

June 2, 1964

V. D. HANES

3,135,327

TELESCOPIC BRIDGING PLUG-PRESSURE SET

Original Filed July 22, 1957

3 Sheets-Sheet 1

Fig. 1

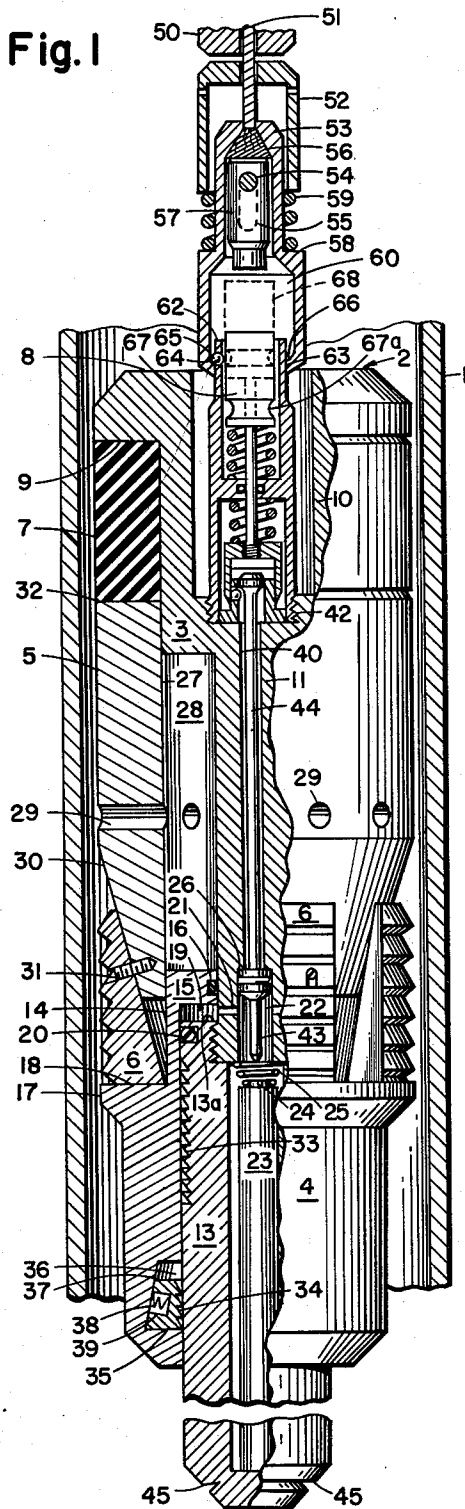
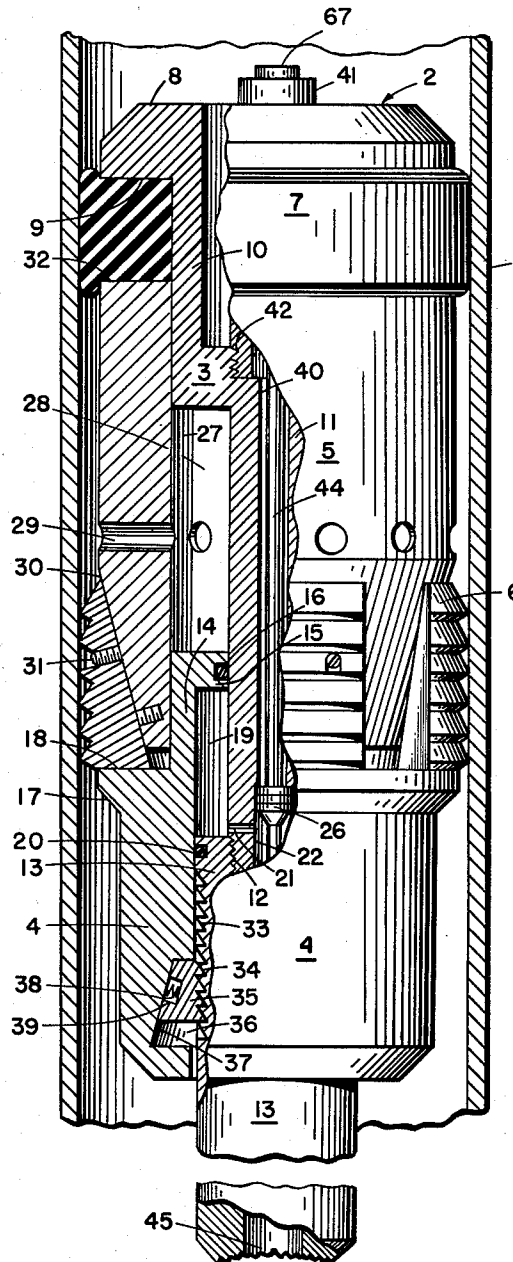


