March 7, 1950 D. T. HARBISON 2,499,951

PUMP BARREL

Filed Jan. 17, 1947 2 Sheets-Sheet 1

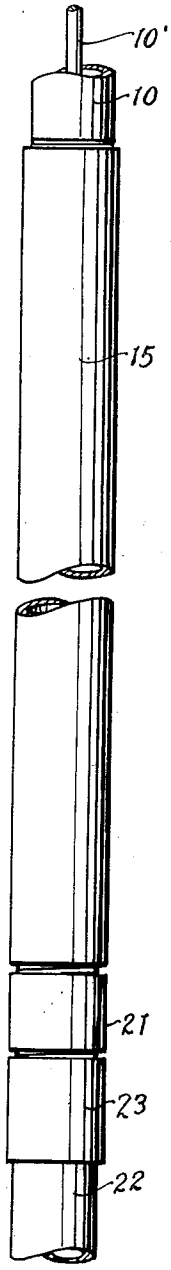


Fig. 1

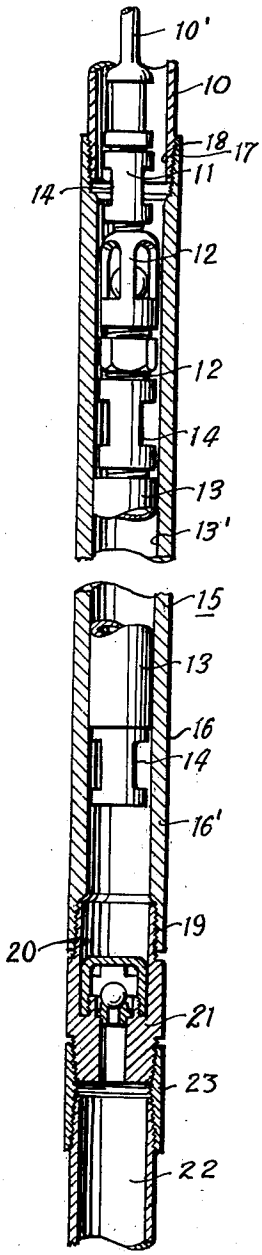


Fig. 2

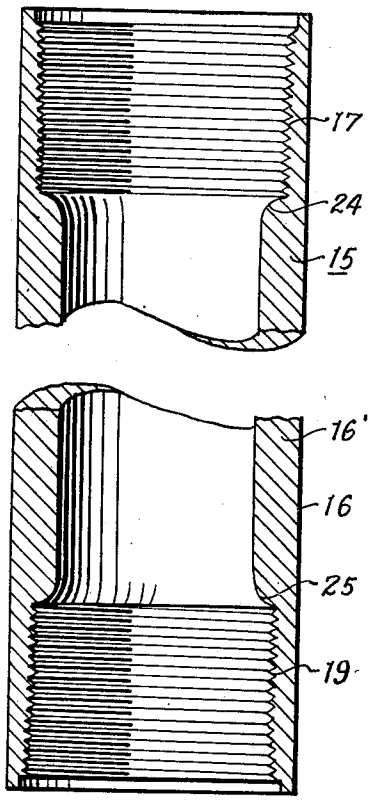


Fig. 3

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PUMP BARREL

Filed Jan. 17, 1947 2 Sheets-Sheet 2

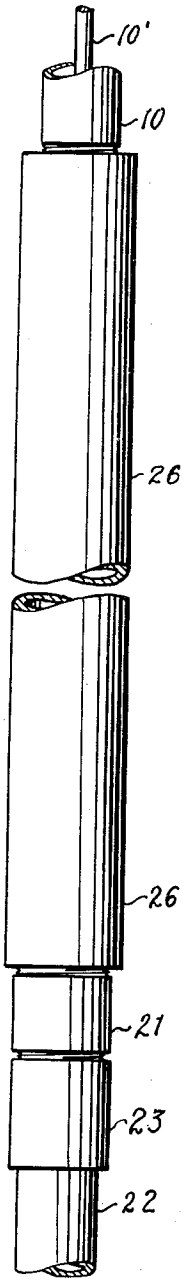


Fig. 4

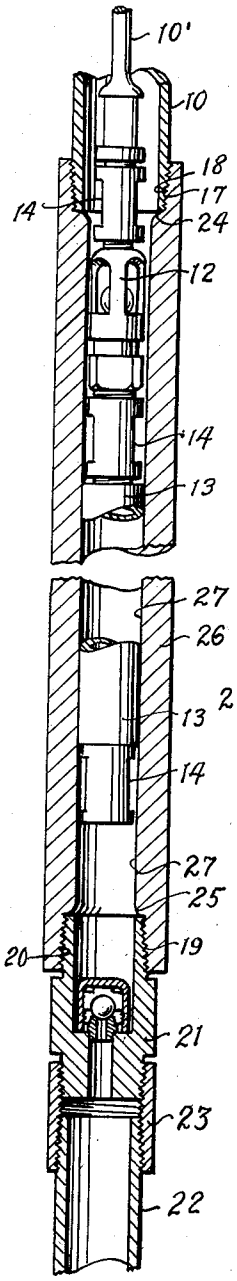


Fig. 5

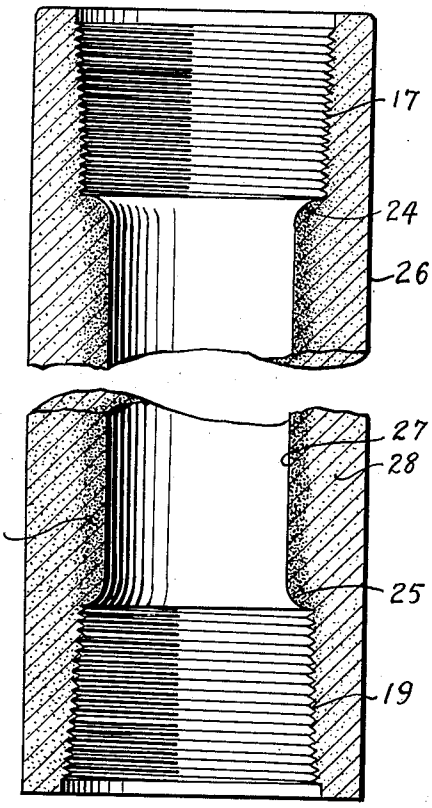


Fig. 6

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UNITED STATES PATENT OFFICE

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PUMP BARREL

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6 Claims. (Cl. 103—216)

1

This invention relates to new and useful improvements in pump barrels.

In the oil fields, two main types of tubing pumps are utilized for pumping wells. These pumps are differentiated by using common working barrels or sectional liners, with either of which metallic or non-metallic plungers are employed. The present invention relates to such a tubing pump which is attached, usually by a screw-threaded connection, to the lower end of the string of tubing. The first-named type of pump, the common pump or working barrel, consists of a seamless, cold-finished tube, threaded on each end for the engagement of the working barrel collars. The inside of the tube is given a smooth finish, accurate as to size, to receive the traveling valve or reciprocating plunger, and the tube is provided with external screw threads at each end. The threads on the outside of the working barrel are tapered pipe threads, as is customary, and very often in practice in the oil fields, when the collars are screwed onto the working barrel, due to this taper and the taper on the collar threads, in tightening the collar on the tube or barrel, the tube