Oct. 25, 1949. G. McCRAY ET AL 2,486,308

PARAFFIN SCRAPER

Filed March 20, 1945 2 Sheets-Sheet 1

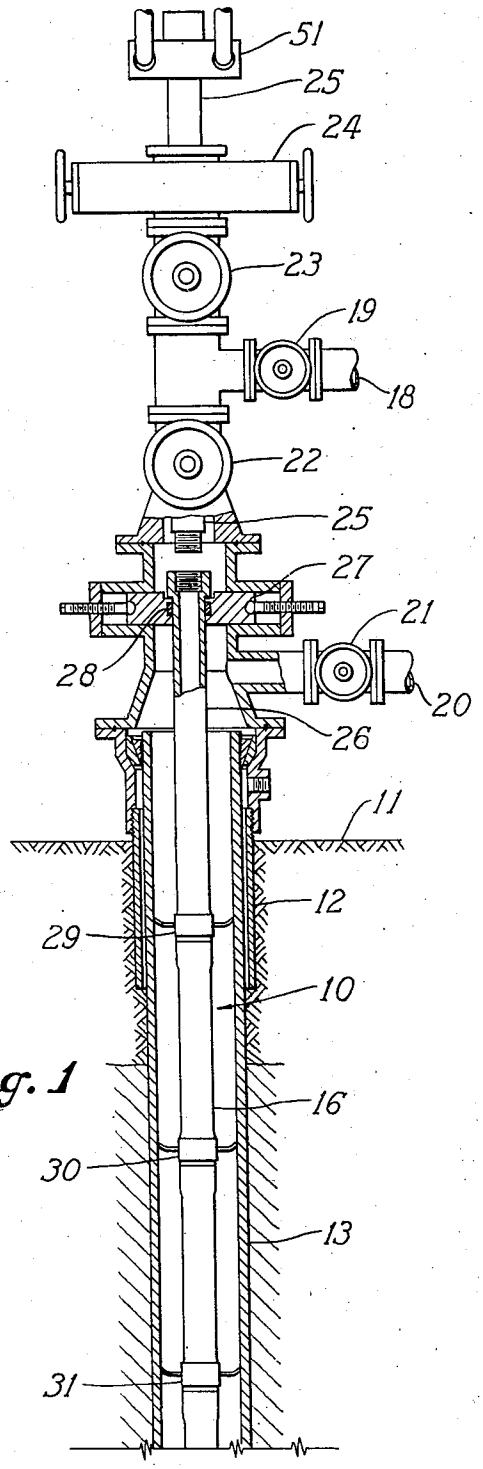

Fig. 1

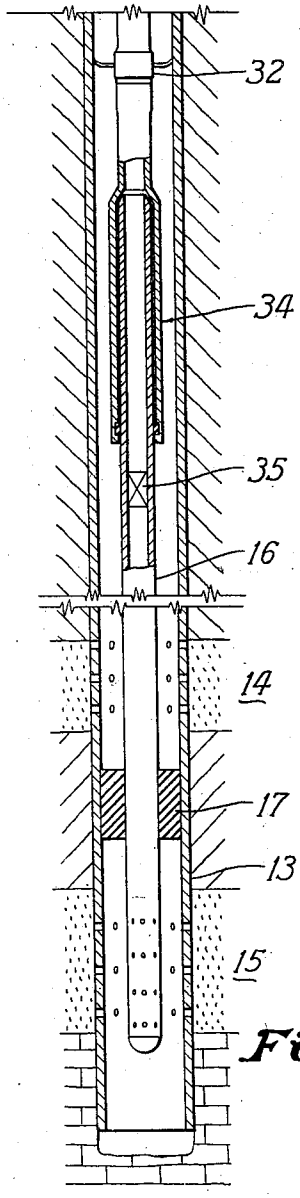

Fig. 2

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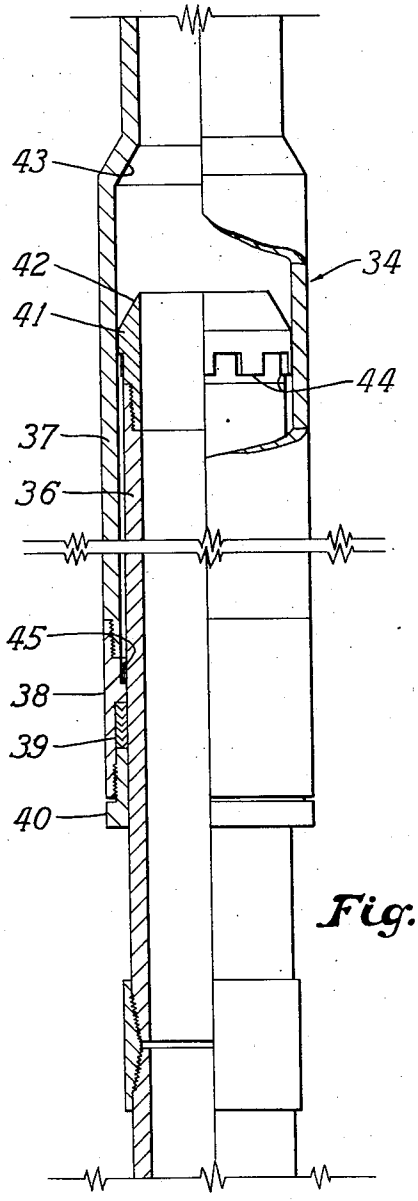

Fig. 3

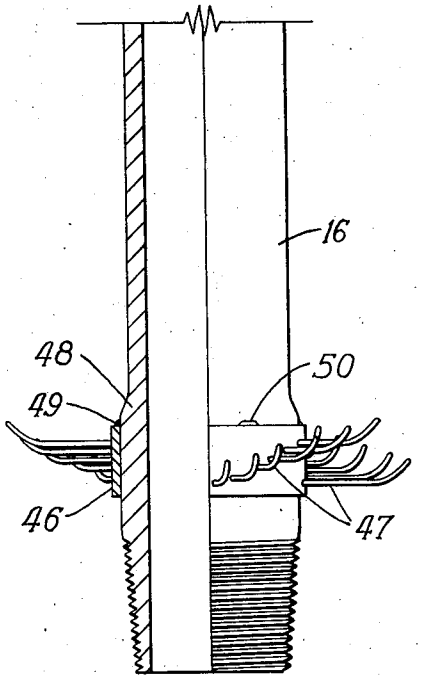

Fig. 4

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PARAFFIN SCRAPER

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8 Claims. (Cl. 166—18)

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This invention relates generally to the removal of paraffin from oil and gas wells, and in particular is directed to apparatus for paraffin removal from the casing of wells producing fluids through the annular space between the tubing and the casing, such as wells producing separately from each of two or more zones.

Various methods and devices have been proposed and used for removing paraffin from the production tubing of wells equipped in the conventional way to produce from a single horizon. For example, solvents have been introduced into the tubing to dissolve and remove paraffin accumulations therein in solution. However, due to the low solubility of the wax in most of the available inexpensive solvents, comparatively large amounts of these are required, or more expensive and highly refined solvents must be used.

Other systems of paraffin removal have relied upon liquefying the solid deposits by the application of heat in some manner, such as by electrical heating, circulation of steam, hot water, hot oil, combustion gases, and the like. While these systems are often satisfactory, special equipment must ordinarily be provided for generating and transmitting this heat energy into the well tubing.

