Dec. 15, 1931. C. A. RASMUSSEN 1,836,508

AUTOMATIC GAS CONTROL AND OIL SAVER

Filed April 15, 1929 2 Sheets-Sheet 1

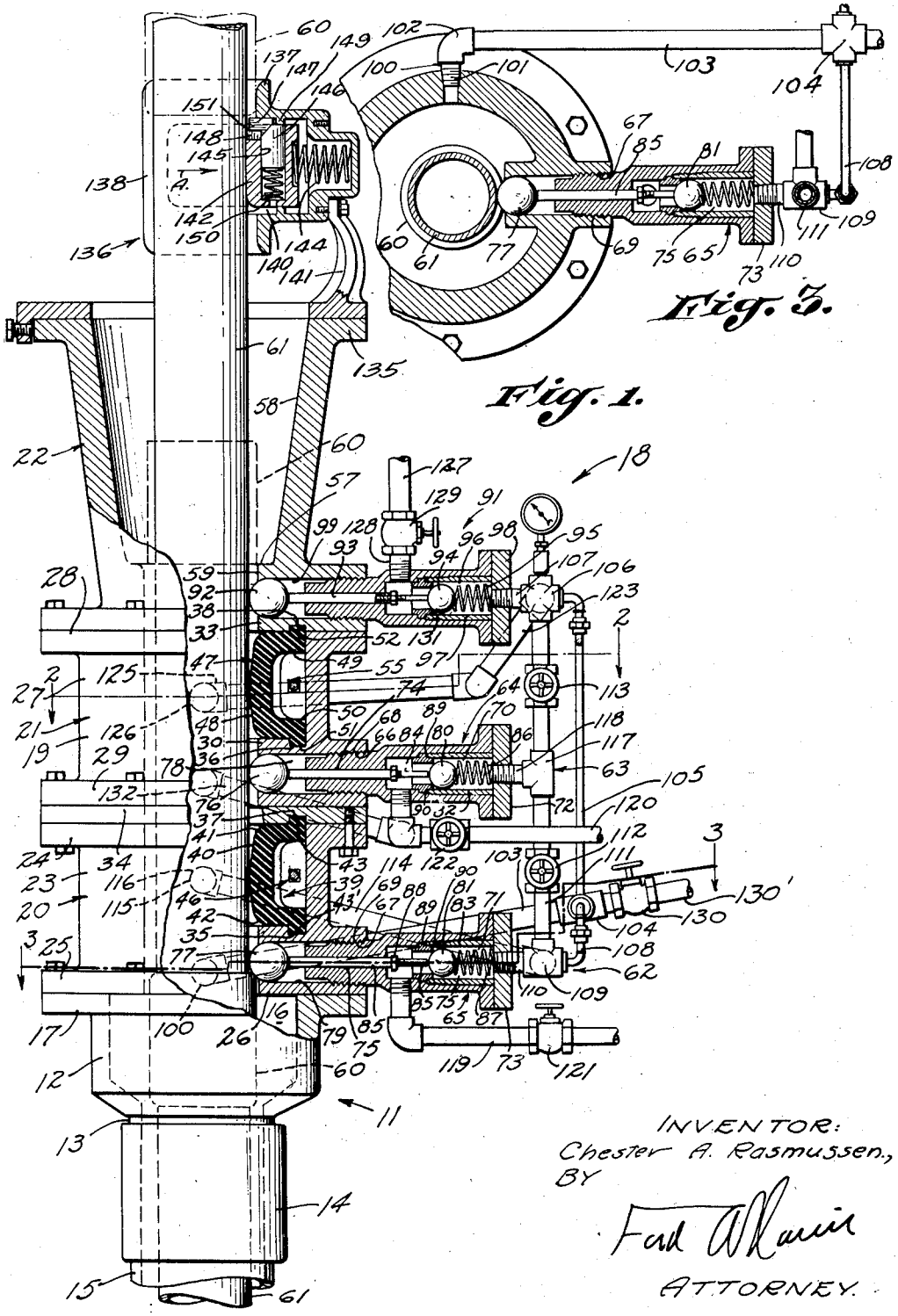


Fig. 1.

Fig. 3.

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Fig. 2.