is squeezed out of round or distorted in the portion of the barrel adjacent the threaded connections, thereby making the inside diameter of the tube at this point slightly oval and/or considerably smaller than the rest of the tube. In other words, the tube is necked down due to the tapered threads on the tube or barrel and the collar.

This disadvantage prohibits the use of an accurate, closely-fitting metallic or non-metallic plunger because of the distortion of the working barrel near the collars. Therefore, the use of a common working barrel is largely confined to valves using non-metallic cups, and to plungers using non-metallic rings, which can yield sufficiently or in a manner to enter the barrel and, after entering the barrel, expand to fit tightly the bore of the barrel. Even so, the cup and rings are quite often damaged in passing through the distorted portion of the common working barrel.

The common working barrel is generally used in the oil fields in shallow wells, mainly under three thousand feet in depth, and are not sufficiently exact in dimensions to be used in deep wells where the plunger must have a precision fit to lift the oil to the surface of the ground. In deeper wells, what is known as a sectional liner tubing pump is used, which consists of a series of cast alloy iron or steel sections, relatively short in length and being precision machined. The sections are aligned axially and clamped into working position inside of a steel housing so as to form a substantially continuous working barrel. This latter form of pump liner or working barrel is expensive and unwieldy, and is subject to misalignment and other causes of leakage in deep wells.

2

Therefore, neither of these tubing pumps has entirely eliminated the difficulties due to distortion or misaligning of the working barrel, which is a continuing problem.

