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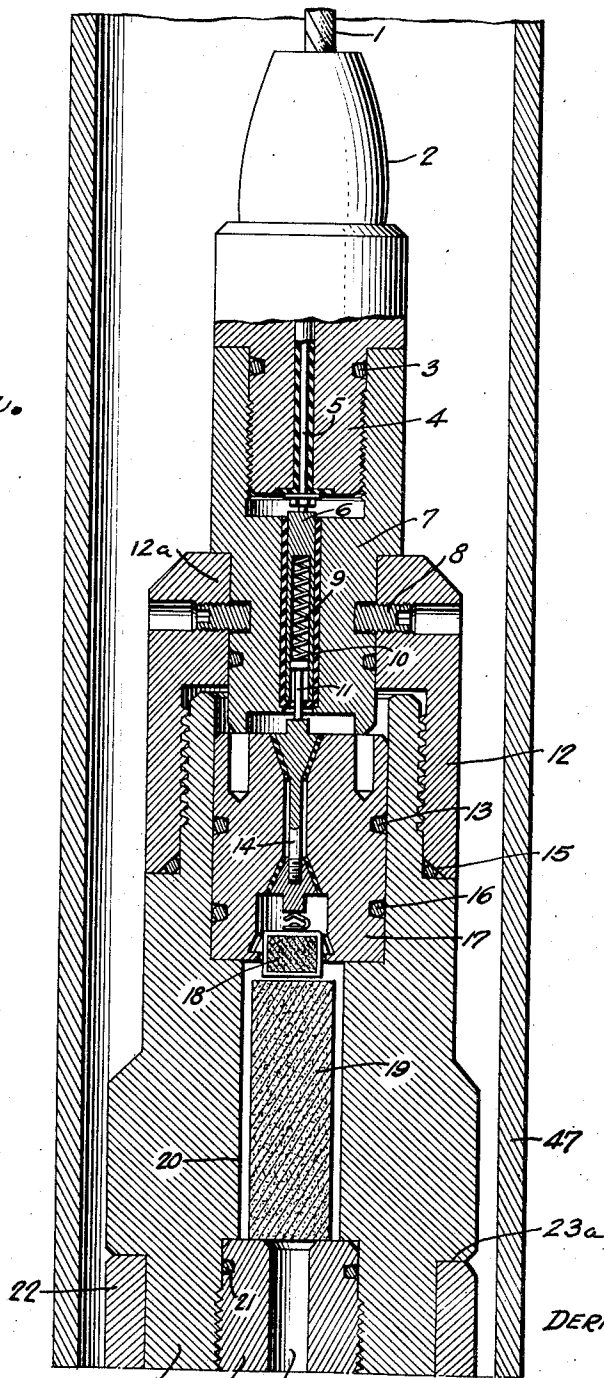
D. D. WEBB
GAS OPERATED WELL SEAL

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2 Sheets-Sheet 1

Fig. 1a.



