

June 15, 1965

P. S. SIZER

3,189,044

PRESSURE DIFFERENTIAL OPERATED SAFETY VALVE

Original Filed April 21, 1959

3 Sheets-Sheet 1

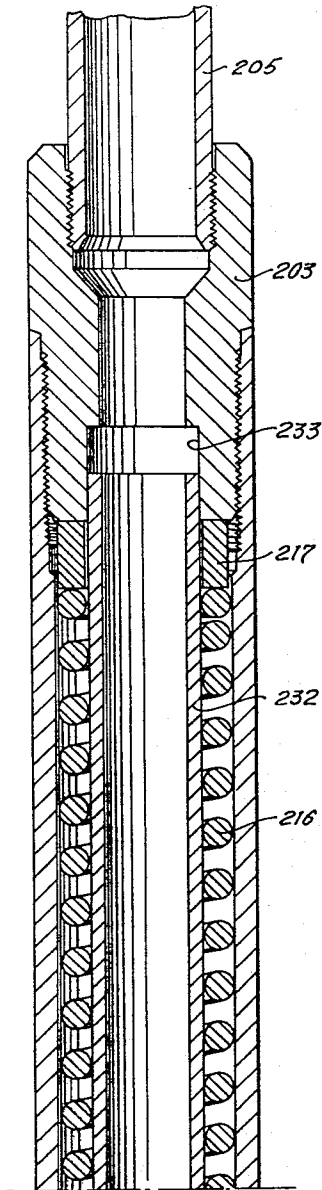


Fig. 1

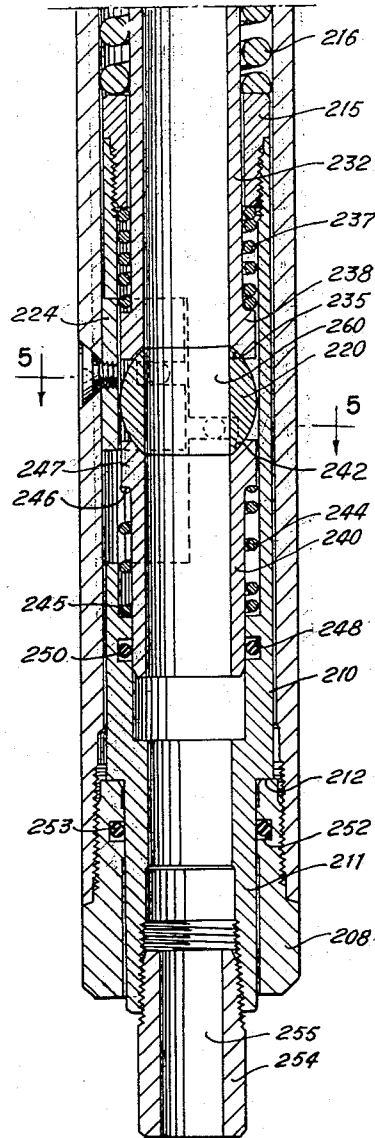


Fig. 2

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3 Sheets-Sheet 2

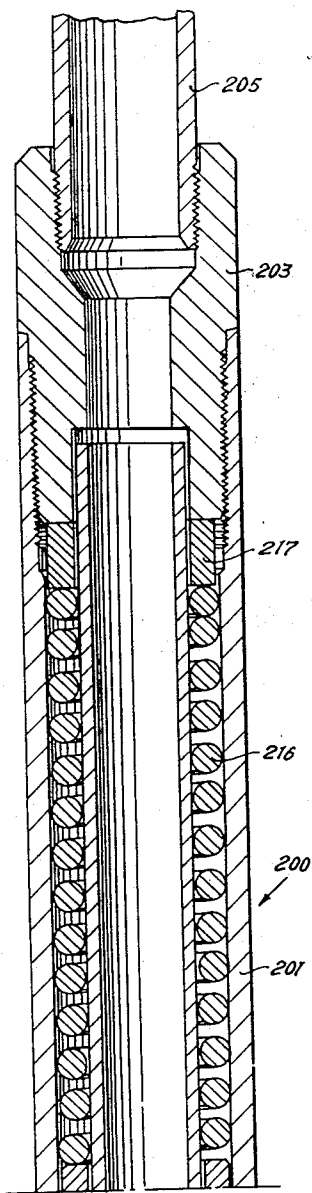


Fig. 3

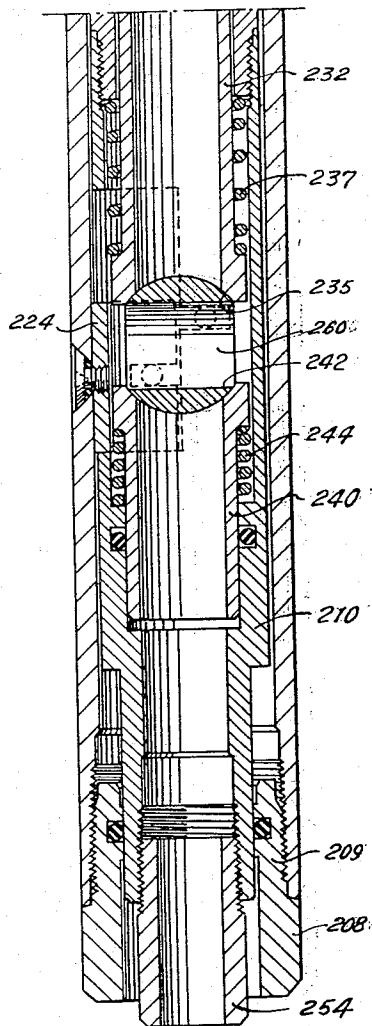


Fig. 4

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PRESSURE DIFFERENTIAL OPERATED SAFETY VALVE

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3 Sheets-Sheet 3

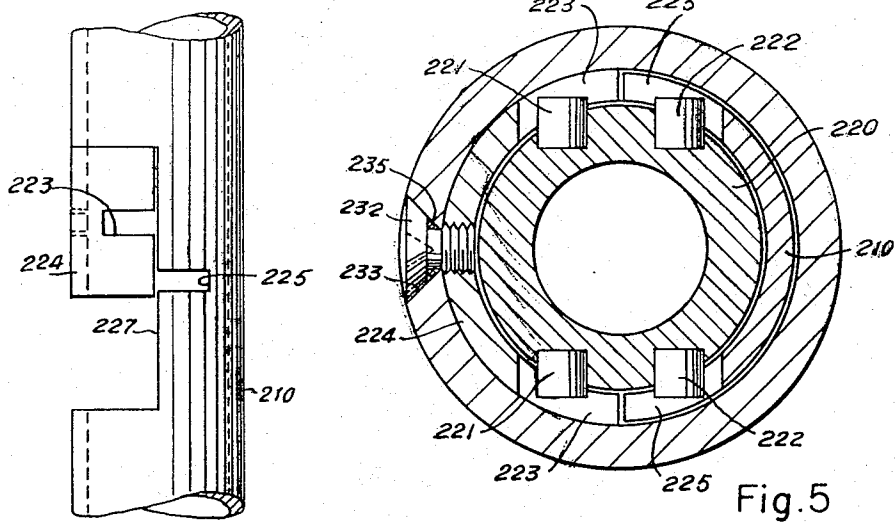


Fig. 6