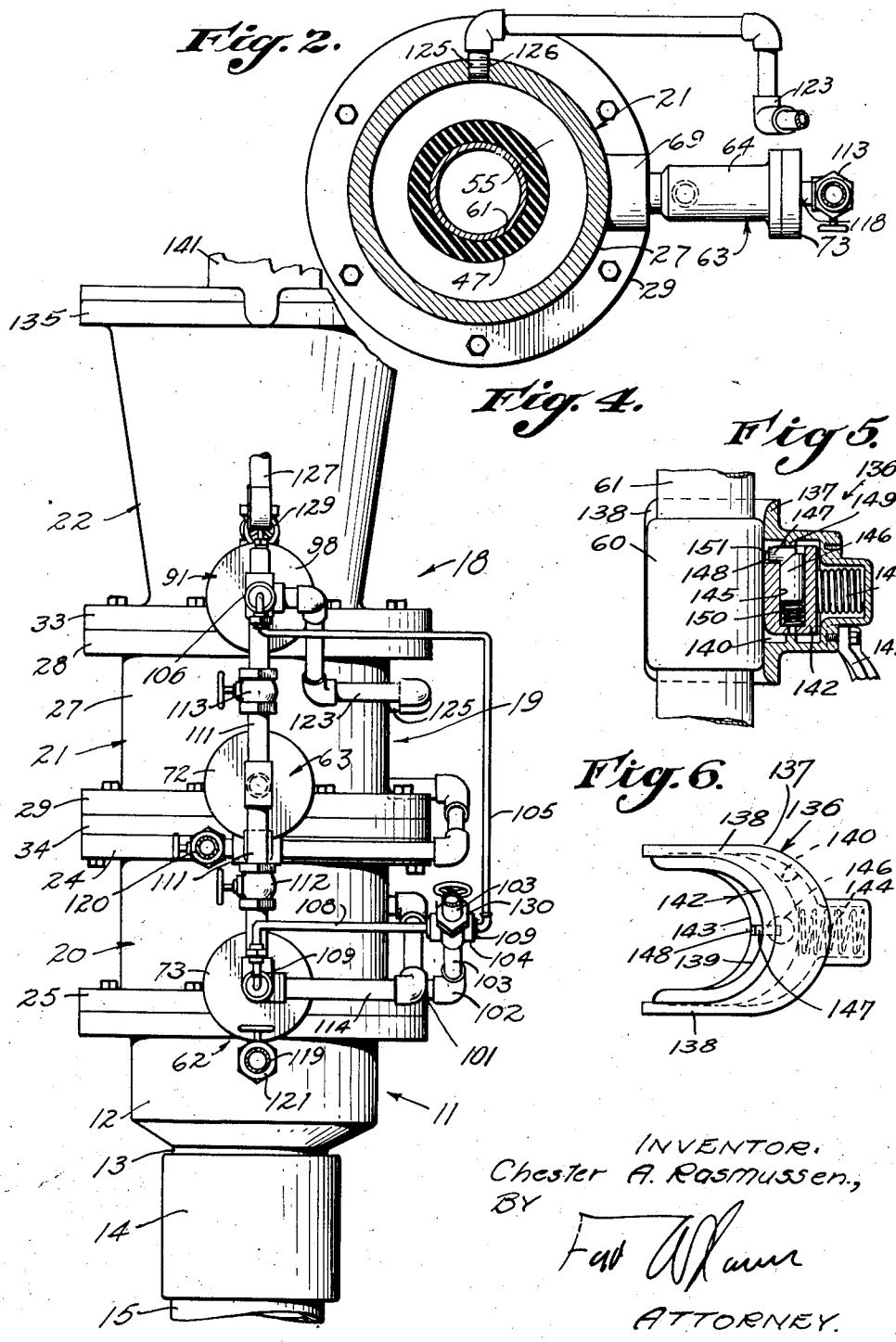


Fig. 4.

Fig. 5.

Fig. 6.

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UNITED STATES PATENT OFFICE

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AUTOMATIC GAS CONTROL AND OIL SAVER

Application filed April 15, 1929. Serial No. 355,108.

My invention relates to the deep well drilling art and particularly to packing devices employed in that art and is an improvement on a seal control and blowout preventer set forth in United States Patent No. 1,709,949 issued to myself and William A. Trout April 23, 1929.

