June 29, 1965 N. F. BROWN 3,191,905

GRAVITY OPERATED KELLY FOOT VALVE

Filed Oct. 12, 1962 2 Sheets-Sheet 1

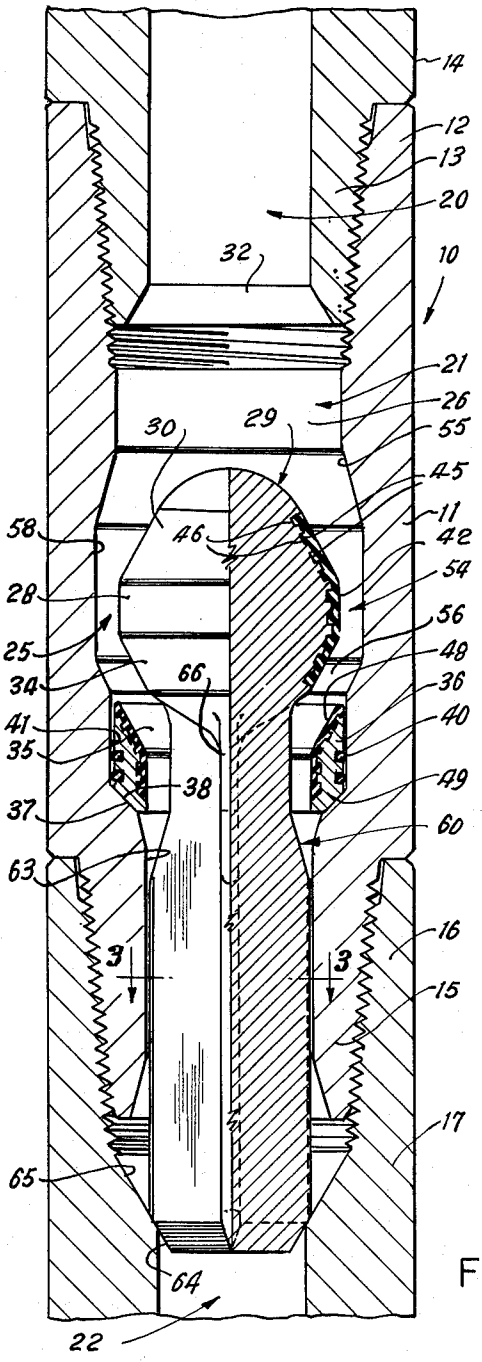


Fig.1

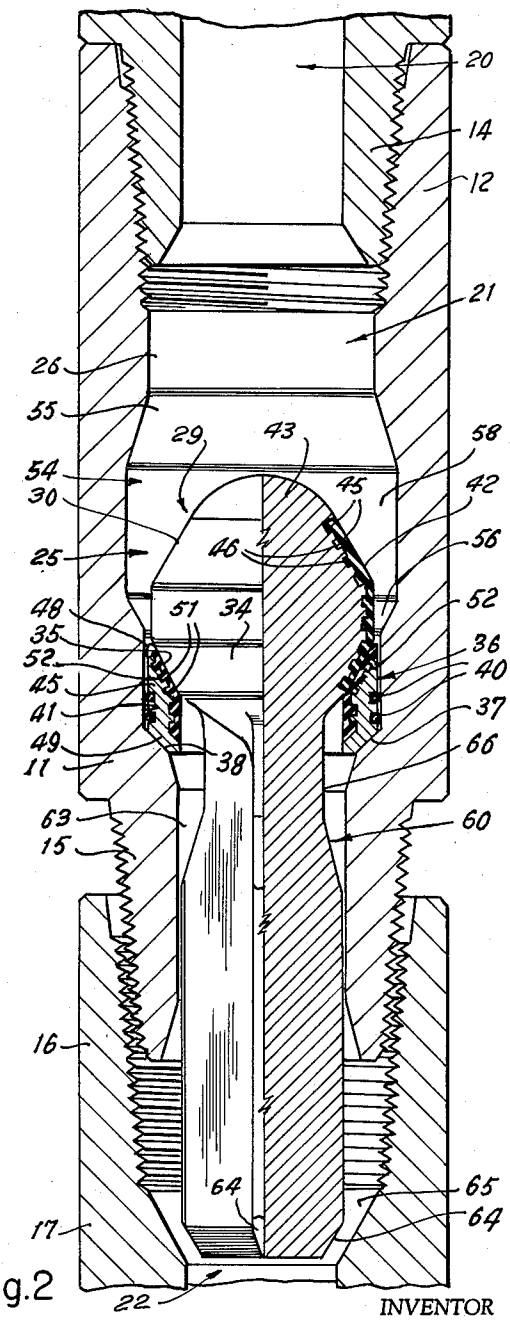


Fig.2

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GRAVITY OPERATED KELLY FOOT VALVE