Another problem has been damaging of the working barrel as it is lowered and set in the well bore. Quite often, in setting a working barrel in a well bore, the tubing is lowered too far, so that the barrel is distorted or sprung by having the weight of the entire tubing string placed thereon. The problem of internal wear of the working barrel has remained a source of trouble and expense.

It is, therefore, one object of this invention to provide an improved working barrel which is not subject to distortion upon being connected into a tubing string.

Another object of this invention is to provide an improved working barrel having internal screw-threads for connection with the tubing sections, so that any distortion of the working barrel would be manifested on the exterior rather than the interior of the barrel; and which is formed of heavy wall tubing so that such distortion is minimized.

Yet another object of this invention is to provide an improved working barrel which may be accurately finished so as to receive a metallic plunger having a very close tolerance fit within the working barrel, so that deep wells may be pumped with facility.

A still further object of the invention is to provide an improved working barrel of greater wall thickness than any section or portion of the tubing string, so that any distortion which takes place due to the weight of the tubing being rested on the barrel, will result in distortion of some other element of the tubing string rather than the working barrel.

Another object of the invention is to provide an improved working barrel which has its inner bore artificially hardened, and which is formed with internal chamfers to facilitate entry of a pump plunger.

A construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood

from a reading of the following specification and by reference to the accompanying drawing, wherein an example of the invention is shown, and wherein:

Fig. 1 is a view in elevation of a pumping barrel constructed in accordance with this invention, connected into a tubing string,

Fig. 2 is a vertical, longitudinal, sectional view,

Fig. 3 is an enlarged, longitudinal, section view of the working barrel without the related parts or elements,

Fig. 4 is a view in elevation of a modified form of the invention,

Fig. 5 is a vertical, longitudinal, sectional view of the modification shown in Fig. 4, and

Fig. 6 is an enlarged, longitudinal view of the modified barrel, showing additional modifications.

In the drawings, the numeral **10** designates a tubing string adapted to be lowered into a well bore and through which oil is to be pumped upwardly to the surface of the ground. Oil well tubing normally consists of lengths of pipe having external screw-threads at each end and joined together by internally screw-threaded collars. However, some pipe is utilized having the collars formed integrally therewith in the shape of a screw-threaded box, the other end of each length of pipe carrying a screw-threaded pin. Such pipe is provided with internal and/or external offsets at the joints to supply the desired wall thickness at these points. In this specification and the claims appended thereto, the word "collars" will be construed as including all these forms of pipe or tubing joints, whether the collar is formed separately or not.

The usual string of sucker rods extends downwardly through the tubing from the well head. Only the lower end **10'** of the sucker rod string is shown, and it has connected thereto, at its lower end, the usual fitting **11** which carries the usual traveling valve **12**. A pump plunger **13** depends axially of the fitting **11** being connected to the valve **12**, and may be of any desired and usual construction. The plunger is provided with wrench faces **14** at its upper and lower ends to facilitate its connection and disengagement with the fitting **11** and the sucker rod string. The traveling valve may be of any suitable type and communicates with the bore **13'** of the pump plunger so as to receive fluid therefrom.

A unitary, one-piece, working or pump barrel **15**, constructed in accordance with this invention, is connected to the lower end of the tubing string **10**. The barrel **15** consists of an elongate cylindrical tube **16** having an outside diameter substantially equal to that of the usual tubing collar, as shown in Fig. 1. The inside diameter of the barrel is in conformance with the American Petroleum Institute standards, and is determined by the characteristics of the well in which the barrel is to be positioned. This internal diameter of the barrel is considerably less than the outside diameter of the barrel so that relatively heavy side walls **16'** are provided, thus lending considerable strength and distortion resistance to the working barrel. A screw-threaded box **17** is formed at the upper end of the barrel and engages the usual screw-threaded pin **18** provided upon the lower end of the lower length of tubing **10**. A similar screw-threaded box **19** is formed at the lower end of the working barrel and receives the upstanding screw-threaded pin **20** of the usual standing valve **21**. A suitable length of tubing or a strainer **22** is connected to the lower end of the standing valve assembly by the usual collar **23**. The barrel carries an internal, annular chamfer **24** at the lower end or bottom of the box **17** to eliminate the sharp shoulder which normally would be present between the box and the heavy side wall **16'** of the barrel. A similar chamfer **25** is provided at the upper end or bottom of the lower screw-threaded box **19** for a similar purpose.

