

Jan. 27, 1970

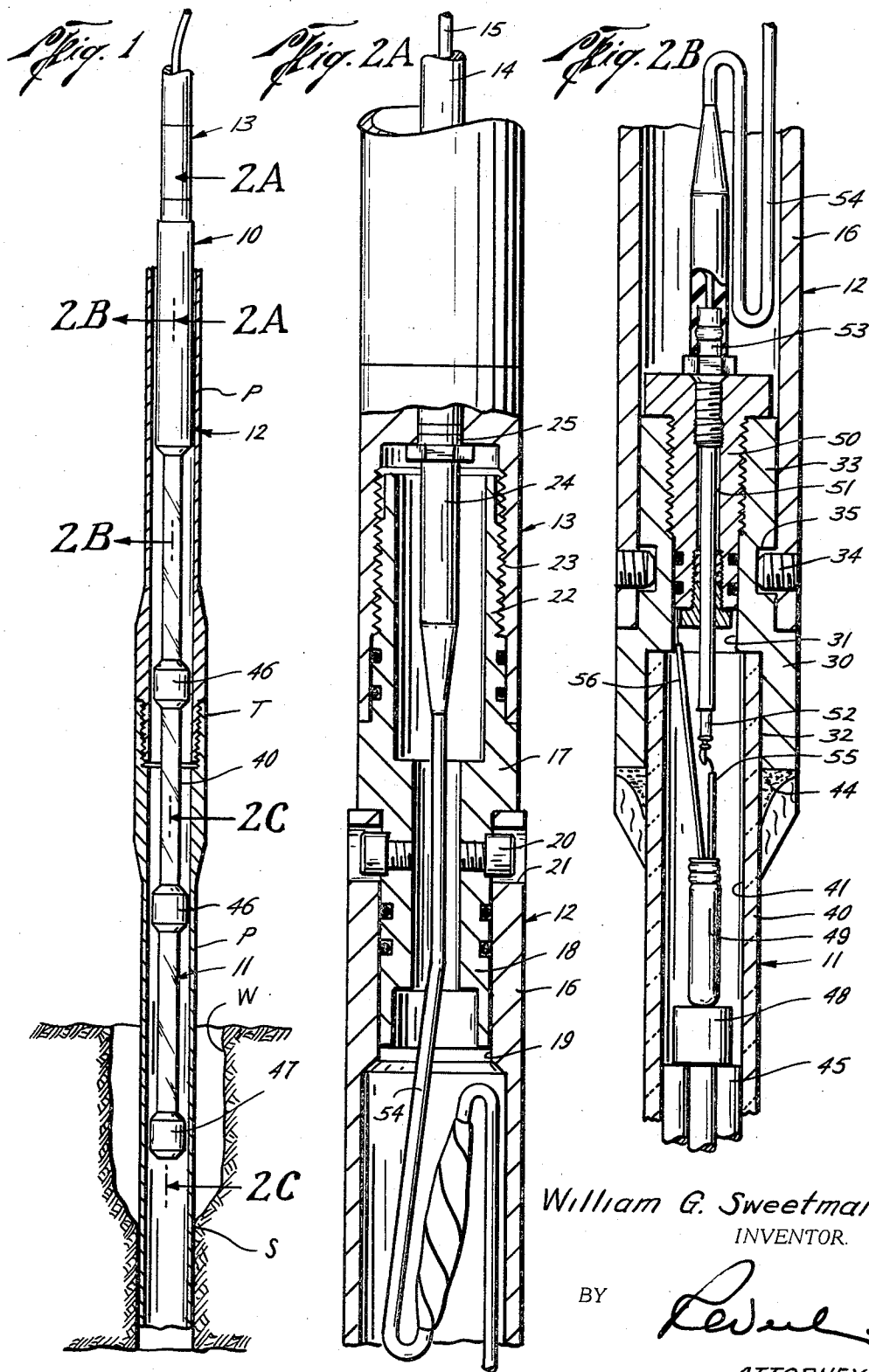
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3,491,830

