

Feb. 15, 1966

K. D. BROWN
ELONGATED TENSION LOAD CARRYING ELEMENT
FOR OIL WELLS AND THE LIKE

3,234,723

Original Filed Aug. 3, 1959

2 Sheets-Sheet 1

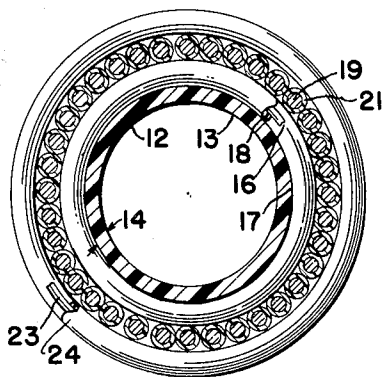


FIG. 2

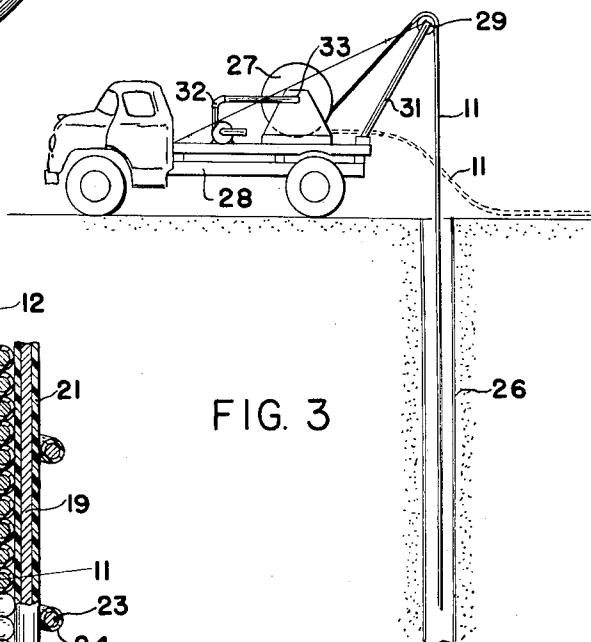


FIG. 3

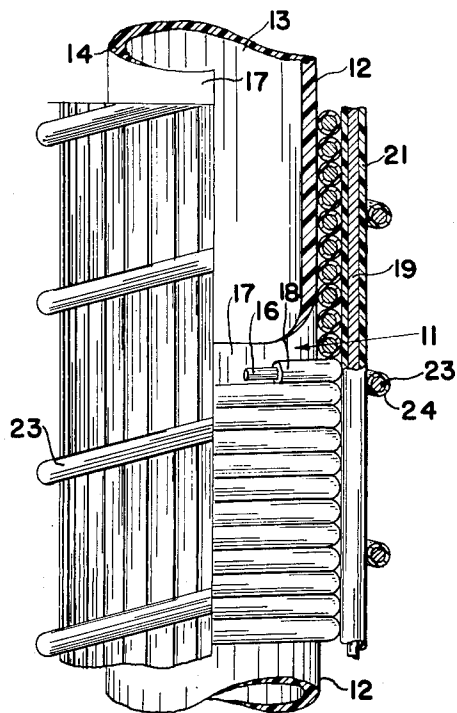


FIG. 1

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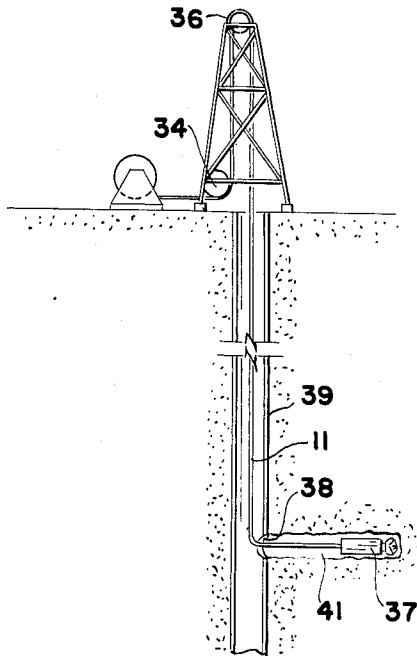


