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PIPE SEVERING METHOD AND APPARATUS

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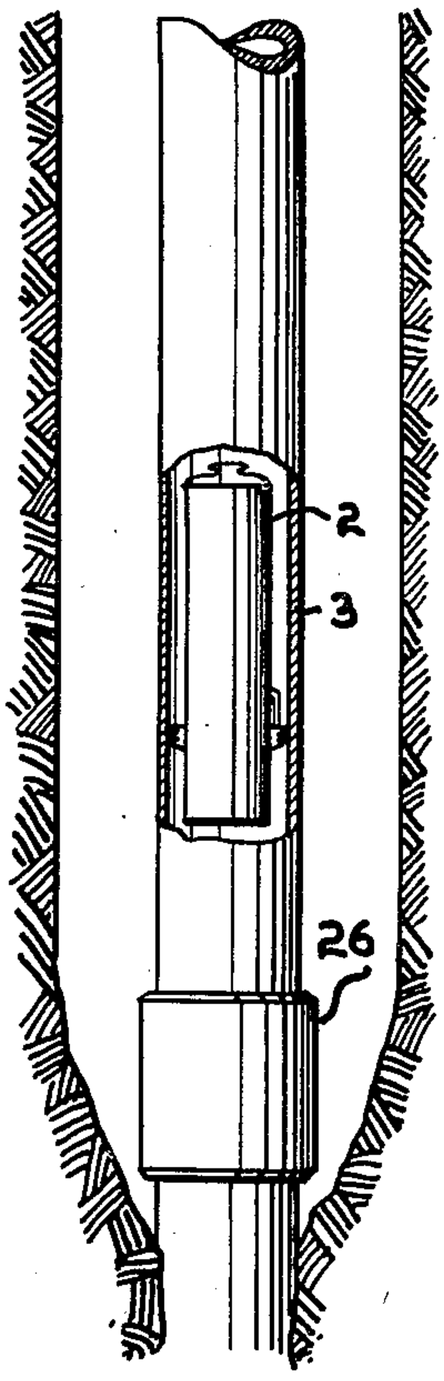

FIG. 2.

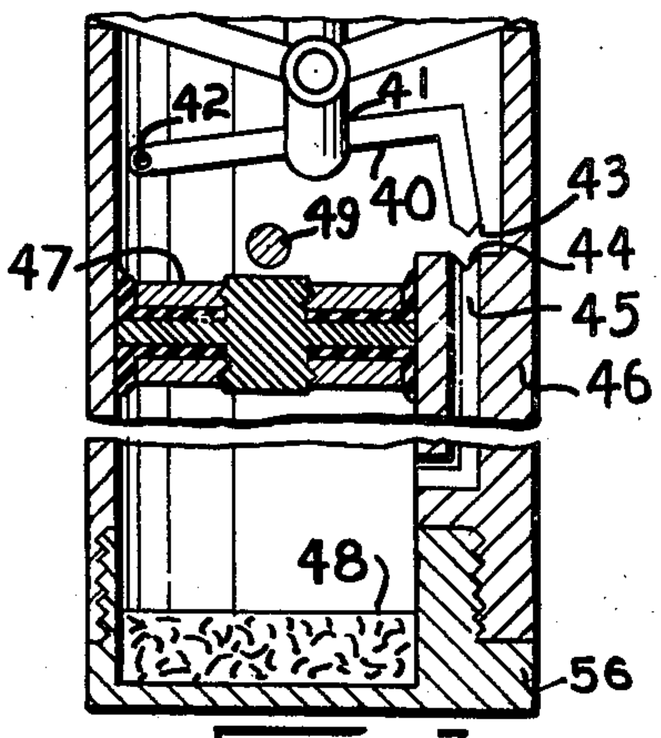

FIG. 3.

