March 2, 1965 I. L. AULT 3,171,487

PARAFFIN CUTTER

Filed Nov. 8, 1962 2 Sheets-Sheet 1

FIG. 1

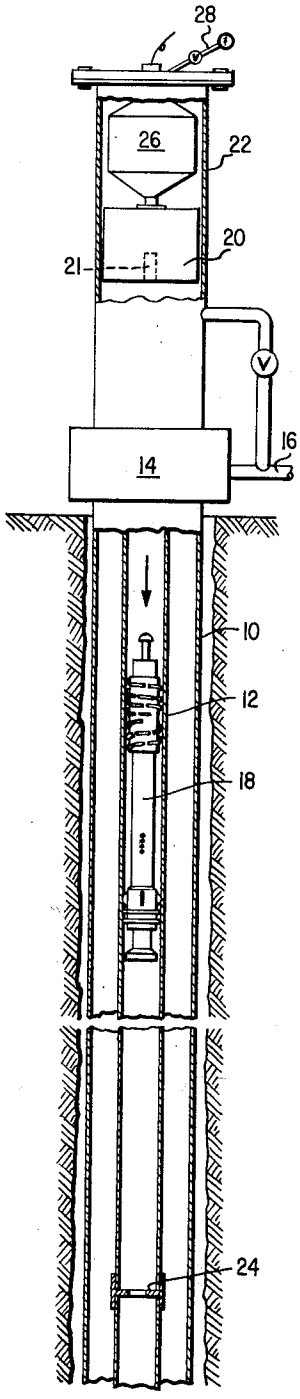


FIG. 2a

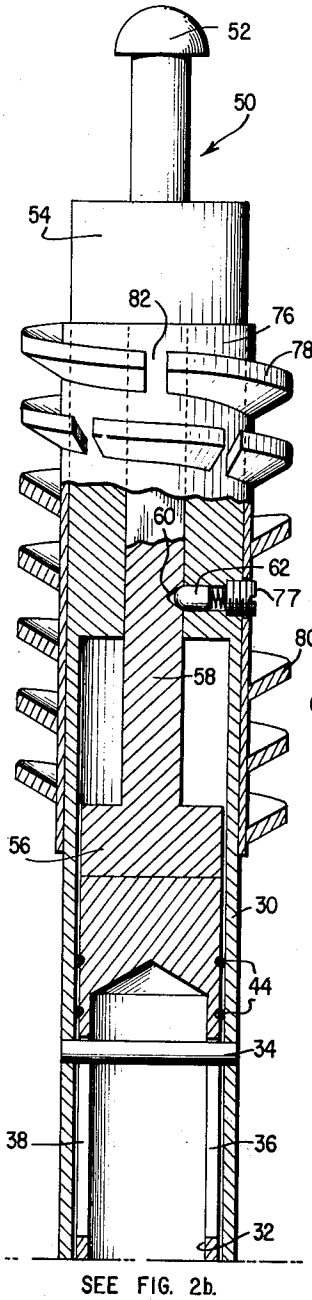
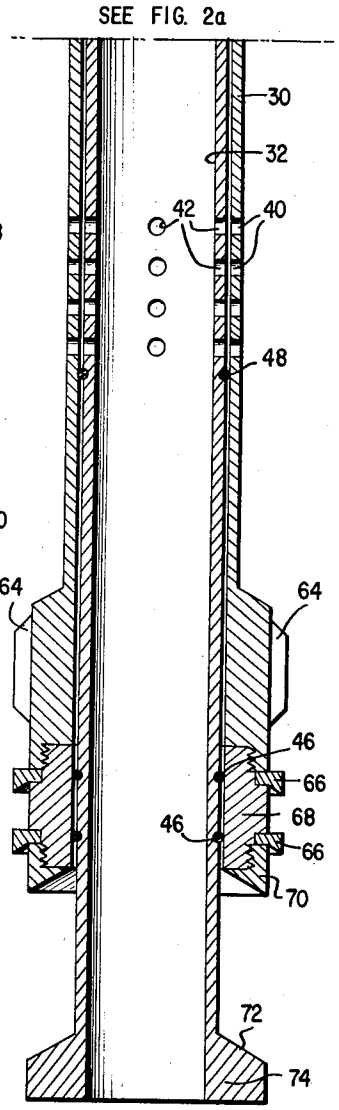


FIG. 2b



INVENTOR.
ISAAC L. AULT

BY Stowell & Stowell

ATTORNEYS.