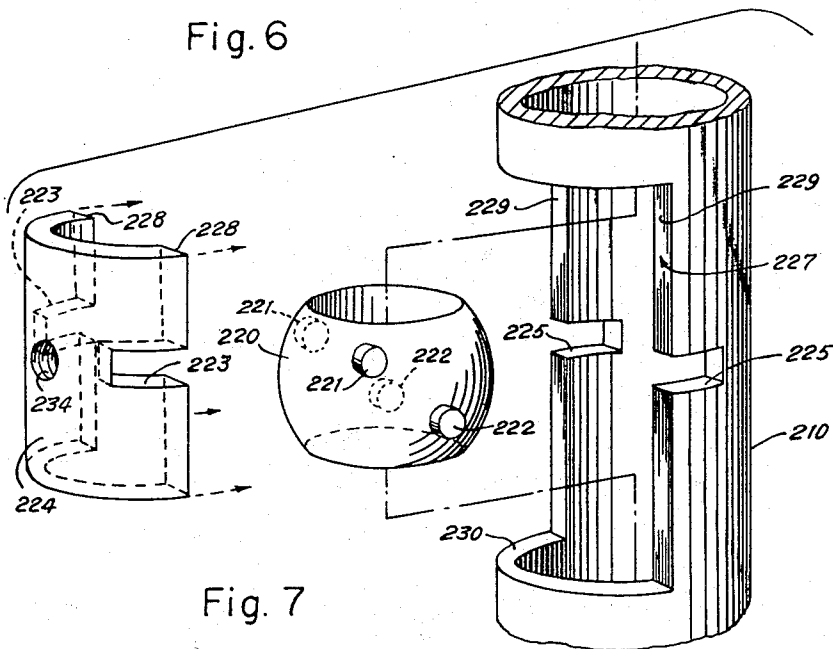


Fig. 7

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1

2

3,189,044 PRESSURE DIFFERENTIAL OPERATED SAFETY VALVE

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Original application Apr. 21, 1959, Ser. No. 807,831.
Divided and this application Apr. 9, 1963, Ser.
No. 278,504

9 Claims. (Cl. 137—498)

This invention relates to well tools and more particularly to pressure operated valves for controlling the flow of fluids through a well flow conductor. This application is a division of applicant's co-pending application, Serial No. 807,831, filed April 21, 1959, now abandoned.

