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2,436,036

MEANS FOR SEVERING WELL CASINGS AND THE LIKE IN PLACE IN THE WELL

Filed Sept. 14, 1944

2 Sheets-Sheet 1

Fig. 1

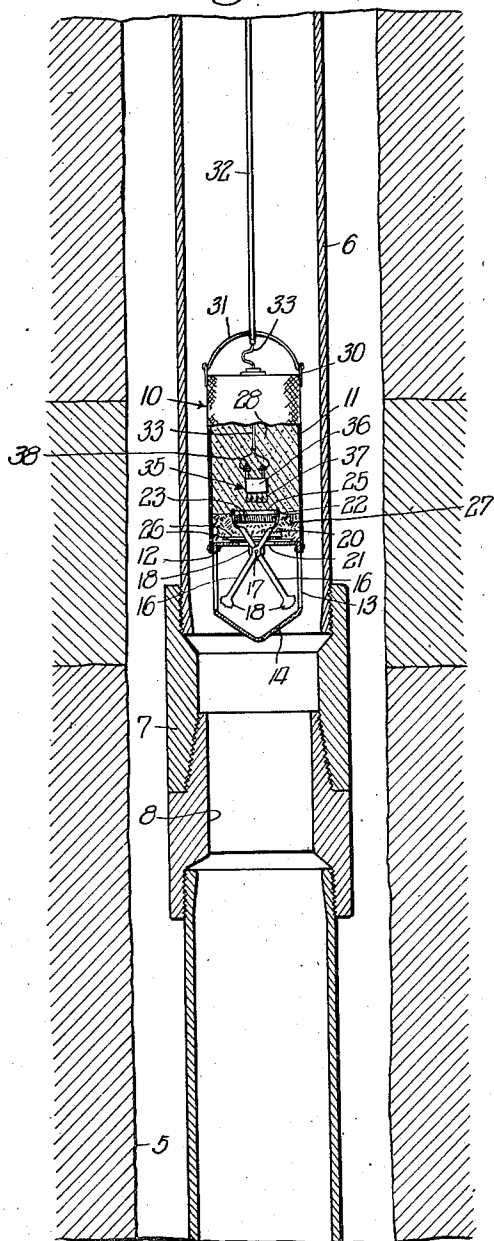
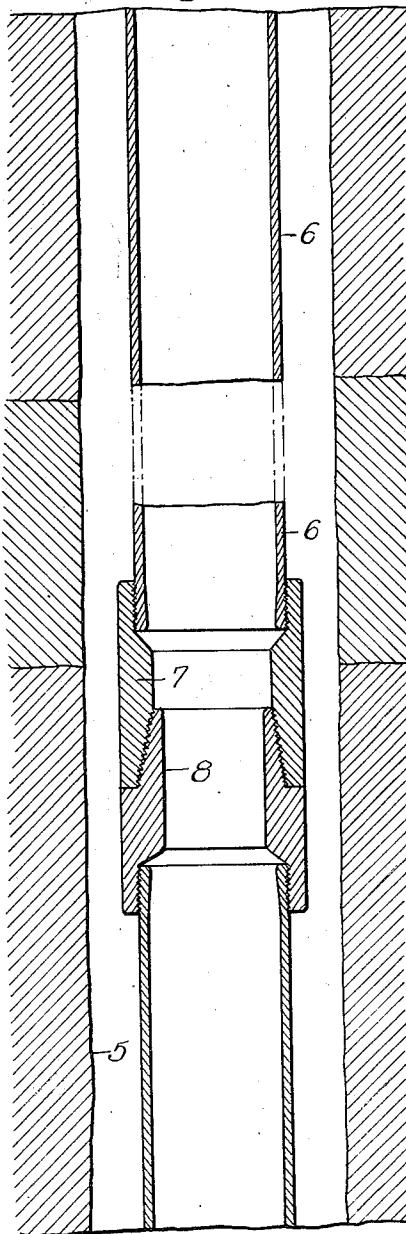


