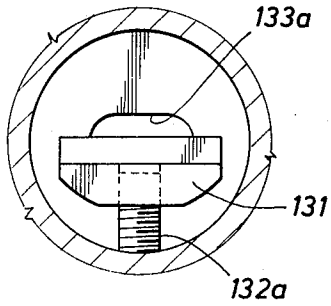


FIG. 5

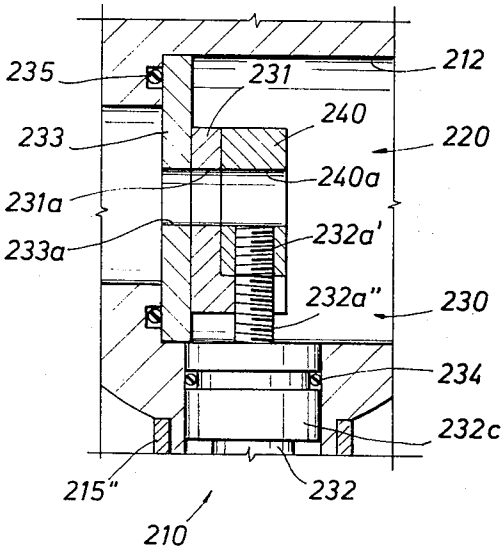


FIG. 6

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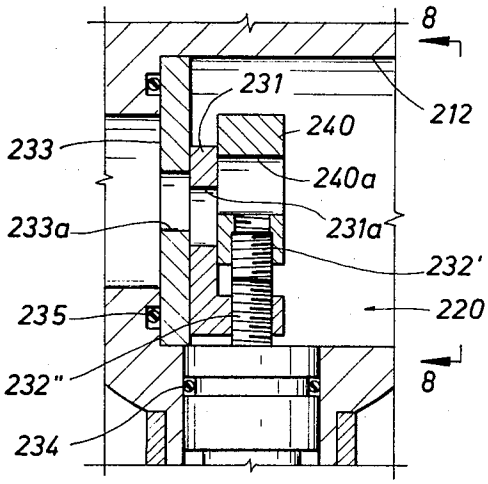