One object of the invention is to provide a new and improved automatic pressure operated valve assembly or well tool for controlling the flow of well fluids through a well conductor.

A further object of the invention is to provide a pressure operated valve assembly or well tool for controlling the flow of well fluids through a well conductor which is responsive to the pressure differential thereacross to shut off flow of fluids therethrough when the pressure differential thereacross rises above or exceeds a predetermined value.

Still another object of the invention is to provide a pressure operated valve assembly for controlling the flow of well fluids through a well conductor which is preloaded by a resilient means to close when the pressure differential across the valve rises above or exceeds a predetermined value.

A further object is to provide a well tool or valve assembly of the character described having a ball valve with a flow passage therethrough which is rotatable to an open position wherein its flow passage is in communication with the flow passage of the well flow conductor and a closed position wherein its flow passage is removed from communication with the flow passage of the well conductor, the flow passage of the ball valve being substantially equal in cross-section to the flow passage of the well tool whereby substantially unrestricted flow through the valve occurs when the ball valve is in its open position.

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

FIGURE 1 is a view partly in elevation and partly in section showing a well tool embodying the automatic pressure controlling valve assembly of the invention mounted on a well tool;

FIGURE 2 is a view similar to and forming a continuation of FIGURE 1 showing the lower portions of the well tool, the ball valve being shown in its open position;

FIGURES 3 and 4 are views similar to FIGURES 1 and 2 showing the ball valve in its closed position;

FIGURE 5 is a cross-sectional view taken on line 5—5 of FIGURE 2;

FIGURE 6 is a fragmentary elevational view showing the mounting means for the ball valve illustrated in FIGURES 2 and 4; and

FIGURE 7 is an exploded perspective view of the ball valve and its mounting means illustrated in FIGURES 2 and 4.

Referring now particularly to FIGURES 1 through 7 of the drawings, the pressure operated flow control or safety valve well tool or assembly 200 includes a tubular valve housing 201 provided at its upper end with an upper sub 203 having its lower reduced portion threaded into the upper end of the valve housing. The upper sub

is internally threaded at its upper end whereby the valve assembly or well tool 200 may be secured to the lower end 205 of an equalizing sub which may be of the type shown on page 4138 of the Composite Catalog of Oil Field Equipment and Services, 1957 edition. The equalizing sub in turn may be secured to the lower end of an anchoring and sealing tool such as that disclosed in the patent to Miller, Patent No. 2,673,614. A tubular plug or bushing 208 has its reduced upper end portion 209 threaded into the lower end of the valve housing 201.

A valve actuating sleeve 210 longitudinally slidably mounted in the valve housing between the upper sub 203 and the plug 208 has a reduced lower portion 211 which extends downwardly through the plug and which provides an external downwardly facing annular stop shoulder 212. The annular stop shoulder abuts the upper end of the plug to limit downward movement of the actuating sleeve in the valve housing. A tubular spring retainer 215 is threaded into the upper end of the actuating sleeve 210. A large helical main spring 216 disposed in the valve housing has its opposite ends bearing against the lower end of an adjusting ring 217 and against the upper end of the spring retainer. The upper end of the adjusting ring bears against the bottom surface of the top sub 203. The spring 216 biases the actuating sleeve 210 downwardly to the position illustrated in FIGURE 2.

A ball valve 220 is mounted in the actuating sleeve 210 for rotation about an axis transverse to the longitudinal axis of the actuating sleeve by means of a pair of pivot pins 221 which extend outwardly of the ball valve into the slots 223 of a cylindrical pivot section 224 rigidly secured to the valve housing and by means of a pair of actuating pins 222 which extend outwardly of the ball valve into the recesses 225 of the actuating sleeve. The fixed cylindrical pivot section 224 is received in a longitudinal slot 227 of the actuating sleeve. The vertical sides 228 of the fixed cylindrical section abut the vertical sides 229 of the longitudinal slot of the actuating sleeve to prevent rotational movement of the actuating sleeve in the valve housing. Upward movement of the actuating sleeve in the valve housing is limited by engagement of the semi-circular upwardly facing stop shoulder 230 of the actuating sleeve with the lower end of the fixed cylindrical section 224. The pivot section 224 is fixed immovably to the valve housing by means of a screw 232 which extends through a lateral beveled aperture 233 of the valve housing into a threaded lateral bore 234 of the cylindrical pivot section 224. The screw 232 is provided with an O-ring or sealing means 235 which seals between the screw 232 and the valve housing to prevent flow of fluids through the aperture.

