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R. E. WESTLING

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STORM CHOKE AND PACKER FOR DUAL-ZONE COMPLETION

Filed Feb. 28, 1955

3 Sheets-Sheet 1

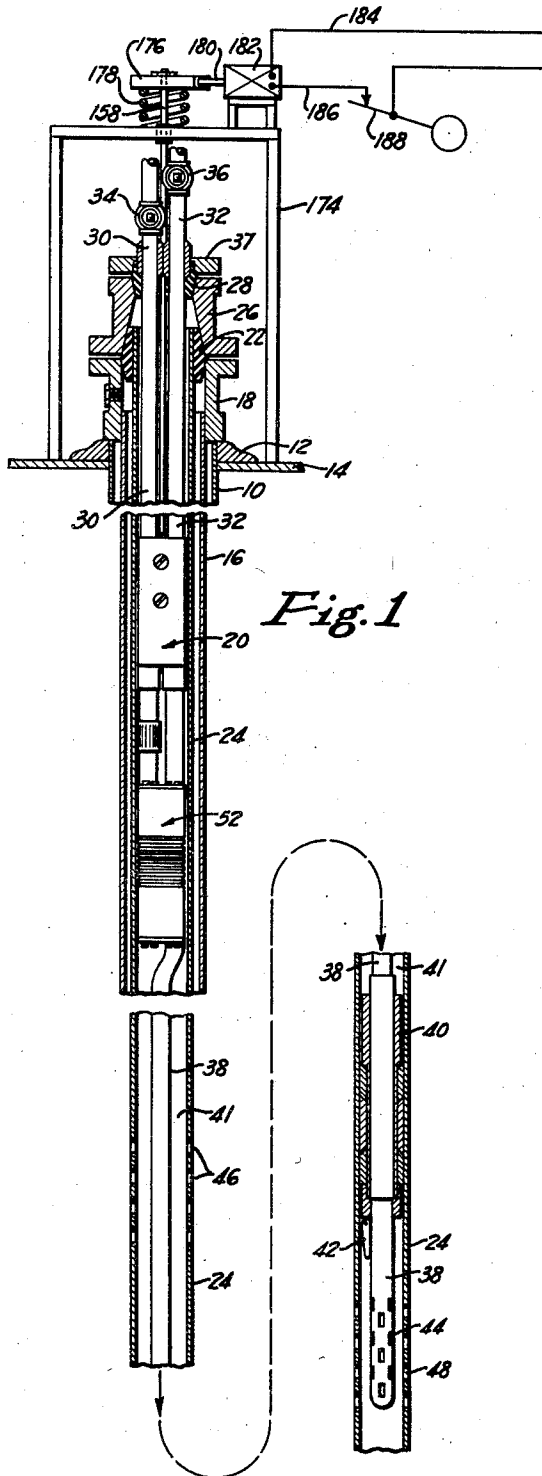


Fig. 1

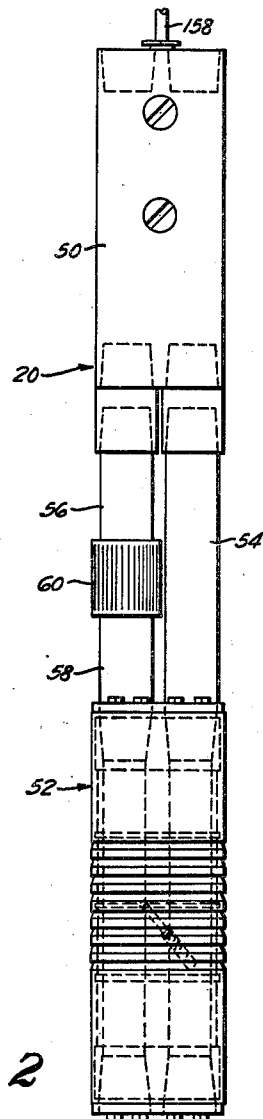


Fig. 2

INVENTOR.
RANDOLPH E. WESTLING
BY
HORACE B. COOKE
HIS ATTORNEY

Feb. 5, 1957

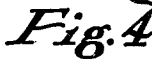
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INVENTOR.