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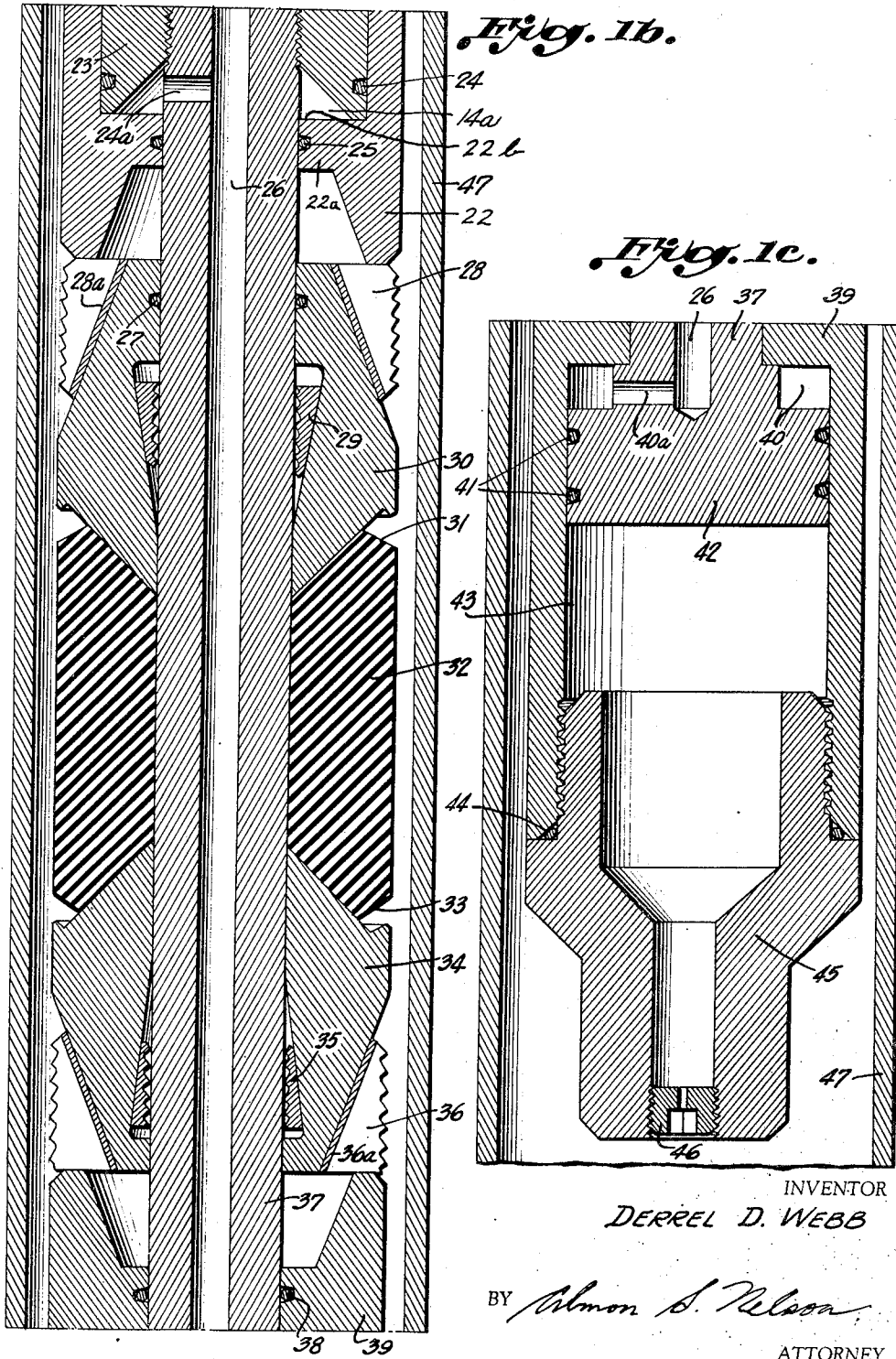
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GAS OPERATED WELL SEAL

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10 Claims. (Cl. 166—63)

This invention relating, as indicated, to a gas operated well seal or packer is more particularly directed to a means for sealing off a well bore at any desired depth.

It is a specific object of the invention to provide a tool that will form a seal within a well casing which often becomes necessary in oil, gas, and water well operations to seal or pack off a lower portion of the well bore.

Another object of the invention is to provide an improved method of sealing a casing in a well bore without the use of cumbersome or unreliable setting tools to operate the device.

Still another object of the invention is to provide a tool which is connected solely by means of a wire line to the surface and wherein the tool is left in the well with the exception of a firing head that is permanently secured to the end of the wire line.

A more particular object of the invention is to provide a tool having an ignition or explosion chamber wherein an explosive may be ignited or detonated at a desired depth to actuate packer setting means so as to set a packer in a casing.

A further object of the invention is to provide a sealing tool which has extremely rugged parts immediately adjacent an explosion chamber so that the explosive gases may be directed to parts that are movable to set the packer or sealing means.

It is also an object of the invention to provide a well seal of the wire line type wherein the interior of the tool is completely sealed so that the explosive gases may be effectively directed to the moving parts to set the packer or sealing means.

It is another object of the invention to provide a well seal or packer of the wire line type wherein the interior of the tool is completely sealed from the exterior thereof so that the gas generating charge will remain dry until the same has been detonated or ignited.

A still further object of the invention is to provide a sealing tool which can be demonstrated on the ground under actual well conditions so as to observe the exact working of the parts and particularly the sequence of movement of the various parts.