Filed Oct. 12, 1962 2 Sheets-Sheet 2

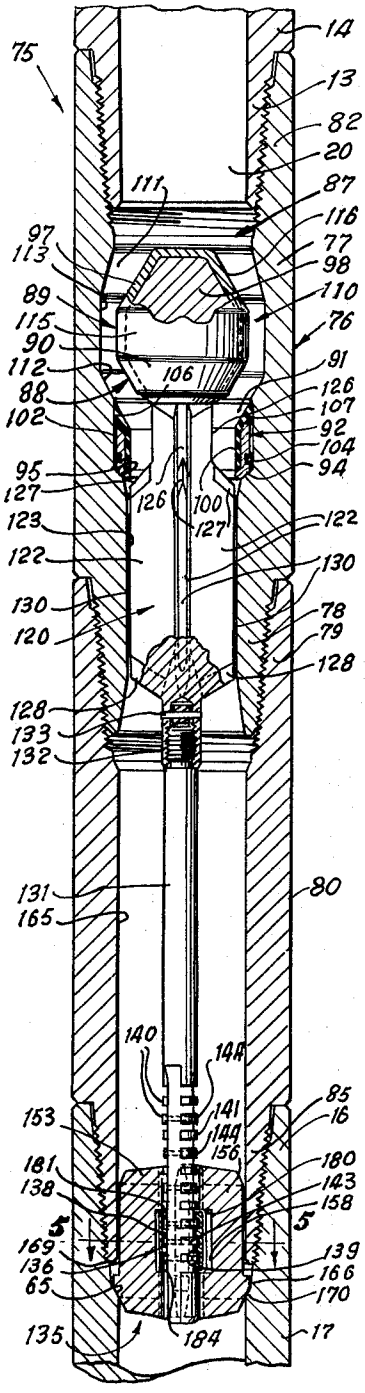


Fig.4

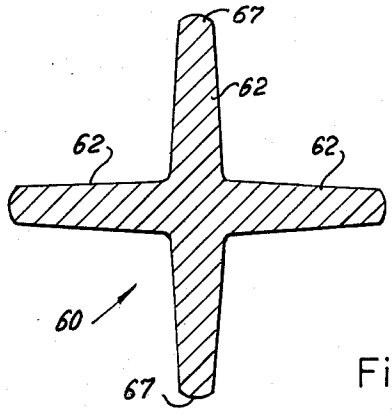


Fig.3

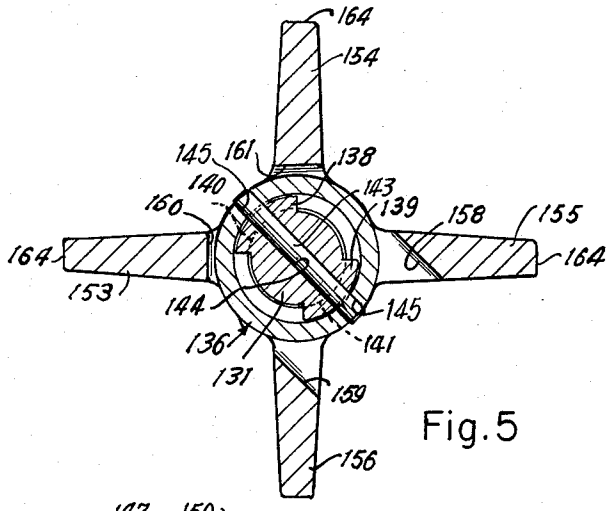


Fig.5

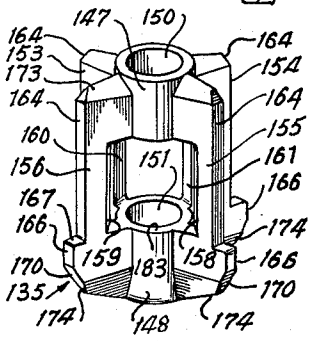


Fig.6

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GRAVITY OPERATED KELLY FOOT VALVE

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This invention relates to well tools and more particularly to a valve for closing the flow passage of a flow conductor having a pair of sections releasably connected to one another which automatically closes the flow passage of one of the sections upon the disconnection of one section relative to the other.

An object of this invention is to provide a new and improved valve for automatically closing the flow passage of an upper section of a flow conductor when the upper section is disconnected from a lower section to prevent flow of fluid from the flow passage of such upper section.

Another object is to provide a valve for a flow conductor having means engageable with the lower section of the flow conductor when the two sections of the flow conductor are connected for holding the valve in open position to permit flow of fluid through the flow conductor whenever the sections of the floor conductor are connected to one another and disengageable from the lower section to permit the valve to move to closed position upon the disconnection of the lower section from the upper section to prevent flow from the upper section.

Still another object is to provide a valve for preventing spillage of drilling fluid from a Kelly joint of a well drilling apparatus when the Kelly joint of the well drilling apparatus is disconnected from the drill pipe, as when it is desired to add another section of drill pipe to the string of drill pipe.

A further object is to provide a valve having a housing connectable between adjacent ends of adjacent sections of a flow conductor, such as a Kelly joint and a section of drill pipe, to constitute a section thereof and provided with a valve member movable by gravity to a closed position to prevent flow of fluid from the upper section upon the disconnection of the lower section from the valve housing, the valve member having means engageable with the lower flow conductor section for holding the valve in open position when the lower section is connected to the housing.

A still further object is to provide a valve for a flow conductor having opposed seat surfaces and a valve member mounted for movement between the two vertically spaced seats wherein the valve member engages the lower seat to close the flow passage of the upper section to prevent flow of fluid from the upper section when it is disconnected from a lower section and which prevents reverse or upward flow of fluid through the flow conductor by engaging the upper seat surface of the flow conductor.

Another object is to provide a valve for a flow conductor having adjustable means engageable with the lower section of the flow conductor for holding the valve member in a desired spaced position relative to a seat surface when the lower section is connected to the upper section.

Still another object is to provide a valve for a flow conductor having a valve member engageable with seat means of the flow conductor for preventing flow through the flow conductor and having anchor means adjustably secured thereto and engageable with longitudinally spaced oppositely facing shoulders of two sections of the flow conductor for holding the valve member in spaced relation to the seat means when the two sections are connected to one another.

A further object is to provide a valve of the type described wherein the valve housing includes a lower tubular sub whose lower threaded end portion provides a downwardly facing shoulder engageable by the anchor means and is threaded in the upper end of the top section of the string of drill pipe to connect the housing to the drill string, the adjustable mounting of the anchor means in the valve member permitting adjustment of the position of the anchor means relative to the seat surfaces of the valve housing and the valve member to compensate for the shortening of the sub resulting from the reworking of the lower threaded end portion of the sub necessitated by the wear thereof as the sub is repeatedly connected and disconnected from the string of drill pipe during its drilling of the well.

A still further object is to provide a valve wherein wear of the valve housing due to repeated connection and disconnection of the valve to the string of drill pipe is precluded by the provision of the sub which is relatively inexpensive and may be replaced at minimum cost.

A still further object is to provide a valve wherein the anchor means is rotatable relative to the valve member in order that the anchor means will not cause the valve member to rotate during connection or disconnection of the valve housing from the lower section of the flow conductor and thus prevent wear on the seating surface of the valve member and the seat means.

A still further object is to provide a valve for a flow conductor whose configuration minimizes turbulence in the fluid flowing therepast when the valve is in open position thereby facilitating flow of fluid therethrough and minimizing wear or erosion thereof by the fluid.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIGURE 1 is a vertical partly sectional view showing the valve embodying the invention in open position and connected between the lower end of a Kelly joint and the upper end of a section of the string of drill pipe;

FIGURE 2 is a view similar to FIGURE 1 showing the valve in closed position preventing flow of fluids from the Kelly joint, the Kelly joint being shown disconnected from the section of drill pipe;

FIGURE 3 is a sectional view of the valve member of the valve illustrated in FIGURES 1 and 2 taken on line 3—3 of FIGURE 1;

FIGURE 4 is a vertical partly sectional view with some parts broken away showing a preferred form of the valve connected between the lower end of the Kelly joint and the upper end of the string of drill pipe;

FIGURE 5 is a sectional view of the valve member of the valve illustrated in FIGURE 4 taken on line 5—5 of FIGURE 4; and,

FIGURE 6 is a perspective view of the adjustable anchor member of the valve illustrated in FIGURE 4.

Referring now particularly to FIGURES 1, 2 and 3 of the drawing, the valve **10** embodying the invention includes a housing or nipple **11** whose upper end portion **12** is internally threaded to receive the reduced threaded lower end portion **13** of a Kelly joint **14** of a well drilling apparatus. The reduced lower end portion **15** of the valve housing is externally threaded whereby it is connectable to the upper end portion **16** of the top section **17** of a string of drill pipe. The valve housing constitutes a section of the flow conductor which includes the string of drill pipe and the Kelly joint when connecting the Kelly joint and the upper end of the top section **17** of the string of drill pipe.