Fig. 2



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2 Sheets-Sheet 2

Fig. 3

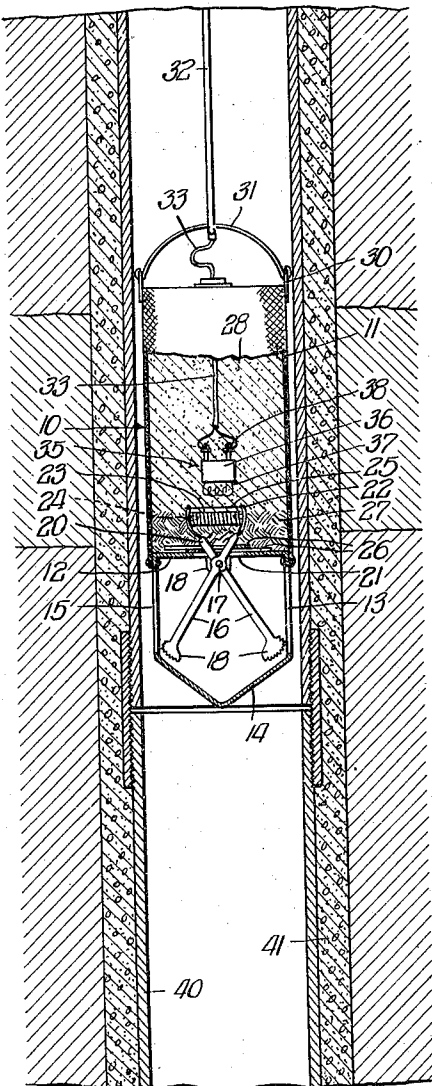
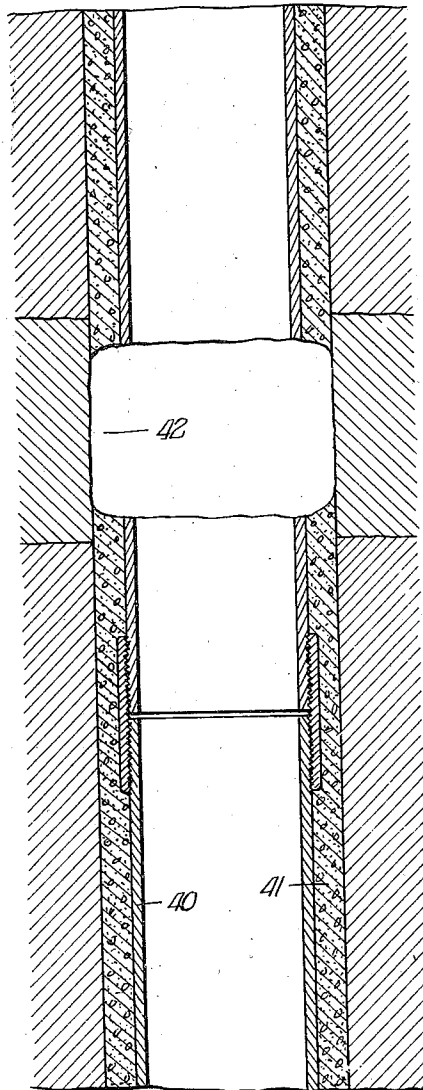


Fig 4



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MEANS FOR SEVERING WELL CASINGS AND
THE LIKE IN PLACE IN THE WELL

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6 Claims. (Cl. 166—1)

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This invention relates to the severing of structures, and has to do with means for severing tubular structures, such as well casings and drill stems used in connection with oil and gas wells, and analogous structures.

During the operations of drilling an oil or gas well, or an exploratory well, particularly when using rotary drills, it frequently happens that the drill stem becomes stuck in the well bore and cannot be withdrawn. The present practice, in such cases, is to shoot the drill stem off with explosives, or to cut it off with mechanical tools, after which the drill and the portion of the stem attached thereto are recovered by known means. Both of these operations are time consuming, expensive and extremely hazardous. Also, after the well casing has been set, during drilling of a well or after completion thereof, it may become necessary to remove a section of the casing. The casing is cemented or grouted in the well bore and cannot be removed therefrom, so that it is necessary to work within the well bore at whatever depth the section of the casing is to be removed. The present practice is to remove the desired section by mechanical means, which requires a considerable amount of equipment and takes considerable time, which is objectionable for obvious reasons. Severing of the well casing at the desired depth may be accomplished by the use of explosives, or shooting, but that shatters the casing and is highly detrimental to normal operations of the well, for which reasons shooting is used as a last resort where attempts to sever the casing and remove a section thereof by mechanical means have proved fruitless.