Yet another object of the invention is to provide a sealing tool wherein an explosive charge may be detonated after which the explosive gases are transmitted through the bore of a hollow mandrel and then through ports extending through the mandrel into expansible chambers, one wall of which is movable and wherein the member containing such wall acts on the packer setting means to set the packer.

A more detailed object of the invention is to provide an explosion-type well seal which is formed with shock absorbing means in the form of a highly resilient packer and a dash-pot arrangement, thus preventing damage to the parts of the tool as well as improper functioning of the parts of the tool.

It is also an object of the invention to provide a well

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seal which is economical to manufacture and which is completely safe in operation.

Other and further objects of the invention will become apparent as the description proceeds, reference being made to the accompanying drawings forming a part of the present disclosure, wherein:

Fig. 1a is a longitudinal vertical section of the upper portion of the tool;

Fig. 1b is a longitudinal vertical section of the intermediate portion of the tool;

Fig. 1c is a longitudinal vertical section of the lower portion of the tool.

Referring now to the drawings, and more particularly to Fig. 1a, it will be seen that a wire line 1 is connected to a cable head 2. This wire line contains an insulated current carrying conductor, and this conductor wire 5 is shown as extending through the central portion of the threaded lower end 4 of the cable head 2. The cable head 2 is sealed off by means of an O-ring 3, thus preventing access of any liquid or moisture to the upper part of the tool. The cable head, as illustrated, is screw-threadedly attached to the firing barrel 7, and this firing barrel has a central bore in which a spring cylinder 6 is mounted, the wall 10 thereof as well as the base 6 being insulated from the firing barrel.

A compression spring 9 is mounted within the cylindrical wall 10 so as to bias the firing pin 11 and insure that it will always contact the upper end of the bolt 14.

The firing barrel 7 is secured to the remainder of the assembly by means of shear screws 8 located in threaded apertures in the flange 12a of the adaptor 12. The adaptor 12 is threaded onto the upper end of the coupling 23.

It may be noted here that the firing barrel 7 and the cable head 2 constitute a removable firing head which is removable by virtue of the shear screws 8 in a manner to be hereinafter described. An enlarged central bore in the upper part of the coupling 23 slidably receives a firing plug 17 which is of relatively massive construction so as to effectively withstand the initial forces of the gases released by the explosive charge.

The firing block 17 is sealed by O-rings 13 and 16 to prevent access of water and moisture to the firing charge and also to prevent escape of the gases resulting from the explosion. It is also provided with a central bore having conical recesses which receive the conical ends of the firing bolt 14. The bolt 14 is insulated from the firing plug and, through means of the small contact shown above the detonator 18, transmits current from the conductor 5, which extends down from the wire line 1, then through the spring cylinder 6, 10 to the firing pin 11 and the firing bolt 14.

The coupling 23 is also formed of relatively thick, strong metal to offset the effects of the explosive charge when detonated. It is connected by screw threads to the upper end of hollow mandrel 37.

An upper slip-setting cylinder 22 slidably embraces the exterior lower portion of the coupling 23, and the two members are sealed by means of the O-ring 24. The coupling 23 is formed with an exterior shoulder 23a which acts as a stop to prevent undue movement of the slip-setting cylinder 22. The coupling has a lower edge which is tapered so as to provide, in conjunction with a part of the exterior surface of the hollow mandrel 37 and a horizontal surface 22b on the slip-setting cylinder, an expansible chamber 14a. The horizontal surface 22b on the slip-setting cylinder is formed on the upper part of the flange 22a.

The mandrel 37 has a hollow bore 26, and this may be provided with one or more radial ports 24a leading into the expansible chamber 14a. The flange 22a is relatively thick and contains a groove so as to receive

the O-ring 25 to seal off the interior of the tool from the exterior thereof. This seal is important due to the fact that the slip-setting cylinder 22 moves down with respect to the hollow mandrel 37. The slip-setting cylinder 22 extends downwardly from a flange 22a and terminates in a flat horizontal surface.

The parts in their normal position as shown, that is, prior to formation of the well seal, will be arranged so that the lower horizontal surface of the slip-setting cylinder 22 rests on top of the slips 28. The slips 28 are formed of segments circumferentially spaced and connected by a web 28a which is frangible for a purpose to be described in greater detail hereinafter. These slips 28 have their web portions 28a received upon the upper exterior portions of the slip cone 30. Internal wedge slips 29 are also provided to assist in preventing upward movement of the cone 30 after the packer is set. The upper slip means thus comprises the slips 28—29 and the cone 30.