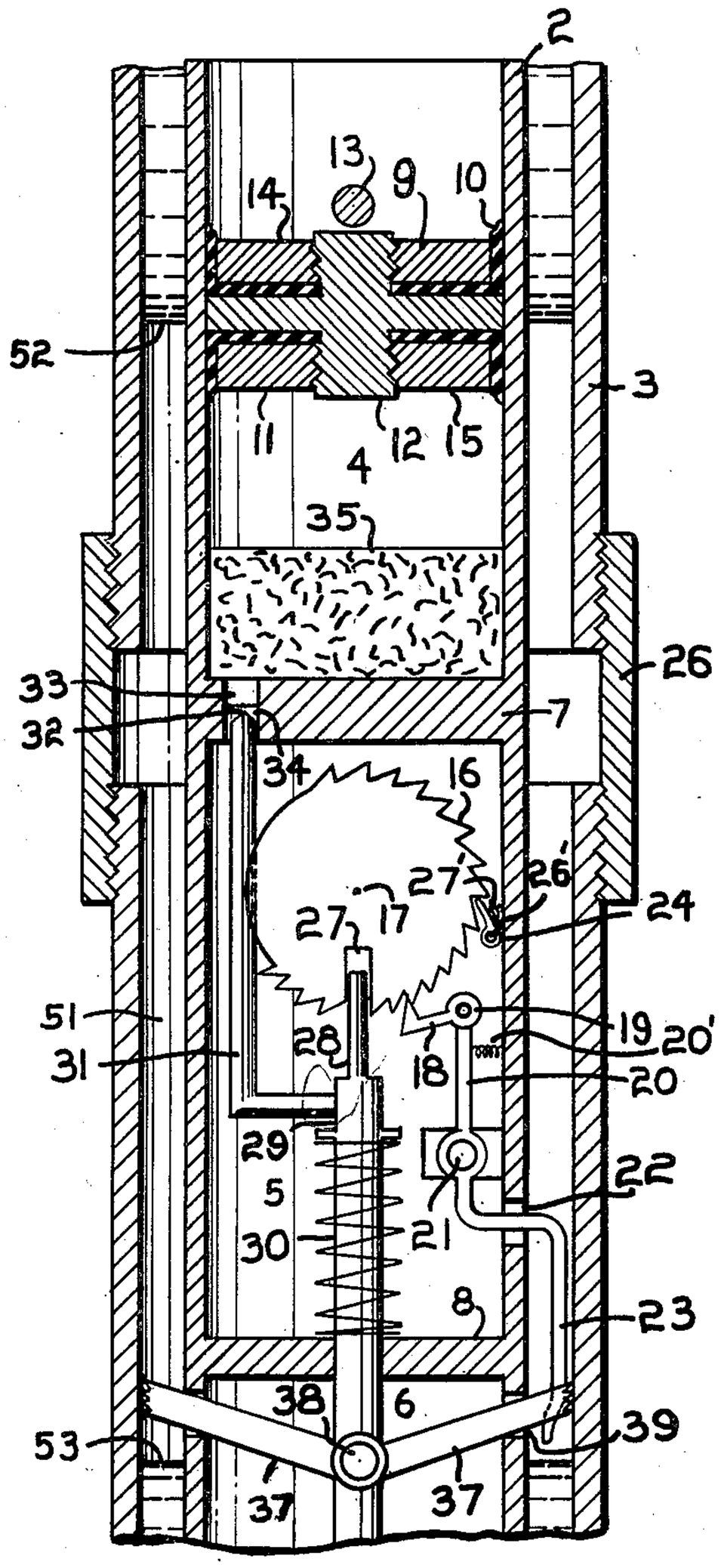

FIG. 1.

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PIPE SEVERING METHOD AND APPARATUS

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The invention relates to a method and apparatus for severing pipes and other elongated objects, and in particular for severing pipes, rods, and the like in wells.

An object of the invention is therefore to provide a method of and apparatus for severing pipes and other elongated objects stuck in wells.

A further object is to provide a device that can be adjusted to be lowered to any desired depth in a pipe, or adjacent an elongated object, and then produce a heating of the pipe or elongated object at such depth so as to reduce the tensile strength thereof whereby severing of the pipe can be readily effected.

Another object is to treat a pipe or elongated object at a point thereon to reduce its tensile strength and to then sever such object by the application of tension thereto.

Still another object is to provide a method of severing stuck pipe in wells in a manner that the severed end of such pipe is of a reduced diameter whereby an overshot or other retrieving tool may engage the remaining portion of the severed pipe.

A still further object is to provide a device that may be lowered to a predetermined position in a string and sufficient heat generated and supplied to the said string so that tension upon the string will effect severing thereof.

Still another object is to provide a device that approximately determines the level at which a pipe or elongated object is stuck in a well bore.

Other objects and advantages will become apparent from a consideration of the following description and drawings wherein:

Fig. 1 is a vertical sectional view of a tubular member showing the device positioned therein;

Fig. 2 is an elevational view showing a portion of a tubular member in section with the device therein, such tubular member being stuck within a well bore; and

Fig. 3 shows the lower end of the device in section showing the gas chamber embodied in the device.

In Fig. 1 the device is shown as comprising a container 2 positioned in the tubular member 3, which member is shown as being stuck in the well bore. The container 2 is divided into chambers 4, 5, and 6 by fixed partitions 7 and 8. A slidable partition 9, fitted in chamber 4, is provided with annular lip seals 10 secured in position by discs 11 threaded onto flange member 12.