Frequently, in drilling deep wells for oil, pockets of gas in which the gas is stored up at an exceedingly high pressure are bored into so that this gas flows upward through the well. The presence of this gas about the upper end of the well where the workmen are employed is a constant danger. Moreover, the high pressure at which this gas flows makes it exceedingly difficult to prevent its escape from the upper end of the well during drilling operations, such as drilling, or running casing.

It is therefore an object of my invention to provide an automatic gas control apparatus which will retain the gas in a well during the insertion of a drill stem or a string of casing into or drawing these from the well.

While apparatus have previously been devised for preventing the escape of gas and oil from a well, these have been faulty in operation due to the fact that there was a considerable escape of gas and oil each time a packer was released to permit a coupling of the casing or drill stem to pass through the packer.

It is a further object of my invention to provide a gas control and oil saver in which the couplings of a sectional member, such as a casing or drill stem, may be advanced through the control apparatus with practically no leakage of gas or oil therefrom.

Former gas control and blowout preventers have been operated by hand, or have manually operable control means, which requires the constant attention of at least one man during the insertion or withdrawal of a drill stem or a string of casing.

It is a still further object of my invention to provide a gas control and blowout preventer as set forth above, the operation of which is automatic.

It is yet another object of my invention to provide an automatic gas control and oil saver which is normally operated by the pressure of fluid in the well and which may be operated by exteriorly disposed pressure means.

Further objects and advantages will be made manifest in the following description and in the accompanying drawings in which a preferred embodiment of my invention is illustrated.

In the drawings,

Fig. 1 is an elevation of the apparatus with parts in section showing the same mounted on the upper end of a casinghead and well string.

Fig. 2 is a horizontal section through the same, taken on line 2—2 of Fig. 1.

Fig. 3 is a horizontal section on line 3—3 of Fig. 1.

Fig. 4 is a front elevational view of the improved apparatus.

Fig. 5 is a fragmentary sectional view similar to the upper portion of Fig. 1, but showing the relative parts of the guide member of the invention in different positions.

Fig. 6 is a plan view of the guide member shown in Fig. 5.

Referring specifically to the drawings:

Fig. 1 shows a casinghead 11 which includes a tubular body 12, the lower end 13 of which is of reduced diameter and is threaded and screwed into a coupling 14 provided on the upper end of an outer well casing 15. The body has a bore 16 and is provided with a suitable annular flange 17 at its upper end.

Adapted to be supported upon the casinghead 11 is an automatic gas control and blowout preventer indicated generally at 18, which is the preferred embodiment of my invention. The apparatus 18 has a tubular body 19 which is built up from a number of tubular sections placed end to end, one upon the other, in this instance only two sections being illustrated. Each of these sections has radial end flanges which are provided with a uniform arrangement of bolt holes. This permits abutting flanges of each pair of adjacent sections to be secured together by bolts, which effects the assembly of the sections to form the body 19. These

tubular sections, beginning at the bottom of the body 19, may be generally designated as lower packer section 20, upper packer section 21, and a slip seat section in the form of a spider 22.

The lower packer section 20 has a central tubular wall 23 which is provided at its upper and lower ends with external radial flanges 24 and 25, and wall 23 at its lower end is provided with an internal radial flange 26. Section 20 has an opening which is of smaller diameter than the bore 16 of the casinghead body 12.

The upper section 21 has a central tubular wall 27 which is provided at its upper and lower ends with external radial flanges 28 and 29 and with an internal radial flange 30 disposed adjacent the lower end thereof.

Section 22 at its lower end is provided with an external radial flange 33 disposed flush against and adapted to be bolted to the flange 28 of the upper section 21. Interposed between the flanges 24 and 29 of sections 20 and 21 respectively is a plate 34, which is separately bolted to the flange 24, thus permitting removal of the upper section from the lower section.

The packer sections 20 and 21 as heretofore stated include the tubular walls 23 and 27, and formed in the upper surfaces of the internal radial flanges 26 and 30 are annular channels 35 and 36, while in the lower surface of the plate 34 and flange 33 are formed annular channels 37 and 38.