Fig. 2



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Fig. 4

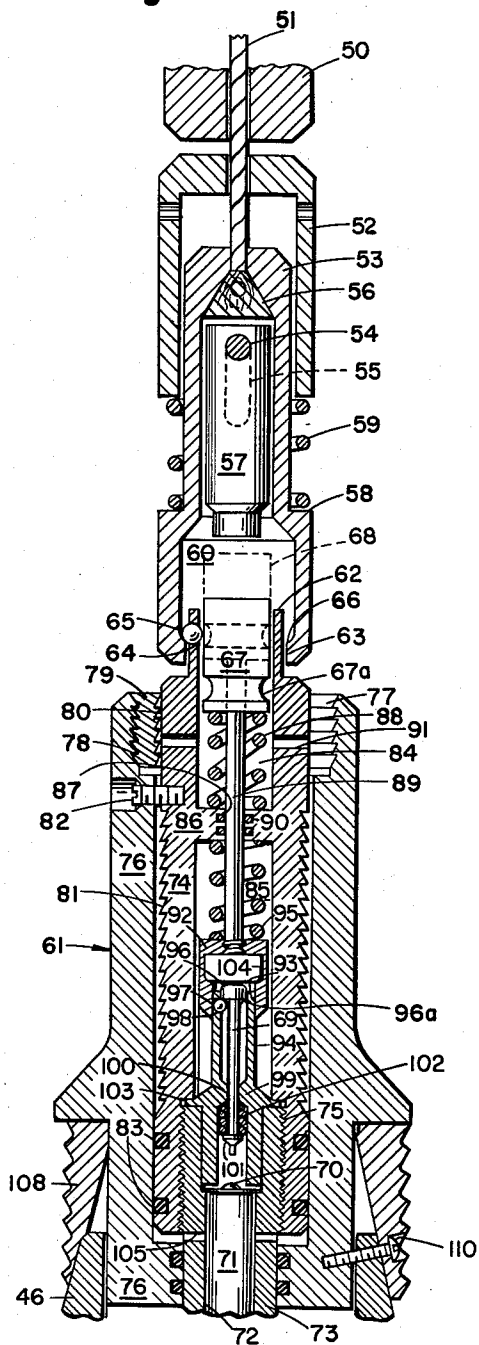
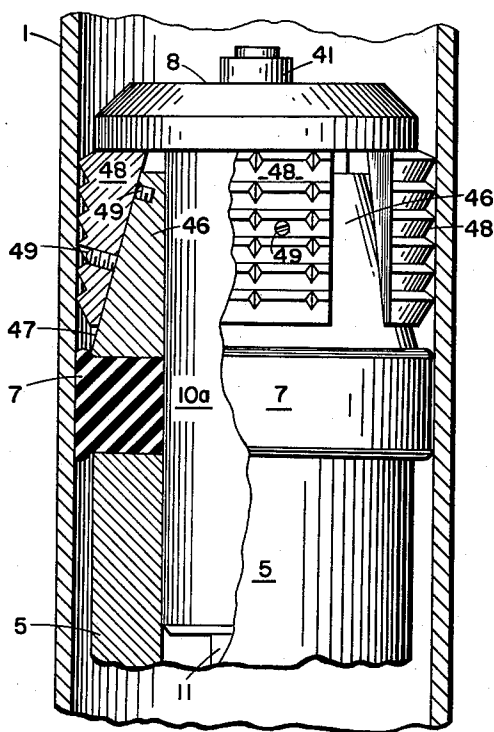