RANDOLPH E. WESTLING

BY

HORACE B. COOKE

HIS ATTORNEY

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3 Sheets-Sheet 3

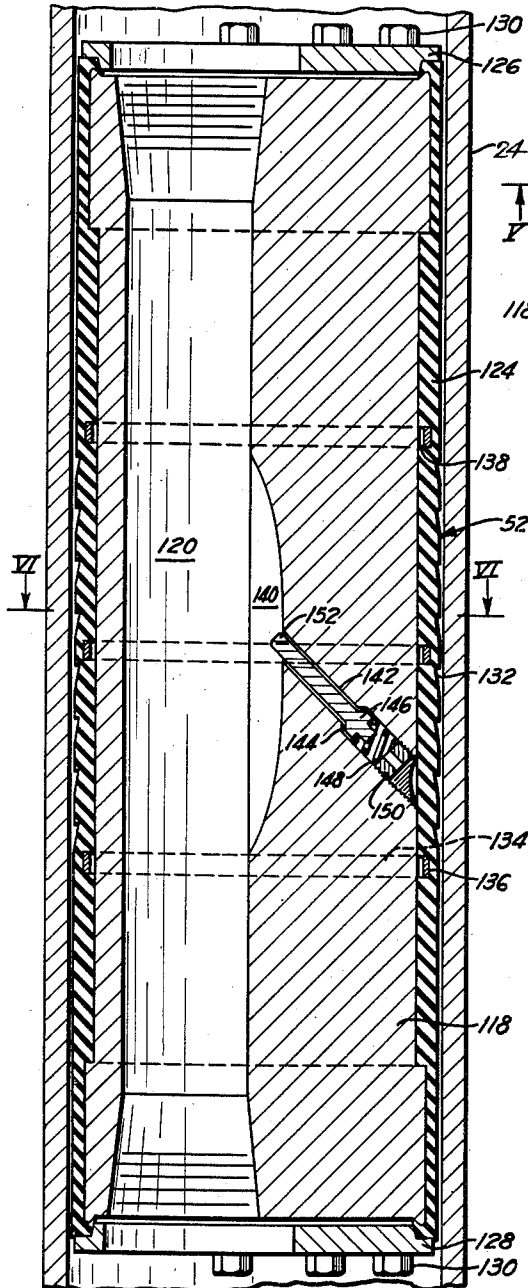


Fig. 5

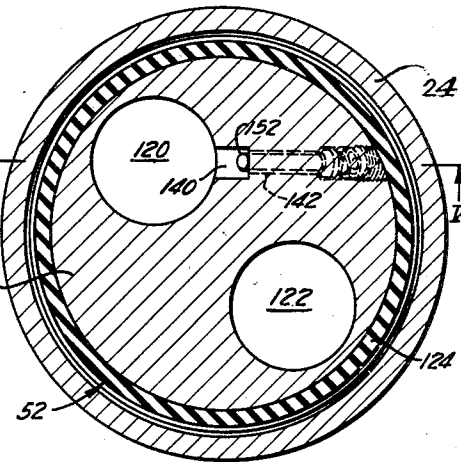


Fig. 6

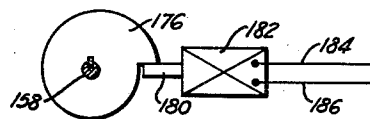


Fig. 7

INVENTOR.
RANDOLPH E. WESTLING
BY

HORACE B. COOKE
HIS ATTORNEY

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2,780,291

STORM CHOKE AND PACKER FOR DUAL-ZONE COMPLETION

Randolph E. Westling, Ridgewood, N. J., assignor to Gulf Oil Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

Application February 28, 1955, Serial No. 491,106

11 Claims. (Cl. 166—73)

This invention relates to apparatus for the control of flow in a well and more particularly to a storm choke adapted for installation within the bore hole of a dual-zone well.

Offshore wells are subjected to hazards such as damage by waves or collision which are not encountered by onshore wells. Moreover, the damage which may result from the hazard is likely to be considerably greater for an offshore well. For example, rupture of a line from an offshore well may cause contamination of water over an extremely large area and result in claims for large damages. Hence, it is desirable to provide means within the bore hole of a well for shutting down the well when hazardous or potentially hazardous conditions arise.

Many oil and gas wells produce from more than one zone through a single casing. The increased cost of drilling offshore wells as compared with inland wells increases the desirability of producing from more than one zone in a single casing in offshore wells. A storm choke for shutting down a well should be capable of installation in dual-zone wells and still provide sufficiently large openings to allow satisfactory production rates and avoid sand cutting of the choke. It is also desirable that the storm choke provide full openings which allow the running of whatever tools may be necessary into the well without interference. Since many wells are completed with seven-inch casing, the storm choke should be capable of installation in that casing without objectionably restricting the openings.