FIG. 4

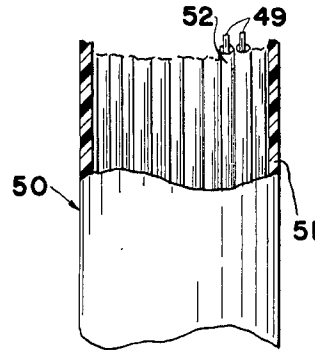


FIG. 6

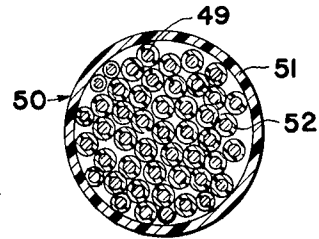


FIG. 7

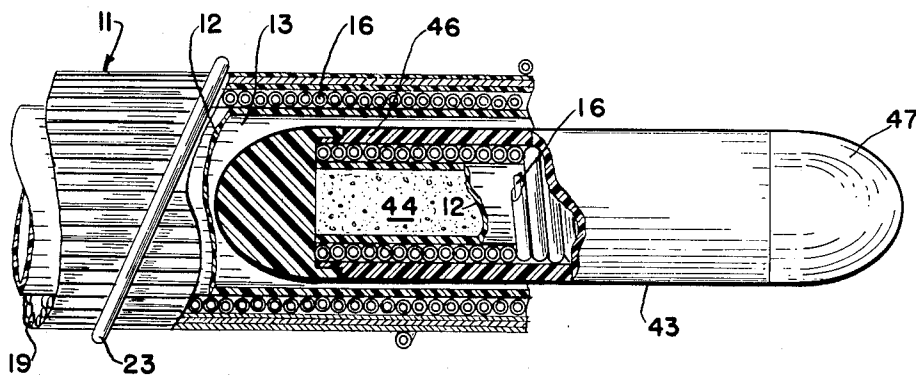


FIG. 5

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ELONGATED TENSION LOAD CARRYING ELEMENT FOR OIL WELLS AND THE LIKE

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Original application Aug. 3, 1959, Ser. No. 831,260, now Patent No. 3,174,512, dated Mar. 23, 1965. Divided and this application May 20, 1963, Ser. No. 281,615
7 Claims. (Cl. 57-149)

The present application is a division of my copending application Serial No. 831,260, filed August 3, 1959, now Patent No. 3,174,512, which is a continuation-in-part of my copending application Serial No. 792,143, filed the 9th day of February, 1959. The present invention relates to an improved type of flexible tubing or similar structure and to related improvements in a pump sucker rod. As set forth in the earlier copending application, it has been found advantageous to provide a tubing structure which is of a flexible nature though capable of withstanding high operating pressures. A general summary of the advantages to be expected from the use of such tubing when made up of a plastic liner and multi-strands of steel wire for the reinforcing thereof would include the fact that the tubing may be made in long lengths without numerous joints. This feature alone enhances the operational characteristics of the apparatus, inasmuch as the absence of a great number of joints makes handling of the tubing more convenient and likewise tends to cut down internal flow friction. When such feature is coupled with the use of a smooth plastic liner, it is expected that materials may be delivered through the tubing in higher volume than would otherwise be possible through jointed lengths of steel pipe.

The improved interior surface condition and the absence of flow disrupting joints and the exposed metal thereof will make use of the present type of tubing especially advantageous in oil production where high paraffin oils having a relatively low solidification temperature are to be handled.

The foregoing features, together with additional advantages, are pointed out in my earlier copending application. The specific advantages of the present embodiment of the invention are intended to satisfy the following further objectives.

It is an object of the present invention is to provide structural features for tubing and well pump or sucker rod which make it easier and more economical to assemble a structure satisfying the objectives summarized above.

It is a further object of this invention to provide a structure which is adaptable to many varied uses inclusive of that of well tubing, on-surface well delivery tubing, as turbine drill string for direct bore and offset drilling, and for other similar uses in which a flexible tubing having high flow delivery and high pressure characteristics is desired.