It will be apparent that when the actuating sleeve 210 moves upwardly from the position illustrated in FIGURE 2 to the position illustrated in FIGURE 4, the ball valve will pivot in a counter-clockwise manner about the pivot pins 221 due to the engagement of the actuating pins in the slots 225 of the actuating sleeve from its opening position to its closed position. The slots 225 and 223 provide for lateral movement of the pivot and actuating pins during such rotational movement of the ball valve. Conversely, when the actuating sleeve moves downwardly in the valve housing, the ball valve will be rotated in a clockwise manner about the pivot pins 221 again due to the engagement of the actuating pins 222 in the slots of the actuating sleeve from its closed position to its open position.

An upper valve seat sleeve 232 disposed in the valve housing has its upper end received in the enlarged lower bore portion 233 of the upper sub 203 and extends downwardly through the helical spring 216 and the sleeve retainer 215 to the ball valve. The lower end of the upper

sleeve is concave and provides a bearing surface 235 on which the ball valve 220 rides and is slidably moved. The upper sleeve 232 is biased downwardly in the valve housing by a helical spring 237 disposed thereabout and between the lower end of the spring retainer 215 and the external annular flange 233 provided on the lower end of the upper seat sleeve. It will be apparent that opposite ends of the biasing spring bear against the lower end of the spring retainer 215 and the upper surface of the flange 233.

A similar lower valve seat sleeve 240 is longitudinally slidably mounted in the actuating sleeve 210 and has its lower end received in an intermediate section 241 of the bore of the actuating sleeve. The upper end of the lower sleeve is concave and provides a bearing surface 242 on which the ball valve rides and may slidably move. The lower seat sleeve 240 is biased upwardly toward the ball valve 220 by a helical biasing spring 244 disposed about the lower seat sleeve. Opposite ends of the biasing spring about the upwardly facing annular shoulder 245 of the actuating sleeve and the downwardly facing shoulder 246 on the under side of the external annular flange 247 on the upper end of the lower seat sleeve 240.

The intermediate portion of the actuating sleeve, in which the lower end of the lower seat sleeve 240 is received, is provided with an internal annular recess 248 in which is disposed an O-ring or seal means 250 for sealing between the lower sleeve and the actuating sleeve. A similar internal annular recess 252 is provided in the tubular plug 208 of the valve housing in which is received a similar O-ring or seal means 253 for sealing between the lower reduced portion 211 of the actuating sleeve and the tubular plug.

A bean or tubular flow restricting member 254 threaded in the lower end of the actuating sleeve 210 has an internal bore 255 of smaller orifice than any portion of the bore of the actuating sleeve in order to provide a means for creating a pressure differential across the actuating sleeve to move the actuating sleeve upwardly upon the occurrence of predetermined pressure conditions across the well tool 200. It will be apparent that if a pressure differential exists across the actuating sleeve causing an upwardly acting force on the actuating sleeve which is of sufficient force to overcome the force of the main spring 216 and the force of the lower seat sleeve spring 244, the actuating sleeve will move upwardly in the valve housing. During such movement the engagement of the actuating pins 222 of the ball valve 220 in the slots 225 of the actuating sleeve will cause the ball valve to rotate on the seats 235 and 242 in a counterclockwise direction about the pivot pins 221 and move upwardly from the open position illustrated in FIGURE 2 wherein the flow passage 260 is aligned with the bores of the upper and lower sleeves to a position wherein the flow passage 260 extends transversely thereof whereby the contact of the ball valve with the seats 242 and 235 of the seat sleeves closes the valve and prevents flow of well fluids therethrough. The O-rings 253 and 250 of course prevent flow of fluids through the valve housing outwardly of the actuating sleeve.

When such pressure differential is removed or eliminated, the main spring 216 will again force the actuating sleeve downwardly from the position illustrated in FIGURE 4 to the position illustrated in FIGURE 2, the ball valve rotating in a clockwise manner and moving downwardly during such movement to a position wherein its flow passage is again aligned with the bores of the seat sleeves. It will be apparent that when the ball valve is in its fully opened position as illustrated in FIGURE 2, the flow of fluids through the valve assembly is rectilinear, without turns or changes in direction of flow.