This invention resides in a storm choke for installation within the casing of a dual-zone well in which a pair of passages through the storm choke are closed by flapper valves normally positioned in recesses to provide full openings for flow from the well. The valves are actuated by rotation of a vertical shaft extending into the well which is connected by gear means to rotatable spindles upon which the flapper valves are mounted. A packer within the casing prevents flow of well fluids between the storm choke and the casing.

In the drawings,

Figure 1 is a diagrammatic vertical sectional view, partially broken away, of the storm choke of this invention installed in a dual-zone well.

Figure 2 illustrates the storm choke and packer assembly in elevation.

Figure 3 is a vertical sectional view of the valve arrangements of the storm choke in open, normal operating position.

Figure 4 is a vertical sectional view along the section line IV—IV in Figure 3 illustrating the mechanism for actuation of the flapper valves.

Figure 5 is a vertical sectional view along section line V—V in Figure 6 of the packer prior to setting in the casing.

Figure 6 is a horizontal sectional view of the packer taken along the section line VI—VI in Figure 5.

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Figure 7 is a diagrammatic plan view of the apparatus for release of the valves in the storm choke to allow them to close.

The storm choke of this invention may be positioned any place within the dual-zone well above the upper production zone. It is preferred, however, that the storm choke be located near the upper end of the well, and still more preferably at, or immediately below, the mud line.

Referring to Figure 1 of the drawings, a surface casing 10 is illustrated extending downwardly from a surface casing support 12 mounted on a platform 14. The surface casing 10 extends downwardly for a distance determined by the usual considerations in drilling practice and is not limited by this invention. Within the surface casing 10 is an intermediate casing 16 suspended from a lower casing head 18 resting on the surface casing support 12. In the illustrated embodiment of this invention, the intermediate casing 16 extends downwardly into the well below the level of the storm choke assembly, indicated generally by reference numeral 20. Both surface casing 10 and intermediate casing 16 are cemented in place in accordance with conventional practice.

Supported on the upper end of the lower casing head 18 is a casing hanger 22 from which production casing 24 is suspended. The production casing 24 extends downwardly into the well at least to a level immediately below the upper production zone of the well and preferably to below the level of the lower production zone, as illustrated in Figure 1. An upper casing head 26 supported on the upper surface of the casing hanger 22 provides a support for a tubing hanger 28 through which conduits 30 and 32 pass. The conduits 30 and 32 are connected at their lower ends to the upper end of the storm choke assembly 20 and are adapted to deliver production from the two zones of the well separately from the storm choke 20 to the well head. Valves 34 and 36 allow control of production through conduits 30 and 32, respectively. The upper end of upper casing head 26 is closed by a cap 37 secured thereto.

A production tubing 38 extends downwardly from the lower end of the storm choke assembly 20 through a packer 40 closing the annulus 41 between the tubing 38 and casing 24 to the lower production zone of the well. The packer 40 is of conventional design having a cap 42 pivotally mounted on its lower end and spring biased towards the closed position. The lower end of the production tubing 38 is perforated at 44 to receive fluids from the lower production zone of the well. The production casing 24 is perforated at 46 and 48 in the upper and lower production zones, respectively, to permit flow into the casing.

Referring to Figure 2 of the drawings, the storm choke assembly 20 consists of a storm choke body 50 and a packer 52. The storm choke body 50 and packer 52 are connected by a nipple 54 which is threaded to the lower end of the storm choke body 50 and to the upper end of the packer 52. A short upper nipple 56 extends downwardly from the lower end of the storm choke body 50 in alignment with a lower nipple 58 extending upwardly from the packer 52. Nipples 56 and 58 are joined together by a union 60. During assembly of the storm choke, nipple 54 is screwed to within about one-half turn of the assembled position. Nipples 56 and 58 are screwed and tightened in position in the storm choke body 50 and packer 52 and packer 52 is then turned to bring nipples 56 and 58 into alignment, after which union 60 is tightened.

