

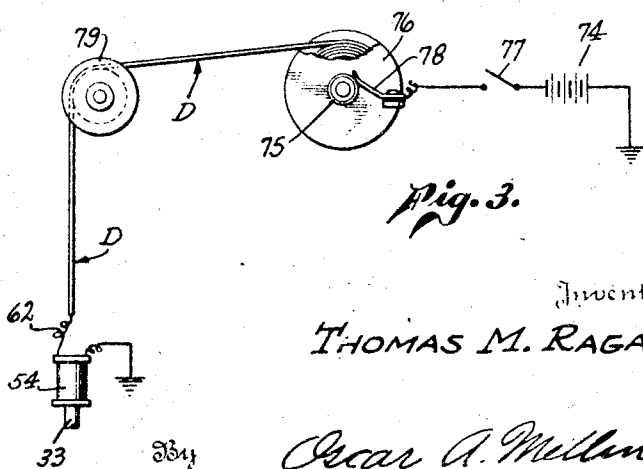
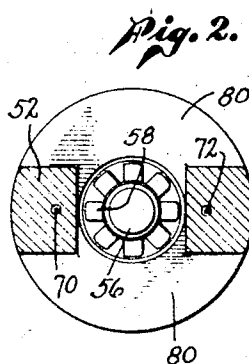
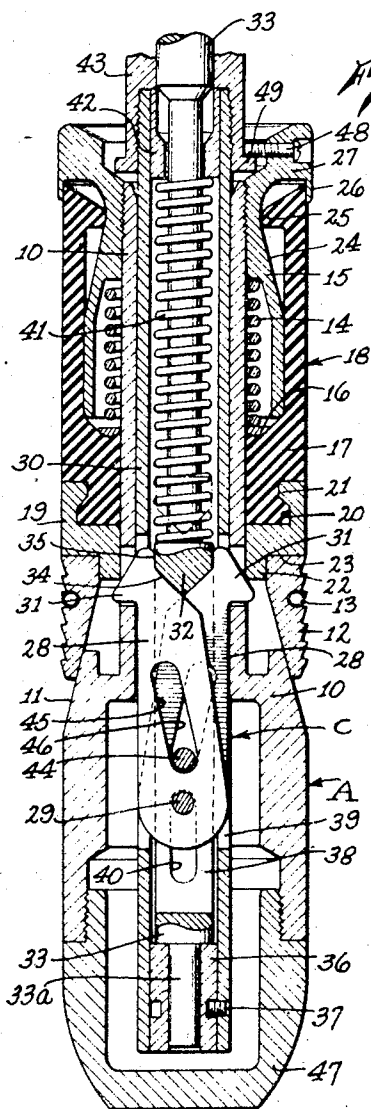
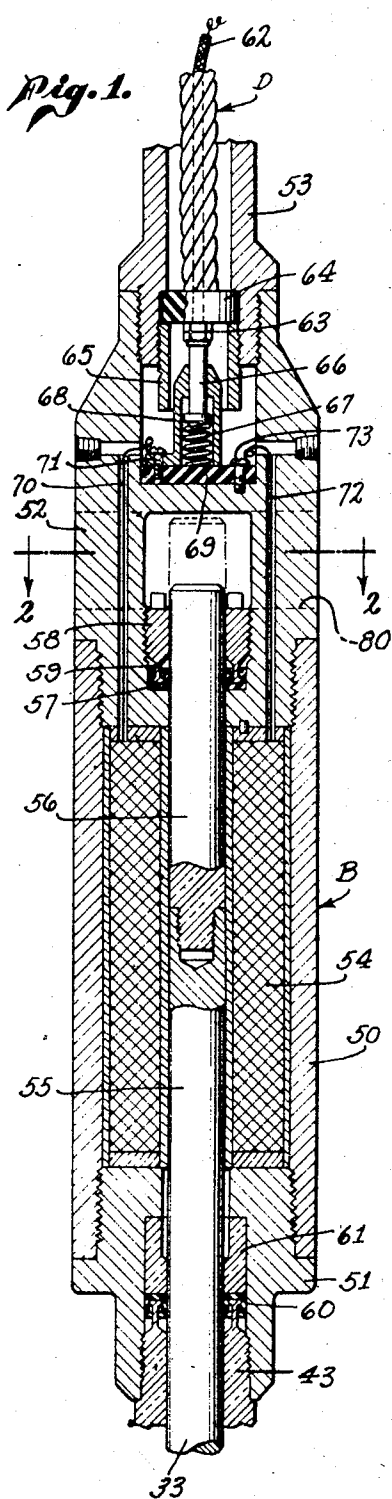
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ELECTRICALLY CONTROLLED WELL PACKER