The stop element 13 extending transversely of the chamber 4 above the partition limits the upward movement of such slidable partition.

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This partition is arranged to move downwardly into chamber 4 in response to well pressure on its upper surface 14 until such pressure is equalized by the compression pressure on the nether surface 15 tending to urge the partition upwardly.

A ratchet wheel 16 is pivoted at 17 in the chamber 5. The pawl 18 is connected at 19 to lever 20, and is provided with suitable means such as a spring to urge the pawl into movable engagement with the teeth on the ratchet wheel to effect rotation thereof in a manner and for a purpose to be more fully described. The lever 20 pivoted at 21 extends through window 22 in the container 2 and terminates in finger 23 adjacent the inner wall of the member 3. Stop 24 pivoted at 26' and held against ratchet wheel 16 by spring 27' prevents backward movement of the ratchet wheel 16. The finger 23 is held in sliding contact with the inner surface of member 3 by spring 20' and as finger 23 passes the joint 26 a rocking motion will be imparted to lever 20 by finger 23, each such rocking motion causing the pawl 18 to move ratchet wheel forward a notch.

A slot 27 in wheel 16 is arranged so as to come into alignment with plunger 28 on the end of rod 29 as will be more fully described, such rod being constantly urged upwardly against wheel 16 by spring 30. Extension 31 of rod 29 ends in point 32 arranged to fire the cap 33 in the cap hole 34 adjacent the heat generating compound 35 in the chamber 5.

Anchor or container supporting means, comprising arms 37 pivoted at 38 on rod 29, extends outwardly through windows 39 and is arranged to engage member 3 when rod 29, is in actuated position as shown in Fig. 1. It is to be understood that such supporting means is normally in retracted position during descent of the container.

The lower end of rod 29 terminates in the chamber 6 in a rocker arm 40 connected at 41 to the rod 29 and pivotally connected at 42 to the container 2. The rocker valve 40 is terminated in valve face 43 arranged to sealably engage the seat 44 of passage 45 through the thickened wall section 46 of the container 2.

Partition 47 is similar to partition 9 and serves to prevent fluid from contacting the gas generating compound 48 provided within the chamber 6. Stop 49 limits upward movement of partition 47.

In operating the disclosed device embodying the invention, the ratchet wheel 16 is rotated until the number of teeth on the periphery thereof

counting from the slot 27, is equal to the number of joints which the container passes in lowering to the desired depth. A quantity of heat generating compound 35 of the exothermic type such as a mixture of aluminum oxide and iron, commonly known as "Thermite," is placed in the chamber 4.

While the above mixture has been denoted as being suitable, it seems obvious that any suitable material capable of producing an exothermic reaction can be used to effect heating of the pipe.

A percussion cap 33 is placed in the cap hole 34 and a gas generating compound 48 which produces gas when mixed with water, such as calcium carbide, is placed in the chamber 6. Partition members 9 and 47 are then placed in position, and the bottom 56 of the container 2 secured in place; the device may then be lowered into the well. It seems obvious that the device may be dropped into the well bore, or it may be lowered by means of a cable.

As the finger 23 slides along member 3, it comes in contact with joints 26 along the string which causes lever 20 to rock thereby actuating pawl 18 to engage each succeeding tooth on ratchet wheel 16 thereby rotating such wheel one notch each time the finger 23 engages a joint in the string. It is understood, of course, that plunger 28 bears against the teeth on the ratchet wheel due to the compression in spring 30.

When the slot 27 comes in alignment with the plunger 28 in rod 29, the plunger moves upwardly due to the compression on spring 30. This upward movement causes container supporting means 37 to move outwardly to engage member 3 thereby positioning the container 2 in the well. Simultaneously rocker arm valve 40 moves upwardly off seat 44 and allows entry of well fluid to contact gas generating compound 48, such reaction evolving gas so as to form a bubble 51 about container 2, such bubble having liquid boundaries as indicated at 52 and 53. It seems obvious that the aforementioned operations occur within the space of a fraction of a second and immediately thereafter the point 32 on the extension 31 contacts the cap 33 causing the heat generating compound 35 to evolve heat directly to the surrounding member 3. A tension is exerted upon members 3 at the top of the well bore so as to cause such member to neck and finally sever while the member is heated to such an extent that the tensile strength thereof is materially reduced.