Referring to Figure 3, parallel passages 62 and 64 extending longitudinally through the storm choke body 50 are threaded at their upper ends for connection with conduits 30 and 32, respectively. The lower ends of the passages 62 and 64 are threaded to receive bushings 66

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and 68 to which nipples 56 and 54 are connected. A downwardly facing valve seat 70 extends across the passage 62 near its upper end. Immediately below the level of the valve seat 70 is a recess 72 in the central wall 74 of the storm choke body 50 separating passages 62 and 64. Extending horizontally across the upper end of recess 72 and pivotally mounted in the valve body is a spindle 76 on which a flapper valve 78 is secured by any suitable means, such as a key 80, in order that rotation of the spindle 76 will cause corresponding rotation of the flapper valve 78. The flapper valve 78 is properly dimensioned to rotate to a substantially horizontal position to engage valve seat 70 and prevent flow through the passage 62 as the storm choke is operated.

Referring to Figure 4 of the drawings, a socket 82 in the outer surface of the storm choke body 50 receives one end of the spindle 76 which engages a disk 84 in the socket in a manner to rotate with the disk. A spring 86 secured in socket 82 by means of a pin 88 urges the disk 84, and consequently the flapper valve 78, to rotate towards the closed position. Leakage of well fluids from the passage 62 along the length of the spindle between it and the storm choke body 50 is prevented by suitable seals 90 and 92. Socket 82 is closed by a plug 94 screwed into its outer end.

Directly below recess 72 is a recess 96 opening into the passage 64. In passage 64, immediately above the upper end of the recess 96, is a downwardly opening valve seat 98 similar to valve seat 70. A flapper valve 100 is mounted on a rotatable spindle 102 in a manner to allow it to swing from a normal position in the recess 96 to a closed position engaging the valve seat 98. An assembly of a disk 104, torsion spring 106, pin 108 and plug 110 in a socket 112 identical with the assembly at the end of spindle 76 is provided at one end of spindle 102. The spring 106 urges flapper valve 100 towards the closed position through the disk 104 and spindle 102. Seals 113 prevent leakage between the spindle 102 and storm choke body.

In order to permit installation of the flapper valves 78 and 100 in the storm choke body 50 grooves 114 and 116 extend downwardly from the recesses 72 and 96 to the lower end of passages 62 and 64. The grooves are closed at their lower ends by the bushings 66 and 68, as illustrated in Figure 4, when the storm choke and packer are assembled.

Referring to Figures 5 and 6, the packer 52 consists of an elongated mandrel 118 having a pair of passages 120 and 122 extending longitudinally therethrough. Passage 120 is positioned to receive the threaded lower end of the nipple 58 and passage 122 is positioned to receive the lower end of nipple 54. The production tubing 38 is screwed into the lower end of passage 122.

A flexible, expansible sleeve 124 of suitable material such as neoprene is secured over the outer surface of the mandrel 118 by means of end plates 126 and 128 at the upper and lower ends of the mandrel 118, respectively. The end plates 126 and 128 are apertured to provide openings in alignment with the passages 120 and 122 and are held in place by suitable means such as bolts 130. The sleeve 124 has a series of horizontal corrugations 132 on its outer surface to improve the seal between the sleeve 124 and the production casing 24. Slippage of the sleeve along the outer surface of mandrel 118 is prevented by a series of horizontal rings 134 on the outer surface of the mandrel 118 which engages grooves 136 on the inner surface of the sleeve. Openings 138 extend through the rings to allow fluid to flow vertically between the outer surface of the mandrel 118 and the sleeve 124 when setting the packer in the casing.

The packer is set in the casing by means of hydraulic pressure resulting from the introduction of fluid between the mandrel 118 and the sleeve. For this purpose, the passage 120 is provided with a groove 140 in its wall. A duct 142 extends at a substantially 45° angle from the

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groove 140 to the outer surface of the mandrel 118. Duct 142 has an enlarged outer end connected with an inner end of smaller diameter by means of inclined surfaces forming a valve seat 144. A valve plug 146 is positioned in the duct 142 in a manner to engage the valve seat 144 and prevent flow of fluids through the duct. The valve plug 146 is urged into engagement with the valve seat 144 by a compressed spring 148 which bears against an apertured and threaded disk 150 screwed into the outer end of the duct. The valve plug 146 has an elongated stem 152 which extends through the smaller portion of the duct 142 and protrudes into the groove 140.

The packer 52 has been illustrated with the groove 140 in the wall of the passage 120 through the mandrel communicating with the annulus 41 and the duct 142 extending from the groove 140 to the outer surface of the mandrel. Groove 140 and duct 142 can be located in passage 122 and extend from that passage to the outer surface of the mandrel to allow fluid pressure from the production tubing 38 to be used in setting the packer, and in many instances this arrangement is preferred.