The exterior of the Kelly joint is usually square in configuration whereby it may be engaged by a suitable rotating table or means of the usual well drilling apparatus

which rotates the Kelly joint, and therefore the string of drill pipe connected thereto, in the usual manner during the drilling of a well. The length of the string of drill pipe must be increased as the well is drilled. This is accomplished by disconnecting the housing 11 of the valve from the top section of the string of drill pipe and then connecting another section of the drill pipe to the lower end of the housing and to the upper end of the previous top section of the string of drill pipe. During the drilling operations, drilling fluid is circulated downwardly through the flow passage 20 of the Kelly joint, the flow passage 21 of the housing and the flow passage 22 of the string of drill pipe and out of the lower end of the string of drill pipe through the usual openings of the drill bit secured to the lower end of the drill string and then back to the surface through the annulus between the bore of the well and the drill pipe. When the valve housing is disconnected from the top section of the strip of drill pipe preparatory to the connection of another section of drill pipe therebetween, the drilling fluid in the flow passage 20 of the Kelly joint would flow outwardly of the lower end of the Kelly joint if the valve 10 were not provided. Such flow of drilling fluid is dangerous since it splashes on the derrick floor of the drilling apparatus and makes it slippery. Since the drilling fluid may be expensive, such wastage of the drilling fluid may be very costly. The valve 10 has a gravity operated valve member 25 which closes the flow passage 21 of the valve housing each time the lower end of the valve housing is disconnected from the upper end of the top joint of the string of drill pipe to prevent such flow of the drilling fluid from the flow passage of the Kelly joint.

The flow passage of the valve housing 11 has an upper portion 26 of enlarged diameter greater than the external diameter of the intermediate section 28 of the head 29 of the valve member in order that the valve member may be moved upwardly in the valve housing to cause its top upwardly and inwardly beveled seat surface 30 to engage the similarly beveled seat surface 32 of the Kelly joint to close the flow passage of the Kelly joint and thus prevent upward or reverse flow of drilling fluid. The bottom downwardly and inwardly inclined annular seat surface 34 of the head is engageable with the inwardly and downwardly inclined seat surface 35 of the seat ring 36 disposed in the flow passage 21 of the nipple below the head 26 and held against downward movement in the housing by the engagement of its lower annular shoulder 37 with the upwardly facing annular shoulder 38 of the nipple. A pair of O-rings 40 are disposed in external annular recesses of the ring and engage the seal surface 41 of the housing to seal between the seat ring and the housing. The seat surfaces 30 and 34 of the valve head are provided by an external layer 42 of a resilient material such as rubber, plastic or the like, which may be molded, bonded or otherwise secured to the metal body 43 of the valve member.

The head 29 may be provided with annular grooves 45 in which the internal annular ribs 46 of the layer 42 may be received to facilitate molding or bonding of the resilient material to the body 43 and to help prevent displacement of the resilient material from the body. The seat ring 36 may similarly be provided with an internal layer 48 of similar resilient material which provides the seat surface 35 and which is molded or bonded to the metal annular body 49 of the seat ring. The body 49 of the seat ring may be provided with internal annular grooves or recesses 51 in which are received the external annular ribs 52 of the layer to facilitate molding of the layer to the body 49 and to provide a better bond or adhesion therebetween. The resilient layers 42 and 48 are provided to minimize erosion of the seat surfaces of the valve member and of the seat ring and also to provide a better seal between the valve member and the seat ring than would be obtainable by metal seat surfaces.

The valve housing 11 has an internal annular recess 54 between the enlarged upper portion 26 of the flow passage 21 and the seal surface 41 spaced therebelow. The upper end of the recess is defined by the annular upwardly and inwardly beveled or extending shoulder or surface 55 and its lower end is defined by the downwardly and inwardly beveled or extending shoulder 56, the beveled shoulders extending in opposite directions from the cylindrical internal surface 58 of the housing defining the intermediate portion of the recess. The provision of the internal recess 54 whose internal configuration corresponds substantially to the external configuration of the head 29 of the valve member, causes the annular space or passage between the valve head and the internal surfaces of the housing 11 to have a relatively large orifice or cross-sectional area so that when the valve member is in the open position illustrated in FIGURE 1, the valve does not unduly restrict the flow of drilling fluids through the housing. The substantially streamlined configuration of the valve member head also minimizes the turbulence in the drilling fluid as it flows through the valve housing.

The valve member has a dependent guide portion 60 integral with the head 29 which comprises a plurality of vertical radially outwardly extending vanes 62 which extend through the lower reduced portion 63 of the flow passage 21 of the valve housing. The lower shoulders 64 of the vanes are engageable with the upwardly facing internal annular shoulder 65 of the top section 17 of the string of drill pipe, when the valve housing is connected to such top section as illustrated in FIGURE 1, to hold the head of the valve member spaced from the seat ring 36. The width of the vanes is reduced immediately below the head, as at 66, to provide a large effective orifice through the seat ring and thus further minimize turbulence of the drilling fluid. The lower vertically extending arcuate outer surfaces 67 of the vanes are engageable with the internal surface of the housing 11 defining the lower reduced portion 63 of the flow passage to hold the valve head in proper central position or alignment in the valve housing so that the width of the annular passage between the valve head and the housing is uniform at all locations and thus ensures a smooth or non-turbulent flow through such annular passage. The vanes also guide movement of the valve member to proper seating engagement with the seat surfaces 32 and 35.

In use, the valve housing 11 is connected to the lower end of the Kelly joint 14 as illustrated in FIGURES 1 and 2. The Kelly joint and the valve housing 11 are disposed in the vertical position illustrated in FIGURES 1 and 2 and the valve member 25 is held by gravity in the lower closed position illustrated in FIGURE 2 wherein its lower seat surface 34 engages the seat surface 35 of the seat ring and thus holds the flow passage 21 of the valve housing, and therefore the flow passage 20 of the Kelly joint, closed. As the Kelly joint and the valve housing 11 connected thereto are lowered to move the lower end portion 15 of the valve housing 11 into the upper end portion of the top section 17 of a string of drill pipe, the shoulders 64 of the vanes 62 of the guide portion 60 of the valve member engage the upwardly facing internal shoulder 65 of the top section to arrest further downward movement of the valve member. The Kelly joint 14 and the valve housing are rotated during such downward movement to cause the lower section 15 of the valve housing to be threadedly connected to the upper end portion 16 of the top section of the drill string in the usual manner.

