Dec. 16, 1952 L. W. TOELKE 2,621,744

PLUGGING DEVICE

Filed Dec. 15, 1948

Fig. 2

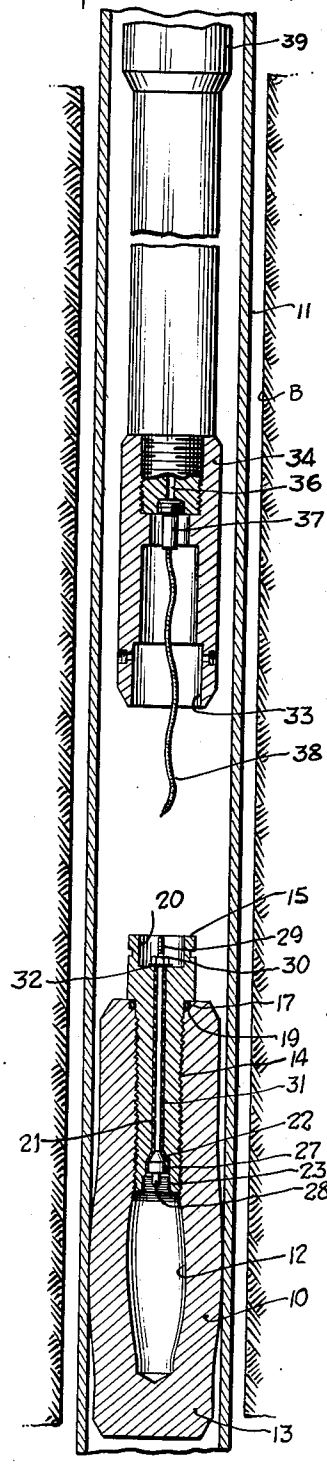


Fig. 1

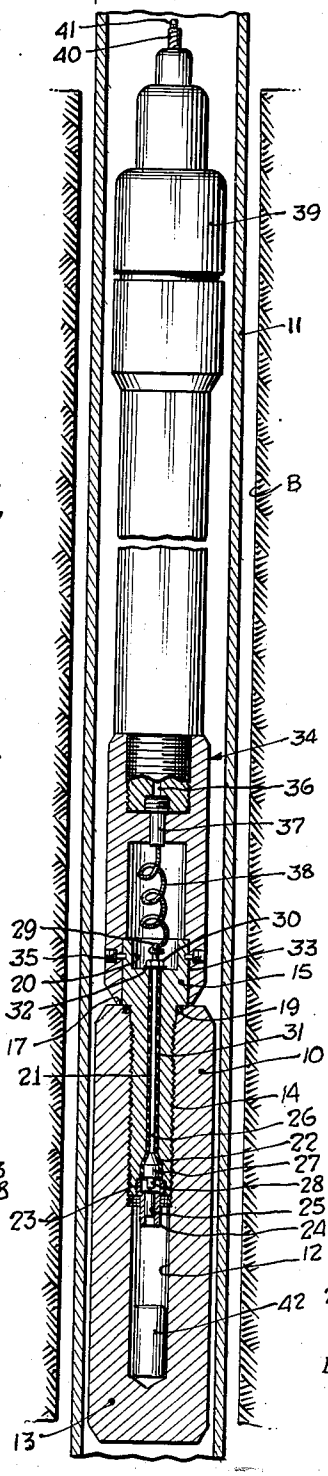


Fig. 3

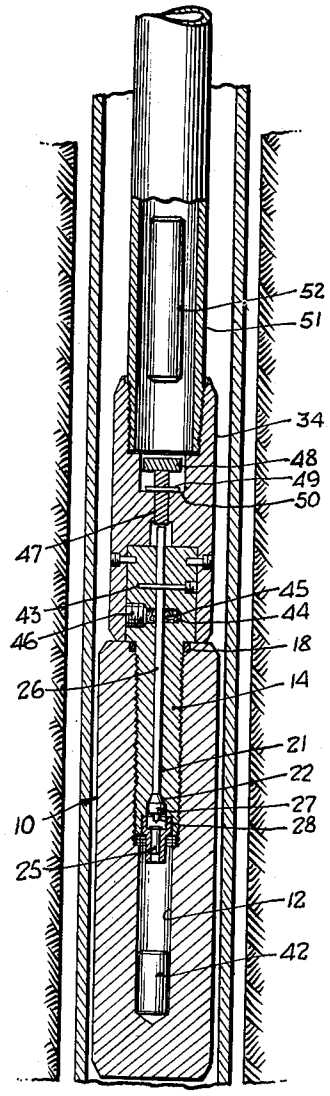
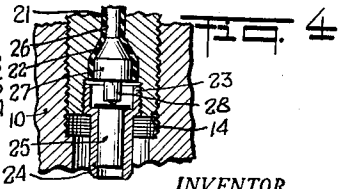


Fig. 4



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PLUGGING DEVICE

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Application December 15, 1948, Serial No. 65,451

3 Claims. (Cl. 166—13)

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The present invention relates to improvements in well plugging devices, particularly well plugging devices expandible by explosive means into plugging engagement with a well wall.