Referring to Figure 4 in which the mechanism for the operation of the storm choke is illustrated, bevel gears 154 and 156 are mounted on the ends of the spindles 76 and 102, respectively, opposite the ends engaged by disks 84 and 104. Extending downwardly through the storm choke body is a vertical shaft 158 having bevel gears 160 and 162 mounted on the shaft in position to engage bevel gears 154 and 156, respectively. The bevel gears 160 and 162 engage opposite faces of gears 154 and 156 in order that rotation of shaft 158 will rotate spindles 76 and 102 in opposite directions to swing the flapper valves 78 and 100 in opposite directions. Sockets 164 and 166 in the storm choke body 50, which provide housings for the bevel gears on the spindles 76 and 102 and shaft 158, are closed by plugs 168 and 170 respectively to prevent leakage into the sockets 164 and 166 of material which might interfere with operation of the gears. The shaft 158 extends upwardly from the upper surface of the storm choke body 50 through a packing gland 172.

Assembly of the gears on shaft 158 is accomplished by inserting gear 162 in place in socket 166 in engagement with gear 156. The lower section 158a of shaft 158 is dropped into place in engagement with gear 162. The lower end of section 158a is shaped to enter a similarly shaped hole in gear 162 to provide positive engagement of those two members. The gear 160 is then held in place in socket 164 and the upper section of shaft 158 is inserted downwardly through the opening in the gear 160 and into a socket in the upper end of section 158a. The socket in section 158a, the lower end of shaft 158 and the hole in the gear 160 are shaped to provide positive engagement of those members in order that rotation of shaft 158 will cause both of gears 160 and 162 to rotate.

Mounted on the platform 14 at the well head is a frame 174 on which apparatus for releasing and rotating the shaft 158 when hazardous or potentially hazardous conditions arise is supported. A cam or detent 176 is secured to the upper end of the shaft 158 which extends above the frame 174. A torsion spring 178 secured to the frame 174 engages the cam 176 to urge the cam, and hence the shaft 158, in a direction to close the flapper valves 78 and 100. Spring 178 also supplies a force holding the valves in the closed position. During normal operation of the well, the cam 176 is engaged by a plunger 180, as is best illustrated in Figure 7 of the drawings, which prevents rotation of the shaft from the open position.

The plunger 180 is operated by a solenoid 182 energized by current supplied through electrical lead lines 184 and 186. The solenoid 182 preferably maintains the plunger 180 in the extended position engaging the cam 176 when energized. Then, a failure of the electric

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current will de-energize the solenoid and allow the plunger 180 to move out of contact with the cam 176 whereupon the spring 178 urges the shaft 158 in the direction of closing the flapper valves.

The solenoid 182 may be made to operate in response to any one or more hazardous or potentially hazardous conditions at the well head, such as, for example, high waves, loss of pressure in delivery lines from the well, excessive temperatures, as well as in response to a manually initiated signal. In the apparatus illustrated in the drawings electrical lead lines 184 and 186 and the solenoid 182 are connected in series with a float-operated switch 188. The float-operated switch 188 is suitably positioned so that high waves will raise the float and open the circuit to the solenoid 182.

The packer 52 is set in the well by the application of a greater fluid pressure in the groove 140 than exists at the outer surface of the sleeve 124. In the embodiment of the invention illustrated in Figure 5 in which the duct 142 opens through groove 140 into the passage 120 which communicates with the annulus production, the setting of the packer can be accomplished best prior to commencing production from the well. This is accomplished by inserting a shut-off valve into passage 120 to a level below the groove 140 to prevent flow downwardly through the well. Then fluid pressure is applied through the conduit 30, passage 62 and passage 120 to the inner end of the valve plug 146. Valve plug 146 is moved out of engagement with valve seat 144 to permit fluid to flow between the outer surface of the mandrel 118 and the inner surface of the sleeve 124. Sleeve 124 is forced against the inner surface of the casing 24 to prevent flow between the casing of the packer. After the packer has been set, the fluid pressure in passage 120 is reduced whereupon valve plug 146 is moved back into engagement with valve seat 144 to prevent further flow of fluids through duct 142.

If the duct 142 extends through the mandrel 118 from the passage 122 which communicates with the production tubing, the packer may be set by merely closing-in the tubing section while the annulus is flowing at a reduced or open pressure. The difference in pressure will then cause valve plug 146 to move in the manner described above to set the packer.