BACK-OFF TOOL ASSEMBLY

Filed April 5, 1968

2 Sheets-Sheet 1



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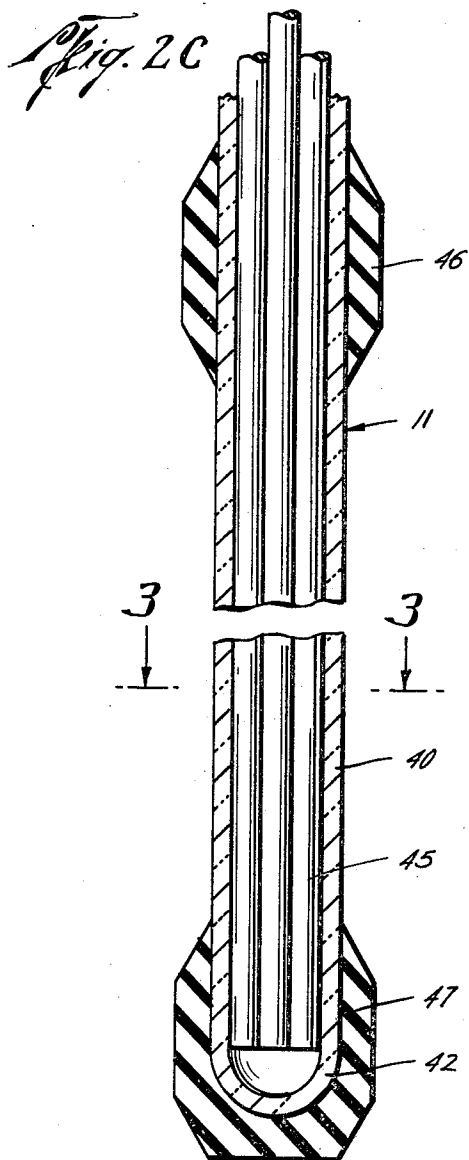
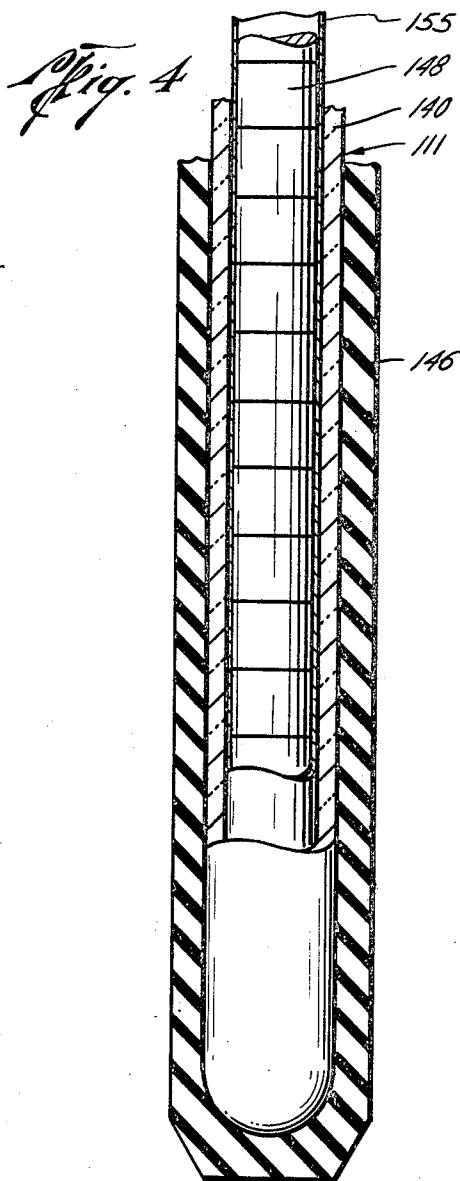
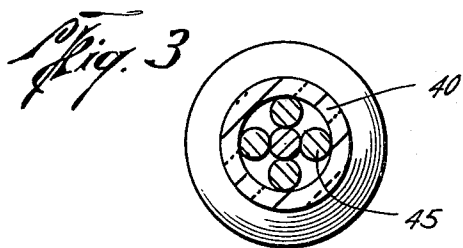
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2 Sheets-Sheet 2



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Filed Apr. 5, 1968, Ser. No. 719,198

Int. Cl. E21b 23/04

U.S. Cl. 166—63

4 Claims

ABSTRACT OF THE DISCLOSURE

An explosive jarring tool for releasing threaded connections between sections of a pipe string in a well, employing detonating explosive encased in glass or ceramic casing adapted particularly for use under high temperature, high pressure conditions.