Fig. 3



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Fig. 5

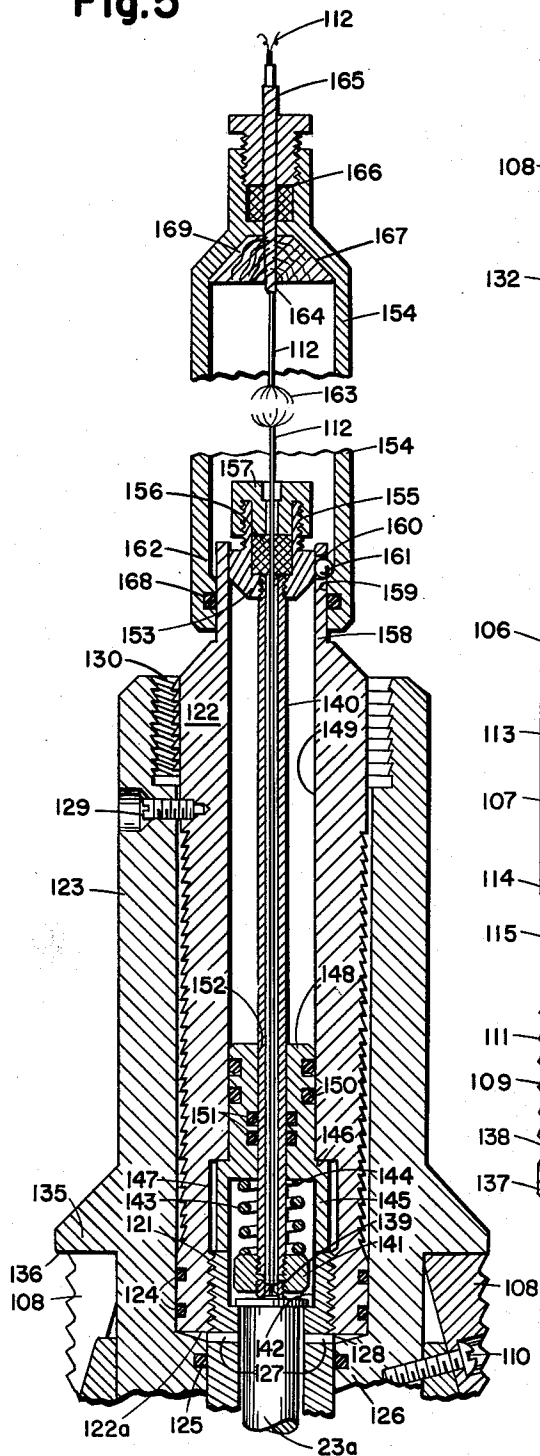
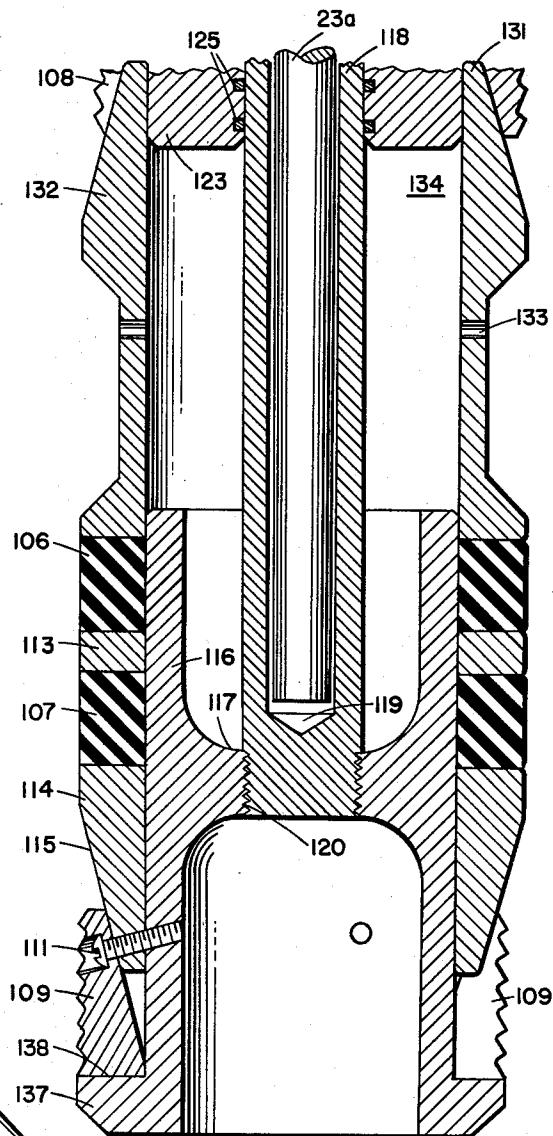


Fig. 6



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TELESCOPIC BRIDGING PLUG-PRESSURE SET

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Original application July 22, 1957, Ser. No. 673,339, now Patent No. 3,029,872, dated Apr. 17, 1962. Divided and this application Feb. 26, 1962, Ser. No. 185,177

2 Claims. (Cl. 166-63)

This invention relates to oil well tools. More particularly, the invention relates to oil well packers of the type commonly known as bridging plugs. This is a divisional application of my co-pending application, Serial No. 673,339, filed July 22, 1957, now Patent No. 3,029,872 patented April 17, 1962, entitled "Telescopic Bridging Plug-Pressure Set."

Bridging plugs are employed in oil wells for the purpose of forming a barrier in the well bore. The barrier may be either permanent or temporary, and may be located either in the well casing or in the uncased portion of the well bore. The barrier, thus formed, serves to separate the well bore into upper and lower sections which are isolated from each other. A pressure differential may exist across the bridging plug and may vary from a few pounds per square inch to several thousand pounds per square inch.

The bridging plug of the present invention is intended for use primarily in those cases where the pressure differential across the plug is high.

Heretofore, it has been the practice, when establishing a high pressure barrier in a well, to employ bridging plugs which are relatively large and which therefore contain a large amount of metal which must be drilled up when it is desired to remove them from the well. Such bridging plugs are relatively complicated and expensive to manufacture.

It is an object of the present invention to provide a high pressure bridging plug which is relatively small, simple in construction and cheap to make.

In recent years the method of setting bridging plugs has undergone a radical change. Formerly, the plugs were run into the well on drill pipe or tubing, necessitating the use of a derrick and rotary drilling equipment, at a cost sometimes of several thousand dollars, for the entire job. In recent years, the development of propellant-actuated setting tools has made possible the running of the plugs on a wire line instead of on pipe, with a consequent large saving in expense.

It is an object of the present invention to provide a bridging plug of the propellant-actuated type, for wire line operation.

Propellant-actuated bridging plugs of the high pressure type, as heretofore constructed, require the use of separate, detachable setting tools containing the propellant-actuated mechanism, which adds to the cost and expense of setting the plugs.