FIG. 7

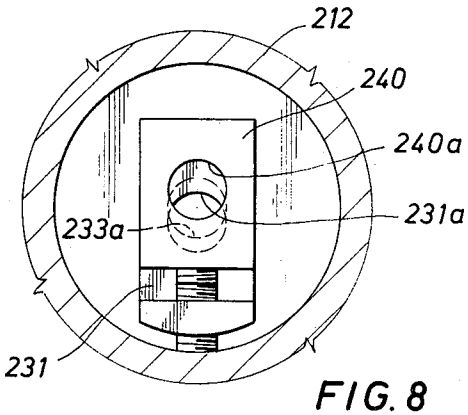


FIG. 8

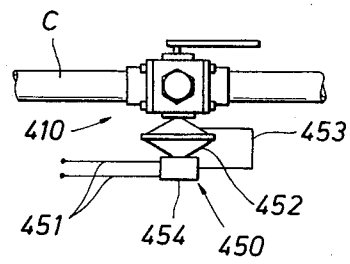


FIG. 10

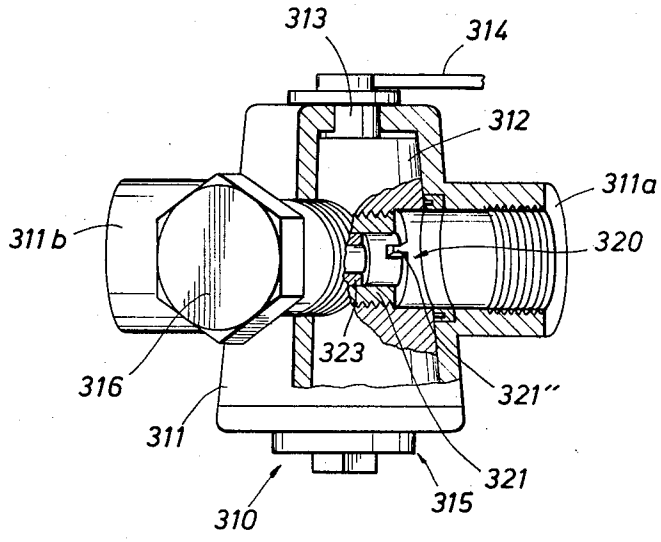


FIG. 9

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VARIABLE CHOKE VALVE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to valves for regulating the flow of fluids, including liquids and gases, through a flow conductor. More specifically, the present invention relates to a new and improved valve mechanism specifically adapted for use with valves of the type wherein flow passages in the closure member may be rotated into or out of communication with the flow passages in the valve housing to permit, terminate or regulate fluid flow through the valve. In a specific application, the variable choke valve of the present invention is employed to regulate or restrict fluid flow through a flow conductor.

2. Brief Description of the Prior Art

It is often necessary, for a variety of reasons, to change the flow passage or choke size in a valving means. When such change is required in conventional flow lines, it may be necessary to terminate flow through the line, remove the valve from its operational position in the flow conductor and replace it with a valve having the desired choke size. In the alternative, it is also conventional to employ upstream and downstream valves which are both closed to permit an intermediate choke housing to be disassembled and equipped with a new choke body to provide the desired flow passage.

In an attempt to overcome the expense associated with a multiple valve assembly and the lost time associated with replacement of a single valve, the prior art dealing with orifice controls and metering systems has employed a single valve which may be moved to the off position to permit replacement of a plate having the desired orifice size. In this device, the valve is turned to the off position and a bottom housing plate is removed to permit removal of the orifice plate and the insertion of a specially apertured orifice plate. While offering many advantages over the conventional approaches to changing orifice size, the prior art valve is objectionable to the extent that removal of the bottom housing plate is difficult and time consuming, the plate is often inaccessible or difficult to reach because of its location at the bottom of the housing, the bottom positioning of the plate prevents the easy use of valve extension or control members at that position, it is difficult to properly align and seal the orifice plate within the valve closure member, and relatively numerous and expensive components are required to hold the orifice plate within the closure member without vibration, leakage or misalignment.

SUMMARY OF THE INVENTION

In the preferred form of the present invention, the valve includes a removable housing section which may be disengaged from the main housing body to permit access to the flow passage in the rotatable closure member of the valve. While the prior art metering valve described previously provides indirect access to the closure member flow passage through the bottom of the valve housing, the present invention provides direct access to the closure member through the side of the valve. When the closure member is rotated to its closed position, the closure member flow passage is out of communication with the housing flow passage so that the sealing functions of the valve may be effected even with the closure member passage exposed during removal of the side housing plate.

Choke inserts with different size flow passages or choke openings may be positioned within the flow passage of the closure member to effect a desired change in choke size. The inserts are rigidly secured and sealed within the closure member flow passage to ensure proper orifice alignment and to prevent undesirable vibrations or leakage. The inserts themselves may be equipped with wear resistant liners to extend the life of the insert and to reduce valve maintenance.

More than one removable side housing plate may be employed to provide internal access to valves of the present invention. There is also disclosed a means for venting high pressure fluids trapped between the closure member and the valve housing to reduce any difficulty in removing the side plate and to prevent sudden high pressure release upon removal of a side housing plate.

In a modified form of the invention, choke adjustment means are provided for continuous variation of choke size without the need for removal of the housing wall or the requirement for the changing of a choke insert. In this latter form, the valve includes the primary, conventional means for rotating the closure member between open and closed positions and also includes a choke size adjustment means extending through the housing coaxially with the axis of rotation of the closure member to provide continuous choke size adjustment while fluid flow is maintained through the valve. Where the choke adjustment extends through the bottom of the valve, the entire adjustment mechanism may be removed from the valve when the closure member has been rotated to off position to permit replacement or repair of the adjustment mechanism.