The most used methods of paraffin removal have been those in which the paraffin is simply scraped or cut loose from the interior of the tubing by a tool passed through it. A large number of such mechanical cutters or scrapers have been designed and used with satisfactory results for a long time.

As long as the producing equipment of a well consists of a casing within which is inserted a tubing for carrying all the production to the surface, the paraffin deposits, if any, are confined chiefly to the interior of this tubing, and can be satisfactorily dealt with by the foregoing removal methods. However, an increasing proportion of the wells now being drilled penetrate two or more separated productive zones, and many of these wells are being equipped to produce separately and simultaneously from each of the zones by utilizing both the tubing and the annular space between it and the casing to convey the fluids separately to the surface. This arrangement is commonly known as a "dual completion." Also in certain wells produced by gas lifting all of the production is taken through the annular space, the tubing being used to convey high pressure lifting gas from the surface to the bottom of the well.

In such wells it has been found that the deposition of paraffin when it occurs is not on the

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tubing, which remains relatively clear of accumulations, but is mostly on the inner surface of the casing in the upper part of the well. Apparently the cooling of the paraffin-laden oil by heat loss through the casing to the comparatively cool earth formations in contact with the casing near the surface, combined with possible cooling due to gas expansion, encourages this deposition to occur, the inner casing wall affording the necessary cool surface.