It is an object of the present invention to provide a high pressure bridging plug of the wire line type which does not require a separate setting tool and thus reduces the cost and expense of setting the plug.

Heretofore, wire line bridge plugs of the propellant-set type have required the use of insulated electric lines and the associated expensive mobile hoisting equipment for use therewith. The use of such specialized equipment requires the services of a service company. Ordinary well servicing crews do not operate such equipment.

It is an object of the present invention to provide a propellant-set, wire-line bridging plug which does not require the use of an insulated electric line nor a specially equipped mobile hoisting unit. The bridging plug of the

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present invention can be run on the common stranded steel cable which is available on all drilling rigs, work-over rigs or well-pulling rigs. No special service crews are required for operation of the bridging plug of the present invention.

Other objects and advantages will be apparent from the following description and drawings disclosing several embodiments of the invention.

FIG. 1 is an elevation, partly in cross section, illustrating one embodiment of the invention in the running-in position, and having only one set of slips.

FIG. 2 is an elevation, partly in cross section, of the device shown in FIG. 1, in the set position.

FIG. 3 is an elevation, partly in cross section, illustrating the device of FIGS. 1 and 2 equipped with a second set of slips.

FIG. 4 is an elevation, in cross section, of a mechanically actuated firing system for use with the bridging plug, shown in FIGS. 1, 2 and 3.

FIG. 5 is an elevation, in cross section, of an electrical firing system for use with the bridging plugs shown in FIGS. 1-3.

FIG. 6 is a continuation of the bridging plugs of FIGS. 4 and 5, showing the lower end thereof.

Referring to FIG. 1, the numeral 1 indicates a well casing. Disposed within the well casing 1 and supported by a wire line, not shown, is bridging plug 2, in the running-in position. The bridging plug 2 comprises five major parts which are movable relative to each other. These parts are: a piston 3; a cylinder 4; a floating body 5; wedge slips 6; and a compressible packer sleeve 7.

The piston member 3 is provided at its upper end with an enlarged head 8 forming a downwardly facing annular shoulder 9, a tubular body 10 having a downwardly depending tubular shank 11 of still further reduced diameter, to which is connected, as by the threads 12, an enlarged, tubular combustion chamber 13.

The edge 13a of combustion chamber 13 forms an outwardly projecting flange which effects a piston face acted on by pressure in a pressure chamber 19, as will be subsequently made apparent, flange 13a being threadedly integral with piston 3, as shown.

The cylinder 4 is slidably mounted on the shank 11 and chamber 13. To this end, the cylinder 4 is provided with a tubular upper portion 14 which slidably engages the outer surface of the combustion chamber 13 and has an inwardly turned flange 15 at its upper end, slidably engaging the exterior surface of the tubular shank 11. A suitable sealing means, such as an O ring 16 is mounted in the flange 15 in sealing relation with the outer surface of the shank 11. The lower portion of the cylinder member 4 is enlarged as indicated at 17 to provide an upwardly facing annular shoulder 18 which supports the wedge slips 6 when in their retracted position, as shown in FIG. 1. The interior of the cylinder 4, below the flange 15 is enlarged to slidably engage the exterior surface of the combustion chamber 13 and to form the pressure chamber 19. Sealing means, such as the O ring 20, is positioned in the exterior surface of the combustion chamber 13 in sealing engagement between the walls of the cylinder 4 and the combustion chamber 13.

The pressure chamber 19 communicates with the interior of the combustion chamber 13 by means of a port 21 formed in the lower wall of the tubular shank 11. The inner end of the port 21 communicates with an axial passageway 22, the lower end of which communicates with the upper end of the interior of the combustion chamber 13. A charge of gas-generating propellant 23 is positioned within the combustion chamber 13. A percussion cap igniter 24 is positioned in the upper end of the propellant charge 23. A compression spring 25 may be

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placed between the end of the propellant charge 23 and the end of the combustion chamber 13 to prevent movement of the propellant charge with the attendant danger of breaking the charge. The upper end of the passageway 22 is closed by a valve member in the form of a small piston 26, slidable in the passageway 22.

The floating body member 5 is tubular in form with its interior surface 27 in slidable engagement with the exterior surface of the tubular body 10. A fluid relief chamber 28 is formed between the interior wall 27 of the floating body member 5 and the exterior wall of the shank 11. Ports 29 in the wall of the floating body member 5 communicates the chamber 28 with the exterior of the body member 5. The lower portion of the body member 5 is tapered downwardly and inwardly to form a frusto-conical seat 30 for the wedge slips 6. The wedge slips 6 are normally held in their retracted position, resting upon the shoulder 18, by any suitable means, such as shear pins 31 attached to the body member 5.

The upper end of the floating body member 5 terminates in an upwardly facing annular shoulder 32 which serves as a seat for the lower end of the cylindrical, resilient packer sleeve 7.