In assembling the structure, the screw-threaded pins **18** and **20** engage the boxes **17** and **19** and are thus disposed within the heavy walled structure of the working barrel rather than externally thereof. The thickness of the side wall of the barrel eliminates a considerable proportion of any distortion of the barrel which may occur due to the wedging action caused by the engagement of the pins. However, any distortion which does occur due to this wedging action, tends to spread or flare the working barrel rather than to neck or restrict the same. Therefore, no obstruction is offered to the entry of the pump plunger **13**, and a very closely fitting plunger may be utilized. In addition, a metallic plunger or a composition plunger may be used at the option of the operator. Since the barrel is protected against distortion it may be very closely finished and yet no obstacle is presented to the insertion or operation of any desirable type of plunger within the working barrel. The chamfers **24** and **25**, of course eliminate the probability of the plunger, or its allied elements, catching or hanging at the bottom of either of the boxes **17** and **19**, and damaging, in some fashion, the plunger and/or the barrel.

Obviously, since the pump plunger does not normally engage or telescope the lower end of the pump barrel, distortion at this point is not as important and the box structure on the lower end may be omitted with only small impairment of the desirability of the barrel. However, the reversibility feature of the barrel would be lost and such omission, in this respect, is not advantageous.

As stated before, the outside diameter of the barrel is approximately equal to the outside diameter of the usual tubing collar, which, normally, is the element of greater perimeter in a tubing string. Since the inside diameter of the barrel is less than that of a collar and no greater than any element in the tubing string, it follows that the wall thickness of the barrel will be at least equal to the wall thickness of any element in the string, if not greater. Thus, a stout and relatively rigid working barrel is provided which resists distortion. The barrel may be made from a metal having a high elastic limit. Due to the heavy wall structure of the barrel and the high elasticity of the metal, slight bending thereof, to conform to the well bore as the barrel is lowered therein for setting, would not prevent the barrel from resuming its original straightness.

It is to be kept in mind, that the straightness or trueness, as well as the absence of restriction, of the working barrel, after it is set in working position in the well bore, is of paramount importance. A working barrel may be anywhere from 4 to 20 feet in length, and even longer barrels have occasionally been used. The plunger also may be from 2 to 8 or more feet in length, in accordance with the length of the working barrel and the depth of the well. As stated before, different types of plungers may be used, metallic or various non-metallic structures being common. Since the plungers are relatively rigid and must fit closely within the working barrel, any restric-

tion or lack of straightness of the barrel will cause the plunger to bind, to wear prematurely and unevenly, and to be incapable of holding and carrying the hydrostatic load necessary to pump a well efficiently. This improper functioning does not necessarily depend on accelerated wear and may occur almost immediately after the barrel has been set in the well bore. If the barrel is restricted, distorted or bent, the plunger may be simply unable to hold the required pressure or may bind in the barrel. This is especially true in deeper wells. In any event, the unnatural friction and wearing conditions will overload the sucker rods and source of pumping power as well as necessitate early and premature replacement of the plunger and possibly the barrel and other parts.

The tubing string and sucker rod string do not fit closely, and their dimensions are not especially critical except within comparatively large tolerances. Due to the considerable length of these two elements and their inherent flexibility, they may readily take care of bends and convolutions in the well bore so as to protect the working barrel from stresses and bending moments. However, this provision is of no avail if the barrel is damaged in making up the pumping string or in setting said barrel.

The invention described hereinbefore makes adequate provision for substantially eliminating the faulty operation caused by restriction of the working barrel by the working barrel collars, and to a large extent, the damage caused by crooked well bores and by improper setting operations. Such an improper setting operation would be, for example, lowering the entire tubing string with the working barrel, into the well bore until the tubing or strainer **22** rests on the bottom of the well bore (or other obstruction), and thus placing a columnar stress equal to the weight of the tubing string, on the working barrel. The barrel would thus be loaded, possibly beyond its elastic limit, and permanently distorted or deformed, with the consequent impairing of proper and efficient pump plunger functioning. This is not to be desired.