Disposed within the packer section 20 is a packer 39 formed of rubber or other suitable elastic material which is annular in shape and has a cross-section appearing as a gothic U with rectangular serifs and turned upon its side. The packer 39 has a central tubular wall 40 and upper and lower radial walls 41 and 42 extending therefrom. At the outer edge of the radial wall 41 is formed an upwardly extending ridge 43 which seats in the annular channel 37 of plate 34.

At the lower edge of the radial wall 42 is formed the downwardly extending annular ridge 43′ which seats in the annular channel 35 the radial flange 26. The various parts of the packer 39 thus form an interiorly disposed annular channel 46, the outer wall of which is defined by the wall 23. The wall 23 of the section 20 is provided with an opening which communicates with the channel 46, for a purpose to be described later.

Disposed above and bolted to the lower packer section 20, as heretofore stated, the upper packer section 21 includes the tubular wall 27 from the upper and lower ends of which the radial flanges 28 and 29 extend outward, and from the lower end of the tubular wall the radial flange 30 extends inward. An upper packer 47 is of the identical construction and configuration as the packer 39 and has a central tubular wall 48 and upper and lower radial walls 49 and 50 extending therefrom. At the outer edge of the radial walls 49 and 50 are formed outwardly extending ridges 51 and 52, the lower ridge 51 seating in the channel 36 of the flange 30, while the upper ridge 52 seats in the channel 38 in the radial flange 33 of the upper or spider section 22. The space between the packer 47 and the wall 27 forms an interiorly disposed annular channel 55. The wall of the section 21 is provided with an opening which communicates with the channel 55, for a purpose to be described later.

The upper or spider section 22 above its base flange 33 is formed with an annular abutment 57 which projects inwardly of the slip receiving bore 58 of said section. Resultant of the formation of the abutment 57 a smaller vertical bore 59 is provided which aligns with the internal bores of the sections 20 and 21. It will be noted that the internal bore at this point is slightly larger than the outside diameter of the coupling 60 of the casing or tubing 61 which is to be passed through the continuous cylindrical opening formed by the section bores.

Valve mechanism for controlling the pressure operating the rubber packer elements 39 and 47 will now be described. Each packer unit has associated therewith a valve mechanism, and for the purpose of identifying the valve mechanisms the same are indicated as lower valve mechanism 62 associated with lower packer unit 39, upper valve mechanism 63 associated with the upper packer unit 47, and a valve mechanism 91 associated with the upper or spider section 22.

The valve mechanisms 63 and 62 each comprises a body 64 and 65 having exteriorly threaded portions 66 and 67 which are screwed into threaded openings 68 and 69 formed in the walls 27 and 23. The threaded openings 68 and 69 coincide with openings formed in the annular flange 26 and annular flange 30.

The body portions 64 and 65 of valve mechanisms 63 and 62 have chambers 70 and 71 formed therein, the outer ends of which are closed by plates 72 and 73, which latter are connected to the bodies by bolts not illustrated. The threaded portions 66 and 67 are provided with restricted bores 74 and 75 which communicate at one end with bores of sections 21 and 20 and at the other end with the plug chambers 70 and 71 respectively. Balls 76 and 77 of relatively large dimension are loosely mounted in openings 78 and 79 formed in the interiorly disposed flanges 30 and 26, and smaller balls 80 and 81 are freely mounted in bushings 82 and 83 in chambers 70 and 71. Push rods 84 and 85 are slidably mounted in the restricted bores 74 and 75 and have their opposite ends engaging the large

balls 76 and 77 and the smaller balls 80 and 81.

Coil springs 86 and 87 are interposed between the small balls 80 and 81 and plates 72 and 73 and are adapted for tensioning the small balls outwardly into engagement with the inner ends of push rods 84 and 85, a nut 88 being carried by each of the rods for regulating the movement thereof. Collars 89 are held in position in chambers 70 and 71 by the bushings 82 and 83 and have seats 90 for the reception of the small balls 80 and 81, which, as heretofore stated are normally held on the seats by the action of the coil springs 86 and 87.