March 2, 1965 I. L. AULT 3,171,487

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Filed Nov. 8, 1962 2 Sheets-Sheet 2

FIG. 3a

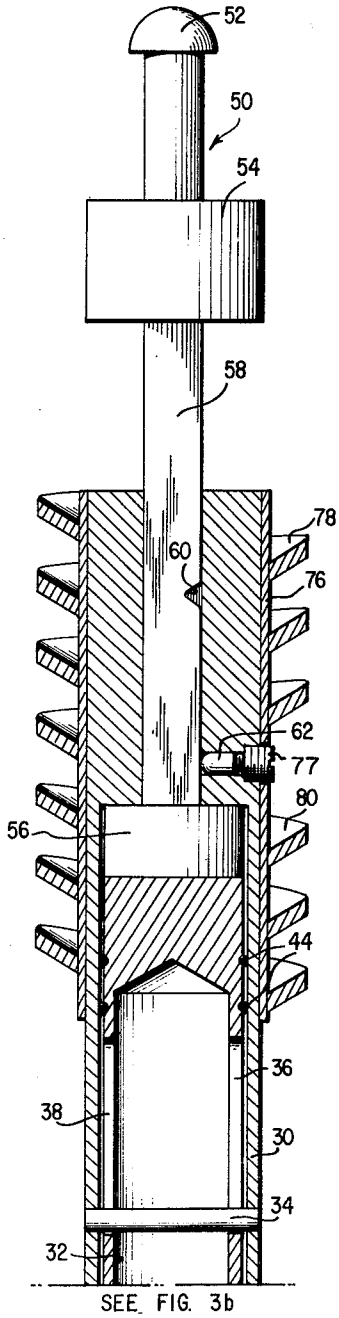


FIG. 3b

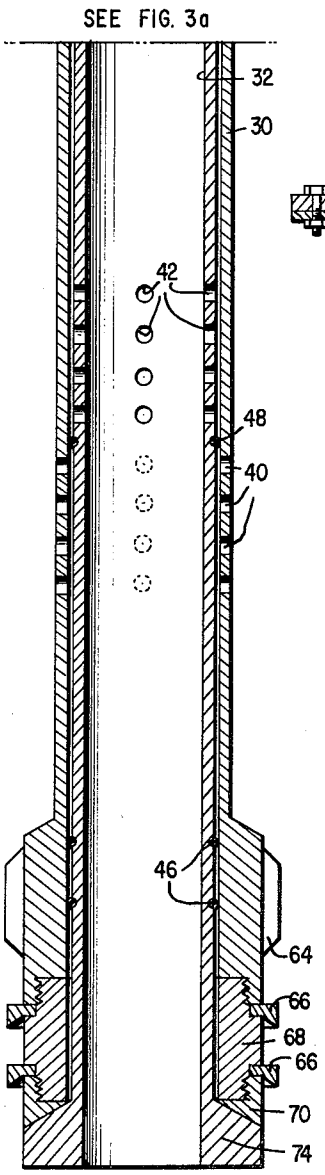
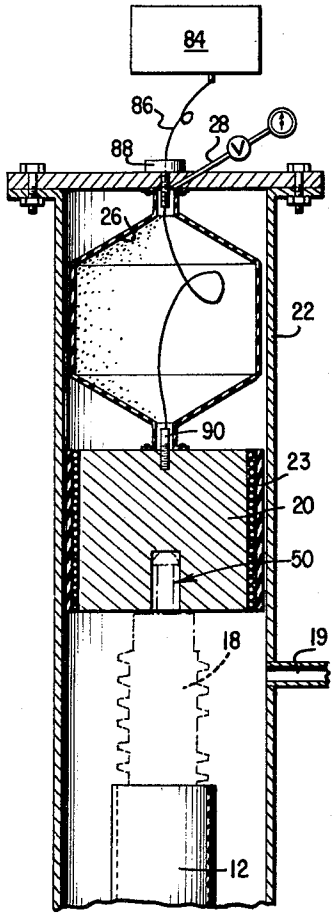


FIG. 4



INVENTOR.
ISAAC L. AULT

BY Stowell & Stowell

ATTORNEYS.

United States Patent Office

3,171,487

Patented Mar. 2, 1965

3,171,487

PARAFFIN CUTTER

Isaac L. Ault, P.O. Box 482, Patterson, La.

Filed Nov. 8, 1962, Ser. No. 236,223

8 Claims. (Cl. 166—65)

The present invention relates generally to oil wells, and more particularly, to a system for cleaning paraffin deposits from the bore of the tubing of an oil well.