My invention is directed to avoidance of the above referred to objections to the present practice. To that end, I provide means whereby a drill stem or valve casing, or analogous structure, may be severed at a desired area thereof with expedition and facility by the application of intense heat at that area. More specifically, I provide means for supporting at the desired area within the tubular structure a mass or body of an exothermic mixture and for closing the bore of the structure at the bottom of such mixture so as substantially to prevent leakage of the molten material resulting from the exothermic chemical reaction, and means for initiating chemical reaction of the mixture, whereby when chemical reaction of the mixture takes place the resultant molten material is maintained in contact with the interior surface of the structure at the desired area thereof and by the intense heat of the chemical reaction of such mixture destroys the struc-

ture at that area thereby severing the structure. Further objects and advantages of my invention will appear from the detail description.

In the drawings:

Figure 1 is a fragmentary vertical sectional view of a well bore, shown rather diagrammatically, and of a drill stem passing through the well bore, with severing means embodying my invention positioned within the drill stem;

Figure 2 is a view similar to Figure 1 but after severing of the drill stem has been completed and the remains of the severing means have been removed from the drill stem;

Figure 3 is a fragmentary vertical sectional view of a well with the casing therein, showing severing means embodying my invention positioned within the casing at the area thereof where it is desired to sever the casing; and

Figure 4 is a view similar to Figure 3 after the severing operation has been completed and the remaining parts of the severing means have been removed from the casing.

In Figure 1 I have shown a portion of a well bore 5 which passes downward through various strata, indicated more or less diagrammatically by oppositely directed cross hatching. A drill stem 6 passes downwardly within the bore 5, this stem including a joint 7 having a bore 8 which is reduced in diameter or restricted relative to the bore of the adjacent lengths of tubing of the stem. It may be assumed, for purposes of description, that the drill (not shown) from which the stem extends, is a rotary drill and has become stuck in the well bore necessitating severing of the drill stem a short distance above the joint 7 thereof.

In order to effect severing of the drill stem, I provide means whereby heat may be generated at the proper area thereof sufficient to fust or destroy that area of the stem. The severing means, indicated in its entirety by reference number 10, is in the form of a container comprising a cylindrical body 11 formed of an elastic fabric, or of any other suitable elastic material, having considerable elasticity and adequate mechanical strength. At its lower end body 11 receives a disc shaped head 12 fitting therein and having a depending cylindrical flange 13 to the lower end of which is secured, conveniently by being formed integral therewith, a cone shaped guide member 14. The lower end of body 11 is secured in a suitable manner, conveniently by riveting, to flange 13, the latter being provided with diametrically opposite lengthwise slots 15. Anchoring members 16, in the form of levers which are crossed and pivoted together at 17, on a supporting tab

or bracket 18 at the under face of head 12, extending downward within flange 13 in alignment with the slots 15 thereof. Each of the levers 16 is provided, at its lower end, with an arcuate serrated member 18 adapted for gripping engagement with the interior surface of the drill stem, when the members 16 are projected through the slots 15 into operating position. The levers 16 have upwardly extending arms 20 projecting through a slot 21 in head 12, the upper portion 22 of each arm 20 being twisted at right angles so as to provide a seat for one end of a compression spring 23 of considerable strength, confined between the upper portions 22 of arms 20 and urging the latter apart so as to force the members 16 outward through slots 15. The end portions of spring 23 receive centering studs 24 carried by upper portions 22 of arms 20, and a strain wire 25 is secured to the upper portions or elements 22 or arms 20 adjacent the upper ends thereof, this wire being of adequate strength normally to hold arms 20 against movement away from each other under the influence of spring 23 and thereby hold the anchor members 16 in their inoperative or retracted position. Preferably, superposed slotted plates 26 fit about arms 20 at the upper face of head 12 and substantially close slot 21, for a purpose which will appear presently.

The body 11, closed at its lower end by head 12, provides a container which receives in its lower portion a mass or body of a suitable refractory material 27, such as clay, which is in a loose condition. The container further receives a mass or body 28 of an exothermic mixture, such as thermit. The depth of the refractory 27 is such that strain wire 25 is disposed adjacent the upper face of the refractory, preferably a slight distance thereabove and in the bottom portion of the body of thermit 27. A securing plate 30, of steel or any other suitable material, is secured to the upper end of the body 11 of the container at each side thereof, these plates being diametrically opposite each other and receiving the end portions of a bail 31. A supporting cable 32, which may be either a steel cable or a rope, is suitably secured to bail 31 and carries an electric cable 33, which passes through the top of body 11 of the container and extends downward therein to an ignition device 35 located in the lower portion of the body of thermit 28. This device may be of any suitable type, conveniently being in the form of a block or body 36 carrying a resistor wire 37 to the ends of which are connected suitably insulated terminal posts 38, to which the wires of cable 33 are connected. It will be understood that when the electric circuit of the resistor 37 is closed, this wire is heated to incandescence or sufficient to assure initiation of the chemical reaction of the thermit. It will be noted that the resistor 37 is disposed in proximity to the strain wire 25, which is fusible or heat destructible, so that upon initiation of the chemical reaction of the thermit 28 the strain wire 25 is immediately destroyed, releasing the arms 20.