In use, when it is desired to control the flow of fluids through a well flow conductor such as the usual flow conductor or well tubing (not shown), the well tool 200 is connected to a suitable anchoring and sealing tool, such as the anchoring and sealing tool disclosed in the patent

to Miller, 2,673,614, by means of a pressure equalizing sub, such as that shown on page 4138 of the Composite Catalog of Oil Field Equipment and Services, 1957 edition, the equalizing sub being connected to the lower end of the anchoring and sealing tool and the well tool 200 being anchored or connected to the lower end 205 of the equalizing sub. The function of the equalizing sub is to equalize the pressure between the interior of the valve housing 201 above the ball valve 220 and the exterior of the valve housing.

The assembly of the anchoring and sealing tool, equalizing sub and the valve assembly or well tool 200 is lowered through the tubing string until the assembly is located and locked in a proper position in the tubing string, in a landing nipple, such as the landing nipple illustrated in the aforesaid Miller Patent 2,673,614. The ball valve during such movement of the assembly through the tubing string is in the open position illustrated in FIGURE 2 since the force exerted by the main spring 216 is sufficient to keep the actuating sleeve 210 in the lower position against the resistance of the biasing spring 244. Fluids may then flow upwardly through the bean 255, the actuating sleeve 210, the lower sleeve 240, the flow passage 260 of the ball valve, the upper sleeve 232, the upper sub 203, and thence through the equalizing sub 205 and the anchoring and sealing device to the surface. It will be noted that the flow of fluids is rectilinear through the well tool 200 without any changes in direction of flow.

In the event that abnormal conditions occur which cause the fluid flow through the well tool 200 to surge for any reason, such as, for example, a rupture in the flow line above the well head or in the tubing string above the anchoring and sealing device, a pressure differential will be created across the bean 254 which will exert an upward force on the actuating sleeve 210. As a result, the actuating sleeve moves upwardly against the combined resistances of the main spring 216 and the resistance of the lower seat sleeve spring 244 and during such upward movement moves the ball valve upwardly and rotates it from the position illustrated in FIGURE 2 to the position illustrated in FIGURE 4. The biasing springs 244 and 237 at all times cause the lower and upper sleeves to remain in engagement with the ball valve so that when the ball valve is in the closed position illustrated in FIGURE 4, the engagement of the ball valve with the seats 235 and 242 of the upper and lower sleeve prevents flow of fluids through the well tool. Since, when the ball valve is in the closed position, a pressure differential is caused to exist across the actuating sleeve which acts upwardly on the actuating sleeve, the ball valve will remain in the closed position and will not reopen until the pressure in the valve housing above the ball valve rises so that the combined force of such pressure above the ball valve and the force exerted by the spring 216 are equal to or greater than the force exerted by fluid pressure below the ball valve. Such fluid pressure above the ball valve exerts a force on the upper surfaces of the actuating sleeve since fluid has access between the interior of the upper sleeve and the exterior thereof, the upper end of the sleeve not being in fluid tight engagement with the enlarged bore of the upper sub.

After the abnormal condition which caused the ball valve to be moved to its closed position has cleared or been ended the equalizing sub is actuated by a suitable means, such as an equalizing prong which is lowered through the well conductor or tubing string to the equalizing sub to cause operative elements of the equalizing sub to move to provide for fluid communication, through the equalizing sub, between the exterior of the valve housing 201 and the interior thereof above the ball valve. When the pressure in the valve housing above the ball valve now increases, such pressure is communicated to the actuating sleeve 210 above the O-ring 250 and, with the fluid pressure acting on the actuating sleeve 210 thus being equalized, the force of the main spring 216 is sufficiently

great to cause the actuating sleeve to again move downwardly to the position illustrated in FIGURE 2, the ball valve rotating to its open position during such movement. The equalizing prong is then withdrawn from the equalizing sub and from the tubing string and the well tool or pressure regulated valve assembly again is in condition to operate if another such abnormal condition arises. It will be apparent that the assembly of the anchoring and sealing tool, equalizing sub and pressure valve assembly or well tool 200 may be removed from the tubing string in the usual manner by wire line and running tool.

The pressure differential at which the ball valve will move from open to closed position may be set at any predetermined value by inserting an adjusting ring 217 of appropriate width. It will be apparent that the greater the width of the ring 217 the greater the compression of the spring 216 and therefore the greater the pressure differential which will be required to move the ball valve to its closed position.