The upper or spider valve mechanism numbered as 91 is of identical construction as the valve mechanisms described and has associated therewith a large ball 92, a push rod 93, a small ball 94, and a coil spring 95, the last two elements being located in chamber 96 of the valve body 97. Likewise, a plate 98 is secured by bolts to the outer end of the valve body and closes the open end of chamber 96. The large ball 92 is freely mounted in an opening 99 formed in the annular abutment 57 of spider 22. Balls 76, 77, and 92 as heretofore stated, are mounted for free movement in openings 78, 79, and 99 of flanges 30 and 26 and abutment 57, and normally have portions extending into the continuous bore of the apparatus 18, through which the casing string is extended, and as heretofore stated, these balls are normally held in extended position by the push rods and coil springs described.

The packer units 39 and 47 may be actuated either by the pressure of gas directly from the well or by pressure induced exteriorly of the well. However, we shall first describe the operation of the packer units by gas pressure from the well. For this purpose, there is provided a gas inlet opening 100 from the well bore and leading outward through the wall 23 of lower section 20 as illustrated in Fig. 3. Opening 100 is of relatively large dimension, and screwed into said opening is a threaded nipple 101 connected to an elbow 102 of a pipe 103. Pipe 103 extends diagonally upward and connects with a four-way fitting 104.

Connected to an opening in fitting 104 is a pipe 105 of relatively small dimension which connects at its upper end with one of the openings in a four-way fitting 106. A nipple 107 extends through plate 98 and connects fitting 106 with chamber 96 of the valve mechanism 91. A small pipe 108 is likewise threaded in an opening of the four-way fitting 104 and connects with a three-way fitting 109 which in turn carries a nipple 110, threaded into an opening in plate 73 which seals the lower valve chamber 71. A large pipe 111 is screwed into the upper opening of the coupling 109 and connects at its upper end with the lower opening of the coupling 106. A lower valve 112 and an upper valve 113 are connected to pipe 111 for purposes to be later described. A pipe 114 connects at its lower end to coupling 109 and carries on its upper end a nipple 115 which is screwed into an opening 116 in the wall 23 of lower section 20.

A three-way coupling 117 is connected to pipe 111 between valves 112 and 113 and has screwed therein a nipple 118 which is in turn threaded into an opening in plate 72 which seals the open end of valve chamber 70.

Connected with the valve bodies 64 and 65 are pipes 120 and 119 which lead from valve chambers 70 and 71 and carry hand-operated valves 121 and 122, the purpose of which will be later described.

Leading diagonally downward from the four-way fitting 106 is a pipe 123 having a nipple connection 125 in an opening 126 in the wall 27 of the upper section 21.

An exhaust pipe 127 on the valve element 91 has a nipple connection 128 with the chamber 96 and carries a hand-operated exhaust valve 129, and likewise the pipe coupling 104 carries a hand-operated valve 130 and a pipe 130′ leading away from the apparatus to outside pressure means.

Secured to an upper flange 135 of the section 22, as clearly illustrated in Fig. 5, is a guide unit generally designated by the numeral 136. The unit 136 consists of a U-shaped body 137 having arms 138 adapted to extend laterally on either side of the tubing 61. The inner face 139 of the U-shaped body 137 is recessed as shown at 140. The body 137 is supported in its position relative to the tubing 61 by a bracket 141, the lower end of which is bolted to the flange 135 of the section 22.

Slidable laterally relative to the tubing 61, within the recess 140 is a guide yoke 142. The yoke 142 is U-shaped in form and has an inner face 143 adapted to contact the periphery of the tubing 61 for the purpose of maintaining the tubing centrally of the packers 39 and 47.

The yoke 142 is constantly pressed laterally against the surface of the tubing 61 by a coil compression spring 144 within the recess 140. The yoke 142 has a vertical recess 145 adapted to slidably receive a lock member 146. The member 146 has an integral key 147 extending at right angles to the body thereof. The key 147 is adapted to extend into a slot 148 in the upper face of the yoke 142.

The inner face 143 of the yoke 142 when contacting the tubing 61, and the key 147 carried thereby, extend beyond the inner face 139 of the U-shaped body 137. The lock member 146 is held upwardly so that the key 147 engages a lug 149 extending downwardly within the recess 140, by a spring 150 within the recess 145.