In order to lock the members 4 and 13 in extended position, the outer surface of the combustion chamber 13 is provided with a series of vertically spaced, upwardly facing, teeth 33. The teeth 33 are adapted to engage a series of vertically spaced, downwardly facing teeth 34 formed on the inner face of wedge locks 35 mounted in recesses 36 formed in the lower end of the cylinder member 4. The bearing wall 37 of the recess 36 is tapered upwardly and inwardly. A compression spring 38 mounted in a recess 39 in the back of wedge lock 35 tends to force the wedge lock inwardly toward the outer surface of the combustion chamber 13.

The passageway 22 in shank 11 has an upward extension 40 of reduced diameter. The passageway 40 extends to the top of the shank 11 where it communicates with the interior of a tubular housing 41 which is attached to the piston 3 by any suitable means such as the threads 42. The tubular housing 41 contains the mechanism for actuating a firing pin 43 which contacts the percussion cap 24. The firing pin 43 depends from the lower end of piston valve 26. On the upper end of piston valve 26 is an upwardly extending push rod 44, the upper end of which extends into the housing 41. Any suitable means for actuating the firing pin 43-44 may be utilized, for example, the mechanism illustrated in FIG. 1 that is substantially the same actuating mechanism shown in FIG. 4 and described in detail below.

FIG. 2 illustrates the device of FIG. 1 in set position in the well casing 1. Upon downward movement of the firing pin 43 (FIG. 1), the percussion cap 24 is fired, initiating the burning of the propellant charge 23. High pressure gas generated by the burning of the propellant charge 23 passes upwardly through passageway 22, outwardly through port 21 and into the pressure chamber 19 between the chamber 13 and cylinder 4. The cylinder 4 moves upwardly on the shank 11 of the piston 3 and, in so doing, shears the pins 31, releasing the wedge slips 6. Continued upward movement of the cylinder 4 with respect to the piston 3 pushes the floating body member 5 upwardly. The compressible packer sleeve 7, being restrained by the shoulder 9 on the piston head 8, is compressed and expanded laterally by upward movement of the upper shoulder 32 on the floating body 5, until the packer sleeve 7 is tightly engaged with the inner wall of the well casing 1. At the same time, upward movement of the cylinder member 4 with respect to the piston 3 causes the teeth 34 on the wedge lock 35 to engage the teeth 3 on the piston, to lock the cylinder against any subsequent downward movement, and thus maintaining the packer 7 in sealing engagement with the well casing 1. Continued build-up of pressure in the chambers 19 and 13 will cause the bottom of the chamber 13 to be blown out,

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releasing the pressure in these chambers. The bottom wall of the chamber 13 is intentionally weakened as indicated at 45, for this purpose. The expanded packer sleeve 7 together with the expanded wedge slips 6 will enable the bridging plug 2 to withstand high differential pressures of several thousand pounds per square inch.

The interior passageways 22 and 40 are closed by the piston valve 26 and also by the housing 41 so that fluid cannot pass through the interior of the bridging plug.

The large metal parts 3, 4 and 5 of the bridging plug are preferably made of a metal which is strong but easily drilled up, for example, cast iron or aluminum. The packer sleeve 7 is preferably made of an oil resistant rubber. The wedge slips 6 are provided with hardened teeth to better engage the interior walls of the well casing 1.

FIG. 3 illustrates a variation of the bridging plug shown in FIGS. 1 and 2. The plug shown in FIGS. 1 and 2 has only one set of wedge slips 6, these being so positioned as to prevent downward movement of the bridging plug 2 in the well casing 1. Sometimes there exists an upward pressure below the bridging plug which is greater than the downward pressure from above. In this case it is customary to provide the bridging plug with two sets of wedge slips, one set engaging in a downward direction and the other set engaging in an upward direction. The only changes from the design shown in FIGURES 1 and 2 are: an elongation of the piston body 10a to make room for tubular wedge seat 46 which slidably surrounds the body extension 10a with its base standing on the packer sleeve 7 and has its outer surface 47 tapered downwardly to form a seat for wedge slips 48. The wedge slips 48 are normally held in the retracted position by means of shear pins 49. Upward movement of the floating body member 5 relative to the piston body 10a causes the packer sleeve 7 to shear the pins 49 and move the wedge slips 48 outwardly into engagement with the well casing 1.

FIGURE 4 illustrates one form of actuating device for the bridging plugs shown in FIGURES 1-3. The actuator is of the "go-devil" type wherein a weight 50 is dropped from the top of the well slidably mounted on the hoisting line 51. The weight 50 strikes the top of a tubular sleeve 52, forcing it downwardly. The sleeve 52 has a lost-motion connection with a tubular release member 53 which is slidably mounted within the sleeve 52 by means of a cross pin 54 extending radially through sleeve 52 and through a vertical slot 55 in the release member 53. The lower end of the hoisting line 51 is secured to the upper end of the release member 53 by any suitable means, such as babbitting it into the line socket 56. Suspended on the cross pin 54, within the tubular release member 53, is a cylindrical striker weight 57. The tubular release member 53 is formed with an upwardly facing external annular shoulder 58 on which is seated a helical compression spring 59. Below the shoulder 58 the tubular release member 53 has an enlarged cavity 60 which releasably receives the upper end of the bridging plug 61. The bridging plug 61 is generally similar to the plugs shown in FIGURES 1-3 except as to the actuating means for the propellant, as will be described below.