As the valve housing and the Kelly joint are lowered still further and rotated to connect the lower end portion 15 of the housing to the top portion 16 of the top section, the housing moves downwardly relative to the valve member whose downward movement is now arrested and the flow passage 21 of the housing 11 is opened to permit the drilling fluid from the flow passage 20 of the Kelly joint 14 to flow downwardly into the flow passage 22 of the drill string. Since the lower portion 15 of the valve

housing is telescoped into the upper end portion 16 of such top section of the drill string prior to the engagement of the shoulders 64 of the valve member with the shoulder 65 of the top section, any flow of drilling fluid from the valve housing will not spill over onto the derrick floor but will flow downwardly into the flow passage of such top section.

As soon as the valve housing 11 is properly connected to the top section of the string of drill pipe, normal drilling operations may take place, the Kelly joint 14 being rotated in the usual manner while drilling fluid is pumped downwardly through the flow passage 20 of the Kelly joint and the flow passage 21 of the valve housing, since the valve is now in the upper open position illustrated in FIGURE 1, and thence through the flow passage 22 of the string of tubing and outwardly therefrom through the opening or eye of the drill bit secured to the lower end of the string of drill pipe. The cuttings of the earth formations being penetrated by the drill bit are transported by the drilling fluid which then flows upwardly to the surface through the annulus between the string of drill pipe and the bore of the well.

As the drilling of the well progresses, the string of drill pipe moves downwardly until the Kelly joint approaches the limit of its downward movement. At this time, the rotation of the Kelly joint and the string of drill pipe is stopped, the top section 17 of the drill string is held against movement by a suitable gripping or clamp means and the housing 11 is gripped by suitable tongs and rotated relative to the top section 17 to unscrew the housing from the top section. Alternatively, the housing 11 may be held stationary by a suitable clamp or gripping means and the string of drill pipe, and the top section 17 thereof, rotated in the usual drilling direction to unscrew the housing from the top section. During such unscrewing operaion of the valve housing from the top section, the valve housing and the Kelly joint move upwardly relative to the top section and to the valve member 25 which is held against upward movement by gravity until the upward movement of the housing as it is disconnected from the top section moves the seat surface 35 of the seat ring into engagement with the lower seat surface 34 of the valve head and closes the flow passage 21 of the valve housing. The Kelly joint 14 and the valve housing may then be raised upwardly. The closure of the flow passage of the valve housing occurs before any appreciable flow of drilling fluid can take place out of the valve housing and any such minimum volume of drilling fluid flowing out of the flow passage of the valve passage flows into the upper open end of the top section 17 of the string of drill pipe so that no drilling fluid is spilled on the derrick floor of the drilling apparatus as the valve housing is disconnected from the top section and moved upwardly therefrom to permit another section of drill pipe to be placed in vertical alignment with the section of drill pipe from which the valve housing has been disconnected whereupon the lower end of such next section is threaded into the upper end of the preceding section. The housing 11 is then connected to the top end portion of the next section which is now the top section of the drill string. Since the lower end portion 15 of the housing 11 telescopes into the upper end portion 16 of such next top section of the drill string prior to the downward movement of the valve housing relative to its valve member upon the engagement of the shoulder 64 of the valve member with the shoulder 65 of such next section, any fluid flowing from the valve housing during the connection of the valve housing to said next top section flows into the flow passage 22 of the drill string and does not spill on the derrick floor.

In the event that during drilling operations the pressure in the drill string below the valve increases and tends to cause reverse circulation of drilling fluid through the drill string and the Kelly joint, the pressure differential created across the valve member when such abnormal pressure conditions arise causes the valve member to move upwardly in the valve housing until its top seat surface 30 engages the seat surface 32 at the lower end of the Kelly joint and the valve member then prevents such reverse or upward flow.

It will now be apparent that a new and improved valve member has been illustrated and described which automatically closes the flow passage of an upper section of a flow conductor, which may comprise the Kelly joint 14 and the valve housing 11, when such upper section is disconnected from a lower section, such as a string of drill pipe, in order to prevent flow of fluid, such as drilling mud fluid, from the flow passage of such upper section.

It will further be seen that the valve includes a housing having means, such as the seat ring 36, which provides a seat surface engageable by the seat surface 34 of a valve member mounted in the flow passage of the valve housing for longitudinal movement therein and that the valve member has means extending downwardly of the valve housing and engageable with an upwardly facing shoulder of such lower section to arrest downward movement of the valve member, as the downward movement of the upper section continues during the connection of the housing to the lower section, to open the flow passage of such upper section.

It will further be seen that the valve member and the housing have coengageable means, such as the vanes 62 and the surface defining the lower portion 63 of the flow passage of the housing for holding the valve member in proper concentric position in the flow passage of such upper section and that the spaced surfaces of the valve member and the housing provide an annular flow passage of uniform width therebetween and of relatively large cross-sectional area or orifice when the valve member is in its upper open position relative to the top upper section.

It will further be seen that the head 29 of the valve member and the adjacent spaced surfaces of the valve housing provide a curvilinear annular flow path or passage when the valve is in its open position which does not cause sharp changes in direction of flow of fluid flowing through the annular flow passage to facilitate such flow of the fluid by minimizing turbulence and also to minimize the wear or erosion of such surfaces of the valve member and the valve housing.

It will further be seen that coengageable seat surfaces of the valve member and of the seat ring may be provided by layers of resilient material secured to the valve member and the seat ring to further minimize wear of such surfaces and prolong the operational life of the valve and also to prove a more efficient seal between the seat surfaces.

It will further be seen that the upper section of the flow conductor is provided with the downwardly facing seat surface, such as the seat surface 32, engageable by the top seat surface 30 of the valve member when the valve member is moved to an upper position in such top section to prevent upward or reverse flow of fluid through the flow conductor.

It will further be seen that the top section is provided with longitudinally spaced top and lower seat surfaces, such as the seat surfaces 32 and 35, which are engageable with the top and lower seat surfaces 30 and 34 of the valve member which is disposed in the flow passage of the top section for longitudinal movement in opposite directions between the positions wherein the top and lower seat surfaces 30 and 34 engage the seat surfaces 32 and 35, respectively.

The valve 75 illustrated in FIGURES 4, 5 and 6 is a preferred form of the invention and includes a valve housing 76 having an upper valve section 77 whose reduced externally threaded lower end portion 78 is threaded in the internally threaded upper end portion 79 of the lower extension section 80 of the housing. The internally threaded upper end portion 82 of the valve section

is threadedly connectable to the reduced externally threaded lower end portion 13 of the Kelly joint 14 while the lower reduced end portion 85 of the extension section 80 is threaded into the upper end portion 16 of the top section 17 of a string of drill pipe.