During normal operation of the well, the flapper valves 78 and 100 are withdrawn into the recesses 72 and 96 in the position illustrated in Figure 3. The flappers thus provide full openings through the passages 62 and 64 which do not restrict flow from the well and also allow insertion of tools which may be necessary for servicing the well. Because of their withdrawn vertical position, the flapper valves 78 and 100 are not subjected to substantial forces resulting from the flow of fluids in the well. The plunger 180 through connection of the cam with shaft 158 and through the bevel gears on the shaft and spindles, holds the flapper valves in open position.

When a hazardous or potentially hazardous condition arises, the circuit to solenoid 176 is opened and the plunger 180 moves out of engagement with the cam 176. Spring 178 urges rotation of the shaft in the direction of closing of the flapper valves. Springs 86 and 106 also urge the spindles 76 and 102 toward the closed position. As the flapper valves move into the fluid stream through passages 62 and 64, they are moved to the closed position and held closed by the pressure exerted by the fluids.

The storm choke of this invention may be tested periodically to determine whether or not it is in operating condition. After testing, the storm choke may be returned to the normal operating condition without interfering with subsequent operation of the well by building up pressure in the well above the flapper valves to open the valves and energize the solenoid. Similarly, the packer can be withdrawn from the well after it has been set in position. This is accomplished by merely lowering

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a tool having an expanding finger into the well. When the tool reaches the elevation of the groove 140, the expanding finger is moved into the groove and engages the stem 152 to displace the plug 146 from the valve seat 144, whereupon the fluid pressure on the sleeve 124 is released. The position of the stem 152 in the groove 140 avoids interference with other tools which may be run into the hole for servicing the well.

I claim:

1. Apparatus adapted for arrangement in the casing of a dual-zone well comprising an elongated body, a packer preventing flow between the outer wall of the body and the casing, a pair of passages extending downwardly through the body, a valve seat in each of the passages, a flapper valve in each of the passages mounted on a rotatable spindle, said flapper valves constructed and arranged for movement on rotation of the spindles to a position engaging the valve seat in the respective passages, a shaft extending downwardly within the casing from the surface of the well, gear means on the shaft, gear means on the spindles in engagement with the gear means on the shaft, means to rotate the shaft to move the flapper valves from a normal position in which the passages are fully opened to a closed position to engage the valve seats, a tubing extending from one of the passages in the elongated body to the lower zone of the well, packing means engaging the tubing and casing preventing flow between the two zones of the well, and means for separately delivering production from the passages to the well head.

2. Apparatus adapted for arrangement in the casing of a dual-zone well comprising an elongated body, a packer preventing flow between the outer wall of the body and the casing, a pair of passages extending downwardly through the body, a valve seat in each of the passages, a flapper valve in each of the passages mounted on a rotatable spindle, said flapper valves constructed and arranged for movement on rotation of the spindles to a closed position engaging the valve seat in the respective passages, a shaft extending downwardly within the casing from the surface of the well, gear means on the shaft, gear means on the spindles in engagement with the gear means on the shaft, a detent engaging the shaft to prevent rotation thereof, means for disengaging the detent from the shaft to permit rotation to move the flapper valves from the normal open position to the closed position, a tubing extending from one of the passages in the elongated body to the lower zone of the well, packing means engaging the tubing and casing preventing flow between the two zones of the well, and means for separately delivering production from the passages to the well head.

3. Apparatus adapted for arrangement in the casing of a dual-zone well comprising an elongated body, a packer preventing flow between the outer wall of the body and the casing, a pair of passages extending downwardly through the body, a valve seat in each of the passages, a flapper valve in each of the passages mounted on a rotatable spindle, said flapper valves constructed and arranged for movement on rotation of the spindles to a closed position engaging the valve seat in the respective passages, a shaft extending downwardly within the casing from the surface of the well, gear means on the shaft, gear means on the spindles in engagement with the gear means on the shaft, a detent engaging the shaft to prevent rotation thereof, a solenoid-operated plunger engaging the detent, an electrical circuit adapted to operate the solenoid to move the plunger from engagement with the detent when a condition potentially hazardous to operation of the well arises, a tubing extending from one of the passages in the elongated body to the lower zone of the well, packing means engaging the tubing and casing preventing flow between the two zones of the well, and means for separately delivering production from the passages to the well head.