In my co-pending applications Serial No. 12,523, filed March 2, 1948, and Serial No. 31,350, filed September 27, 1948, there are disclosed methods and apparatus whereby tubular bodies may be expanded into tight plugging engagement in a well bore by setting-off explosive materials within the bodies, the pressure of the gases generated by the explosives within the bodies being employed to effect the desired degree of expansion thereof.

The present invention has for its principal object improvements in devices of the same general character as disclosed in the afore-mentioned applications and particularly means whereby the expansive efficiency of the explosive force is considerably improved in order to assure greater sealing effectiveness of the plugging device.

A more specific object is the provision of the valve means in the plugging body which is operative in response to the pressure of the explosive gases to prevent escape of the gases before dissipation of their expansive action.

Other and more specific objects and advantages of the present invention will become apparent from the following detailed description when read in conjunction with the accompanying drawings which illustrate useful embodiments in accordance with this invention.

In the drawings:

Fig. 1 is a longitudinal elevational view, partly in section, of an apparatus employing a plugging device in accordance with one embodiment of this invention and showing the plugging device in position in a well casing preparatory to its expansion therein;

Fig. 2 is a view similar to Fig. 1, showing the plugging device after expansion into plugging engagement with the well casing;

Fig. 3 is a view similar to Fig. 1 showing a plugging device in accordance with another embodiment of this invention; and

Fig. 4 is an enlarged view of a detail of the embodiment illustrated in Fig. 1.

Referring particularly to Fig. 1, the plugging device comprises a generally cylindrical metallic body 10 adapted to be inserted in a casing 11, extending into a well bore B, and to be radially expanded into sealing engagement with the wall of casing 11. As disclosed in the afore-mentioned application Serial No. 12,523, the material

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of which body 10 is constructed may be any metallic material possessing a sufficient degree of ductility or plasticity such that when subjected to the requisite internal pressure, the walls thereof will expand to the desired extent without rupturing or cracking and will become permanently set in their expanded condition. Such metallic materials include aluminum and magnesium and their various alloys, copper and its alloys including various brasses and bronzes, mild steels, etc.

Body 10 is provided with an axial bore 12 closed at one end by an end wall 13 preferably formed as an integral part of body 10. The opposite end of bore 12 is threaded internally at 14 and a closure member comprising a head portion 15 and an externally threaded shank portion 16 is adapted to be screwed into the threaded portion of bore 12. Head portion 15 is of somewhat larger diameter than bore 12 providing an annular shoulder 17 which is adapted to seat against the upper end of body 10 when shank portion 16 is fully inserted in bore 12, and to compress a sealing ring 18 which is seated in an annular recess 19 in the end of body 10 concentric with shank portion 16, and is adapted to form a fluid tight seal between the outer end of bore 12 and the closure member. Head portion 15 of the closure member is provided with a cavity 20 and an axial passageway 21 which extends through the closure member between the bottom of cavity 20 and the opposite end of shank portion 15. Adjacent its inner end, passageway 21 is flared outwardly to form a tapered seat 22 and a tubular socket 23. A tubular cartridge retainer 24 is screwed into the end of socket 23 and is adapted to hold an initiating cartridge 25 of the conventional electrically fired type. A cylindrical rod 26 extends through passageway 21 and is provided at its inner end with an enlarged valve head 27 having a tapered surface complementing that of seat 22 and adapted to cooperate therewith to form a closure for passageway 21 when rod 26 is moved in the outward direction. Head 27 is provided with an extension 28 adapted to make electrical contact with the head of cartridge 25. The opposite end of rod 26 is threaded at 29 and provided with a nut 30 which when screwed down against the bottom of cavity 20 will act to draw head 27 into engagement with seat 22 and thereby lock rod 26 in passageway 21. An insulating sleeve 31 surrounds rod 26 and head 27 and is adapted to electrically insulate these parts from the closure elements. An insulat-