In one form of the choke adjustment means, a plate is moved relative to the flow passage in the closure means to provide continuous variation in the dimensions of the valve aperture. In another form of the variable choke adjustment means, dual closure elements are movable relative to each other and to the flow passage in the closure means to vary the dimensions of the valve aperture uniformly about the central longitudinal axis of the flow passage. The latter modification is particularly well suited for applications where turbulence is to be minimized or where precise regulation is desired. In both of the latter modified forms, the adjustable valve stem for the choke adjustment means extends coaxially with the axis of rotation of the rotatable closure member which permits rotation of the ball by means of the primary control mechanism and adjustment of the choke size by the choke adjustment means.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical elevation, in section, illustrating a rotatable ball valve of the present invention;

FIG. 2 is a view taken along the line 2—2 of FIG. 1, partially broken away;

FIG. 3 is a partial vertical section of a modified form of a ball valve of the present invention with a continuously variable choke adjustment means;

FIG. 4 is a partial view taken along the line 4—4 of FIG. 3 showing the flow passage choke in full open position;

FIG. 5 is a view similar to FIG. 4 showing the flow passage choke partially closed;

FIG. 6 is a partial vertical section illustrating a third modification of the present invention having dual closure elements movable relative to each other;

FIG. 7 is a view similar to FIG. 6 illustrating the flow passage choke partially closed;

FIG. 8 is a view taken along the line 8—8 of FIG. 7;

FIG. 9 is a perspective view, partially broken away, illustrating a plug valve of the present invention; and

FIG. 10 illustrates a valve of the present invention equipped with a self-controlled operator.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIG. 1, one form of the valve of the present invention is indicated generally at 10. The valve 10 includes a main housing body assembly 11 within which is disposed a ball valve closure member 12. The closure member is connected to a valve stem 13 which in turn is secured to a handle 14 and both are used to rotate the closure member in a conventional manner between open and closed positions or any intermediate position.

With reference jointly to FIGS. 1 and 2, it may be seen that a plurality of removable housing wall plates 15, 16 and 17 are removably secured to the bottom and sides, respectively of the main housing 11. O-ring seals 15*a*, 16*a* and 17*a* are positioned between the removable wall plates and the main valve housing to provide a leakproof engagement. As illustrated, each of the removable housing wall means 15 through 17 is threadedly secured to the main housing 11. The housing 11 also includes upstream and downstream connectors 11*a* and 11*b* which may be employed in conventional manner to connect the valve 10 into a fluid flow conducting line (not illustrated).

Annular upstream and downstream seal assemblies 18 and 19, respectively, are positioned between the main housing 11 and the connectors 11a and 11b in the manner illustrated to provide continuous sealing engagement with the ball closure member 12. The assemblies 18 and 19 include annular O-ring seals 18*a* and 19*a*, respectively, annular sliding seals 18*b* and 19*b*, respectively, and spring biasing means 18*c* and 19*c*, respectively. The O-ring seals provide sealing between the connectors and the seal assemblies, the sliding seals provide the necessary seal between the ball closure member and the seal assemblies and the spring bias means urge the sliding seal into continuous engagement with the ball closure member 12.

The upstream and downstream connecting means 11*a* and 11*b* are secured to the housing 11 by means of bolts 11*a'* and 11*b'*, respectively. O-ring seals 11*a''* and 11*b''* provide leakproof engagement between the connecting means and the housing. Sealing of the valve 10 is completed by O-rings 13*a* and 13*b* which are positioned about a valve stem bonnet 13'.

From an inspection of FIGS 1 and 2, it may be seen that the closure member 12 is mounted for rotation in upper and lower mounting sleeves 13'' and 15', respectively. The ball valve closure member 12 includes a fluid flow passage means indicated generally at 20. When the closure means 12 is in the position illustrated in FIG. 1, it will be apparent that the fluid flow passage means 20 is aligned with the housing flow passages in the connecting means 11a and 11b to permit flow through the valve 10. When the handle 14 is rotated 90° from the position illustrated in FIG. 1, the passage 20 is positioned at right angles to the housing flow passages which permits the sealing assemblies 18 and 19 to cooperate with the solid portions of the closure member 12 in terminating fluid flow through the valve.