It will be seen that means are provided for moving the ball valve to a lower open position and that the ball valve moves upwardly when the pressure differential across the ball valve exceeds a predetermined value.

It will further be seen that the ball valve is pivotally eccentrically mounted in a housing for movement about an axis transverse to the longitudinal axis of the housing between an open position wherein the flow passage of the ball valve is in alignment with the flow passage of the upper and lower sleeves which abut the ball valve and a transverse position wherein the flow passage is closed from communication with passages of such sleeves.

It will further be noted that the ball valve is biased toward its open position by means of the main spring 216.

It will further be seen that in the well tool the ball valve is adjustable to open at different values of a pressure characteristic, the value of the pressure differential between the interior and exterior of the valve housing, and the adjustment is obtained by varying the width of the adjusting ring 217.

It will further be seen that resilient means are provided to yieldingly urge the upper and lower sleeves, which abut the ball valve and ball into engagement with one another whereby any wear of the seat or of the ball valves is compensated for.

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 well tool for controlling flow of fluids including: an elongate body having a longitudinal flow passage; an actuating sleeve disposed in the flow passage of the body for limited longitudinal movement therein; a ball valve rotatably mounted in the body and having a flow passage therethrough; means pivotally connecting said ball valve with said body eccentrically of the longitudinal axis thereof; means operatively connecting the ball valve to the actuating sleeve whereby when the actuating sleeve moves to one extreme longitudinal position in the body the ball valve is rotated; seat means slidable longitudinally in the body and operatively engaging the ball valve for co-acting therewith with the flow passage thereof when the ball valve is rotated to control flow of fluid through the flow passage of the body; means in the body biasing the actuating sleeve to another extreme position spaced longitudinally from said one position, the actuating sleeve having a restricted orifice upstream of the ball valve whereby when the pressure differential between the upstream side of the actuating sleeve and the flow passage exceeds a predetermined value, the actuating sleeve moves to said one extreme position.

2. A well tool for controlling flow of fluids including: an elongate body having a longitudinal flow passage; an

actuating sleeve disposed in the flow passage of the body for limited longitudinal movement between two opposite extreme longitudinally spaced positions therein; a ball valve rotatably and longitudinally movably mounted in the body and having a flow passage; means operatively connecting said actuating sleeve with said ball valve; an upper sleeve extending through the body and downwardly into the actuating sleeve and providing a seat for the ball valve, means biasing the upper sleeve downwardly toward the ball valve; and a lower sleeve slidably mounted in the actuating sleeve and engaging the lower surfaces of the valve body, means biasing said lower sleeve upwardly toward the ball valve, the ball valve when the actuating sleeve is in one extreme position having its flow passage extending transversely of the bores of the sleeves and out of communication therewith to prevent the flow of well fluids therethrough, the ball valve having its flow passage longitudinally aligned with the bores of the sleeves and of the body when the actuating sleeve is in the opposite extreme position, the actuating sleeve having a restricted orifice upstream of the ball valve whereby when an increase in the pressure differential between the upstream side of the actuating sleeve and the flow passage exceeds a predetermined value, the actuating sleeve moves to said one extreme position.

3. A well tool for controlling flow of fluids including: an elongate body having a longitudinal flow passage; an actuating sleeve disposed in the flow passage of the body for limited longitudinal movement between two opposite extreme longitudinally spaced positions therein; a ball valve rotatably and longitudinally movably mounted in the body and having a flow passage; means operatively connecting said actuating sleeve with said ball valve; an upper tubular seat sleeve extending through the body and downwardly into the actuating sleeve and providing a seat for the ball valve, means biasing the upper sleeve downwardly toward the ball valve; a lower tubular seat sleeve slidably mounted in the actuating sleeve and sealingly engaging the lower surfaces of the flow passage of the valve body, means biasing said lower sleeve upwardly toward the ball valve, the ball valve when the actuating sleeve is in one extreme position having its flow passage extending transversely of the bores of the sleeves and out of communication therewith to prevent the flow of well fluids therethrough, the ball valve having its flow passage longitudinally aligned with the bores of the sleeves and of the body when the actuating sleeve is in the opposite extreme position, means in the actuating sleeve providing a restricted orifice upstream of the ball valve whereby when an increase in the pressure differential between the upstream side of the actuating sleeve and the flow passage exceeds a predetermined value the actuating sleeve moves to said one extreme position; and means sealing between the lower sleeve and the actuating sleeve.