It is a further object of this invention to provide auxiliary structures of similar design and construction useful in connection with such tubing, such structural modifications being inclusive of a well pump or sucker rod structure and a flexible insert cell adapted for passage through the tubing as necessary for selected purposes.

Further objects and advantages of the present invention will be apparent from the appended description and drawings, in which:

FIG. 1 is an elevation in partial section showing the general structural features of an embodiment of this invention;

FIG. 2 is a cross-section view of the structure shown in FIG. 1;

FIG. 3 illustrates one method of use of the invention;

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FIG. 4 shows an alternate method of use emphasizing the flexible features of the tubing structure;

FIG. 5 is an elevation in partial section showing the structure of an insert cellular unit;

FIG. 6 is an elevation in partial cross section showing the structure of a well pump rod or sucker rod used in conjunction with the apparatus described herein; and

FIG. 7 is a cross section showing further features of the sucker rod.

Briefly stated, the present invention provides alternate means for obtaining desirable structural characteristics in flexible tubing and related units. A main distinction between the present application and that of my copending application Ser. No. 792,143 is the use of independent reinforcing and tensioning wires which have been separately coated with a layer of protective material prior to assembly into the composite derived structure. The independent and separate protective coating of plastic or the like about each of the wires makes it easier to provide an assembled structure that is more flexible, that withstands high pressures, and that is able to withstand the high tensional forces coincident with the use of a long string of tubing within a vertically disposed well structure.

In addition to the adaptation of the separately coated reinforcing wires to tubing, the present invention shows the use thereof in a well pump or sucker rod and in the building of an insert cellular unit which is useful when introduced through tubing liner to obtain a well plug or as a carrier unit for chemicals or explosives as necessary for well or well structure development.

Referring now to the drawings, the detailed features of a preferred embodiment of this invention are shown in FIGS. 1 and 2. Here a tubing structure which may be used for various flow delivery installations is shown. This tubing structure 11 includes an interior liner 12 which is preferably made of a resin base or plastic material of a type that will provide an extra smooth interior surface 13. Further, the liner 12 should provide a wall 14 of uniform thickness adaptable to flexural use.

While natural and synthetic rubbers could be used for such liner, plastic materials are preferred. It has been found that extruded nylon tubing satisfies most requirements of oil production and further provides a highly glazed internal surface 13. Other plastics are suitable and undoubtedly could be used to advantage for installations where different types of chemicals are to be carried by the tubing structure 11. It is recognized that other plastics, such as Teflon, may be used where improved characteristics for specific purposes are desired. If the tubing is to be used for the flow delivery of oils having a low paraffin solidification temperature, the smooth interior surface 13 or a material having a decreased chemical and mechanical affinity for paraffin is highly desirable.

Since most of the materials that might be used to provide the flexible liner 12 have a relatively low tensile strength, and since cost factors dictate the use of relatively thin wall sections 14 for the liner 12, it is desirable to provide reinforcement to improve the burst strength of the structure. As in my copending application Ser. No. 792,143, this increased pressure resisting strength is obtained through use of a continuous, tightly wound, helical reinforcing wire 16 intimately disposed about the exterior surface 17 of the liner 12. Preferably the reinforcing wire 16 is made of a material having high tensile strength, such as steel. Where steel or other corrosible material is used, it is desirable to provide a protective coating 18 about the wire 16. As shown, this protective coating 18 may have a relatively thin wall section and may be made of the same type of plastic as the liner 12, as shown, or of other material. Where plastics are used, the protec-

tive coating 18 may be extruded about the reinforcing wire 16 as it is passed through an extrusion die to obtain an intimate bond on the wire and a uniform wall thickness. In order to obtain the desired intimate bond between the wire 16 and protective coating 18, it is desirable that the wire be acid etched prior to its passage through the extrusion die. When the process is properly regulated, an intimate bond between the wire and protective covering 18 is obtained which is highly resistant to destruction or displacement by abrasive and other forces.