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ELECTRICALLY CONTROLLED WELL
PACKER

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This invention relates to well packers, and more particularly to devices for setting packers, such as bridge plugs, within a well casing or the like.

It is an object of the present invention to provide an improved well packer and an electrical device for controlling its setting within a well casing, the entire device being available for subsequent employment in connection with other well packers.

Another object of the invention is to provide a wire line operated bridge plug mechanism capable of being set through the utilization of electromagnetic instrumentalities contained within the casing.

The invention has other objects that will become apparent from a consideration of one form in which it is embodied, which form is shown in the drawing accompanying and constituting part of the present specification. This embodiment will not be described in detail, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawing:

Figures 1 and 1a constitute a two-part longitudinal section of a well packer and its associated tripping and setting mechanism, the parts being shown in position for being run in a well casing prior to tripping and setting of the packer;

Figure 2 is a transverse section taken along the line 2—2 in Figure 1; and

Figure 3 is a diagrammatic view of an electric circuit for controlling the setting of the packer.

The apparatus includes a well packer in the form of a bridge plug A adapted to be set in position within a casing by means of an electrical device B initially coupled to the packer through the agency of a tripping mechanism C. This entire assembly is lowered into the casing from the surface of the bore on a wire line D to the desired point at which the packer is to be set.

The packer includes a main body 10 having a frusto-conical expander 11 contactable with a plurality of segmental slips 12 initially retained inwardly from the casing by an encircling coil spring 13. The slips are set against the casing walls by moving them downwardly along the surface of the cone expander under the influence of a helical spring 14 initially held in compressed condition against a spring retainer 15 threadedly secured to the main body 10 and against a setting ring 16 positioned within the base 17 of a cup-shaped packing element 18 secured to a retainer 19 through the medium of interlocking flanges 20, 21 respectively provided on the base of the packing and the retainer.

The packing retainer carries a depending annulus 22 forming an outer recess 23 receiving the upper ends of the slips. The upper side of this recess will abut the slips to move them downwardly over the cone face 11 and into engagement with the casing upon release of the latching or tripping device C retaining the spring 14 in energized condition. Upon being released, the spring will not only set the slips against the casing but will also move the packing sleeve 18 downwardly along the conical portion 24 provided on the spring retainer to force its free end into sealing engagement with the casing through the cooperation between the inturned packing portion 25 and the diverging surface on the retainer 15. Initially, the free end of the retainer is held from contact with the casing walls by an annular lip 26 depending from an outwardly directed flange 27 on the spring retainer. However, it is apparent that downward movement of the packing sleeve 18 under the influence of the spring 14 will disengage this end from the lip and permit its positive sealing with the casing because of the cooperation between the inturned packing portion 25 and conical retainer skirt 24.