ing washer 32 is provided between nut 30 and the bottom of cavity 20 to complete the insulation of rod 26 from the adjacent metallic parts. Rod 26 is made of a suitable electrically conductive metal in order that it may serve as an electrode for the transmission of electrical current to cartridge 25. Head portion 15 of the closure is slidably inserted into a socket 33 provided in the lower end of a carrier 34. A plurality of angularly spaced shear pins 35 extend radially through the wall of socket 33 into engagement with the inserted walls of cavity 20 to thereby lock closure head portion 15 and its attached body 10 to carrier 34. The latter has a suitable electric current conductor lead 36 threaded therethrough and connected to a terminal member 37 having one end of a wire lead 38 connected thereto, the other end of lead 38 being electrically connected to end 29 of rod 26. The upper end of carrier 34 is connected to a conventional cable connector 39 which is suspended from a wire cable 40 having an electrical conductor 41 threaded therethrough. It will be understood that connector 39 and carrier 34 carry conventional electrical terminals (not shown) which are connected to conductor 41 and lead 36, respectively, and adapted, when connector 39 has been suitably inserted in the upper end of carrier 34, to make contact with each other and complete an electrical circuit between them. Such arrangements for conducting electrical current from a suspending cable to a tool suspended therefrom are entirely conventional and well understood in the art and their details form no part of this invention. It will also be understood that the upper end of conductor 41 will be connected to a suitable source of electric current (not shown) located on the surface at the top of the well.

A suitable explosive charge 42 will be inserted in bore 12 of body 10 when the apparatus is assembled preparatory to lowering it into casing 11. Explosive charge 42 may consist of any of the well known chemical explosive substances including the various detonating and deflagrating types. Detonating type explosives may be exemplified by trinitrotoluene (TNT), pentaerythritol tetranitrate (PETN), "pentolite," "cyclonite," "tetryl," "tetrytol," and the like. The deflagrating types include the various smokeless nitrocellulose base explosives and the various black powders. These explosive materials may be employed in granular, plastic or molded and compressed pelletized form, the pressure generating characteristics of all such explosive materials being well understood and readily determinable for each particular case. It will be understood that the quantity of explosive used will depend in general upon the character of the particular explosive material and the pressures to be developed in each case.

In operation the plugging apparatus, assembled as illustrated in Fig. 1 and with a suitable charge of explosive 42 enclosed in bore 12, will be lowered by means of cable 40 to a point in casing 11 at which the plug is to be set. Thereupon electric current will be transmitted through conductor 41, lead 36, terminal 37 and wire 38 to rod 26, through which the current will be applied to initiating cartridge 25. The latter will be set off and its explosion will, in turn, cause the main explosive charge 42 to be set off and generate high pressure gases. The pressure of the explosive gases will substantially instantaneously uniformly expand the walls of body 10 radially into compressive engagement with casing 11 and effect permanent deformation thereof in the expanded position to thereby form a tight plug in the casing (see Fig. 2). This operation is described in considerably greater detail in the afore-mentioned application Serial No. 12,523.

The pressure generated in bore 12 by the explosion of initiating cartridge 25 will also react instantaneously against the lower face of head 27 and will drive the latter rearwardly tightly against seat 22 effectively closing passageway 21 against escape of any portion of the pressure of the explosive gases from bore 12 and will thereby permit the full utilization of the maximum expansive energy of the explosion gases in effecting expansion of the walls of body 10. Despite the fact that head 27 may initially be drawn tightly against seat 22, by providing this valve arrangement, additional assurance is thereby provided that none of the explosion gases can escape until they have expended their maximum potential expansive energy. This is important because the quantity of explosive will normally be calculated to provide a maximum force of pre-determined energy sufficient to produce the requisite degree of expansion of body 10. Any appreciable loss of this energy will ordinarily be reflected in the failure to obtain a tight seal between body 10 and casing 11. As such seals may often be required to withstand hydrostatic or gas pressures of several thousand pounds per square inch, the importance of assuring a tight seal with body 10 will be evident.

The shock of the explosion will ordinarily break shear pins 35 and release carrier 34, which may then be withdrawn from the well (see Fig. 2) for re-use. If the shear pins are not broken by the shock of the explosion they may be readily broken by a sharp pull applied to cable 40 to effect release of carrier 34 from the plug body.

Fig. 3 illustrates another embodiment in accordance with this invention, wherein percussion means, rather than electrical means, is employed to set-off the explosive charge.