It seems obvious that the diameter of the necked portion will be much smaller than the normal diameter of the pipe, thus enabling the operator to easily engage such severed portion with an overshot or other grappling tool if an effort is to be made to remove an additional portion of the string stuck in the well.

It seems obvious that the device may be used as a means to locate the level at which a string is stuck in the well bore. By using a series of the devices embodying the invention, and by starting at the lowest possible point in the string with the first device, and step wise moving upwardly to discharge each device at a higher level, the position or level at which the string is stuck may be located.

So long as the heating of the string is effected below the level at which the pipe is stuck, the string will not part when tension is placed thereon in unison with the heating, since the tension will not be transmitted to the level of heating.

The container is of any suitable material, such as plastic, so that it is dissipated during the heating of the member 3 thereby reducing debris in the string, or well bore, so that further operations will not be greatly hindered.

Broadly the invention contemplates an apparatus and method for effecting the separation of a tubular member or other elongated object stuck in a well bore by applying heat above such stuck position and applying a tension to the stuck pipe to pull it in two.

The invention claimed is:

1. In a device for generating and applying heat to effect separation at a predetermined level about the periphery of a tubular string stuck in a well the combination of, a container adapted to be lowered into the well, said container having a chamber therein to receive a quantity of heat generating material, means to anchor said container in the well at the predetermined level, and means operable by said anchor means for initiating reaction of the material whereby the string is heated about its periphery at such level.

2. In a device for generating and applying heat at a predetermined area to a tubular string stuck in a well the combination of, a container adapted to be lowered into the well, said container having a chamber therein to receive a quantity of heat generating material, means operable for initiating reaction of the material whereby the string is heated at such level, and additional means for creating a volume of gaseous fluid about the container while the reaction within the material takes place.

3. In a device for generating and applying heat at a predetermined level to a tubular string stuck in a well the combination of, a container adapted to be lowered into the well, said container having a chamber therein to receive a quantity of heat generating material, and means operable by passage of the device through a predetermined length of tubular string for initiating reaction of the material within said chamber.

4. In a device for generating and applying heat at a predetermined level to a tubular string stuck in a well the combination of, a container adapted to be lowered into the well, said container having a chamber therein to receive a quantity of heat generating material, and means operable by passage of the device through successive joints for initiating reaction of the material when a predetermined level is reached.

5. In a device for generating and applying heat at a predetermined level to a tubular string stuck in a well the combination of, a container adapted to be lowered into the well, said container having a chamber therein to receive a quantity of heat generating material, and means operable by passage of the device through a predetermined number of joints in the pipe string for anchoring the device within the string and initiating reaction of the material when the selected level is reached.

6. The method of removing from a well a portion of a string stuck therein comprising the steps of, applying heat to an area of the string at a selected point in the well to decrease the tensile strength of the string at such point, and applying tension to the string to effect separation at the heated area.

7. The method of locating the level where a string of pipe is stuck in a well comprising the steps of, applying heat to the area of the string at a series of selected points in the well to decrease the tensile strength of the string, and

applying tension to the string to effect separation of the string of pipe at the first heated area above the level of sticking whereby the levels at which the pipe does not separate will indicate the level at which the pipe is stuck in the well.

8. The method of severing pipe stuck in a well comprising the steps of heating the pipe proximate the area where the pipe is stuck to decrease the tensile strength of such area and applying tension to the string to effect reduction in size of the pipe and separation at the heated area into an upper and lower portion, the reduction in size of the pipe leaving the upper end of the lower portion reduced in size to facilitate the engagement of such portion with a grappling tool, removing the upper portion of such cut pipe from the well bore, engaging the lower portion of such cut pipe and subsequently removing it from the well bore.

9. The method of removing from a well a portion of a string stuck therein and surrounded by well fluids comprising the steps of, applying tension to said string, providing a bubble in the fluids at a predetermined level, and applying heat to the string at that level to decrease the tensile strength of the string so that separation is effected by said applied tension.

10. The method of removing from a well a portion of a string stuck therein comprising the steps of, applying tension to the string and applying heat to an area of the string at a selected point in the well to decrease the tensile strength of the string at such point so that separation of the string is effected by said applied tension.

11. The method of locating the level where a string of pipe is stuck in a well comprising the steps of, applying a tension to the string and applying heat to the string at a series of seselected points in the well to decrease the tensile strength of the string so that separation of the string of pipe at the first heated area above the level of sticking is accomplished.

12. In a pipe joint counting mechanism for locating a device at a predetermined number of joints below the surface in a string of pipe in place in a well bore, means to register movement of said mechanism through successive joints and means actuated by said registering means to sever the pipe when the device is located at the predetermined joint.

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