In the operation of oil wells, it has been found that paraffin and other asphaltic or bituminous compounds tend to collect on the bore of the tubing within the well. This accumulation builds up gradually until it seriously restricts the flow of the well, and sometimes entirely clogs it. When either of these conditions arise, it becomes necessary to pull the tubing from the well and clean it of the accumulation of paraffin by steaming or some other suitable manner. This operation takes considerable time and is expensive, not only from the standpoint of labor costs but the delay in obtaining production from the well until the tubing has been cleaned and rerun into the well.

The present invention is designed to remove the accumulation of paraffin in the tubing by providing a system including a device that is continuously and automatically operated.

It is an object of the invention to produce a system for automatically removing paraffin deposits from the bore of oil well tubing which is continuous and automatic in its operation.

Another object of the invention is to produce a system for removing paraffin deposits from the bore of oil well tubing which may operate on a predetermined cycle.

Still a further object of the invention is to produce a device for removing paraffin from the bore of oil well tubing which includes relatively few moving parts and may be readily and economically manufactured.

Other objects and advantages of the invention will be apparent from the following detailed description of a preferred embodiment of the invention when considered in the light of the accompanying drawings, in which:

FIG. 1 is an elevational view partly in section of an oil well equipped with a paraffin cutting tool in accordance with the invention;

FIG. 2*a* is a fragmentary elevational view partially in section showing the upper portion of the paraffin cutter device and showing the relative position of the elements thereof for effecting a downward movement of the device within an associated well tubing;

FIG. 2*b* is a fragmentary elevational view in section of the lower portion of the device illustrated in FIG. 2*a*;

FIG. 3*a* is a fragmentary elevational view partially in section of the upper portion of the cutter device showing the relative position of the elements thereof for effecting an upward movement of the device within an associated well tubing;

FIG. 3*b* is a fragmentary elevational view in section of the lower portion of the device illustrated in FIG. 3*a*; and

FIG. 4 is a fragmentary sectional elevational view of the upper end of the well tubing and showing the mechanism for holding the paraffin cutter in its uppermost position.

Referring to FIG. 1, there is shown a well casing 10 through which a well tubing 12 extends. As is well known, the annular space or zone between the casing 10 and the tubing 12 is sealed off by suitable packing means within the casing head 14. The well fluids which are being produced flow upwardly through the well tubing 12 and are discharged therefrom to an outlet line 16 which has suitable control valving mounted therein, not specifically shown. Paraffin accumulation occurs, in general, at the upper portion of the well tubing 12 where the temperature is low enough to cause it to precipitate from the oil. Most of the accumulation occurs during periods when the well is not producing as, for example, during the period of shutdown in a prorated area, at which time wax tends to precipitate from the oil in the tubing. Manifestly, this tends to diminish the flow of the oil through the tubing and, in certain instances, may entirely cut off the flow. In order to militate against undue and unwanted accumulation of paraffin in the well tubing 12, the paraffin cutter 18 is automatically and periodically caused to be dropped into the well tubing 12 from an electromagnet 20 maintained or suspended within an upper receiver housing 22. The cutter 18 is of such a structure, as will be explained in detail hereinafter, that it will fall downwardly through the tubing 12 until it contacts a stop member 24 which is perforated to permit the passage of oil therethrough. Upon contacting the stop member 24, the cutter 18 closes the ports therein, causing the well pressure to carry the cutter upwardly in the tubing 12. During the ascent, the cutter scrapes the paraffin accumulation off the side of the tubing.

The receiver housing 22 is provided with a flow line by-pass 19 which is necessary to induce fluid flow up into the receiver. The other end of the flow line by-pass 19 is connected to the outlet 16.

The momentum of the cutter 18 is sufficient to propel the cutter into the receiver housing 22 and to cause it to come into contact with the electromagnet 20. The electromagnet 20 is provided with a cavity 21 adapted to receive the uppermost end of the cutter 18. Assuming the electromagnet 20 is placed in an energized condition, the cutter 18 will be suitably held thereby for the period of time in which the electromagnet 20 is energized. The electromagnet 20 is suspended within the receiver housing 22 by a flexible pressure chamber 26 formed of rubber, for example. An electrical insulating sleeve 23 is disposed about the outer peripheral surface of the electromagnet 20 to effectively insulate the magnet from the receiver housing 22. The pressure chamber 26 is charged to a predetermined pressure and is maintained at a desired pressure by inserting pressure fluid through an associated line 28 and serves as a buffer or impact dampener to cushion the electromagnet 20 when impacted by the cutter 18 which has been propelled by the fluid pressure within the well tubing.