4. Apparatus adapted for arrangement in the casing of a dual-zone well comprising an elongated body, a

packer preventing flow of well fluids between the outer surface of the elongated body and the casing of the well, a pair of passages extending through the elongated body, a valve seat in each of the passages, a recess in the wall of each of the passages directly below the valve seats, a flapper valve in each of the passages mounted on rotatable spindles in position to move from a normal open position in the recesses upwardly to a closed position in engagement with the valve seats upon rotation of the spindles, a shaft extending downwardly from the well head through the casing, gear means connecting the shaft and spindles whereby rotation of the shaft moves the flapper valves between the normal open position in the recesses and the closed position in engagement with the valve seats, means at the well head to rotate the shaft, releasable means at the well head preventing rotation of the shaft, tubing extending from one passage to the lower production zone of the well, packing means preventing flow between the lower and upper zones of the well, and means for separately delivering production from the two passages to the well head.

5. Apparatus adapted for arrangement in the casing of a well comprising an elongated body, a packer preventing flow of well fluids between the elongated body and the casing, a first passage extending through the elongated body, a valve seat in said first passage, a recess in the wall of the first passage below the valve seat, a first flapper valve secured to a first rotatable spindle for movement from a normal open position in the recess in the wall of the first passage to a closed position in engagement with the valve seat upon rotation of the spindle, a second passage through the elongated body, a valve seat in said second passage positioned at a lower level in the body than the valve seat in the first passage, a recess in the wall of the second passage below the valve seat, a second flapper valve secured to a second rotatable spindle for movement upon rotation thereof from a normal open position in the recess in the wall of the second passage and a closed position in engagement with the valve seat in the second passage, said second spindle being directly below the first spindle, a shaft extending downwardly from the well head, first gear means on the shaft engaging gear means on the first spindle and second gear means on the shaft engaging gear means on the second spindle whereby rotation of the shaft rotates both flapper valves between the normal position in the recess to the closed position in engagement with the valve seat, means for rotating the shaft, tubing extending from one of the passages downwardly to the lower production zone of the well, packing means for preventing flow between the upper and lower production zones of the well, and means for separately delivering production from the first and second passages to the well head.

6. Apparatus adapted for arrangement in the casing in a multi-zone well comprising a storm choke body, a packer preventing flow of well fluids between the storm choke body and the casing, a plurality of passages through the storm choke body, a valve seat in each of the passages, a recess in the wall of each of the passages below the valve seat therein, a flapper valve mounted on a rotatable spindle in each of the recesses for movement from a normal open position in the recess to a closed position in engagement with the valve seat upon rotation of the spindle, said spindles for the flapper valves being in vertical alignment, a vertical shaft extending from the storm choke body to the well head, gear means positioned at intervals along the shaft for engagement with gear means on the spindles whereby rotation of the shaft rotates all of the flapper valves, conduit means for delivering production from the several zones of the well separately to the passages in the storm choke, and conduit means for separately delivering production from the passages in the storm choke to the well head.

7. Apparatus adapted for arrangement in combination with a casing of a dual-zone well above the upper zone

thereof comprising an elongated body, a pair of passages extending longitudinally through the elongated body, a valve seat in each of the passages, a recess in the wall of each of the passages below the valve seat, a flapper valve positioned in each of the passages mounted on a rotatable spindle and adapted to move from a normal position in the recess to a position in engagement with the valve seat upon rotation of the spindle, a bevel gear secured to each of the spindles, a shaft extending vertically through the elongated body and upwardly to the well head, bevel gears on the shaft engaging the bevel gears on the spindles, means to rotate the shaft whereby the flapper valves are simultaneously moved from a normal open position in the recess to the closed position in engagement with the valve seats, a flexible, expandable sleeve surrounding the body, means for anchoring the sleeve at its ends to the body, a duct extending from one of the passages transversely through the body between the ends of the sleeve, a valve in the duct, a groove in the wall of the passage adjacent the valve whereby a portion of the valve protrudes into the groove, a tubing extending from one of the passages to the lower zone of the well, a packer engaging the tubing and casing below the upper zone of the well to separate the upper and lower zones of the well, and means for separately delivering production from the passages to the well head.