As aforementioned, the spring 14 is held in energized position by a tripping device C, including a pair of latches 28, 28 pivotally mounted on a fulcrum pin 29 fixed to a trip sleeve 30 extending from the main body 10 of the packer. These latches have oppositely directed noses or pawls 31, 31 formed with inclined surfaces engageable with the underside of the depending retainer annulus 22 and due to such coaction prevent the setting of the slips 12 and packing element 18. The helical spring 14 will normally tend to move the latch levers 28 inwardly out of locking position, due to the inwardly directed thrust component presented by the engagement of the retainer annulus 22 with the inclined latch noses, but such inward movement is resisted by a detent 32 provided on a trip rod 33 extending through the sleeve 30. This detent has tapered portions 34 engaging companion tapered surfaces at the upper end of the latches 28 and also parallel abutments 35 engageable by corresponding parallel surfaces provided at the terminal ends of the latches. The cooperation between these parallel surfaces prevents inward movement of the latches under the influence of the helical slip setting spring.

The trip rod 33 extends through the sleeve 30

to a position below the latch levers, its lower end 33a being piloted within a guide ring 36 secured to the sleeve by suitable means, such as a screw 37. The rod is formed with a slot 38 intermediate its ends, which acts as a guide for the latch levers 28 in their pivotal movement into and out of contact with the retainer annulus 22, and which is aligned with communicating guide slots 39 provided in the sleeve 30. The rod also has a second longitudinally extending slot 40 at right angles to the first-mentioned slot to permit lengthwise movement of the rod with respect to its enclosing sleeve, and obviate interference with such movement by the fulcrum pin 29 fixed to the latter member.

The rod detent 32 is urged to holding position with respect to the latches by a helical spring 41 within the sleeve, abutting at one end against the detent portion and at its other end against a stop ring 42 engaging a packing nut 43 threaded onto the upper end of the sleeve 30. By moving the trip rod 33 upwardly through means to be hereinafter described, the cooperative parallel detent surfaces 35 are moved out of engagement to permit the helical spring 41 to force the latch levers 28 inwardly and move the slips 12 and packing sleeve 18 downwardly over their respective expander cones 11, 24 into engagement with the casing. As assurance that the latches will be moved inwardly, the rod is provided with a pin 44 extending through slots 45, 46 in each lever inclined in opposite directions with respect to one another, in order that upward movement of the rod will forcibly retract the nose or pawl ends 31 of the latch levers into the confines of the trip sleeve 30. To enable the parallel detent surfaces to first be moved out of complete engagement, the widths of the slots 45, 46 are made greater than the diameter of the pin 44, thereby allowing a sufficient degree of longitudinal rod movement before the pin engages the sides of the slots to positively retract the levers entirely within the outer confines of the trip sleeve.

The lower end of the main body 10 is enclosed by a guiding portion 47 threaded thereto, and its upper end preferably is provided with a shear screw 48 engageable with a flange 49 extending from the packing nut 43. These latter elements provide a safety device allowing withdrawal of the bridge plug A in the event that the latches are tripped and the slips fail to set against the casing. Upon proper setting of the slips and packing, the taking of an upward strain on the wire line D will cause the flange 49 to engage the shear screw 48 and fracture it, whereupon the entire latching device C and setting tool B can be withdrawn from the packer and raised to the surface of the casing or bore.

An electrically operated device B is provided for moving the trip rod 33 to disengage its parallel detent faces 35 from the latches and engage its pin 44 with the sides of the inclined slots 45, 46 in the latter members. This device is of the electromagnetic type, including an outer housing formed by a sleeve 50 threadedly secured to a lower member 51, which, in turn, is threaded onto the packing nut 43. The other end of the sleeve is threaded onto an upper member 52 which, in turn, is threaded to a cable head 53 suitably secured to the cable or wire line D on which the entire assembly is moved within the casing.

A solenoid 54 is contained within the housing, and when energized is adapted to draw a co-operable plunger 55 within its coil. This plunger

is preferably constituted by the upper end of the trip rod 33 and is made of a suitable magnetic material throughout that part of its length initially positioned within the solenoid. The upper terminal portion 56 of the trip rod is of non-magnetic material threadedly secured to the magnetic portion and extending initially through the remainder of the solenoid in order to guide the rod for movement within the electromagnetic coil 54.