The operation of my invention is as follows:

In Fig. 1, a casing 61 is shown extending downward through the gas control apparatus 18 into the well, at the top of which it is mounted. This casing 61 is made up of sections of tubing which are connected by couplings 60, one of which is shown disposed in the spider section 22. The gas control apparatus 18 is more particularly adapted for use in running casing into the well, and its operation will therefore be described in this connection.

As the gas control apparatus 18 is used only when there is gas present in the well, this gas tends to flow up in the casinghead and section bores and around the casing 61 as the latter is being lowered into the well. The pressure of this gas generally ranges between 200 and 2,000 pounds per square inch.

When it is desired to operate the gas control apparatus by the fluid pressure of this gas, that is, during the introduction or running in of the casing string 61, the exhaust valve 121 is closed and the valves 122 and 129 are kept open, and the valve 112 is open and the valve 113 is closed, as is likewise the valve 130 which controls the outside or auxiliary pressure means.

The gas pressure from the well passes upwardly through the bores of the casing head 12 and lower section 20, and out through the opening 100 in the wall 23 of said section and into the large feed pipe 103 to the small feed pipe 105. The gas under well pressure then passes through the fitting 106, nipple 107 into the upper chamber 96 of the valve 91, serving with the spring 95 to hold the small ball 94 on its seat 131 which in turn projects the push rod 93 into engagement with the large ball 92, forcing the latter into operative position in the bore of the spider abutment 57. Simultaneously, the larger part of the gas is fed through the large pipe 123 to the annular space 55 of the section 21 disposed between the packer element 47 and the section wall 27, serving to inflate the upper packer 47. Also, due to the fact that the valves 113 and 130 are closed, a large quantity of gas will pass downwardly through the small pipe 108, the large pipe 114, and into the annular space 46 of the lower packer 39, serving to inflate the latter. It is thus seen that both of the packer elements 39 and 47 are simultaneously inflated, and during this time the gas pressure and springs 86 and 87 hold the small balls 80 and 81 on their respective seats 90, which serves to move the rods 74 and 75 into engagement with the large balls 76 and 77.

When the coupling 60 on the pipe string 61 reaches the abutment 57 of the spider 22, it engages with and forces the large ball 92 inward, thereby moving the rod 93 against the small ball 94 and unseating the same. Due to the unseating of the ball 94, the gas under pressure in the packer 47 is evacuated through the large pipe 123, the fitting 106, the nipple 107, the chamber 96, and past the ball 94 which has been unseated as previously explained, and outwardly through the pipe 127 to the atmosphere.

When the pipe string is lowered still further, the coupling 60 pushes the large ball 76 and the rod 84 outward, so as to unseat the small ball 80, which allows the gas from the space 46 of the packer 39 to evacuate through the pipes 114, 111, the nipple 118, the chamber 70 of the valve assembly 64, past the unseated ball 80 and out to the atmosphere through the pipe 120, the valve 122 being open.

The lower valve assembly 65 is used when the pipe string is run out of the well, and when the coupling 60 engages the large ball 77 the small ball is unseated, which allows the gas in the packer 39 to be evacuated through the pipe 114, the fitting 109, the nipple 110, the valve chamber 71 and the pipe 119 to the atmosphere, the valve 121 at this time being open.

The upper packer 47 is operated in substantially the same manner by the ball valve 76, which when engaged by the coupling 60 unseats the ball 80 in the valve assembly 64. At this time, the ball 94 of the valve assembly 91 is seated and the valve 113 is open and the valve 112 is closed. Due to the unseating of the ball 80, the gas in the upper packer 47 is evacuated through the large pipe 123, the upper pipe 111, the fitting 117, the nipple 116, the valve chamber 70, and past the small ball 80, which is unseated, and through the pipe 120 which is open to the atmosphere.

By using a large inlet pipe 103 for the passage of gas at well pressure, relatively restricted gas pipes 105 and 108, and large exhaust pipes 111, 114, 119, 120, 123 and 127, I am enabled to keep the inlets to the packers 39 and 47 constantly open and operate the mechanism by the use of the exhaust only, thereby saving any added mechanism required to open and close the valves controlling the power fluid.

It will be readily seen that the rubber sleeves or packers 39 and 47 are kept pressurably in contact with the casing 61 by having gas or other fluid pressure applied to the outside of the sleeves in spaces 46 and 55 through the above described connections leading from the source of pressure.