The valve section 77 of the valve housing 76 may be substantially identical in configuration to the valve housing 11 of the valve 10 and have a longitudinal flow passage 87 whose upper end communicates with the flow passage 20 of the Kelly joint and in which is movably disposed the valve member 88. The valve member has a head 89 provided with an annular inwardly and downwardly extending or beveled seat surface 90 engageable with the similarly beveled seat surface 91 of a seat ring 92 disposed in the flow passage 87 and held against downward movement in the housing by the engagement of its lower annular shoulder 94 with the upwardly facing annular shoulder 95 of the valve section. The seat surface of the valve head 89 is provided by a layer 97 of a suitable resilient substance, such as rubber or plastic, which is molded or otherwise secured to the metal body 98 of the valve member. The seat surface of the seat ring 92 may similarly be provided by the annular layer 100 of a similar resilient material which is bonded or otherwise secured to the annular metal body 102 of the seat ring. An O-ring 104 is disposed in an external annular recess of the body 102 of the seat ring to seal between the seat ring and the internal seal surface 106 of the valve section. The outer annular surface 107 of the layer 100 may also abut the seal surface 106 to provide a further seal means for sealing between the seat ring and the valve section, it being apparent that when the valve member is moved downwardly to a position wherein its seat surface engages the seat surface of the seat ring, the resilient material of the layer 100 is compressed and forced outwardly into tight sealing engagement with the seal surface 106.

The valve section of the housing has an internal annular recess 110 above the seal surface 106 whose upper end is defined by the annular upwardly and inwardly beveled or extending shoulder as surface 111 and whose lower end is defined by the downwardly and inwardly beveled or extending annular shoulder 112, the beveled shoulders extending in opposite directions from the cylindrical internal surface 113 of the valve section defining the intermediate portion of the recess. The internal recess 110 has an internal configuration which corresponds substantially to the external configuration of the head 89 of the valve member 88 which has an intermediate peripheral annular surface 115 which extends parallel to the intermediate surface 113 of the valve section and an annular upwardly and inwardly beveled surface 116 which extends substantially parallel to the upper shoulder or surface 111 of the valve section. The beveled seat surface 90 of the head 89 is disposed substantially parallel to the lower shoulder or surface 112 of the valve section. The provision of the internal recess in the valve section whose internal configuration corresponds substantially to the external configuration of the head 29 of the valve member causes the annular space or passage between the valve head and the internal surfaces of the valve section to have a relatively large orifice or cross-sectional area so that when the valve member is in the upper open position illustrated in FIGURE 4, the valve does not unduly restrict the flow of drilling fluids through the housing. The substantially streamlined configuration of the valve member head also minimizes the turbulence of the drilling fluid as it flows through the valve housing.

The dependent guide portion 120 of the valve member 88 is integral with the head and comprises a plurality of vertical radially outwardly extending vanes 122 which extend through the lower reduced portion 123 of the flow passage of the valve section. The width of the vanes is reduced immediately below the head, as at 126, to provide a large effective orifice through the seat ring and thus further minimize turbulence of the drilling fluid. The upwardly and downwardly facing edges or shoulders 127 and 128 of the vanes are tapered upwardly and downwardly, respectively, to help minimize the turbulence of the drilling fluid as it flows downwardly through the flow passage of the valve section of the housing.

The vertically extending outer edge surfaces 130 of the vanes 122 are engageable with the internal surface of the valve section defining the lower reduced portion 123 of the flow passage thereof to hold the valve head in proper central position or alignment in the flow passage of the valve section so that the width of the annular passage between the valve member and the housing is uniform at all locations about the valve member and thus insures a smooth or non-turbulent flow of fluid through such annular passage. The vanes by their engagement with the internal surface of the valve section of the housing also guide longitudinal movement of the valve member to proper seating engagement with the seat surface 91 by holding the valve member in proper centralized position relative to the seat ring as well as to the valve housing.

The upper end of the anchor rod 131 is threaded in a suitable bore of the dependent central extension 132 of the valve member and is secured against rotation relative thereto by a pin 133 which extends through suitable aligned apertures in the extension and in the anchor rod.

An anchor 135 is releasably and adjustably secured to the anchor rod by means of an annular nut 136 provided with two sets of vertically aligned spaced internal flanges 138 and 139 which extend through angles of less than ninety degrees and which are receivable between the similarly spaced vertically aligned sets of external arcuate flanges 140 and 141 integral with the anchor rod and which also extend through angles of less than ninety degrees. It will be apparent that the nut may be moved longitudinally on the lower end of the anchor rod when rotated to a position wherein its two sets of internal flanges are out of alignment with the sets of external flanges of the anchor rod whereby the flanges of the nut and the rod cannot engage each other. When the nut is moved longitudinally to a desired position on the anchor rod, the nut is rotated through substantially ninety degrees to cause the internal flanges of the nut to move between and into vertical alignment with the external flanges of the anchor rod whereupon the engagement of adjacent surfaces of the sets of flanges prevents longitudinal movement of the nut on the anchor rod. The nut may be secured against rotation at any such longitudinally adjusted position on the anchor rod by means of the pin 143 which may extend through any one of the vertically spaced transverse apertures 144 of the anchor rod which extend through the rod and through horizontally aligned flanges 140 and 141 of the anchor rod and through the diametrically aligned apertures 145 of the nut.

The nut is receivable within the anchor member 135 between the upper and lower collar sections 147 and 148 thereof whose bores or passages 150 and 151, respectively, are of greater diameter than the external diameter of the anchor rod and of its external flanges so that the anchor rod may extend rotatably through the collar sections. The collar sections are connected to one another by the vertical vanes 153, 154, 155 and 156 which extend radially outwardly from the collar sections. The flanges 155 and 156 are provided with the parallel spaced vertical surfaces 158 and 159 which define a longitudinal slot in one side of the anchor member through which the annular nut may be inserted into the anchor member and between the collar sections 147 and 148. The vanes 153 and 154 are relieved or provided with internal recesses 160 and 161 to accommodate the nut when it is disposed between the collar sections of the anchor member.

The outer vertically extending edge surfaces 164 of the

vanes are receivable in the flow passage or bore 165 of the extension section 80 of the valve housing and are engageable with the internal surfaces thereof to hold the lower end of the anchor rod in centralized position in the valve housing, it being apparent that the vanes of the valve member and the vanes of the anchor member will operate to hold the valve member in proper centralized position in the valve housing at all times. The vertical flanges are provided adjacent their lower ends with outwardly extending bosses 166 whose upper abrupt shoulders 167 are adapted to engage the lower annular end surface 169 of the extension section to limit upward movement of the anchor member, and therefore of the valve member, in the valve housing and whose lower upwardly and outwardly extending beveled shoulders 170 are engageable with the internal upwardly facing annular shoulder 65 of the top section 17 of the string of drill pipe to limit downward movement of the anchor and of the valve member relative to the housing. The upper ends of the vertical flanges are tapered as at 173 and their lower end surfaces are similarly tapered as at 174 to facilitate flow of drilling fluid past the anchor member and minimize the turbulence thereof.