It may be assumed that the drill stem has one or more joints above joint 7 which, like the latter joint, present relatively restricted bores. The diameter of flange 13 is somewhat less than the most restricted bore in the drill stem which, in conjunction with the inverted frustoconical guide member 14, and the elasticity of body 11 of the container, assures that the container can readily be lowered to any desired position within the drill stem. In that connection, it will be understood that the load supported by head 12 is ap-

preciable so that when the device 10 is supported by cable 32 the elastic body 11 is under lengthwise tension and its maximum diameter is substantially the same as the diameter of head 12, plus the thickness of the wall of body 11. Further, body 11 being elastic and readily flexible may be distorted to sufficient extent to assure ready passage of the heating device through restrictions in the drill stem, the bail 31, being of arcuate shape and possessing appreciable resiliency, being also capable of distortion for that purpose.

When the device 10 has been properly positioned within the drill stem, chemical reaction of the thermit mixture 28 is initiated by means of the igniter 35. When that occurs, the strain wire 25 is destroyed and compression spring 23, which is of considerable strength, projects the members 16 outward of slots 15 so as to cause the serrated elements 18 thereof to grip the inner surface of the drill stem, anchoring the device 10 therein against downward movement. The operator at the well top then slacks the supporting cable 32 so that the device 10 is then supported by the anchoring means and body 11 of the container is relieved of lengthwise tension. In that connection, the operator can readily determine by the feel of cable 32 whether or not the device is properly anchored within the drill stem. In the outward movement of the anchoring members 16, and the accompanying outward movement of arms 20, elements 22 of these arms force a portion of the refractory or clay 27 outward of head 12 toward the periphery thereof, so that upon relieving the lengthwise tension of body 11 the latter bulges outward about head 12 so as to close the space between the head and the drill stem. This outward movement of the refractory is augmented by the superposed mass of thermit, the lower portion of which now is in liquid condition due to the chemical reaction which has been initiated, and the molten material resulting from such reaction which may tend to flow between the drill stem and head 12 is restrained by the clay or refractory and on cooling provides a further seal about head 12. In that manner the body or mass of molten material resulting from the chemical reaction of the thermit is supported upon the bed of clay or refractory, the latter in conjunction with the plates 26 and the portions of arms 20 within the body of clay or refractory serving to prevent any objectionable leakage of the molten material through slot 21 of head 12.

Since the body 11 of the container is elastic, as above noted, when it is relieved of lengthwise tension it contracts and displaces the refractory and the thermit mixture outward radially, causing bulging of the clay containing portions of body 11 into contact with the surrounding wall of the drill stem, and also causing bulging of the thermit containing portion of the body into contact with the surrounding wall of the drill stem, or substantially so. The body 11 of the container is heat destructible, as will be understood from the above, and is quickly destroyed by the heat generated by the chemical reaction of the thermit, which generates heat at a temperature of approximately 3000° C. The molten mass resulting from the chemical reaction of the thermit mixture is thus brought into direct contact with the drill stem and quickly destroys the area thereof at which the device 10 is located, thus severing the stem, the upper portion of which is then separated from the lower portion by the resultant gap, as shown in Figure 2. The

severed upper portion of the stem is then withdrawn from the well bore and the remaining portion of the stem and the drill may be recovered by a fishing operation in a known manner.

In Figures 3 and 4 I have shown a section of a well with a casing 40 secured therein by cement or concrete 41 in a known manner. Assuming that it is desired to remove a section of the casing 40, the heating device 10, such as that above described, is suitably positioned within casing 40, after which the chemical reaction of the thermit mixture is initiated, the device 10 is anchored in position within the casing, and the latter and the surrounding cement or grouting 41 are destroyed by the heat of the chemical reaction of the thermit mixture, leaving a gap 42 in the well casing and the cement or grouting, as shown in Figure 4. After that has been done, the desired section of the casing 40, above or below the gap 42, or between two properly spaced gaps produced in the same manner as the gap 42, is removed in a known manner.