The tubular release member 53 is releasably attached to the upper end of the bridging plug 61 in the following manner. A tubular neck 62 on the upper end of the bridging plug 61 passes slidably through an opening 63 in the lower end of the wall of enlarged cavity 60. An opening 64 in the wall of the neck 62 receives a retaining ball 65 which is of greater diameter than the wall thickness of the neck 62 and seats partially upon an upwardly extending annular shoulder 66 and partially upon the upwardly facing portion of the wall of the opening 64 in neck 62. The ball 65 is normally prevented from moving radially by the inner wall of the cavity 60 and the outer surface of a plunger member 67 having a circumferential recess 67a. The cable releasing operation will be described later.

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As shown in FIGURE 4, initiation of the firing device is accomplished before the releasing of the bridging plug 61 from the hoisting line 51. This initiation is accomplished in the following manner. When the plunger 67 is pushed downwardly by the striker weight 57 (which is accomplished by the falling "go-devil" 50 striking the sleeve 52), the downward movement of the plunger actuates a firing pin 69 which strikes a percussion cap 70 in the upper end of an igniter 71 in the upper end of the combustion chamber 72 within the tubular member 73, igniting the propellant (not shown). The upper end of member 73 is attached to the lower end of tubular housing 74 by suitable means such as the threads 75. The tubular housing 74 is slidably mounted within the bore of a tubular extension 76 which corresponds to the tubular piston members 10 and 10a of FIGURES 1-3. The upper end of the tubular extension 76 is counter bored and provided with a series of vertically spaced, downwardly facing, circumferential teeth 77 which engage upwardly facing teeth 78 on the outer face of a locking member 79. Locking member 79 has upwardly facing, vertically spaced ratchet teeth 80 which engage a series of vertically spaced, downwardly facing ratchet teeth 81 formed on the outer surface of the tubular housing 74. A shear pin 82 normally locks the members 74 and 76 against relative movement. The tubular housing 74 is provided, near its lower end, with suitable means for sealing the space between the members 74 and 76, such as the O rings 83.

The tubular housing 74, which is attached to the combustion chamber 72 is divided into upper and lower compartments 84 and 85 by means of a transverse wall 86 having a central opening 87. The plunger 67 is slidably mounted in the upper chamber 84 and is supported upon a compression spring 88 which rests upon the top of the transverse wall 86. The purpose of the spring 88 is to offset any tendency for the fluid submergence pressure to depress the plunger 67 and release the firing pin 69 and firing the igniter 71, prematurely. The plunger 67 is provided with a downwardly depending push rod 89 which passes through the opening 87 in the barrier 86. Sealing means, such as the O rings 90 seal the space between the push rod 89 and opening 87. The upper chamber 84 is provided with vent ports 91 to permit the escape of fluid as the plunger 67 moves downwardly in the chamber 84. The lower end of push rod 89 is provided with an enlarged, tubular head 92 having a circular opening 93 in its lower end. Slidably received within the opening 93 is a tubular sleeve 94 which houses the firing pin 69. In the lower chamber 85, between the enlarged head 92 and the under side of the barrier 86 is a compression spring 95 which determines the cable release pressure, as will be explained.

The firing pin 69 has an enlarged head 96 having an annular beveled downwardly facing shoulder 96a which normally bears against the upper surface of a ball detent 97 positioned within an opening 98 in the wall of the sleeve 94. A barrier 99 is provided midway of the sleeve 94. There is an opening 100 through the barrier 99 through which the shank of the firing pin 69 extends. The lower end of the firing pin shank terminates in an enlarged head 101 which serves as an abutment for a compressed spring 102, the other end of which seats against the under side of the barrier 99. The sleeve 94 is provided with a radially extending flange 103 which is secured between adjoining shoulders on the threadedly joined members 73 and 74. The firing pin 69 is so positioned as to strike the percussion cap 70 when the compressed spring 102 is released.

The operation of firing mechanism of FIGURE 4 is as follows: When the "go-devil" 50 is dropped into the well bore and strikes member 52 the plunger 67 is driven downwardly by the striker weight 57, thus moving the push rod 89 and its enlarged, tubular head 92 downwardly with respect to the sleeve 94. The upper portion

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104 of the interior of the tubular head 92 is of larger diameter than the lower opening 93, with the result that when the ball detent 97 enters the enlarged chamber 104 it releases the head 96 on the upper end of the firing pin 69. The compressed spring 102 then drives the firing pin downwardly, striking the percussion cap 70 in the igniter 71 and igniting the propellant (not shown) in the combustion chamber 72.

High pressure gas generated by the combustion of the propellant passes upwardly through the combustion chamber 72, outwardly through ports 105 in the wall 73 of the combustion chamber, and into the space between the relatively movable members 74 and 76, causing these members to move in an axial direction with respect to each other. Such axial movement continues until the packer sleeves 106 and 107 (FIGURE 6) have been expanded by axial compression and wedge slips 108 and 109 have been set. The wedge slips 108 and 109 are normally held in retracted position by shear pins 110 and 111, respectively. Engagement of the ratchet teeth 80 and 81 prevents return movement of the members 74 and 76. Continued generation of pressure in the combustion chamber 72 results in the shearing of the lower end of the combustion chamber 72, as indicated in FIGURES 1 and 2. The release of the hoisting line 51, carrying the "go-devil" 50, from the bridging plug 61 is accomplished in the following manner.