When it is desired to assemble the valve 75, the upper end of the anchor rod 131 is threaded into the dependent extension 132 of the valve member and secured against rotation relative thereto by the pin 133. The two housing sections 77 and 80 are then connected by threading the lower reduced end portion 78 of the valve section into the upper end portion 79 of the extension section, the seat ring 92 is installed in the valve section and the assembly of the valve member and the anchor rod is then inserted downwardly through the valve section and the extension section until the seat 90 of the head 89 of the valve member engages the seat surface 91 of the seat ring. At this time the lower end of the anchor rod 131 extends below the lower end of the extension section of the housing with at least the two lowermost flanges of the two sets of external flanges disposed below the lower end of the extension section. The annular nut 136 is then inserted into position between the collar sections 147 and 148 of the anchor member 135 and the assembly of the nut and the anchor member is then telscoped upwardly on the lower end of the anchor rod. The internal flanges 138 and 139 of the nut are positioned out of alignment with the external flanges 140 and 141 of the anchor rod so that the nut, and therefore the anchor member, may be moved upwardly on the rod to a desired longitudinal position thereon whereupon the nut is rotated approximately ninety degrees to position its internal flanges between the external flanges of the anchor rod and to position its apertures 145 in alignment with one of the apertures 144 of the anchor rod, which is now disposed below the lower end of the extension section of the housing, and the pin 143 is inserted through such apertures to lock the nut against rotation relative to the anchor rod. The nut now holds the anchor member 135 in such longitudinally adjusted position to the anchor rod but the anchor member is free to rotate about the anchor rod since it is supported on the anchor rod against downward movement by the engagement of the downwardly facing end surface 180 of the upper collar section with the upper end surface 181 of the nut and against upward movement relative to the anchor rod by the engagement of the upper end surface 183 of the lower collar section with the lower annular end surface or shoulder 184 of the nut. The anchor member is positioned in such longitudinal position relative to the anchor rod that when the shoulders 170 of the bosses 166 of the anchor member engage the annular upwardly facing shoulder 65 of the top section 17, the anchor member will be held in the upper open position in the valve housing illustrated in FIGURE 4. The upward movement of the valve member 88 is then limited by the engagement of the upper shoulders 167 of the bosses with the lower end shoulder 169 of the extension section.

It will be apparent that the valve 75 will function in the same manner as the valve 10 to close the flow passage of the upper section of a flow conductor, such as that which comprises the Kelly joint and the valve housing, each time the upper section is disconnected from the lower section of the flow conductor, such as the string of drill pipe, and that it is moved to open position each time the upper section is connected to the lower section of such flow conductor.

When it is desired to disconnect the valve housing 76 from the top section 17 of a string of drill pipe, the extension section 80 of the valve housing is held rigid by a suitable means and the top section 17 is rotated or alternatively the extension section 80 is rotated and the top section 17 of the drill string is held rigid to release or free the valve housing and the Kelly joint from the string of drill pipe. As the valve housing and Kelly joint are moved upwardly during the unscrewing or disconnecting operation, the valve member 88 of the valve is moved downwardly by gravity and closes the flow passage of the valve housing so that the drilling fluid may not flow out the flow passage of the Kelly joint. The small quantity of drilling fluid which is present in the valve housing below the seat ring will usually flow into the upper end of the drill pipe string and will not splash on the derrick floor. Another section of the drill pipe is then connected with its lower end secured to the upper end portion of the previous top section. The valve housing and Kelly joint are then connected to the upper end of such next top section by telescoping the reduced lower end portion 85 of the extension section 80 into the upper end portion of such next top section. As the extension section telescopes into the next top section and is threadedly connected to it, the shoulders 170 of the anchor member engage the upwardly facing shoulder 65 of such next top section and hold the valve member stationary while the downward movement of the valve housing and Kelly joint continues. The valve member is thus placed in open position and permits flow of fluid from the flow passage of the Kelly joint through the valve housing into the flow passage 22 of the string of drill pipe. During the connection and disconnection of the valve housing to and from the string of drill pipe the valve member is free to rotate with the housing and relative to the anchor member so that no wear of seat surfaces 90 and 91 due to relative rotational movement between the valve member and the valve housing takes place.

The lower end portion 85 of the extension section of the valve housing is repeatedly connected to and disengaged from the top section of the string of drilling pipe and thus is subjected to considerable wear and to accidental damage so that the lower end portion must be reworked or rethreaded quite frequently. Each time the threaded lower end portion is reworked, the extension is shortened slightly and unless the spacing or distance between the anchor member and the valve member is decreased as the length of the extension section 80 is decreased by such reworking, the valve head will be held in progressively higher open positions in the flow passage 87 of the valve section and will be out of alignment with the internal recess 113, restricting unduly the annular flow passage between the valve member head and the valve section and thus the flow of drilling fluids during drilling operations. As the length of the extension section of the housing is decreased, however, the position of the anchor member on the anchor rod is adjusted by removing the pin 143, rotating the nut 136 through approximately ninety degrees so that its internal flanges are moved out of alignment and out of engagement with the external flanges of the anchor rod, moving the anchor member 135 and the nut upwardly on the anchor rod to a new adjusted position thereon wherein the anchor will hold the valve in proper open position in the valve section of

the housing, and then inserting the pin 143 to lock the nut in such new adjusted position. The extension section 80 of the housing is of simple tubular form and is relatively inexpensive as compared to the valve section 77. The provision of such extension which gradually is shortened and must eventually be replaced thus provides for economy of repair. In addition, the rotatable mounting of the anchor member on the anchor rod 131, and therefore relative to the valve member precludes rotation of the valve member relative to the housing each time the valve housing is connected to or disconnected from the drill string thus precluding or minimizing wear of the valve member and of the seat ring. It will be apparent that if the anchor member were rigid with the anchor rod, the weight of the valve member and the downward force exerted thereon by the drilling fluid thereabove would tend to hold the valve member stationary relative to the top section 77 due to the frictional engagement of the shoulder 170 of the anchor member with the shoulder 65 of the top section 17 during rotational movement of the valve housing relative to the top section during connecting and disconnecting operations and the housing would rotate relative to the valve member causing wear of the seat surfaces 90 and 91 due to their frictional engagement when the valve member moves to its closed position.

It will thus be seen that the valve member when in open position is held against upward movement by the engagement of the shoulders 167 of the anchor member with the lower end surface 169 of the extension section 80 so that the valve 75 will not prevent reverse circulation of the drilling or other fluid through the annulus between the string of drill pipe and the bore of the well, then upwardly through the opening of the usual drill bit secured to the lower end of the string of drill pipe and thence upwardly through the flow passage 22 of the string of drill pipe, the flow passages 165 and 87 of the two sections of the valve housing and the flow passage 20 of the Kelly joint.