The packer sleeve 32 is of relatively heavy construction and formed of any soft resilient material such as rubber, neoprene, and the like, and it is supported below by the lower slip cone 34. This lower slip cone 34 is internally recessed, similar to cone 30, so as to receive the lower internal wedge slips 35. The same type of slips are used with respect to the lower cone as described with respect to the upper cone. In this case the segments 36 are connected by the webs 36a.

Referring more particularly to the lower portion of Fig. 1b and the upper portion of Fig. 1c, it will be seen that the slips 36 are supported on the upper horizontal edge of the slip-setting cylinder 39. This cylinder slidably engages the circular vertical surface of the piston head 42 located on the lower end of the hollow mandrel 37. The piston head 42 is provided with grooves in which O-rings 41 are received so as to seal the lower portion of the tool. Immediately above the piston head 42 a radial port 40a extends from the bore 26 of the hollow mandrel into the chamber 40. In this case the expandable chamber 40 is formed by means of four walls instead of the three walls as described in connection with the upper expandable chamber. The lower slip-setting cylinder 39 has an inwardly extending flange similar to flange 22a and this is provided with an interior groove seating an O-ring 38. The lower slip means comprises slips 35—36 and cone 34.

The lower end of the lower slip-setting cylinder 39 is provided with screw threads so as to receive the screw-threaded upper end of a closure plug 45 which, in conjunction with the slip-setting cylinder 39, forms a dashpot or shock absorbing chamber 43. A choke 46 is mounted in the lowermost end of the closure plug 45 so as to meter air or fluid as it is forced out of the chamber 43 by upward movement of the slip-setting cylinder 39 with respect to the hollow mandrel and its attached piston head 42.

In operation, a source of current is connected from one side thereof to the conductor 5 in wire line 1, there being a switch preferably interposed on such side. The other side of the source of current is connected to the casing 47. When it is desired to ignite the explosive or gas generating charge 19 in the chamber 20 in the coupling 23, the switch is closed, and current passes down through wire line 1 via the wire 5 and to the detonator 18 in a manner described above. Inasmuch as the switch has been closed, the entire circuit is closed, since the tool will normally contact one side of the casing 47. If, for some reason, it does not contact the casing 47, a slight jerk of the wire line will cause it to do so. Closing of the circuit as thus described actuates the detonator 18, whereupon the charge 19 explodes and the gases therefrom first move downwardly in the bore 26 of the hollow mandrel 37. The gases then pass through the radial ports 24a and 40a. Gas entering chamber 14a will cause

downward movement of upper slip-setting cylinder 22 due to pressure on the upper horizontal surface 22b of flange 22a. This movement causes the slips 28 to move the cone 30 downwardly, thus compressing the packer and forcing the same radially outwardly.

At the time the above action is occurring, the same action takes place at the lower portion of the tool, whence the explosive gases pass through the port 40a into the chamber 40, forcing the lower slip-setting cylinder upward so as to act through the slips 36 and push the cone 34 upwardly. This movement of both cones will take place first, because the highly resilient packer 32 offers the least resistance to pressure. After the cones have moved toward each other as far as possible, then further pressure will cause rupture of the slip webs 28a and 36a, forcing the slips 28 and 36, respectively, further toward each other to lock the cones 30 and 34 in place and to fully expand the sealing element. An additional locking element is provided in the form of the two wedge slips 29 and 35, which are likewise caused to travel toward each other. After the slips have been set, and the packer is fully extended so as to lie in tight sealing engagement with the casing 47, there is no other path for the gases to take except upwardly against the firing plug 17. This firing plug can move only a predetermined distance due to the provision of the inwardly extending flange 12a on the adaptor 12. However, this distance is sufficient to rupture the shear screws 8 and to free the firing head consisting of the cable head 2 and firing barrel 7. All other parts of the device are left in the well, and thereafter the wire line may be withdrawn with its attached firing head.