While I have shown, by way of example, one form of means for anchoring the heating device within the drill stem or the well casing, any other suitable means may be provided for that purpose. Likewise, the heating device may be positioned within the tubular structure to be severed in any suitable manner, or by any suitable means other than the lowering cable illustrated by way of example. While I have referred to the body of the container as being heat destructible, it is not essential to my invention that it be completely destroyed, it sufficing if the body is of such character as to permit of severing the tubular structure by the heat generated by the exothermic mixture or material of the heating device. The body of the container should be elastic for use in drill stems and other structures having restricted bores spaced apart therein, but that is not essential in all cases and for use in well casings and other structures of like character the container body may be nonelastic if desired. Also, any suitable means other than the ignition device, shown by way of example only, may be provided for initiating chemical reaction of the exothermic mixture, within the broader aspects of my invention.

As above indicated, and as will be understood by those familiar with the drilling and operation of wells, changes in details may be resorted to both with respect to the heating device of my invention and the method of my invention, and I intend to include all such variations, as fall within the scope of the appended claims, in this application in which the preferred form only of my invention has been disclosed.

I claim:

1. In means for severing tubular structures by heat, a container comprising a body formed of flexible heat destructible material adapted to be disposed in desired position within a tubular structure to be severed, a body of loose refractory material in the lower portion of said container, a body of an exothermic mixture in said container overlying said body of refractory material, means for initiating chemical reaction of said mixture, and initially inoperative means for anchoring said container in position within the tubular structure, said anchoring means comprising heat destructible means maintaining said anchoring means inoperative and being rendered operative responsive to initiation of chemical reaction of said mixture and resultant destruction of said heat destructible means.

2. In means for severing tubular structures by heat, a container adapted to be disposed in desired position within a tubular structure to be severed, said container comprising a body formed of a heat destructible material and a head at the lower end thereof, a body of refractory material in the lower portion of said container overlying said head, a body of an exothermic mixture in said container overlying said body of refractory material, means for initiating chemical reaction of said mixture at a point adjacent the bottom thereof, and means for anchoring said container in position within the tubular structure comprising initially retracted members and means urging said members outward for engagement with the tubular structure and heat destructible means adjacent the point of initiation of reaction of said mixture initially holding said members in retracted position, said heat destructible means upon destruction thereof releasing said members for movement outwardly into anchoring engagement with said tubular structure.

3. In means for severing tubular structures by heat, a container adapted to be disposed in desired position within a tubular structure to be severed, said container comprising a body formed of a heat destructible material and a head at the lower end thereof, a body of refractory material in the lower portion of said container overlying said head, a body of an exothermic mixture in said container overlying said body of refractory material, means for initiating chemical reaction of said mixture at a point adjacent the bottom thereof, anchoring members pivoted on said head for movement outward thereof into engagement with the tubular structure, means urging said members outward, and heat destructible means adjacent the point of initiation of reaction of said mixture initially holding said members retracted.

4. In means for severing tubular structures by heat, a container adapted to be disposed in desired position within a tubular structure to be severed, said container comprising a heat destructible body and a head at the lower end thereof, a body of refractory material in the lower portion of said container, a body of an exothermic mixture in said container overlying said body of refractory material, means for initiating chemical reaction of said mixture at a point adjacent the bottom thereof, said head having a slotted depending cylindrical flange and a guide cone at the lower end thereof, locking levers pivoted on said head movable outward through the slots of said flange, said levers having arms extending upward through said head, spring means connecting said arms urging said levers outward, and a fusible strain wire connecting said arms restraining outward movement of said levers and disposed adjacent the point of initiation of reaction of said mixture.

5. In means for severing tubular structures by heat, an elastic heat destructible container adapted to be disposed in desired position within a tubular structure, a body of loose refractory material and a body of an exothermic mixture in said container disposed in superposed relation with said material underlying said mixture, and means for initiating chemical reaction of said mixture.

6. In means for severing tubular structures by heat, a heat destructible container adapted to be disposed in desired position within the tubular structure to be severed, a body of an exothermic mixture in said container, initially inoperative anchoring means carried by said container ren-

dered operative responsive to initiation of chemical reaction of said exothermic mixture and effective when operative for anchoring said container in position within said tubular structure, and means for initiating chemical reaction of said mixture.

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