Due to the comparatively large volume within this casing and to its intimate contact with the surrounding earth, neither the solvent nor the heating methods of removal are as effective as when only a relatively small diameter tubing is to be cleaned. Excessively large volumes of solvent are required merely to fill this space, and when heating is attempted, large heat losses to the formations outside the casing inevitably occur.

Since almost all wells deviate at least slightly from the vertical, the tubing is practically certain to lie close to or contact the casing at one or more points along its length. Due to this irregularity of the annular space the design of a cutting or scraping tool that can be raised or lowered through it presents apparent difficulties, with the result that no such tool has been available. Consequently the procedure adopted for field use heretofore has required that the well tubing be completely removed from the well before scraping tools are introduced. Ordinarily this means that heavy mud or other control means must be employed to shut off or "kill" the well production while the operations are being performed. The interruption of the well production and the time and expense of cleaning out the casing are correspondingly greatly increased, and the possibility exists of temporarily or permanently impairing the well productivity if all of the heavy mud should not be removed.

In view of this it is a primary object of our invention to provide an improved and practical apparatus for removing paraffin deposits from the interior of a well casing without removing the well tubing. Another object is to provide equipment for mechanically cutting or scraping paraffin from the casing of a dually completed or other well where production flows through the annular space, by the use of relatively light and easily portable well pulling tools. A further object is to provide such equipment in the form of a permanent installation which may be left in the well, but which does not impede well production through the annular space. A still further object is to provide for paraffin removal from a well cas-

ing apparatus which can be employed without killing or shutting in the well for an extended period of time, the only interruption necessary being only minor and temporary. Other objects, uses, and advantages of the invention will become apparent as the description thereof proceeds.

In the drawings appended hereto and forming a part of this specification we have shown an embodiment of our invention applied to a well producing from two separated zones. It is to be understood that this embodiment is for purposes of illustration only, and that the novelty of our invention is not to be considered as limited solely to the apparatus shown. In these drawings, in which the same reference numeral in different figures indicates the same or a corresponding part,

Figure 1 is a cross section of the upper end of an oil well showing partly in elevation and partly in section typical surface equipment and part of the apparatus of the invention;

Figure 2 is a cross section of the intermediate and lower parts of the well with the remainder of the apparatus of the invention shown therein;

Figure 3 is an elevation with parts cut away showing the details of a telescoping or slip joint used in the invention; and

Figure 4 is an elevation, partially cut away, of a section of well tubing with a preferred type of cutting or scraping member attached thereto.

Essentially, this invention comprises a plurality of paraffin-cutting members attached to the tubing and spaced approximately uniformly throughout the zone of paraffin deposition on the casing. At some point in the tubing string below where the paraffin deposition starts is installed a telescoping or slip joint which allows the upper part of the tubing string thereabove, carrying the cutting members, to be raised and lowered a distance equal to or greater than the spacing between cutting members. Thus by the simple operation of raising and lowering only a part of the tubing string for a limited distance, which can be done with easily portable and light weight pulling tools, the entire inner surface of the casing in that part of the well subject to paraffin deposition can be scraped and cleaned. Dislodged pieces of solid paraffin are carried out by producing the well at an appropriate rate during the operations.

Referring now to Figures 1 and 2, a well 10 is shown drilled from the earth's surface 11, equipped with a surface casing 12, an oil string of casing 13 extending through producing zones 14 and 15, and a production tubing 16. Ordinarily a packer 17 is placed in the annular space between zones 14 and 15, and the casing 13 is perforated opposite both zones. With perforations in tubing 16 opposite only the lower zone 15, it is apparent that production from each of the two zones is kept segregated. Production from zone 15 reaches the surface 11 via tubing 16 where it is discharged into a flow line 18 controlled by a valve 19, while that from zone 14 flows through the annular space between tubing 16 and casing 13, leaving the well through a flow line 20 controlled by a valve 21. Master gate valve 22 may be provided to afford additional control of well 10.