With reference to FIG. 2, it will be appreciated that with the valve in the closed position, the wall plate means 16 or 17 may be removed to permit direct access to the ball closure passage 20. Where high pressure fluids are contained within the valve, a relief valve 17' may be opened to slowly bleed off any entrapped pressure, thereby permitting the side walls to be removed.

The ball closure member 12 is equipped with a removable choke body insert 21 which is threadedly engaged within the valve flow passage 20. An annular O-ring seal is positioned between the insert 21 and the ball closure member to prevent bypass of fluid around the central choke opening of the insert. A removable sleeve 23 formed of a very hard, wear resistant material is press fitted within the central choke opening of the insert 21. An internally developed shoulder 21' formed at the rear of the insert 21 retains the sleeve 23 in proper position within the insert. The upstream end of the insert 21 is provided with lateral slots 21'' with which the insert may be engaged by a suitable tool permitting it to be rotated into and out of engagement with the ball closure member.

By means of the illustrated construction of the valve of the present invention, it will be apparent that the valve closure member 12 may be rotated to off position to terminate flow through the valve 10. When in this position, the side plate 16 or 17 may be removed to expose the slots 21'' of the choke insert 21. The insert may be removed through the opening provided by the removal of the side wall plate and replaced with an insert body having the desired choke dimensions. The wall plate may thereafter be reattached to the housing and the valve rotated back into open position to reinitiate flow through the valve. Thus, it will readily be appreciated that removal of a side wall plate in the valve of the present invention provides direct communication between the exterior of the valve and the flow passage in the closure member. By this means, aperture dimensions may be easily and quickly changed in any desired manner. In addition, the positive seating of the insert within the ball closure member ensures proper alignment of the choke with the flow passage in the valve and prevents undesirable vibration, leakage or misalignment.

A modified form of the present invention is indicated generally at 110 in FIG. 3. The valve 110 is similar to the valve 10 and the various valve components have been designated by reference characters which are higher by 100 than the reference character for the same or similar components illustrated in FIGS. 1 and 2. The primary distinction between the valve 10 and the valve 110 is the inclusion in the latter of a choke adjustment means indicated generally at 130 in FIG. 3. The adjustment means 130 is formed by a laterally movable plate 131 which is adapted to be moved upon rotation of an adjustment valve stem 132 to advance laterally across the face of a choke plate 133 to vary the

effective flow area of an aperture **133***a*. Threads **132***a* formed at one end of the valve stem **132** are adapted to engage and mate with threads formed in the choke plate **131** whereby rotation of the valve stem provides the desired movement of the adjustable plate. The valve stem extends through an assembly bushing **150** which is threadedly mounted in the base plate **115**. The lower exposed end of the valve stem **132** is provided with a suitable means such as the rectangular head **132***b* by which the valve stem may be secured for rotation by a suitable mechanism or handle (not illustrated). A radially developed flange **132***c* extends about the valve stem **132** and is seated against a bearing surface **115** on the bushing **150**. O-ring seals **134, 135** and **131** ensure leakproof engagement between the rotatable ball closure member **112**, valve stem **132**, aperture plate **133**, and assembly bushing **150**, respectively.

In operation, the valve stem **132** may be rotated causing the movable plate **131** to advance upwardly and partially cover the aperture opening **133***a* to reduce the effective flow passage through the valve. FIG. **5** of the drawings illustrates the plate **131** adjusted to provide partial opening through the choke opening. Operation of the choke adjustment means **130** is permitted even while the flow passage **120** is aligned with the flow passages in the valve housing to permit continuous regulation of fluid flow through the valve.