The parts are so arranged and constructed that their relative strength insures the following sequence of movements. First, travel of the cones 30 and 34 toward each other takes place, then expansion of the packer 32 occurs, after which the slips are set as well as the slip wedges, whereupon the wire line is ready for removal, and at this time the shear pins 8 are severed, freeing the wire line.

From the foregoing description it will be seen that a tool of relative simplicity is provided which is economical to manufacture, easy to assemble and which is formed with parts of a rugged nature, thus insuring safety as well as proper sequence of operations.

It will also be noted that the interior of the tool is completely sealed from the exterior thereof to prevent ingress of moisture, etc., and to insure efficient usage of all of the explosion gases.

In addition, it will be observed that a precise calibration of the quantity of explosive may be easily determined while on the ground because the tool can be operated out of the well, and close observation can be made of the parts and particularly of the sequence of movements of the various parts.

It will be obvious that modifications may be made by those skilled in the art without departing from the spirit of the invention, and it is desired to cover all such modifications as come within the scope of the appended claims.

I claim:

1. A wire line supported, gas operated well packer comprising a wire line, a gas generating chamber, a hollow mandrel, upper slip means, an upper expanding chamber operable as an upper slip-setting means, a packer sleeve, lower slip means, and a lower expanding chamber mounted on said mandrel, operable as a lower slip-setting means; said wire line containing an electrical conductor wire, said wire extending to said gas generating chamber, ignition means in said chamber connected to said conductor, the bore of said hollow mandrel communicating with said gas generating chamber, said hollow mandrel having radial ports leading from the bore thereof into said expanding chambers, said upper and lower slip-setting means including movable members, each of which has a surface that forms a wall of each of said expanding

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chambers, whereby upon ignition of a charge in said gas generating chamber said slip-setting means are caused to move toward each other to expand and set said slip means and said packer sleeve.

2. A gas operated well packer as set forth in claim 1, wherein said hollow mandrel has secured to its upper end a coupling of rugged construction, the bore of which forms said explosion chamber.

3. A gas operated well packer as set forth in claim 2, wherein the upper end of said coupling is closed by a firing plug and said upper end has an adaptor secured thereto, said adaptor having inwardly extending flanges adapted to prevent separation of said plug from said coupling.

4. A gas operated well packer as set forth in claim 3, wherein a firing head is secured to said adaptor by frangible means whereby the same may be removed after said packer is set.

5. A gas operated well packer as set forth in claim 4, wherein said conductor extends through and is insulated from said firing head and said firing plug.

6. A gas operated well packer as set forth in claim 5, wherein said firing head is removable after setting said packer and consists of a cable head and a firing barrel secured in depending relation thereto, said frangible securing means connecting said firing barrel and said adaptor.

7. A gas operated well seal comprising a hollow mandrel, an expansible packer sleeve, a slip cone, slips, a slip-setting cylinder, a coupling having an explosion chamber therein, said packer sleeve surrounding said hollow mandrel, said slip cone slidably surrounding said hollow mandrel, and said slips engaging and surrounding said cone, said slip setting cylinder surrounding said coupling, fluid tight packing between said cylinder and said coupling, an expansible chamber initially formed by the lower edge of said coupling, the exterior surface of said hollow mandrel, and an inwardly extending surface of the slip-setting cylinder, fluid tight packing between said cylinder and said mandrel, a port communicating the bore of said hollow mandrel with said expansible chamber, said explosion chamber being in communication with the bore of said hollow mandrel, electric current conducting means extending to said explosion chamber, said coupling being connected to said mandrel, said slip-setting cylinder slidably embracing said coupling, whereby upon detonation of an explosive in said explosion chamber, gas is forced through the bore of said mandrel and then through said port and into said expansible chamber, causing said slip-setting cylinder to move and to compress and expand said packer sleeve and to set said slips.