Manifestly, it is extremely desirable to have a one-piece or unitary working barrel or pump liner, since these oil well pumps, in spite of their specialized nature, are in reality a simple form of pump. This does not mean ordinary pump practices are always applicable; but, it does mean that to obtain a precision-fitting pump, quite a few feet long, which may be lowered thousands of feet into the earth and still operate properly, a unitary working barrel which may be accurately and precisely machined and finished and set in the well bore without distortion, is highly desirable. True, such pumps have been manufactured and used for many years, but they have never been entirely satisfactory, and have required more servicing and replacements than would seem justified.

To further adapt this invention to normal as well as abnormal well-pumping conditions as described above, a modified form of the invention is shown in Figs. 4 and 5 of the drawings. This modification is very similar to the form previously described, with the exception that the working barrel **15** is replaced by an extremely heavy-walled, one-piece, working barrel **26** having an axial bore **27**. The other elements of the structure remain the same and have been designated by the same numerals.

This barrel of increased wall thickness represents more than a mere change in dimensions. It

carries out the purposes and objects of this invention to a greater and more certain degree under more severely trying circumstances or conditions. The increased wall thickness provided for the upper and lower boxes diminishes the possibility of necking or restriction of the barrel at these points. It makes more certain that any distortion will be in the pins which engage in these boxes, which pins do not have a close internal fit with the pump plunger.

The extra heavy-walled construction also protects the barrel against permanent distortion in passing through restricted portions of the well bore while being lowered, or in being subjected to the dead weight of the entire tubing string while being set. It is noted, that the barrel is heavier and more rigid than any other element of the tubing string, including the collar **23**. Thus, any distortion incurred will take place in the lighter elements and the straightness of the working barrel preserved to insure proper pump plunger operation.

Being thus assured of a substantially indistortable working barrel, further steps may be taken to enhance the efficiency and desirability of the well pump. The barrel and plunger may be more closely machined and finished. The bore of the barrel may be polished to a very close fit with the plunger to minimize slippage and increase efficiency. It is estimated that clearances as small as .001 inch may be achieved and maintained. Thus, considerably deeper wells may be pumped without undue operating costs, while the expenses of pumping shallower wells may be materially reduced.

In addition, the bore of the working barrel may be artificially or differentially hardened, as indicated in Fig. 6, by carburizing or nitriding, or other methods of selective hardening such as localized inductiton heating, whereby a barrel having increased wear resistance, as well as closer clearances, obtains. The carbon content of the body **28** of the barrel may be held within any desired limits to give the desired physical characteristics to the main portion of the latter, while the carbon content (or other metallurgical criterion) of the inner metal or "case" **29** next the bore **27** may be varied to give the desired degree of hardness. As an illustration, the barrel may be formed of a heat-treatable alloy and only the bore hardened by selective heating, such as by induction heating. Any desired method or means of hardening may be used. Practices heretofore not usable in tubing pumps, are thus made available and of benefit. The internal hardening and closer tolerances go hand in hand with the protection against distortion of the working barrel.

The various advantages and results set out hereinbefore apply to all forms of the invention described. Of course, some of the results approach the optimum more closely in the second form than in the first, due largely to the extra heavy-walled structure of the former. However, extremely beneficial results are characteristic of both forms.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

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

1. A one-piece pump barrel for well tubing pumps adapted to be connected into tubing

strings having collars, including a heavy-walled tube having a substantially continuous outer surface of a diameter at least equal to the outside diameters of the tubing collars, said tube having an inside diameter less than the inside diameter of any element of the tubing string thereabove and an internally screw-threaded box at one end of the tube.

2. A one-piece pump barrel as set forth in claim 1, wherein the bore of the tube is artificially hardened.

3. A one-piece pump barrel as set forth in claim 1, and an internally screw-threaded box at the opposite end of the tube.

4. A one-piece pump barrel as set forth in claim 3, and chamfers at the bottom of each box between said boxes and the bore of the tube.

5. A one-piece pump barrel for well tubing pumps adapted to be connected into tubing strings having collars, including, a heavy-walled tube having a substantially continuous outer surface of a diameter greater than the outside diameters of the tubing collars, said tube having an inside diameter less than the inside diameter of any element of the tubing string thereabove, and an internally screw-threaded box at one end of the tube.

6. A one-piece pump barrel for well tubing pumps adapted to be connected into tubing strings having collars, including, a heavy-walled elongate tube, an internally screw-threaded box in each end of the tube, said tube being of substantially uniform cross-section throughout its length between said boxes, the tube having an outside diameter at least equal to the outside diameters of the tubing collars and in inside diameter less than the inside diameter of any element of the tubing string thereabove.

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