It will be appreciated that the coaxial mounting of the valve stem **132** with the axis of rotation of the ball closure member **112** permits a double acting valve function in that the closure member **112** may be rotated by the primary control secured to the valve stem **113** while also permitting variation in the choke size of the ball member by rotation of the stem **132**. When it is desired to remove the choke mechanism **130** for any reason, the valve closure member **112** may be rotated **90°** from the position illustrated in FIG. **3**, the side housing plates (not illustrated) along the housing wall similar to those illustrated in FIGS. **1** and **2** may be removed, and the valve stem **132** may be rotated to completely disengage the plate **131** so that it may be removed through the side wall opening. The bushing **150** may then be disengaged from the housing **111** to permit withdrawal of the valve stem, and the choke plate **133** may thereafter be removed through one of the side wall openings. It will, of course, be understood that all of the foregoing procedures may be undertaken while the valve closure member **112** is functioning to form a seal against fluid flow through the flow conductor within which the valve **110** is connected.

With reference to FIGS. **6, 7** and **8**, a third modification of the present invention is indicated generally at **210**. The valve **210** is similar to the valve **110** and components have been designated by reference characters which are **100** higher than those employed in identifying the corresponding components of valve **110**.

The adjustable choke means of the valve **210** is indicated generally at **230** and includes first and second adjacent aperture plates **231** and **240**, respectively. The plates are provided with apertures **231***a* and **240***a*. Left hand threads **232***a'* engage the aperture plate **240** while right hand threads **232***a''* are secured to the movable plate **231**. The illustrated connection between the valve stem **232** and the plates **231** and **240** causes the plates to move away from each other as illustrated in FIGS. **7** and **8** upon rotation of the valve stem. The resulting relative movement between the two apertured plates and the fixed plates **233** maintains a uniform aperture area which is evenly distributed about the central longitudinal axis of the flow passage **220**. As with the valve **110**, the valve **210** may be adjusted to change the effective choke size of the valve during conditions of fluid flow.

When removal or replacement of the orifice adjustment means **220** is desired, the ball closure member **212** may be rotated to its closed position and the assembly bushing in the bottom housing plate, (not illustrated) may be removed to permit the entire assembly to be withdrawn from the valve. The fixed plate **233** may then be removed from the ball closure member **212** by removal of the side housing wall plate in the manner described with reference to valve **110**.

FIG. **9** of the drawings illustrates a plug valve indicated generally at **310** which includes the teachings of the present invention. The valve includes a rotatable, frustroconical closure member **312** set within a main valve housing assembly **311**. The main housing is provided with one or more removable side wall sections such as the section **316** which is threadedly engaged to the main housing body. A lower, removable housing section **315** is also provided at the base of the housing. As with the valves previously described, the valve **310** includes an upstream housing section **311a** and a downstream section **311***b*. The valve closure member **312** includes a valve stem **313** secured to a master handle **314** which may be employed to rotate the flow passage **320** between closed position and the full opened position illustrated in FIG. **9**. A removable choke insert body **321** is threadedly engaged within the passage **320** and may be removed from the passage when the closure member **312** is rotated to the off position in the manner previously described with reference to the valve **10**. A lateral slot **321''** permits the use of a tool to assist in rotating the insert **321** and a hard, sleeve insert **323** is positioned within the central flow passage of the insert for the same purpose as described previously with reference to the valve of FIG. **1**.

It will be appreciated that the operation of the valve **310** is similar to that previously described with reference to the valve **10**. It should also be noted that if desired, the plug valve of FIG. **9** may be modified to include choke adjustment means such as those previously described with reference to the valves **110** and **210**.

FIG. **10** of the drawings illustrates a valve of the present invention indicated generally at **410** which has been equipped with a choke adjustment means such as that illustrated with reference to valves **110** and **210**. The valve **410** is positioned in a flow conduit C to regulate flow of a fluid medium through the conduit. The choke adjustment mechanism of the valve **410** is secured to an operator indicated generally at **450**. The operator is provided with a suitable drive means such as an electric motor which is supplied through a source of external electrical power through input lines **451**. The operator **450** is equipped with a conventional sensor or regulator device **452** which is adapted to detect pressure or flow or other conditions of the fluid flowing through the valve **410**. An appropriate control signal is conveyed from the regulator **452** to a drive mechanism

454 to rotate the valve stem in the choke adjustment means to appropriately increase or decrease the effective size of the choke opening.