The interior of the solenoid 54 and its housing are sealed against leakage of fluid through the use of suitable packings between the plunger and the housing portions. A U-shaped packing 57 is placed between the upper housing portion 52 and the non-magnetic plunger rod 56, being expanded into sealing engagement with these members by a castellated packing nut 58 threaded into the upper housing portion and having an annulus 59 adapted to produce radial expansion of the U-shaped packing against the rod and housing member. Leakage through the lower end of the housing is prevented by a U-shaped packing 60 abutting a stop ring 61 at its base portion and being pressed into sealing engagement with the lower housing portion 50 and the surface of the plunger by the packing nut 43 previously described. To minimize leakage of flux through the housing and consequent diminution of its attractive force upon the magnetic portion of the plunger, the stop ring 61 and packing nut 43 are preferably made of non-magnetic material, thereby concentrating potentially all of the flux emanating from the magnetic coil 54 for passage through the magnetic plunger 55.

The wire line or cable D is preferably of hollow construction with an insulated conductor 62 contained therein. The end of this conductor is connected with a cable terminal 63 extending from an insulation block 64 held within the cable head 53 by a threaded sleeve 65. Current from the conductor 62 passes to the solenoid 54 through a trip terminal 66 urged against the cable terminal 63 by a spring 67 contained within a conductor cap 68 resting upon an insulation block 69, the current passing from the cap to a lead 70 secured to the cap by a suitable screw 71 and running to the coil 54. The other end of the coil is grounded through a lead 72 connected to a screw 73 threaded into the upper housing portion 52 of the solenoid.

A suitable circuit is shown in Figure 3, the solenoid 54 drawing current from a battery 74 connected to a slip ring 75 on a cable drum 76 through a suitable switch 77 and slip contact 78. The slip ring is connected with the insulated conductor 62 in the cable which is wound on the drum for passage over a sheave 79 prior to entrance into the well casing. One terminal of the battery is grounded so that the closing of the switch 77 will complete the circuit through the solenoid coil 54 and produce its energization, causing upward movement of the magnetic plunger and trip rod 33 into the coil and removal of the rod detent 32 to permit release of the trip latches 28 and setting of the bridge plug A within the casing, in the manner aforementioned. The trip assembly C and the electromagnetic setting tool B can then be elevated out of the packer A, the circuit to the solenoid broken, and the elevated mechanisms withdrawn from the casing.

As assurance that resistance to upward movement of the plunger 55, 56 within the solenoid 54 will be at a minimum, openings 80 are provided

through the walls of the upper housing portion 52 to prevent entrapment of any fluid therein upon elevation of the plunger, which might serve as a dash pot or other means retarding or preventing movement of the plunger.

I claim:

1. In an apparatus of the character described, a packer body adapted to be lowered in a well casing, retracted means carried by said body for engagement with said casing, means tending to move said retracted means into engagement with said casing, means for restraining said moving means, and means operatively associated with said restraining means and movable upwardly with respect to said packer body to release said restraining means.
2. In an apparatus of the character described, a packer body carrying retracted means for engagement with a well casing, means for restraining movement of said retracted means into engagement with said casing, and a device operatively associated with said restraining means and movable upwardly relative to said packer body to release said restraining means.
3. In an apparatus of the character described, a packer body carrying one or more retracted elements for engagement with a well casing, means for urging said elements into engagement with said casing, means for restraining operation of said first-mentioned means, and electrically controlled instrumentalities movable relative to said body to release said restraining means.
4. In an apparatus of the character described, a packer body carrying one or more retracted elements for engagement with a well casing, means for urging said elements into engagement with said casing, means for restraining operation of said first-mentioned means, and electromagnetic instrumentalities comprising an electromagnetic coil and a cooperable armature operatively associated with said restraining means and adapted to be moved by said coil to release said restraining means.
5. In an apparatus of the character described, a packer body carrying one or more retracted elements for engagement with a well casing, means for urging said elements into engagement with said casing, means preventing operation of said first-mentioned means, and electromagnetic instrumentalities comprising a solenoid and a plunger operatively associated with said preventing means and adapted to be pulled within said solenoid to release said preventing means.
6. In an apparatus of the character described, a packer body carrying a plurality of slips for engagement with a well casing, yieldable means for urging said slips into engagement with said casing, latch means preventing operation of said yieldable means, means initially holding said latch means in effective position, and means for releasing said holding means comprising a plunger connected to said holding means and a solenoid receiving said plunger.
7. In a well packer, a body carrying a plurality of slips for engagement with a well casing, yieldable means for urging said slips into engagement with said casing, a releasable latch preventing operation of said yieldable means, a plunger having a detent, means urging said detent against latch to hold it in effective position, and a solenoid receiving said plunger to move its detent from engagement with said latch to release the latch.
8. In a well packer, a body carrying a plurality of slips for engagement with a well casing, yieldable means for urging said slips toward engagement with said casing, a releasable latch preventing operation of said yieldable means, a solenoid, a plunger within said solenoid, a detent on said plunger to hold said latch in effective position, and means between said plunger and latch to move the latter to ineffective position upon energization of said solenoid and attraction of its associated plunger.
9. In a well packer, a body carrying slips for engagement with a well casing, spring means for urging said slips toward engagement with said casing, a releasable latch holding said spring means in energized condition, a solenoid, a plunger within said solenoid, a detent on said plunger for holding said latch in effective position, and a spring cooperable with said plunger and urging said detent against said latch.
10. In a well packer, a body carrying slips for engagement with a well casing, spring means for urging said slips toward engagement with said casing, a guide sleeve within said body, a latch pivoted to said sleeve for holding said spring means in energized condition, a solenoid, a plunger slidable within said sleeve and solenoid, a detent on said plunger for holding said latch in effective position, a spring cooperable with said plunger to urge said detent against said latch, and a pin and slot connection between said plunger and latch to retract the latter upon energization of said solenoid and movement of the plunger therewithin.
11. In apparatus of the character described, a packer body adapted to be lowered in a well casing on the lower end of an electrical wire line conductor, normally retracted means carried by said body for engagement with such casing, means for moving said means into engagement with said casing, and releasable means for maintaining said moving means in ineffective position comprising an electromagnetic coil electrically connectable with said conductor and an armature adapted to be moved by said coil.
12. In apparatus of the character described, a packer body adapted to be lowered in a well casing on the lower end of an electrical wire line conductor, normally retracted means carried by said body for engagement with such casing, means for moving said retracted means into engagement with said casing, means initially holding said moving means in ineffective position, an electromagnetic coil electrically connectable with said conductor, and an armature connected with said holding means, said armature being movable by said coil to release said holding means and permit disconnection between said wire line conductor and packer body.
13. In apparatus of the character described, a packer body adapted to be lowered in a well casing on the lower end of an electrical wire line conductor, normally retracted slips carried by said body for engagement with said casing, means for moving said slips into engagement with said casing, and electromagnetically operable means releasably connecting said wire line with said packer body, comprising means initially holding said moving means in ineffective position, a conductive coil electrically connectable with said wire line, and an armature connected with said holding means, said armature being movable by said coil to release said holding means and enable disconnection of said electromagnetically operable means and wire line to occur from said packer.

14. In apparatus of the character described, a packer body adapted to be lowered in a well casing on the lower end of an electrical wire line conductor, normally retracted slips carried by said body for engagement with said casing, spring means for moving said slips into engagement with said casing, and electromagnetically operable means releasably connecting said wire line with said packer body, comprising latching means in-

5 initially holding said spring means in ineffective position, a solenoid mechanically and electrically connected with said wire line, and a plunger connected to said latching means and movable into said solenoid upon passage of current there-through to release the latching means and permit disconnection between said electromagnetically operable means and packer body.

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