4. A well tool for controlling flow of fluids including: an elongate body having a longitudinal flow passage; an actuating sleeve disposed in the flow passage of the body for limited longitudinal movement between two opposite extreme longitudinally spaced positions therein; a ball valve rotatably and longitudinally movably mounted in the body and having a flow passage; an upper sleeve extending through the body and downwardly into the actuating sleeve and providing a seat for the ball valve, means biasing the upper sleeve downwardly toward the ball valve; a lower sleeve slidably mounted in the actuating sleeve and engaging the lower surfaces of the valve body, means biasing said lower sleeve upwardly toward the ball valve, the ball valve when the actuating sleeve is in one extreme position having its flow passage extending transversely of the bores of the sleeves and out of communication therewith to prevent the flow of well fluids therethrough, the ball valve having its flow passage longitudinally aligned with the bores of the sleeves and of the body when the actuating sleeve is in the opposite extreme position, the actuating sleeve having a restricted orifice

upstream of the ball valve whereby when an increase in the pressure differential between the upstream side of the actuating sleeve and the flow passage exceeds a predetermined value the actuating sleeve moves to said one extreme position; means sealing between the lower sleeve and the actuating sleeve; and means sealing between the actuating sleeve and the body below the ball valve.

5. A well tool for controlling flow of fluids including: an elongate body having a longitudinal flow passage; an actuating sleeve disposed in the flow passage of the body for limited longitudinal movement between two opposite extreme longitudinally spaced positions therein; a ball valve rotatably and longitudinally movably mounted in the body and having a transverse flow passage there-through; seat means in said body and actuating sleeve engaging said ball valve and coaxing therewith to control flow there-through; the actuating sleeve having a longitudinal slot, the ball valve extending into the actuating sleeve through the longitudinal slot and having transverse actuating pins extending into lateral slots provided in the actuating sleeve, the ball valve having pivot means engageable with said body and spaced from the actuating pins whereby when the actuating sleeve moves to one extreme longitudinal position in the body the ball valve is rotated to a first position in which the flow passage of the valve is disposed in a position transversely of the flow passage of the body preventing flow of fluids through the flow passage and when the actuating sleeve is moved to the opposite extreme longitudinal position in the body the ball valve is moved to a second position in which the flow passage of the ball valve is disposed in communication with the flow passage of the body permitting flow of fluids through the flow passage; means in the body biasing the actuating sleeve to said opposite extreme position, the actuating sleeve having a restricted orifice upstream of the ball valve whereby when the pressure differential between the upstream side of the actuating sleeve and the flow passage exceeds a predetermined value the actuating sleeve moves to said one extreme position to rotate said ball valve to position the flow passage thereof transversely with respect to the flow passage of the body to close the flow passage of said body.

6. A well tool for controlling flow of fluids including: an elongate body having a longitudinal flow passage; an actuating sleeve disposed in the flow passage of the body for limited longitudinal movement between two opposite extreme longitudinally spaced positions therein; a ball valve rotatably and longitudinally movably mounted in the body and having a transverse flow passage there-through; an upper tubular seat sleeve extending through the body and downwardly into the actuating sleeve and providing a seat for the ball valve; means biasing said upper sleeve toward said ball valve; a lower tubular seat valve slidably mounted in the actuating sleeve and engaging the lower surface of the ball valve; means biasing said lower sleeve toward the ball valve; the actuating sleeve having a longitudinal slot, the ball valve extending into the actuating sleeve through the longitudinal slot and having transverse actuating pins extending into lateral slots provided in the actuating sleeve, the ball valve having pivot means engageable with said body and spaced from the actuating pins whereby when the actuating sleeve moves to one extreme longitudinal position in the body the ball valve is rotated to a closed position preventing flow of fluids through the flow passage and when the actuating sleeve is moved to an opposite extreme longitudinal position in the body the ball valve is moved to an open position permitting flow of fluids through the flow passage; means in the body biasing the actuating sleeve to said opposite extreme position, the actuating sleeve having a restricted orifice upstream of the ball valve whereby when the pressure differential between the upstream side of the actuating sleeve and the flow passage exceeds a predetermined value the actuating sleeve moves to said one extreme position to close the flow passage,

said means biasing the actuating sleeve to said opposite extreme position comprising a first spring disposed about the actuating sleeve and in the body above the actuating sleeve.