8. A gas operated well seal comprising a hollow mandrel, an expansible packer sleeve, an upper slip cone, upper slips, an upper slip-setting cylinder, a coupling connected to said mandrel and having an explosion chamber therein, a lower slip cone, lower slips, a lower slip-setting cylinder, said packer sleeve surrounding said mandrel and said slip cones slidably surrounding said hollow mandrel, said upper and lower slips engaging said upper and lower slip cones respectively, said upper slip-setting cylinder engaging said upper slips and slidably surrounding said coupling, an upper expansible chamber initially formed by the lower edge of said coupling, the exterior surface of said mandrel, and an inwardly extending surface of the upper slip-setting cylinder, fluid tight packings between said upper slip-setting cylinder and said coupling and also between said upper slip-setting cylinder and said mandrel, a port leading from the bore of said mandrel to said upper expansible chamber, said explosion chamber being in communication with the bore of said hollow mandrel, a lower expansible chamber formed by a surface on a piston head on the end of said mandrel, the exterior surface of said mandrel and two angularly related surfaces on said lower slip-setting cylinder, fluid tight

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packings between said lower slip-setting cylinder and said piston head and also between said lower slip-setting cylinder and said mandrel, a port in said mandrel leading from the bore thereof to said lower expansible chamber, electric current conducting means extending to said explosion chamber, whereby upon detonation of an explosive in said explosion chamber gas is forced into the bore of said mandrel and then through said ports and into said expansible chambers causing said slip-setting cylinders to move toward each other and set said packer sleeve.

9. A gas operated well seal comprising a hollow mandrel, an expansible packer sleeve, an upper slip cone, upper slips, an upper slip-setting cylinder, a coupling connected to said mandrel and having an explosion chamber therein, a lower slip cone, lower slips, a lower slip-setting cylinder, said packer sleeve surrounding said mandrel and said slip cones slidably surrounding said hollow mandrel, said upper and lower slips engaging said upper and lower slip cones respectively, said upper slip-setting cylinder engaging said upper slips and slidably surrounding said coupling, an upper expansible chamber initially formed by the lower edge of said coupling, the exterior surface of said mandrel, and an inwardly extending surface of the slip-setting cylinder, fluid tight packings between said upper slip-setting cylinder and said coupling and also between said upper slip-setting cylinder and said mandrel, a port leading from the bore of said mandrel to said upper expansible chamber, said explosion chamber being in communication with the bore of said hollow mandrel, a lower expansible chamber formed by a surface on a piston head on the end of said mandrel, the exterior surface of said mandrel and two angularly related surfaces on said lower slip-setting cylinder, fluid tight packings between said lower slip-setting cylinder and said piston head and also between said lower slip-setting cylinder and said mandrel, a port in said mandrel leading from the bore thereof to said lower expansible chamber, electric current conducting means extending to said explosion chamber, whereby upon detonation of an explosive in said explosion chamber gas is forced into the bore of said mandrel and then through said ports and into said expansible chambers causing said slip-setting cylinders to move toward each other and set said packer sleeve, the lower slip-setting cylinder slidably embracing said piston head and extending below the same and having a terminal closure member to provide a shock-absorbing means.

10. A gas operated well seal comprising a hollow mandrel, an expansible packer sleeve, an upper slip cone, upper slips, an upper slip setting cylinder, a coupling connected to said mandrel having an explosion chamber therein, a lower slip cone, lower slips, a lower slip-setting cylinder, said packer sleeve surrounding said mandrel and said slip cones slidably surrounding said hollow mandrel, said upper and lower slips engaging said upper and lower slip cones respectively, said upper slip-setting cylinder engaging said upper slips and slidably surrounding said coupling, an upper expansible chamber initially formed by the lower edge of said coupling, the exterior surface of said mandrel, and an inwardly extending surface of the slip-setting cylinder, fluid tight packings between said upper slip-setting cylinder and said coupling and also between said upper slip-setting cylinder and said mandrel, a port leading from the bore of said mandrel to said upper expansible chamber, said explosion chamber being in communication with the bore of said hollow mandrel, a lower expansible chamber formed by a surface on a piston head on the end of said mandrel, the exterior surface of said mandrel and two angularly related surfaces on said lower slip-setting cylinder, fluid tight packings between said lower slip-setting cylinder and said piston head and also between said lower slip-setting cylinder and said mandrel, a port in said mandrel leading from the bore thereof to said lower expansible chamber, electric current conducting means extending to said explosion chamber, whereby upon detonation of an explosive in said explosion

chamber gas is forced into the bore of said mandrel and then through said ports and into said expansible chambers causing said slip-setting cylinders to move toward each other and set said packer sleeve, the lower slip-setting cylinder slidably embracing said piston head and extending below the same and having a terminal closure member to provide a shock absorbing means, said closure member being provided with a choke.

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