If it is desired that the valve 75 automatically prevent such reverse circulation, the Kelly joint 14 may be provided with a seat means, such as the seat ring 92, above the valve member whose seat surface would be engaged by the upper beveled surface 116 of the head 89 of the valve member upon upward movement of the valve member. In this case, the internal diameter of the flow passage 165 of the extension section would be increased to permit upward movement of the anchor member therethrough and the anchor member would not be provided with any means, such as the shoulders 167, for engaging the lower end of the extension section and its shoulders 170 would function in the same manner as the shoulders 64 of the valve 10 to hold the valve member in open position.

It will now be apparent that both forms of the valve illustrated and described have means for closing the flow passage of an upper section of a flow conductor when the upper section is disconnected from a lower section thereof to prevent flow of fluid from the flow passage of such upper section and that the valve automatically opens upon the connection of such upper flow section of a flow conductor to the lower section thereof to permit such flow through the flow passage of the flow conductor.

It will also be apparent that in both forms of the valve the seat surfaces of the valve member and of the seat ring when the valve is open are continuously exposed to the working action of the drilling fluid as it flows therepast so that these surfaces are kept clean and provide the sealing action desired when the valve is closed.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A valve for closing the flow passage of an upper section of a flow conductor upon the disconnection of the upper section from a lower section of the flow conductor, the lower section having an internal stop means, said valve including: a housing comprising a lower end portion of said upper section and having a flow passage, said housing having a lower end connectable to the upper end of the lower section; a valve member disposed in said flow passage for movement relative to said housing between an upper open position and a lower closed position, said valve member and said housing having seat means engageable to close said flow passage when said valve member is in said lower closed position in said flow passage and to limit upward movement of the housing relative to said valve member, said valve member having anchor means at its lower end engageable with the stop means of the lower section when said lower end of said housing is moved downwardly relative to and to connected engagement with said upper end of said lower section to position said valve member in said upper open position in said flow passage wherein said seat means are spaced from one another, said housing being moved upwardly relative to said valve member when the housing is moved upwardly relative to said lower section and out of connection therewith to cause said seat means to engage and close said flow passage; and means providing rotatable connection between said valve member and said anchor means whereby said valve means may rotate about its longitudinal axis while supported by said anchor means engaging said stop means of said lower section.

2. A valve including: a housing having means at opposite ends thereof for connecting the housing in a flow conductor to constitute a section thereof, said housing having a flow passage and an annular internal recess intermediate the ends thereof; said housing having removable annular valve seat means disposed in said flow passage below said internal annular recess and providing an upwardly facing annular seat surface extending inwardly of said recess; said seat ring having resilient means providing an upwardly facing resilient seat surface thereon; a valve member having an upper enlarged portion providing a downwardly facing seat surface engageable with said seat surface of said seat means when said valve member is in a lower closed position in said flow passage, said enlarged portion of said valve member having an external coating of resilient means providing said downwardly facing seat surface on said enlarged portion and engageable with said upwardly facing seat surface of said seat ring member to provide resilient sealing closure preventing downward flow through said seat past said valve member, said enlarged portion of said valve member being disposed in substantial axial alignment and centrally located within said recess when said valve member is in an upper open position in said flow passage with said seat surfaces spaced from one another, said valve member having dependent means extending downwardly of said seat means and outwardly of the lower end of said housing, said last mentioned means having guide means engageable with said housing for holding said valve member centrally disposed in said flow passage; and stop means on the lower end of said guide means engageable with the flow conductor below the housing for moving the valve upwardly to said upper open position in said housing when said housing is connected in said flow conductor, said valve element being movable downwardly by gravity when said housing is disconnected from said flow conductor.

3. A valve including: a housing having means at its lower end for connecting the housing in a flow conductor to comprise a section thereof, said flow conductor below said housing and the lower end of said housing providing a pair of longitudinally spaced opposed stop means when said housing is connected in the flow conductor, said housing having a flow passage therethrough; a valve member movably mounted in said flow passage, said housing having seat means in said flow passage provid-

ing an upwardly facing seat surface, said valve member having a downwardly facing seat surface engageable with said seat surface of said seat means when said valve member is in a lower closed position in said flow passage, said valve member having dependent means extending downwardly of said seat means and outwardly of the lower end of said housing; anchor means axially rotatably connected to the lower end of said dependent means, said anchor means having stop means engageable with said longitudinally spaced opposed stop means for holding said valve member in said upper open position when said housing is connected in said flow conductor section thereof, said axial rotatable connection between said anchor means and said dependent means permitting said valve member to rotate about its longitudinal axis when said anchor means engages said stop means of said flow conductor whereby the flow conductor may be rotated about its axis with respect to the housing and valve member without rotation of said valve member with respect to the seat in said housing.

4. A valve including: a housing having means at its lower end for connecting the housing in a flow conductor to comprise a section thereof, said flow conductor below said housing and the lower end of said housing providing a pair of longitudinally spaced opposed stop means when said housing is connected in the flow conductor, said housing having a flow passage therethrough; a valve member movably mounted in said flow passage, said housing having seat means in said flow passage providing an upwardly facing seat surface, said valve member having a downwardly facing seat surface engageable with said seat surface of said seat means when said valve member is in a lower closed position in said flow passage, said valve member having dependent means extending downwardly of said seat means and outwardly of the lower end of said housing; anchor means axially rotatably mounted on the lower end of said dependent means, said anchor means having stop means engageable with said stop means of said flow conductor for holding said valve member in said upper position for holding said valve member in said upper open position when said housing is connected in said flow conductor section thereof, said axially rotatable mounting of said anchor means on said dependent means of said valve member permitting said anchor means to rotate about the longitudinal axis of said dependent means of said valve member whereby the flow conductor may rotate with respect to the housing and the valve member without causing rotation of the valve member.

5. A valve including: a housing having means at its lower end for connecting the housing in a flow conductor to comprise a section thereof, said flow conductor below said housing and the lower end of said housing providing a pair of longitudinally spaced opposed stop means when said housing is connected in the flow conductor, said housing having a flow passage therethrough; a valve member movably mounted in said flow passage, said housing having seat means in said flow passage providing an upwardly facing seat surface, said valve member having a downwardly facing seat surface engageable with said seat surface of said seat means when said valve member is in a lower closed position in said flow passage, said valve member having a dependent member extending downwardly of said seat means and outwardly of the lower end of said housing; anchor means; means for rotatably and releasably connecting said anchor member to said dependent member in any one of a plurality of longitudinally spaced positions relative to said dependent member whereby said anchor member may rotate about the longitudinal axis of said dependent member at any one of said plurality of longitudinally spaced positions, said anchor member having stop means engageable with said longitudinally spaced opposed stop means for holding said valve member in said upper open position when said housing is connected in said flow conductor section thereof, said rotatable connection of said anchor member with said dependent member permitting rotation of said flow conductor with respect to said housing and said valve member without causing rotation of said valve member.