In rotary drilling of wells, drilling strings are conventionally employed which are made up of sections of pipe connected together by heavy screw couplings, commonly called "tool joints." Such tool joints conventionally comprise an internally threaded box member and an externally threaded pin member adapted to be screwed tightly into the box member when the joints are made up. Such drilling strings frequently become stuck tightly in a well, whereupon it becomes highly desirable to retrieve maximum amounts of the pipe above the point at which the string is stuck. Unscrewing of the string from the top of the well is generally unsatisfactory because there is no way of assuring that the lowermost joint above the point at which the pipe is stuck will be the one which will unscrew to thereby permit maximum recovery. Also because of the tightness with which the joints are normally made up, or become set up during use, the unscrewing torque required will often lead to twisting-off of the string, which will result in excessive losses and damage to the pipe.

The common method employed to effect release of the pipe is to locate the stuck point and a collar above the stuck point at which the pipe is to be released. Such locating devices are well known and may be made a part of the tool string employed for releasing the connection. Release of the connection is effected by applying sufficient reverse torque to the pipe string at the top of the well to subject the connection to unscrewing torque, and then applying a jarring blow to the connection by setting-off an explosive force at or near the so-stressed connection.

These explosive releasing devices have heretofore been made in various forms, a conventional form comprising a flexible tube, commonly called "Primacord," filled with a suitable high explosive, set off by an electrical detonating cap. This system, while generally satisfactory when used under relatively low temperature, low pressure conditions, has proven unsatisfactory where high temperatures and high pressures are existent at the point at which the pipe is to be released. In many deep wells the temperatures may attain 400° F. or more, and pressures of several thousand pounds per square inch. In an effort to meet these conditions, some conventional back-off tools encase the explosive in metal casings, but these necessarily produce a substantial amount of "junk" when the explosive is set off, which may seriously interfere with subsequent operations in the well.

In other instances, the Primacord-type of explosive is used in which the cord is sheathed in soft lead tubing. While this type of protection may be effective under relatively high temperatures, the lead sheathing will be crushed under the high hydrostatic pressures, which normally will be present, and the crushing force transmitted to the explosive. The resultant crushing of the explosive will cause the latter to burn or explode low

order rather than detonate at high order, thereby rendering the shot ineffective for the purpose of providing the necessary jarring force on the connection.

The present invention has for its primary object, the provision of a back-off tool which employs a high temperature resistant detonating explosive encased in a tubular casing constructed of high pressure, high temperature resistant glass or ceramic material which will disintegrate substantially completely under the force of the explosive, thereby reducing or substantially eliminating any objectionable junk in the well, while assuring high order detonation of the explosive such as to apply the necessary jarring force to the threaded connection to be released.

In accordance with this invention, high temperature detonating explosives, either in the form of cord or in the form of pellets, will be inserted into a tubular casing constructed of an appropriate glass or ceramic material adapted to withstand the high pressure, high temperature conditions to be encountered. Because of the frangible nature of the casing, the latter is provided with external protectors made of high temperature resistant, resilient material, such as silicone rubbers. These may be in the form of short sleeves mounted at spaced points along the casing, or as a continuous envelope covering the entire exterior of the casing and of sufficient thickness to serve as a resilient padding capable of preventing breakage of the casing by bumping of the casing against the wall of the well pipe, which may occur as it is being lowered through the well pipe.

Other and more specific objects and advantages of this invention will become more readily apparent from the following detailed description when read in conjunction with the accompanying drawing which illustrates preferred embodiments in accordance with this invention.

In the drawing:

FIG. 1 is an elevational view of the back-off tool assembly shown inside a well pipe string adjacent a threaded coupling;

FIGS. 2A, 2B, and 2C, together constitute a longitudinal, sectional view of the tool assembly;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 2C; and

FIG. 4 is a longitudinal, sectional view corresponding generally to the portion of the assembly illustrated by FIG. 2C, but showing a modification of this portion of the assembly.

Referring to the drawing, there is shown a portion of a well W in which a pipe string P is stuck at a point S and in which it is desired to back-off the pipe string at a threaded tool joint T. The tool assembly, designated generally by the numeral 10, is shown installed in the pipe string P with the explosive jarring element positioned opposite the tool joint.