8. Apparatus adapted for arrangement in a casing of a dual-zone well comprising an elongated body, a pair of passages through the body, a valve seat in each of the passages, a recess in the wall of each of the passages below the valve seat, a flapper valve positioned in each of the passages adapted to move from a normal open position in the recess to a closed position in engagement with the valve seats, each of said flapper valves being keyed to a rotatable spindle, a bevel gear on an end of each spindle, a shaft extending through the elongated body upwardly to the well head, bevel gears on the shaft positioned for engagement with the bevel gear on each of the spindles whereby rotation of the shaft rotates the spindles to move each of the flapper valves from the normal open position to the closed position, means to rotate the shaft, a flexible, expandable sleeve enclosing the elongated body, the ends of said sleeve being secured to the elongated body, a duct from one of the passages transversely through the valve body between the ends of the sleeve, valve means in the duct, a groove in the wall of the passage in alignment with the valve means and exposing a portion thereof, transverse grooves in the inner surface of the sleeve, transverse rings around the outer surface of the body extending into the grooves in the sleeve, and passages through the transverse rings to permit flow longitudinally between the elongated body and sleeve.

9. Apparatus adapted for arrangement in the casing of a dual-zone well comprising an elongated body, a packer preventing flow of well fluids between the outer surface of the elongated body and the casing of the well, a pair of passages extending through the elongated body, a downwardly facing valve seat in each of the passages, a recess in the wall of each of the passages directly below the valve seats, a flapper valve keyed to a spindle in each of the recesses in position to rotate from a normal open position in the recesses upwardly to a closed position in engagement with the valve seat in the respective passage, a shaft extending downwardly from the well head through the casing, gear means connecting the shaft and spindles whereby rotation of the shaft moves the flapper valves between the normal open position in the recesses and the closed position in engagement with the valve seats, means at the well head to rotate the shaft, tubing extending from one passage to the lower production zone of the well, packing means preventing flow between the lower and upper zones of the well, means for separately delivering production from the two passages to the well head,

and grooves in the wall of the passages extending from the lower end thereof upwardly to the level of the recesses allowing assembling of the flapper valves in the recesses.

10. Apparatus for arrangement in the casing of a dual-zone well above the upper zone thereof comprising an elongated body, a packer preventing flow between the outer surface of the body and the casing, passages extending longitudinally through the body, a conduit connected with the upper end of each of the passages extending upwardly to the well head for separate delivery of well fluids from each of the passages, a downwardly facing valve seat in each of the passages, a recess in the wall of each of the passages immediately below the valve seats, a flapper valve mounted on a rotatable spindle in each of the passages, said flapper valves adapted to move from a normal open position in the recesses to a closed position in engagement with the valve seats upon rotation of the spindles, a shaft extending upwardly from the body to the well head, gear means connecting the shaft and the spindles whereby rotation of the spindles rotates the shaft, detent means connected to the shaft to prevent rotation thereof, means to release the detent means, a spring urging the flapper valves to the closed position, a tubing extending from one of the passages to the lower production zone, and a packer preventing flow between the upper and lower production zone.

11. Apparatus for arrangement in the casing of a dual-zone well comprising a storm choke body, a pair of passages threaded at their upper and lower ends extending longitudinally through the storm choke body, a downwardly facing valve seat extending around the wall of each of the passages, a recess in the wall of each of the passages immediately below the valve seat, a flapper valve mounted on a rotatable spindle in each of the passages and adapted for movement from a normal open position in the recess to a closed position in engagement

with the valve seat, a shaft extending upwardly from the storm choke body to the well head, gear means connecting the shaft and spindles whereby rotation of the shaft results in rotation of the spindles, means for initiating rotation of the spindles for moving flapper valves from the normal position to the closed position, a groove in the wall of each of the passages extending from the recess to the threaded lower end of the passages to permit installation of the flapper valves, bushings closing the lower ends of the slots screwed into the threads at the lower end of the passages, a packer mandrel, a pair of longitudinal passages through the mandrel, nipples extending from the bushings to the upper ends of the passages through the mandrel, a flexible, expansible sleeve covering the mandrel, said sleeve secured at its ends to the mandrel, means for introducing a fluid between the sleeve and the mandrel to expand the sleeve against the casing, a tubing extending from the lower end of one of the passages in the mandrel to the lower production zone of the well, packing means in the casing between the upper and lower production zones preventing flow between the upper and lower production zones, and conduits extending from the upper ends of the passages in the storm choke body to the well head for separate delivery of the fluids from each of the passages to the well head.

References Cited in the file of this patent

UNITED STATES PATENTS

202,570	Minniss et al.	Apr. 16, 1878
600,529	Hall	Mar. 15, 1898
1,267,314	Brogniez	May 21, 1918
2,189,703	Burt et al.	Feb. 6, 1940
2,335,355	Penick et al.	Nov. 30, 1943
2,467,065	White	Apr. 12, 1949