7. A well tool for controlling flow of fluids including: an elongate body having a longitudinal flow passage; an actuating sleeve disposed in the flow passage of the body for limited longitudinal movement between two opposite extreme longitudinally spaced positions therein; a ball valve rotatably and longitudinally movably mounted in the body and having a transverse flow passage there-through; an upper tubular seat sleeve extending through the body and downwardly into the actuating sleeve and providing a seat for the ball valve; means biasing said upper sleeve toward said ball valve; a lower tubular seat valve slidably mounted in the actuating sleeve and engaging the lower surface of the ball valve; means biasing said lower sleeve toward the ball valve; the actuating sleeve having a longitudinal slot, the ball valve extending into the actuating sleeve through the longitudinal slot and having transverse actuating pins extending into lateral slots provided in the actuating sleeve, the ball valve having pivot means engageable with said body and spaced from the actuating pins whereby when the actuating sleeve moves to one extreme longitudinal position in the body the ball valve is rotated to a closed position preventing flow of fluids through the flow passage and when the actuating sleeve is moved to the opposite extreme longitudinal position in the body the ball valve is moved to an open position permitting flow of fluids through the flow passage; means in the body biasing the actuating sleeve to said opposite extreme position, the actuating sleeve having a restricted orifice upstream of the ball valve whereby when the pressure differential between the upstream side of the actuating sleeve and the flow passage exceeds a predetermined value the actuating sleeve moves to said one extreme position to close the flow passage, said means biasing the actuating sleeve to said opposite extreme position comprising a first spring disposed about the actuating sleeve and in the body above the actuating sleeve, the means biasing the upper sleeve downwardly comprising a second spring disposed about the upper sleeve and in the actuating sleeve, opposite ends of said second spring engaging oppositely facing shoulders of the sleeves.

8. A well tool for controlling flow of fluids including: an elongate body having a longitudinal flow passage; an actuating sleeve disposed in the flow passage of the body for limited longitudinal movement between two opposite extreme longitudinally spaced positions therein; a ball valve rotatably and longitudinally movably mounted in the body and having a transverse flow passage there-through; an upper tubular seat sleeve extending through the body and downwardly into the actuating sleeve and providing a seat for the ball valve; means biasing said upper sleeve toward said ball valve; a lower tubular seat valve slidably mounted in the actuating sleeve and engaging the lower surface of the ball valve; means biasing said lower sleeve toward the ball valve; the actuating sleeve having a longitudinal slot, the ball valve extending into the actuating sleeve through the longitudinal slot and having transverse actuating pins extending into lateral slots provided in the actuating sleeve, the ball valve having pivot means engageable with said body and spaced from the actuating pins whereby when the actuating sleeve moves to one extreme longitudinal position in the body the ball valve is rotated to a closed position preventing flow of fluids through the flow passage and when the actuating sleeve is moved to the opposite extreme longitudinal position in the body the ball valve is moved to an open position permitting flow of fluids through the flow passage; means in the body biasing the actuating sleeve to said opposite extreme position, the actuating sleeve having a restricted orifice upstream of the ball valve whereby when the pressure differential between the upstream side of the actuating sleeve and the flow passage exceeds a

9

predetermined value the actuating sleeve moves to said one extreme position to close the flow passage, said means biasing the actuating sleeve to said opposite extreme position comprising a first spring disposed about the actuating sleeve and in the body above the actuating sleeve, the means biasing the upper sleeve downwardly comprising a second spring disposed about the upper sleeve and in the actuating sleeve, opposite ends of said second spring engaging oppositely facing shoulders of the sleeves, the means biasing the lower sleeve upwardly comprising a third spring disposed about the lower sleeve, opposite ends of said third spring abutting oppositely facing shoulders of the lower sleeve and the actuating sleeve.

9. A well tool for controlling the flow of fluid through a well flow conductor including: an elongate tubular body having a longitudinal flow passage; a tubular member slidably mounted in the body for limited longitudinal movement in the flow passage of the body; a ball valve rotatably mounted in the body and engaged by said tubular member; means pivotally connecting said ball valve with said body for movement longitudinally thereof while connected with the body whereby the ball valve is rotated in the body as it is moved longitudinally therein; means

10

operatively connecting said tubular member with said ball valve whereby the ball valve is moved with said tubular member in the body; tubular seat means slidable in said body and engaging said ball valve, said ball valve having a transverse flow passage movable into and out of flow communication with the tubular seat means for controlling flow of fluids through the body; biasing means engageable with the tubular member for biasing the tubular member in a direction tending to move the ball valve toward the open position, and flow restricting means operatively associated with said slidable member responsive to the fluid pressure differential between the pressure of fluid within the flow passage of the body and the pressure of the fluid exterior of the body to cause the slidable member to move longitudinally in the body to move the ball valve from open and closed position therein.

References Cited by the Examiner

UNITED STATES PATENTS

2,894,715	7/59	Bostock	251—58
3,035,808	5/62	Knox	251—62

MARTIN P. SCHWADRON, *Acting Primary Examiner.*