As a safety measure a gate valve 23 and a blowout preventer 24 are preferably installed just prior to carrying out the paraffin removal operations. For lifting and lowering tubing string 16 a nipple 25 may be inserted through preventer 24 and valves 22 and 23, engaging threads at the

upper end of the top joint or section 26 of tubing 16. The upper end of joint 26 may suitably be of larger diameter than the rest of the joint so as to provide a shoulder for supporting it and the rest of tubing string 16 in tubinghead hanger 27. The outer surface of joint 26 is preferably ground smooth and polished so as to slide easily through a packing 28 in hanger 27 without causing excessive wear to the packing.

Spaced at approximately equal intervals throughout the entire zone of paraffin deposition, such as at the couplings of tubing 16, are scraping or cutting devices 29, 30, 31, and 32. At some depth below the lowermost of these cutters, which should be well below the lowest occurrence of paraffin deposits, a telescoping or slip joint indicated generally at 34 is incorporated in tubing string 16. Below slip joint 34 is also inserted in tubing 16 a removable tubing plug 35 for cutting off flow through the tubing temporarily during the operations. This plug 35 may be any of the commercially available types, preferably one which may be inserted and withdrawn on a steel wire line, and should be equipped with an equalizing vave by which the pressure in the tubing therebelow can be released before the plug is withdrawn.

The details of construction of the slip joint 34 may be varied within wide limits, that shown in Figure 3 possessing certain advantages for use in the present invention. This joint may suitably comprise an inner tubing 36 and an outer tubing 37 of somewhat larger inside diameter than the outer diameter of tubing 36, leaving a small annular space between them. Threaded to the lower end of outer tubing 37 is a sleeve 38 carrying a recess containing packing 39 compressed by a threaded nut 40. Packing 39 seals against the outer surface of inner tubing 36, which is preferably ground smooth and polished. Threaded to the upper end of inner tubing 36 is a tip 41 having a beveled face 42 adapted to seat against a shoulder 43 at the upper end of outer tubing 37 when joint 34 is in closed position. When seated, this prevents possible foreign matter from entering and clogging the space between tubes 36 and 37.

The outside of tip 41 is provided also with spurs or teeth 44, which engage corresponding teeth 45 on the inside of sleeve 38. It will be apparent that when joint 34 is extended so that teeth 44 and 45 are engaged, as in the manner of a spline joint or jaw clutch, torque may be transmitted through joint 34 to that part of tubing 16 below it for any desired purpose, such as setting a packer, regulating a bottom hole choke, backing off or unscrewing a left-hand threaded safety nipple, and the like. As indicated previously, the lengths of tubes 36 and 37 must be sufficient to permit a vertical movement of the upper part of tubing 16 somewhat in excess of the spacing between the cutters fixed to it.

A variety of types of paraffin scraping or cutting members may be devised, bearing in mind the limitation that flow through the annular space must not be unduly impeded. The scraper shown in Figure 4 has been tried and found practical. Secured to and projecting radially from a sleeve 46 are a large number of spring wire fingers 47, of a length sufficient to contact casing 13 simultaneously at points around its entire circumference. If desired, the ends of each of the wire fingers 47 may be flattened so as to present a sharp knife-like edge to the paraffin deposits.

In Figure 4 is shown also a preferred manner of securing these scraping devices to the tubing

16. The inside diameter of sleeve 46 being slightly larger than the outside diameter of the upset portion 48 of tubing 16 near each tubing coupling, sleeve 46 is accordingly slipped over upset 48, thin metal shims being inserted between if necessary to make a tight fit. Thereafter sleeve 46 is tack welded to upset 48 at two or more places, such as at 49 and 50.

In operation, after the insertion of plug 35 to shut off the flow through tubing 16 and the installation of valve 23 and blowout preventer 24, lifting nipple 25 is coupled to the upper end of tubing joint 26. Then by means of a hoisting or pulling unit, of which only the tubing elevator 51 is shown, that part of the tubing 16 above slip joint 34 is slowly raised and lowered while the well is being produced through the annular space to sweep out the dislodged paraffin. By noting any decrease in tension required to raise the upper end of tubing 16 and by examining the oil flowing in line 20 for the presence of paraffin cuttings, an estimate can be made of when the casing has been sufficiently cleaned. The cutting action is improved if tubing 16 is rotated slowly while being raised and lowered, as this tends to make the cutting fingers follow new paths or grooves in the paraffin accumulations.