Referring to FIGS. 2*a* and 2*b*, there is a detailed illustration of the cutter 18 which comprises an outer cylindrical sleeve 30 and a cooperating inner sleeve 32. The inner sleeve 32 is adapted to slide within the outer sleeve 30 between limits determined by a pin 34 in the outer sleeve and cooperating slots 36 and 38 formed in the inner sleeve 32. It will be noted that the lower portion of the outer sleeve 30 is provided with a plurality of ports 40; while the inner sleeve is provided with a plurality of ports 42. The spacing between the ports 40 and 42 in their respective sleeve element is the same such that when the inner and the outer sleeve elements are in the position shown in FIGS. 2*a* and 2*b*, the ports are in alignment. With the ports 40 and 42 in alignment, fluid may thereby flow through the cutter, allowing the cutter to fall within the tube casing 12.

Near the top portion of the inner sleeve 32 there is disposed a pair of similar O-rings 44 which are preferably disposed in annular grooves formed in the outer surface of the sleeve 32. At the opposite end of the inner sleeve, there is disposed another pair of O-rings 46 which are disposed in suitable annular channels or grooves formed in the outer surface of the inner sleeve 32. Slightly below the lowermost port member 42 in the inner sleeve 32, there is disposed an O-ring 48 positioned in

an annular groove formed in the outer surface of the inner sleeve **32**. The O-rings **44**, **46**, and **48** act to provide a fluid-tight seal between the inner surface of the outer sleeve **30** and outer surface of the inner sleeve **32**.

Disposed within an elongate bore in the upper end of the outer sleeve element **30** there is slidingly disposed a sliding member, generally indicated at **50**, which comprises a fishing neck **52** formed of a magnetizable material, an upper shock block **54**, a lower shock block **56**, and an intermediate portion **58**. The intermediate portion **58** is adapted to slide within the elongate bore hole of the outer sleeve **30** between the limits defined by the upper and lower shock blocks **54** and **56**, respectively. The intermediate portion **58** is provided with a V-shaped slot **60** which is adapted to engage with a spring-urged detent member **62**, as shown in FIG. 2*a*, to militate against any relative movement of the sliding member **50** and the inner sleeve **32** within the outer sleeve **30**.

The lower portion of the outer cylindrical sleeve **30** is provided with a plurality of radially extending fin members **64** which may be welded to the base of the outer sleeve **30** or otherwise formed thereon to control the cutter wobble and reduce wear on an annular cup member **66**, as will be described in detail hereinafter. The lower end of the outer sleeve **30** is internally threaded to receive an externally threaded member **68** which is adapted to carry two spaced annular cup members **66**. A cup retainer nut **70** is affixed to the lower externally threaded portion of the member **68**. The lower face of the cup retainer nut **70** is formed to mate with the upper surface **72** of the enlarged lower portion of the inner cylindrical sleeve element **32**.

At the upper end of the outer sleeve assembly there is disposed a sleeve member **76** which carries a plurality of radially extending helically-arranged cutting knife portions **78** and **80**. It will be understood that the helix of the cutting knife **78** is opposite to that of the cutting knife **80**. The sleeve member **76** is held in position by a set screw **77** which is threadedly engaged within the outer sleeve **30**. The set screw **77**, in addition to being effective in maintaining the sleeve member **76**, is also effective in retaining the spring biased detent **62**.

The cutting knives **78** and **80** have spaces, as at **82**, which act as by-passes for the flow of fluid as the cutter travels in the well tubing **12**.

In operation, it will be appreciated that if the electromagnet **20** is de-energized allowing the fishing neck **50** to be released, the cutter **18** will readily fall downwardly within the well tubing **12**. The downward flow of the cutter **18** is facilitated by the fact that the outer and inner sleeves **30** and **32**, respectively, are positioned relative to one another as illustrated in FIGS. 2*a* and 2*b*. In this relative position, the ports **40** and **42** are in alignment allowing the fluid within the well tubing **12** to pass therethrough thereby militating against an undue pressure build-up within the interior of the cutter.

When the cutter **18** reaches the stop member **24**, the base **74** of the inner sleeve **32** contacts the stop **24** and the momentum of the outer sleeve **30** is sufficient to overcome the force of the detent **62** causing the outer sleeve to travel downwardly to the position illustrated in FIGS. 3*a* and 3*b*.