Referring now to FIGS. 2A, 2B and 2C, which, together, comprise the entire back-off tool assembly, the major parts, starting at the lower end, include the explosive jarring element, designated generally by the numeral 11, the upper end of which is connected to the firing head, designated generally by the numeral 12, which is, in turn, connected to a conventional rope socket, designated generally by the numeral 13, which is connected to the conventional lowering cable 14 which carries an electrical conductor 15 by which current is supplied from the surface to the firing head.

Firing head 12 includes a tubular body made up of a lower part 16 and an upper part 17 having a reduced diameter pin 18 at its lower end adapted to be telescopically received in the bore 19 of lower part 16. Upper and lower parts 16 and 17 are releasably connected by means of the cap screws 20 which extend through openings 21 in the upper end of part 16 and are screwed

into pin 18. The upper end of upper part 17 is reduced in diameter to form an externally threaded pin 22 to be received in the internally threaded box portion 23 of rope socket 13. An electrical contact 24 is mounted in the upper end of pin 22 for engagement by an electrical contact 25 carried in rope socket 13 and connected to conductor 15.

The lower end of firing head 12 is connected to jarring element 11 by means of a tubular coupling 30 having an axial bore 31, the lower end of which is counterbored at 32 to receive the upper end of jarring tool 11. The upper end of coupling 30 is reduced in diameter to form a pin 33 which is telescopically received in the bore of lower part 16 and releasably secured thereto by means of set screws 34 which extend through the wall of lower part 16 into an annular recess 35 formed in the exterior of coupling pin 33.

Jarring element 11 comprises a cylindrical tubular body 40, having a bore 41, open at its upper end and closed at its lower end by an integral hemispheric wall 42. Body 40 is constructed of glass or ceramic material having high-strength properties adapted to resist both high external pressures and high temperatures but which when subjected to the shock of internally detonated explosive, will shatter completely into virtually a powder. Such materials include "Pyrex" glass materials, particularly "Code 7740," and "Pyroceram" ceramic compositions, particularly "Code 8605 (opaque)" both manufactured by Corning Glass Co., Corning, N.Y. Various products sold under these trademarks and similar known products of other manufacturers, are capable of withstanding external hydrostatic pressure of as much as 25,000 lbs. per square inch and temperatures well above 400° F., conditions well above those likely to be encountered in oil wells.

As previously noted, the upper end of body 40 is inserted into counterbore 32 and is strongly secured and sealed to collar 30 by means of a high temperature-resistant epoxy-type sealing adhesive 44.

Bore 41 of body 40 has mounted therein one or more strands of a suitable detonating cord 45, commonly called "Primacord," which may be constructed of any conventional high temperature-resistant detonating explosive enclosed within a suitable and well known sheathing material. The sections of Primacord 45 will generally extend the full length of body 40 and will be arranged in parallel and in longitudinal contact with each other. The number of strands of Primacord will be a measure of the quantity of explosive employed and this will, in turn, be selected in accordance with the hydrostatic pressure of the fluid expected to be encountered in the well through which the shock is to be imparted to the coupling. The exterior of body 40 will have mounted thereon a plurality of longitudinally spaced protector sleeves 46, the lowermost one 47 being shaped to encase the lower end of the body defined by end wall 42. These protectors will be constructed of any suitable resilient, high temperature-resistant materials, such as the known silicone rubbers adapted to serve as effective shock absorbers. As many will be employed as may be needed to assure protection against breakage of body 40 as a result of contact with the metal walls of a surrounding well pipe through which the tool is run.

The mechanism employed for firing the explosive Primacord is mounted in the bore of the firing head and includes a tubular bushing 50 having an axial bore 51 which is screwed into the upper end of bore 31 of collar 33 and an electrode 52 mounted in bore 51. The upper end of electrode 52 is connected by an electrical connector 53 carried by one end of an insulated conductor cable 54, the other end of which is connected to contact 24. A conventional electrically fired explosive cap 49 has one lead 55 connected to electrode 52 and a second lead 56 connected as a ground to the lower end of bushing 50. Cap 49 is placed in initiating contact with a pellet 48 of a suitable booster explosive which is positioned in bore 41

in direct contact with the upper ends of the several strands of Primacord.