6. A gravity actuated Kelly foot valve including: a Kelly; a housing having means at its upper end for connecting it to the lower end of said Kelly and having means at its lower end for connecting the housing to the upper end of a first drill pipe collar for connecting the same to a second drill pipe collar at the upper end of a drill pipe flow conductor for releasably connecting the housing by means of said drill pipe collars in a drill pipe flow conductor to comprise a section thereof, said second drill pipe collar at the upper end of said flow conductor having upwardly facing stop means and said first drill pipe collar connected to the lower end of said housing having downwardly facing stop means which with said stop means of said second drill pipe collar provide a pair of longitudinally spaced opposed stop means when said housing is connected in the flow conductor, said housing having a flow passage therethrough and a valve member movably mounted in said flow passage, said housing having seat means in said flow passage providing an upwardly facing seat surface; said valve member having a downwardly facing seat surface engageable with said seat surface of said seat means when said valve member is in a lower closed position in said flow passage, said valve member having dependent means extending downwardly of said seat means and outwardly of the lower end of said housing; anchor means; means for rotatably and releasably connecting said anchor means to said dependent means in any one of a plurality of longitudinally spaced positions relative to said dependent means whereby said anchor means is rotatable about the longitudinal axis of said dependent means, said anchor means having stop means engageable with said opposed stop means of said drill pipe collars for holding said valve member in said upper open position when said upper and lower drill pipe collars are connected to connect said housing with said flow conductor, said rotatable connection of said anchor means to said dependent means permitting said second drill pipe collar and the flow conductor therebeneath to rotate with respect to said first pipe collar and the housing and the valve member without rotating said valve member, whereby said drill pipe collars may be connected without rotating said valve member on said valve seat.

7. A valve including: a housing having an upper valve section and a lower extension section releasably connected to one another, said housing having a flow passage extending longitudinally therethrough, said valve section having seat means; a valve member movable longitudinally in said flow passage and having seat means engageable with said seat means of said housing for closing said flow passage, said valve member having guide means engageable with internal surfaces of said housing for holding said valve member in alignment with the longitudinal axis of said flow passage, said valve member having a dependent member extending downwardly through said flow passage and outwardly of the lower end of said extension section; and an anchor member axially rotatably secured to the lower end of said dependent member, said anchor member providing downwardly facing stop means extending radially outwardly of said flow passage and engageable with an upwardly facing shoulder of a flow conductor connectable to the lower end of said extension section, said anchor member being rotatable about the longitudinal axis of said dependent member whereby said anchor member may rotate independently of the valve member when said anchor member is engaged with said upwardly facing shoulder of said flow conductor whereby said flow conductor may be rotated with respect to said housing to connect the flow conductor with the lower end of said extension section without causing rotation of said valve member.

8. A valve including: a housing having an upper valve section and a lower extension section releasably connected to one another, said housing having a flow passage extending longitudinally therethrough, said valve section having seat means; a valve member movable longitudinally in said flow passage and having seat means engageable with said seat means of said housing for closing said flow passage, said valve member having guide means engageable with internal surfaces of said housing below said seat means for holding said valve member in alignment with the longitudinal axis of said flow passage, said valve member having a dependent member extending downwardly through said flow passage and outwardly of the lower end of said extension section; an anchor member axially rotatably secured to the lower end of said dependent member, said anchor member providing downwardly facing stop means extending radially outwardly of said flow passage and engageable with an upwardly facing shoulder of a flow conductor connectable to the lower end of said extension section, said anchor member also providing upwardly facing stop means extending radially outwardly of said flow passage and engageable with the lower end of said extension section to limit upward movement of said valve member away from said seat, said anchor member having means extending into said lower extension section and engageable with the internal surfaces thereof for holding said dependent member and said valve member in alignment with the longitudinal axis of said flow passage, said anchor member being rotatable about the longitudinal axis of said dependent member whereby said anchor member may be rotated without rotating said valve member while said anchor member is in engagement with said upwardly facing shoulder of said flow conductor connectable to the lower end of said extension section.

9. A valve including: a housing having an upper valve section and a lower extension section releasably connected to one another, said housing having a flow passage extending longitudinally therethrough, said valve section having seat means; a valve member movable longitudinally in said flow passage and having seat means engageable with said seat means of said housing for closing said flow passage, said valve member having guide means engageable with internal surfaces of said housing for holding said valve member in alignment with the longitudinal axis of said flow passage, said valve member having a dependent member extending downwardly through said flow passage and outwardly of the lower end of said extension section; an anchor member rotatably secured to the lower end of said dependent member whereby said anchor member may rotate about the longitudinal axis of said dependent member without rotating said dependent member and the valve member from which it depends, said anchor member having radially outwardly extending means providing an upwardly facing stop means engageable with the lower end of said extension section for limiting upward movement of the valve member in said housing and downwardly facing stop means engageable with an upwardly facing shoulder of a flow conductor connectable to the lower end of said extension section for holding said valve member in an upper open position when said extension section is connected to said flow conductor connectable to the lower end of said extension section; said means rotatably connecting said anchor member to said dependent member providing for vertical adjustment of the position of said valve member with respect to the upwardly facing seat of said housing.

10. A valve including: a housing having an upper valve section and a lower extension section releasably connected to one another, said housing having a flow passage extending longitudinally therethrough, said valve section having seat means; a valve member movable longitudinally in said flow passage and having seat means engageable with said seat means of said housing for closing said flow passage, said valve member having guide means engageable with internal surfaces of said housing for holding said valve member in alignment with the longitudinal axis of said flow passage, said valve member having a dependent member extending downwardly through said flow passage and outwardly of the lower end of said extension section; an anchor member secured to the lower end of said dependent member, said anchor member providing downwardly facing stop means extending radially outwardly of said flow passage and engageable with an upwardly facing shoulder of a flow conductor connectable to the lower end of said extension section, said anchor member having means extending into said lower extension section and engageable with the internal surfaces thereof for holding said dependent member and said valve member in alignment with the longitudinal axis of said flow passage; and means for rotatably mounting said anchor member on said dependent member including a plurality of peripherally spaced sets of vertically aligned and spaced external flanges on said dependent member and a lock member having a plurality of annularly spaced sets of vertically aligned and spaced internally extending flanges, said flanges of said lock member and of said dependent member being engageable with one another to limit longitudinal movement of said lock member on said dependent member when said internal and external flanges are vertically aligned and in intermeshed relation relative to one another, said lock member and said anchor member having coengageable stop means for limiting longitudinal movement of said anchor member relative to said lock member.

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