When the outer sleeve **30** moves downwardly with respect to the inner sleeve **32**, the respective ports **40** and **42** move to a position of non-alignment. Thus, fluid passage through the cutter **18** is effectively prevented by the plurality of O-rings **44**, **46**, and **48**. The fluid pressure within the well tubing **12** will now act on the cutter **18** and specifically on the annular cup elements **66** causing the cutter to rise in the tubing. The fins **64** control and help to eliminate any wobble of the cutter by stabilizing its travel and thereby prevent undue wear on the cup elements **66**. Also, it will be appreciated

that since the helices of the cutting knife **78** and the cutting knife **80** are reverse with respect to one another, the cutter **18** is prevented from spinning and travels along the axis of the well tubing **12**. On its upward path, the cutting knives **78** and **80** scrape off and carry any paraffin which has adhered to the inner surface of the well tubing **12**.

As the cutter **18** reaches the receiver chamber defined by the housing **22**, the fishing neck **52** is received within the cavity **21** formed in the bottom of the electromagnet **22**. The upper shock block **54** contacts and is stopped by the lower surface of the electromagnet **22** which positively stops the inner sleeve **32**. The momentum of the outer sleeve **30** causes it to travel upwardly until it reaches the position shown in FIGS. 2*a* and 2*b*, in which position the spring biased detent **62** engages within the V-shaped slot **60**, maintaining the inner and outer sleeves in such relation that the ports **40** and **42** align with one another.

The cutter **18** is maintained or held in the receiver housing **22** so long as the electromagnet **20** is in an energized condition. Electromagnetic energy is supplied to the magnet **20** from the output of a controllable timed power supply **84** through a suitable electrical conductor **86**. The conductor **86** passes through the top wall of the receiver housing **22** within a suitable pressure-tight fitting **88**, through the interior of the chamber **26** and finally is coupled to an electrical connector **90**, in electrical contact with the electromagnet **20**.

The individual conditions of the particular well being considered will dictate the duty cycle of the above-described system. For example, if the frequency of the duty cycle is once in each twenty-four hour period, the power supply **84** will be turned off by suitable timing mechanisms, such as a clock, for approximately five minutes every twenty-four hours. This will cause the cutter **18** to be released from the electromagnet **20** and travel down the well tubing **12**. When the cutter **18** returns to the receiver housing **22**, the electromagnet **20**, being in an energized condition, will be effective to hold the cutter for another predetermined period.

According to the patent statutes, I have explained the principles and mode of operation of my invention, and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A system for removing paraffin from oil wells including a paraffin cutter assembly having a magnetizable end portion and adapted to periodically drop within the oil well to a predetermined position and then rise to its original position at the upper end of the oil well, electromagnetic means capable of producing a magnetic field mounted on the upper end of the oil well adapted to receive said magnetizable end portion of said cutter assembly, and means for periodically automatically de-energizing said electromagnetic means permitting said cutter assembly to be released from said electromagnetic means and drop in said oil well and for thereafter energizing said electromagnetic means to produce a magnetic field and enable said magnetizable end portion of said cutter assembly upon its return to the upper end of the oil well to be secured to said electromagnetic means.

2. The invention defined in claim 1 wherein said cutter assembly comprises an outer cylindrical sleeve, radially extending cutters mounted on the outer surface of said sleeve and adapted to remove paraffin deposits which accumulate on the inner surface of the oil well tubing, annular cup ring means disposed near one end of said sleeve and adapted to provide snug sliding engagement with the interior surface of the oil well, port means providing communication through said sleeve, and an inner member slidable between a first and a second position

within said sleeve, said inner member provided with port means adapted to align with the port means in said sleeve when said inner member is in the first position and out of alignment when said inner member is in the second position.

3. The invention defined in claim 2 wherein said magnetizable end portion of said cutter assembly is slidable between a first and a second position within said sleeve, the distance between the first and second position of said end portion being the same as the distance between the first and second position of said inner member.

4. The invention defined in claim 3 wherein said end portion is provided with a pair of spaced apart shock blocks, one of said blocks being positioned within said sleeve and the other of said blocks being positioned outside of said sleeve.

5. The invention defined in claim 2 wherein fin means are attached to the outer surface of said sleeve to stabilize the movement of said assembly within the oil well.

6. The invention defined in claim 1 wherein said electromagnetic means is mounted on the upper end and the top of said oil well by a shock absorbing means.

7. The invention defined in claim 6 wherein said shock absorbing means comprises an inflatable chamber.

8. The invention defined in claim 7 wherein said inflatable chamber is formed of a flexible material for containing a pressure fluid.

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CHARLES E. O'CONNELL, *Primary Examiner.*