The increasing pressure within the combustion chamber 72, due to the burning of the propellant within the chamber, causes the spring 95 to be compressed upward due to the increasing pressure forcing push rod 89 upward through opening 87. The upward movement of push rod 89 moves plunger member 67 upward. This upward movement continues as the pressure in chamber 72 increases until the recess 67a carried by the plunger member 67 is opposite the cable releasing ball 65 as indicated by dotted lines 68 allowing the ball 65 to fall inwardly into the recess 67a and thereby releases the tubular member 53 from the packer neck member 62. The entire release member is then withdrawn from the well by means of the hoisting cable 51.

FIGURE 5 illustrates an embodiment of the invention in which the bridging plug is adapted to be set by electrical initiation. Electric current is conducted through an insulated electric hoisting line 112 from the top of the well. The bridging plug is shown in the running-in position, with two sets of slips 108 and 109 and two sleeve packers 106 and 107. A spacer ring 113 may be used to separate the sleeve packers 106 and 107, if desired. The lower set of slips 109 are supported on a tubular shoe 114, the outer surface of which is tapered downwardly and inwardly as indicated at 115 to provide a seat for the wedge slips 109. Shoe 114 is slidably mounted on a tubular body member 116 which is part of the piston assembly. The tubular body 116 has a partition 117 approximately midway between its ends. A tubular piston rod 118 serves also as a combustion chamber 119 for the propellant 23a. The piston rod 118 is attached to the partition 117 by any suitable means such as the threads 120 and extended upwardly therefrom. Attached to the upper end of piston rod 118, as by the threads 121, is a tubular piston 122 of enlarged diameter. The end 122a of piston 122 forms an outwardly projecting flange in conjunction with piston rod 118 to effect a piston face in expansion chamber 128, as will subsequently be made apparent. Slidably mounted on the piston 122 and piston rod 118 is a cylinder 123. The piston 122 is provided with suitable sealing means, such as the O rings 124 mounted between the walls of the cylinder 123 and the piston 122. The lower end of cylinder 123 has an inwardly directed flange 126 in which the sealing means, such as O rings 125, are mounted between the walls of flange 126 and rod 118. High pressure gas from the burning propellant 23a in the combustion chamber 119 passes through ports 127 in the wall of the tube 118 and into expansion chamber

128 below the piston 122 and within the cylinder 123, thus forcing the cylinder 123 to move downwardly with respect to the piston 122. A shear pin 129 secures the piston 122 to the cylinder 123 and prevents premature relative movement between these parts. Ratchet type locking means 130 is provided between the piston 122 and cylinder 123 similar to the locking means described in connection with the device shown in FIGURE 4. A second tubular shoe 131 (46 in FIGURE 4) is slidably mounted on the lower end of the cylinder 123 at which flange 126 is formed and on the upper end of the piston body member 116. The outer surface of the shoe 131 is tapered downwardly and outwardly as indicated at 132, to provide a seat for the wedge slips 108. The lower end of shoe 131 rests upon the top of the upper packer sleeve 106. Fluid ports 133 are provided in the wall of the shoe 131 intermediate the ends thereof to permit well fluid to pass in or out of the chamber 134 between the shoe 131 and the tube 118. In order to force the wedge slips 108 and 109 into engagement with a well casing, the cylinder 123 is provided with an outwardly directed flange 135 having a downwardly facing shoulder 136 which bears on top and supports the wedge slips 108, and the piston body 116 is provided at its lower end with a similar outwardly directed flange 137 having an upwardly facing shoulder 138 which bears and supports the lower end of wedge slips 109.

The ignition system shown in FIGURE 5 is different from that shown in FIGURE 4 in that, in FIGURE 5, ignition is accomplished by passing an electric current downwardly through the insulated electric hoisting line 112. The lower end of line 112 is connected to an igniter 139 positioned adjacent the upper end of the propellant 23a. The line 112 is enclosed within a tube 140 which serves also as a piston rod, the lower end of which is attached to an enlarged guide 141, the latter containing the igniter 139. The guide 141 is normally contained within a cylinder 142 formed by counter boring the upper end of the tube 118. The guide 141 is normally held in its lowermost position, as shown, by means of a compression spring 143, the lower end of which bears against the top of guide 141 and the upper end of which bears against the under face 144 of a cup-shaped body 145 which is confined between the upper end of the tube 118 and a shoulder 146 formed within a counter bore 147 in the lower end of the tubular piston 122. The cup-shaped body 145 has an upward extension 148 which fits within the upper bore 149 of the tubular piston 122. O ring seals 150 are provided in the extension 148 to seal the space between the outer wall of the extension and the inner wall of the bore 149. Other O ring seals 151 are provided in the extension 148 to seal the space between the inner wall of a bore 152 in the extension 148 and the outer wall of the tube 140. The purpose of the seals 150 and 151 is to prevent the passage of fluid to the interior of the bridging plug, past the members 145 and 148. To the upper end of tube 140 is attached an enlarged head 153 which provides means for sealing the inside of tube 140 from outside pressure and also provides means for releasing collar 154 from piston 122. The upper end of the head 153 contains a stuffing box 155 having packing means 156 surrounding the line 112 and a threaded follower 157 for tightening the packing 156.