By means such as that illustrated in FIG. 10, it will be appreciated that the valve of the present invention may be easily modified for continuous regulation of flow in a remotely located conductor. In general, the valves described herein are susceptible of use in any location requiring regulation of a flowing fluid. A specific example is the regulation of injection or input gas into an oil well during a gas lift operation. The valves of the present invention are capable of effectively and efficiently regulating the quantity of fluid moving past a point in such systems to provide a desired production rate in the well.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof, and various changes in the size, shape and materials as well as in the details of the illustrated construction may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A valve choke assembly comprising:
   a. housing means having connection means for connecting said housing means into a fluid flow conducting means;
   b. valving means included within said housing means for regulating the flow of a fluid through said housing means;
   c. closure means included within said valving means;
   d. fluid flow passage means included in said closure means with said closure means being rotatable within said housing means to open or close said passage means with respect to said conducting means for regulating fluid flow through said housing means;
   e. control means for rotating said closure means with respect to said housing means;
   f. choke adjustment means extending through said housing means for changing the dimensions of said flow passage means;
   g. movable valve stem means included in said choke adjustment means and extending through said housing means substantially coaxially with the axis of rotation of said closure means; and
   h. dual closure elements included in said choke adjustment means and movable relative to each other and to said flow passage means upon manipulation of said stem means, said dual closure elements including two adjacent apertured plates threadedly connected with said valve stem means whereby rotation of said valve stem means moves said plates toward or away from each other to vary the coincident aperture area between said plates to thereby vary the dimensions of said passage means.

2. A valve choke assembly comprising:
   a. housing means having connection means for connecting said housing means to a fluid flow conducting means;
   b. valving means included within said housing means for regulating flow of fluid through said housing means;
   c. closure means included within said valving means;
   d. fluid flow passage means included in said closure means with said closure means being movable within said housing means to open or close said passage means with respect to said conducting means for regulating fluid flow through said housing means;
   e. control means for moving said closure means with respect to said housing means;
   f. externally operable choke adjustment stem means extending through said housing means and connecting with removable flow passage defining means for externally effecting a change in the dimensions of said flow passage means;
   g. removable housing wall means for removing said removable flow passage defining means from said stem means and said housing means when said closure means is moved to the position closing said passage means; and
   h. means cooperating with said closure means for preventing flow of fluids through said conducting means while said removable housing wall means are removed.

3. A valve choke assembly as defined in claim 2 wherein said closure means is rotatable within said housing means to open or close said passage means and said choke adjustment means includes movable valve stem means extending through said housing means substantially coaxially with the axis of rotation of said closure means.

4. A valve choke assembly as defined in claim 3 wherein said choke adjustment means further includes dual closure elements movable relative to each other and to said flow passage means upon manipulation of said valve stem means.

5. A valve choke assembly as defined in claim 2 wherein said closure means includes ball valve closure means.

6. A valve choke assembly as defined in claim 2 wherein said removable wall means intersects the longitudinal axis of said flow passage means when said closure means is moved to a position which closes said passage means with respect to said conducting means.

7. A valve choke assembly comprising:
   a. housing means having connection means for connecting said housing means to a fluid flow conducting means;
   b. valving means included within said housing means for regulating flow of fluid through said housing means;
   c. closure means included within said valving means;
   d. fluid flow passage means included in said closure means with said closure means being movable within said housing means to open or close said passage means with respect to said conducting means for regulating fluid flow through said housing means;
   e. control means for moving said closure means with respect to said housing means;
   f. choke adjustment means extending through said housing means and connecting with removable flow passage defining means for externally effecting a change in the dimensions of said flow passage means;
   g. removable housing wall means for removing said removable flow passage defining means from said

housing means when said closure means is moved to the position closing said passage means; and

h. plural means in said choke adjustment means movable relative to each other and to said flow passage means for varying the dimensions of said flow passage means about the central longitudinal axis of said passage means whereby said central longitudinal axis of said passage means remains substantially coaxial with the opening in said flow passage means as the dimensions of said flow passage means are varied by said choke adjustment means.

* * * * *