In this embodiment body 10 is identical in form with that illustrated in Fig. 1 and the parts thereof are designated by the same numerals. Head portion 15 of the closure member is slightly modified in that it is made solid with passageway 21 extending entirely through it to the upper end thereof. Rod 26 is made somewhat longer than in the previous embodiment so that its upper end will extend above the upper end face of head portion 15 into the bore of carrier 34. Rod 26 is slidable in passageway 21 and extension 28 is held above and out of contact with the head of initiating cartridge 25 by means of a shear pin 43 which extends transversely through head portion 15 and rod 26. An annular packing groove 44 is provided in head portion 15 surrounding rod 26 and is filled with grease or other suitable sealing material 45 held in place by means of a screw plug 46. In this embodiment, initiating cartridge 25 will be of the conventional percussion type adapted to be set off in the usual manner by impact of extension 28 against the usual cap (not shown) in the head of the cartridge. Slidably mounted in the bore of carrier 34 above the upper end of rod 26 and in alignment therewith is a plunger 47 provided at its upper end with an enlarged head 48. A shear pin 49 extends transversely through plunger 47 and has its ends supported on a

shoulder 50 in the bore of carrier 34. Shear pin 49 is provided to temporarily hold plunger 47 out of contact with the end of rod 26. The upper end of carrier 34 is screwed to the lower end of a pipe string 51 which extends to the surface through the casing.

This embodiment is operated in the following manner: The structure assembled on the end of pipe string 51 in the manner illustrated in Fig. 3, will be lowered into casing 11 to the desired depth. Thereupon a weighted member or "go-devil" 52 will be dropped through the bore of pipe 50 and caused to strike plunger head 48. The resulting impact will break shear pin 49 and drive plunger 47 against the end of rod 26, breaking shear pin 43, and driving rod 26 downwardly to cause extension 28 to strike the cap of initiating cartridge 25, the resulting explosion of which will set-off explosive charge 42. As in the previously described embodiment the gas pressure generated by the explosion in bore 12 will drive head 27 back against seat 22 and seal passageway 21 against the escape of the explosion gases which will then exert their maximum energy in effecting the desired expansion of body 10.

In each of the foregoing embodiments it will be seen that passageway 21 provides a passageway for the transmission of initiating energy to the explosive and that head 27 and seat 22 cooperate to form a back pressure valve actuable by the pressure of the explosive gases to close the passageway against escape of the gases.

It will be understood that various alterations and modifications may be made in the details of the illustrative embodiments within the scope of the appended claims but without departing from the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. A plugging device for sealing a well bore, comprising, a tubular body having its bore closed at its lower end, said body being constructed of ductile metal and expandible by an internally contained explosive, a closure member threadedly inserted into the upper end of said bore, a head portion on said closure member extending above the upper end of said body, a carrier having a socket slidably enclosing said head portion, shear pins extending radially through the wall of said socket into engagement with said head portion to form a breakable connection between said carrier and said head portion, an axial passageway through said closure member providing communication between the interiors of said body and said socket, a rigid rod member extending longitudinally through said passageway from said socket to the interior of said body and adapted to transmit initiating energy from said carrier to said explosive, and back pressure valve means carried by the inner end of said rod actuated by pressure generated in the interior of said body by said explosive to close said passageway.

2. A plugging device for sealing a well bore, comprising, a tubular body having its bore closed at its lower end, said body being constructed of ductile metal and expandible by an internally contained explosive, a closure member threadedly inserted into the upper end of said bore, a head portion on said closure member extending above the upper end of said body, a carrier having a socket slidably enclosing said head portion, shear pins extending radially through the wall of said socket into engagement with said head portion to form a breakable connection between said carrier and said head portion, an axial passageway through said closure member providing communication between the interiors of said body and said socket, a rigid rod member extending longitudinally through said passageway from said socket to the interior of said body and adapted to transmit electrical initiating energy from said carrier to said explosive, electric current conducting means mounted in said carrier and connected to the outer end of said rod, and back pressure valve means carried by the inner end of said rod actuated by pressure generated in the interior of said body by said explosive to close said passageway.

3. A plugging device for sealing a well bore, comprising, a tubular body having its bore closed at its lower end, said body being constructed of ductile metal and expandible by an internally contained explosive, a closure member threadedly inserted into the upper end of said bore, a head portion on said closure member extending above the upper end of said body, a carrier having a socket slidably enclosing said head portion, shear pins extending radially through the wall of said socket into engagement with said head portion to form a breakable connection between said carrier and said head portion, an axial passageway through said closure member providing communication between the interiors of said body and said socket, a rigid rod member extending longitudinally through said passageway from said socket to the interior of said body and adapted to transmit mechanical initiating energy from said carrier to said explosive, percussion means mounted in said socket and percussively engageable with the outer end of said rod, and back pressure valve means carried by the inner end of said rod actuated by pressure generated in the interior of said body by said explosive to close said passageway.

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