When high pressure gas generated by the propellant 23a of FIGURE 5 pushes the tube 140 upwardly, against the pressure of spring 143, through its guide 141 the enlarged head 153 is also pushed upwardly with respect to the tubular piston 122. The upper end of the tubular piston 122 is provided with means for allowing the releasing collar 154 to be detached therefrom. For this purpose, the upper end of the tubular piston 122 is provided with a tubular neck 158 which is slidably received within an opening 159 in the lower end of the releasing collar 154. An opening 160 in the wall of the neck 158 contains a ball detent 161 which has a diameter greater

than the wall thickness of the neck 158. The ball detent 161 is normally held from inward movement by the head 153 and the inner wall of the releasing collar. The outer, underface of the ball detent 161 is supported on an annular upwardly facing shoulder 162 on the inner wall of the releasing collar 154. When the head 153 moves upwardly with respect to the neck 158, under the influence of high pressure gas, as previously explained, the head 153 moves above the ball 161, allowing the ball to fall inwardly, inside the neck 158, thus releasing the collar 154 from the neck 158. The line 112 is a relatively weak line and will be broken as indicated at 163 by the upward pull of the collar 154 after the bridging plug has been set. The collar 154 may be provided with O ring seal 168 to prevent fluid entering the inside chamber of collar 154.

The upper portion of the releasing collar 154 is provided with means for attaching it securely to the hoisting line 112. It is customary to provide electric conductor lines such as 112 with several wraps of insulation 164 and an outer sheath of stranded steel wire 165 which carries the load. The outer sheath 165 is passed through a stuffing box 166 into a line socket 167 and the outer wires of the sheath 165 are turned back and/or imbedded in a body of babbitt or lead as indicated at 169. Such a construction permits the hoisting line to support a considerable load, on the order of 600 lbs., but permits the line to be pulled out of the socket 167 if the releasing collar 154 should become stuck in the well, thus saving the line and avoiding a fishing job.

The methods of igniting the propellant and releasing the cable as outlined in the description of FIGURE 4 and FIGURE 5, also provide for a time interval between the igniting of the propellant and the releasing of the hoisting cable. This time interval is provided so that the packer and its slips may be set into holding contact with the casing wall before the packer is released from the cable. Premature release could allow the packer assembly to fall downwardly in the well bore or casing before the slips have engaged the well casing. In FIGURE 5, this time interval is provided in the following manner.

The propellant 23a, when ignited by means of igniter 139, burns and produces gas with increasing pressure within the chamber 119 and in the chamber 128 provided between the seals 124 and 125, thus, shearing pins 129, 110 and 111, releasing the slips 108 and 109 and the shoes 114 and 131 between the shoulders 136 and 138. Increasing pressure within the chamber 128 forces piston 122 upward in relation to cylinder 123 and moves shoulder 138 upward in relation to shoulder 136. This upward movement compresses the packer sleeves 106 and 107 and expands them outwardly into contact with the well casing (not shown). Further upward movement of the shoulder 138 forces the slips 108 and 109 outward into contact with the casing due to the tapers 132 and 115 of shoes 131 and 114. The pressure developed within the propellant chamber 119 may increase during the packer setting time interval described above and will increase to higher pressures when the packer sleeves 106 and 107 and the slips 108 and 109 are forced into full contact with the casing, resulting in the release of the collar 154. The collar releasing means, as described in the operation of FIGURE 5, provides pressure responsive means for releasing the collar. A compression spring 143 may be provided to prevent the collar from being released from the packer before the packer sleeves and slip are set and adapted to operate at high pressures to release the collar after they are set.

The foregoing description is illustrative only of several embodiments of the invention which is not to be limited thereto but is of the scope defined by the appended claims.

I claim:

1. In a bridging plug adapted to be run on a hoisting line and having a tubular piston and tubular cylinder mounted on and in telescopic relation to each other, a combustion chamber in said piston, an expansion cham-

ber in said cylinder, and a fluid passageway connecting said combustion chamber with said expansion chamber; ignitable propellant means in said combustion chamber; an igniter in said tubular piston and associated with said propellant, spring-pressed percussion means for initiating said igniter; a latch for said percussion means normally holding the percussion means in its retracted position; plunger means for releasing said latch; and means associated with said hoisting line for actuating said plunger.

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2. In a bridging plug as set forth in claim 1, further including means associated with said plunger for releasing said hoisting line from said plug after said plug has been set in a well.

References Cited in the file of this patent**UNITED STATES PATENTS**

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