When the scraping has been completed, it is necessary only to remove lifting nipple 25, valve 23, blowout preventer 24, and withdraw tubing plug 35, whereupon production of zone 15 through tubing 16 can be resumed.

By way of example only, and not by way of limitation, in an actual producing well to which this invention was successfully applied, paraffin deposition was occurring on the top 1500 feet of casing. The telescoping or slip joint assembly 34 in this well was installed at a depth of about 3000 feet, the total length of the tubing being about 10,000 feet. This joint 34 allowed about a 28-foot vertical movement of the top 3000 feet of tubing, and the individual cutters were installed at approximately 25-foot intervals, beginning slightly more than 25 feet below the tubing hanger and extending about 100 feet below the lowest known paraffin deposits. Using a light weight pulling unit, and adjusting the production through the annular space to about 12 or 15 barrels per hour, it was found that raising and lowering the apparatus about 17 times at 90-day intervals kept the casing satisfactorily free of excessive paraffin. The total time to perform each entire cleaning operation averaged only about six hours, representing a very great saving in time.

Naturally the time interval between successive cleanings will vary widely from well to well, and the details and dimensions of the various parts of the apparatus can be modified to suit particular well conditions. For example, if three or more formations are produced through concentric tubing strings, and deposition is found to be occurring on one of the outer strings, the next adjacent inner string can be equipped with scrapers and a slip joint as taught herein, for the purpose of removing the deposits.

It will be apparent also that in wells where the lower end of the tubing is free to move, as where the well fluids are being gas lifted through the annular space and there is no packer, cleaning of the inner casing wall may be satisfactorily done by omitting the sliding joint and using only the plurality of scrapers on the tubing. As in such an installation the entire tubing string must be lifted and lowered, heavier hoisting equipment

may be required, but one of the principal advantages of the present invention is still retained in not having to remove the tubing from the well.

As such modifications are deemed to be within the spirit of this invention, its novelty should not be considered as limited solely to the embodiment here described in detail, but is best defined by the scope of the appended claims.

We claim:

1. In a cased dual-completion well structure, adapted for recovery of hydrocarbon products from a plurality of spaced producing strata, a tubular producing conduit extending within and spaced from the well casing, thereby providing an inner producing conduit and an outer producing conduit within the well, the outer conduit having spaced fluid inlets, the inner conduit having a fluid inlet adjacent its lower end, a fluid-excluding seal between said conduits and between the spaced fluid inlets of the outer conduit and above the fluid inlet of the inner conduit, said seal preventing fluid flow between said conduits, a telescoping, fluid-tight joint in said tubular conduit, a plurality of spaced paraffin-cutting members fixed to the exterior wall of said tubular conduit above said joint, and means for reciprocating the portion of said tubular conduit above said joint.

2. In a cased dual-completion well structure, adapted for recovery of hydrocarbon products from a plurality of spaced producing strata, a tubular producing conduit extending within and spaced from the well casing, thereby providing an inner producing conduit and an outer producing conduit within the well, the outer conduit having spaced fluid inlets, the inner conduit having a fluid inlet adjacent its lower end, a fluid-excluding seal between said conduits and between the spaced fluid inlets of the outer conduit and above the fluid inlet of the inner conduit, said seal preventing fluid flow between said conduits, a telescoping, fluid-tight joint in said tubular conduit, a plurality of spaced paraffin-cutting members fixed to the exterior wall of said tubular conduit above said joint, the spacing between said members being less than the telescoping movement of said joint, and means for reciprocating the portion of said tubular conduit above said joint.

3. In a cased dual-completion well structure, adapted for recovery of hydrocarbon products from a plurality of spaced producing strata, a tubular producing conduit extending within and spaced from the well casing, thereby providing an inner producing conduit and an outer producing conduit within the well, the outer conduit having spaced fluid inlets, the inner conduit having a fluid inlet adjacent its lower end, a fluid-excluding seal between said conduits and between the spaced fluid inlets of the outer conduit and above the fluid inlet of the inner conduit, said seal preventing fluid flow between said conduits, a telescoping, fluid-tight joint in said tubular conduit and a plurality of spaced paraffin-cutting members fixed to the exterior wall of said tubular conduit above said joint, said joint and the lowermost of said spaced members being disposed at points on said tubular conduit below the point at which paraffin deposits in the conduit formed between the outer surface of said tubular conduit and the inner surface of said casing.