With this arrangement it will be seen that when electrical current is applied by conventional means to cable 15, the current will be transmitted through the several electrical connections to cap 49 to fire the same, setting-off booster explosive 48 and the several strands of Primacord. The explosive material employed in the detonating cord may be any of the known explosives of this type which are especially adapted to detonate at high order under high temperatures of the range likely to be encountered in very deep wells. Examples of such explosives include: Tetranitro-1, Tetrazadibenzocyclo-Octatetrene, Picryl Sulfone, and various other commercial explosives sold under the trademarks "Tacot" (Du Pont), and "Thermex III" and "Thermex VI" (Amcel Corp.).

In operation, the back-off tool assembly heretofore described will be installed in a tool string, which may include a conventional stuck-point indicator, a collar locator, or both. The tool string will be lowered on cable 14 into the bore of the pipe string to the predetermined point at which the explosive is to be set off. Body 40 will normally be made two to three feet in length in order to accommodate some margin of error in determining the exact location of the threaded tool joint which is to be released. When the jarring element is suitably located adjacent the selected joint, current will be supplied from the surface by conventional means to set-off cap 49 and this, in turn, will explode booster 48 and the main charge of explosive constituted by the Primacord. Detonation of the latter will shatter body 40 to a powdery material and the shock resulting from the detonation of the Primacord will be transmitted through any fluid in the pipe string to the threaded joint forming the coupling to be released. As indicated previously, this joint will be under the stress of unscrewing torque applied at the surface to the section of pipe P above selected tool joint T, and the shock of the explosion will result in release of the threads, permitting the portion of the pipe string above tool joint T to be unscrewed and removed from the well.

By making jarring element 11 of highly friable material, such as the glass or ceramic materials listed, only that element will be destroyed in the course of operation of the tool assembly and all of the metal structure represented by firing head 12 and the other parts connected thereabove can be recovered substantially intact and in condition enabling their re-use upon attachment of a new jarring element and explosive cap.

FIG. 4 illustrates a modification of jarring element and is designated generally by the numeral 111. In this modification, the glass or ceramic tube 140 is identical with that previously described. The bore of tube 140 is filled with a stack of pellets 148 constructed of high temperature-resistant explosive similar to that used in the Primacord, but constructed in the form of cylindrical pellets illustrated. The pellets are preferably encased in a loading cylinder 155 constructed of cardboard or similar light destructible material, serving primarily as a supporting container for the pellets.

In this modification, the explosive cap will be directed against the uppermost pellet or an intervening body of a suitable booster explosive (not shown), as will be well understood by those skilled in the art.

In this modification, tube 140 is illustrated as sheathed throughout its length with a continuous protective, shock-absorbing sheath 146 constructed of high temperature-resistant silicone rubber, as previously described. It will be understood that the spaced sleeve protectors, such as previously described, may be employed instead of the continuous sheath.

It will be understood that various other 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.

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

1. Apparatus for releasing a threaded joint between sections of a well pipe string under well conditions of high-pressure and high-temperature, comprising:

- (a) an elongate tubular body adapted to be positioned longitudinally within a threaded joint;
 said body being constructed of a material selected from the group consisting of "Pyrex" glass and "Pyroceram" ceramic materials characterized by high-pressure, high-temperature-resistant properties but highly friable when subjected to an internally applied explosive force;
 (b) an elongate charge of high temperature-resistant detonating explosive enclosed within and extending longitudinally substantially the full length of said body and operable when exploded to shatter said body and apply an effective thread-releasing jarring force to said joint; and
 (c) explosive initiating means mounted on the body in detonation relation to said charge;
 said explosive being in the form of a plurality of parallel lengths of Primacord extending substantially the full length of said body and disposed in continuous longitudinal contact with each other.

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2. Apparatus according to claim 1 wherein said explosive initiating means is of the electrically fired type.

3. Apparatus according to claim 1 having resilient shock absorber means mounted about the exterior of said body.

4. Apparatus according to claim 1 having a body of a booster explosive disposed in boosting contact between said initiating means and the adjacent end of said charge.

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DAVID H. BROWN, Primary Examiner.

U.S. Cl. X.R.,

166—301