It is essential to release the pressure in the packer space 55, bore of the apparatus between the upper and lower packers, and the lower packer space 46 when a coupling 60 is passed through the sections, and as described, this is done by the coupling 60 operating an exhaust valve before entering a packer sleeve. The exhaust valves are adapted to let out a greater volume of fluid than is admitted through the inlet pipe. This is accomplished

by reducing the inlet to a smaller diameter than the outlet.

The exhaust pipe 120 which exhausts pressures collecting in the space between the upper and lower packer sleeves will by closing valve 122 act as a balance against the pressure of the lower packer 39, making it unnecessary to release the pressure on the back of this packer when couplings are run through it. It may be operated in this manner, but in most instances the pressure will be released the same as in the upper section.

The lower valve 62 operates substantially the same as the upper valve 91 and is used only when the casing string 61 is pulled from the well, the valve causing the gas pressure in packing space 46 to be evacuated in the same manner as the upper packer 47 is evacuated.

It will be seen that the yoke 142 contacting the surface of the tubing 61 will maintain the same centrally of the packers 39 and 47 and also maintain a proper relationship between the tubing 61 and the balls 76, 77 and 92. When the tubing 61 is lowered in the well one of the couplings 60 will contact the key 147, causing the same to be depressed within the slot 148, to a position in which it clears the lug 149. As the coupling 60 progresses downwardly it will contact the cam surface 151 of the yoke 142, forcing the same laterally within the recess 140 in the direction of the arrow of Fig. 1, against the force of the spring 144, until the relative parts assume the position shown in Fig. 5.

Due to the spring 144 the yoke 142 will return to its outward position as soon as the coupling 60 has passed the recess 140, and the lock member 146 being forced upward by the spring 150 will cause the yoke to be locked in the position shown in Fig. 1 until again actuated by one of the couplings 60.

The unit 136 is adapted to operate while the tubing is being raised from a well by detaching it from the bracket 141 and positioning it so that the key 147 will extend downwardly to be contacted by the coupling 60 on its upward movement.

I claim as my invention:

1. In an automatic gas control apparatus adapted for location in the space between the upper end of a well and a sectional member connected by couplings, the combination of: a body through which said member extends; walls forming a packer space within said body; a packer positioned within said space and adapted to be expanded by fluid pressure into contact with said member; upper valve means associated with said packer; lower valve means associated with said packer; a movable actuating member included in said upper valve and operable to be moved by frictional contact with one of said couplings when said member is moved downward through said body to actuate said upper valve to evacuate said packer, permitting said packer to relax so as to allow said coupling to pass downward therethrough; and a movable actuating member included in said lower valve and operable to be moved by frictional contact with one of said couplings when said member is moved upward through said body to actuate said lower valve to evacuate said packer, permitting said packer to relax so as to allow said coupling to pass upward therethrough.

2. In an automatic gas control apparatus adapted for location in the space between the upper end of a well and a sectional member connected by couplings, the combination of: a body through which said member extends; walls forming an upper packer space within said body; walls forming a lower packer space within said body; an upper packer positioned within said upper packer space; a lower packer positioned within said lower packer space, said upper and said lower packers being adapted to be expanded by fluid pressure into contact with said member; upper valve means associated with said upper packer; intermediate valve means associated with both said upper and said lower packers; lower valve means associated with said lower packer; a movable actuating member included in said upper valve and operable to be moved by frictional contact with one of said couplings when said member is moved downward through said body to actuate said upper valve to evacuate said upper packer, permitting said packer to relax so as to allow said coupling to pass downward therethrough; a movable actuating member included in said intermediate valve and operable to be moved by frictional contact with one of said couplings to actuate said intermediate valve to evacuate said lower packer when said member is moved downward through said body, and said intermediate actuating member being operable to be moved by contact with one of said couplings to actuate said intermediate valve to evacuate said upper packer when said member is moved upward through said body; and a movable actuating member included in said lower valve and operable to be moved by frictional contact with one of said couplings when said member is moved upward through said body to actuate said lower valve to evacuate said lower packer, permitting said packer to relax so as to allow said coupling to pass upward therethrough.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 9th day of April, 1929.

CHESTER A. RASMUSSEN.