4. In a cased dual-completion well structure, adapted for recovery of hydrocarbon products from a plurality of spaced producing strata, a tubular producing conduit extending within and spaced from the well casing, thereby providing an inner producing conduit and an outer producing

conduit within the well, the outer conduit having spaced fluid inlets, the inner conduit having a fluid inlet adjacent its lower end, a fluid-excluding seal between said conduits and between the spaced fluid inlets of the outer conduit and above the fluid inlet of the inner conduit, said seal preventing fluid flow between said conduits, a telescoping, fluid-tight joint in said tubular conduit and a plurality of spaced paraffin-cutting members fixed to the exterior wall of said tubular conduit above said joint, said paraffin-cutting members comprising a plurality of flexible elements with interstices therebetween, and means for reciprocating the portion of said tubular conduit above said joint.

5. In a cased dual-completion well structure, adapted for recovery of hydrocarbon products from a plurality of spaced producing strata, a tubular producing conduit extending within and spaced from the well casing, thereby providing an inner producing conduit and an outer producing conduit within the well, the outer conduit having spaced fluid inlets, the inner conduit having a fluid inlet adjacent its lower end, a fluid-excluding seal between said conduits and between the spaced fluid inlets of the outer conduit and above the fluid inlet of the inner conduit, said seal preventing fluid flow between said conduits, a telescoping, fluid-tight joint in said tubular conduit and a plurality of spaced paraffin-cutting members fixed to the exterior wall of said tubular conduit above said joint, said paraffin-cutting members comprising a plurality of radially disposed wires the outer ends of which contact the inner surface of said casing, and means for reciprocating the portion of said tubular conduit above said joint.

6. In a cased dual-completion well structure, adapted for recovery of hydrocarbon products from a plurality of spaced producing strata, a tubular producing conduit extending within and spaced from the well casing, thereby providing an inner producing conduit and an outer producing conduit within the well, the outer conduit having spaced fluid inlets, the inner conduit having a fluid inlet adjacent its lower end, a fluid-excluding seal between said conduits and between the spaced fluid inlets of the outer conduit and above the fluid inlet of the inner conduit, said seal preventing fluid flow between said conduits, a telescoping, fluid-tight joint in said tubular conduit and a plurality of spaced paraffin-cutting members fixed to the exterior wall of said tubular conduit above said joint, stops at either end of said telescoping joint to limit the vertical movement of said tubular conduit above said joint while permitting vertical movement for a distance greater than the spacing between said paraffin-removing members, and means for reciprocating the portion of said tubular conduit above said joint.

7. In a cased dual-completion well structure, adapted for recovery of hydrocarbon products from a plurality of spaced producing strata, a tubular producing conduit extending within and spaced from the well casing, thereby providing an inner producing conduit and an outer producing conduit within the well, the outer conduit having spaced fluid inlets, the inner conduit having a fluid inlet adjacent its lower end, a fluid-excluding seal between said conduits and between the spaced fluid inlets of the outer conduit and above the fluid inlet of the inner conduit, said seal preventing fluid flow between said conduits, a telescoping, fluid-tight joint in said tubular conduit and a plurality of spaced paraffin-cutting members fixed to the exterior wall of said tubular conduit above said joint, a clutch built into said telescoping joint whereby the portion of said tubular conduit below said joint may be rotated around its major axis responsive to similar rotation of the portion of said tubular conduit above said joint, and means for reciprocating the portion of said tubular conduit above said joint.

8. In a cased dual-completion well structure, adapted for recovery of hydrocarbon products from a plurality of spaced producing strata, an outer casing in said well, said outer casing having spaced fluid inlets, an inner producing tubular conduit within said casing and spaced therefrom, said inner tubular conduit comprising a tubular upper section, a tubular lower section and a telescoping, fluid-tight joint connecting said upper and lower sections, said lower section having a fluid inlet adjacent its lower end, a fluid-excluding seal between said casing and said lower section and between the spaced fluid inlets of said casing and the fluid inlet of said lower section, said seal preventing fluid flow between the channels formed by said casing and said inner conduit respectively, a plurality of spaced paraffin-cutting members affixed to said upper section, means for vertically reciprocating and rotating said upper section independently of said lower section to remove paraffin from the inner surface of said casing, above said joint, without shutting off well production.

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