In addition to providing anti-corrosion protection, the protective coating 18 prevents galling of the exterior face 17 of the liner 12 and of the longitudinal tension wires 19. Where these longitudinal tension wires 19 are likewise provided with a protective coating 21, as shown, the operational service life of the tubing will be greatly increased, and deterioration of the tubing or of the wires 16 or 19 will be greatly minimized.

While the closely wound reinforcing wires 16 are used to provide a high pressure structure, it is recognized that in certain usages the tubing structure 11 will have to further provide resistance to high tensile stresses. The longitudinal tension wires 19 are provided for this purpose. These wires are disposed about the tubing structure 11 in longitudinal arrangement. As shown, these wires may be disposed in side-by-side arrangement or may be spaced each from each about the external surface of the reinforcing wires 16. In order to maintain optimum flexural characteristics and further to prevent any tendency of the tensional forces in the wires 19 to collapse the tubing structure 11, spiral placement of the tension wires 19 should be avoided. However, it is recognized that these wires may satisfactorily serve their purpose even though disposed in loose spiral arrangement. Accordingly, any terminology inclusive of the word "longitudinal" used in description of the tension wires 19 is intended to include any arrangement of wires in which the pitch distance for any developed spiral is greater than ten times the diameter of the derived spiral.

With this preferred arrangement of the longitudinal tension wires 19, any tendency of such wires to restrict the flexural bending of the combined structure 11 is eliminated. However, it is recognized that the longitudinal wires 19 should be confined in some manner so that they will not be caught on obstructions within the well casing or on similar objects during surface usage.

While an exterior continuous plastic sheeting may be used, as shown in my copending application Ser. No. 792,143, it has been found that a further shield wire 23 may be used in spiral or coiled arrangement about the exterior surface of the longitudinal tension wires 19 to hold the wires in a closely knit bundle. This wrapping layer made of the shield wire 23 may likewise be provided with corrosion and abrasion protection through provision of a coating 24 on the surface thereof. As illustrated, the pitch distance for this helically wound shield wire 23 is less than ten diameters and is preferably of approximately one helix diameter.

The tubing structure 11 described has many and varied usages. As shown in FIG. 3, the tubing may be readily transported on vehicles to positions of use. In the servicing of well structures the tubing may be introduced and removed from the well 26 by actuation of a power driven reel 27 mounted on a truck vehicle 28. The tubing may be passed over a sheave 29 of relatively small diameter disposed on a boom 31 for straight line introduction into the well. For usage in which fluid is to be pumped through the tubing 11, a flow delivery system 32 may be connected directly to the central trunnion 33 of the reel 27 for passage through the end of the tubing hooked to the reel.

At any time that the tubing is to be removed for use at another site or for cleaning, the entire length of the tubing 11 may be retrieved and coiled upon the reel 27. Since the tubing may be made in long lengths, all

interruptions for the purposes of joining the tubing are avoided. These quick placement and removal features of the invention likewise make this type of tubing highly useful for on-surface use.

As shown by the dotted line representation in FIG. 3, the tubing 11 may be laid out or picked up from surface locations readily and easily through use of the reel structure 27. It is contemplated that the invention will be of great utility in well servicing operations. With the high mobility and quick installation and removal features, it is expected that in some instances several wells may be serviced by a single servicing unit. With a lowered proportionate capital expenditure, the profit margin may be improved.

On other installations where paraffin coagulation of conventional tubing is expected, the provision of the highly polished interior surface 13 having a decreased affinity for deposited paraffins will be a boon to oil producers. A system which cuts down or eliminates paraffin deposits and which may further be readily removed from the well structure for cleaning if necessary presents a two-fold improvement over present conventional practices.

The flexible and pressure resistant characteristics of the tubing structure 11 suggest further uses for such tubing. As shown in FIG. 4, the tubing may be reeved over idlers 34 and bull wheels 36 of small diameter for introduction into a well structure. At the same time application of fluids under high pressures makes it possible to use the tubing 11 as a flow delivery system for a turbine drill 37. When used with a turbine drill, the flexible characteristic will make it possible to more economically accomplish offset drilling in which the tubing 11 will be passed through a window 38 in the well casing 39 to drill lateral or angular openings 41 through oil bearing or other strata.

The smooth interior face 13 of the liner 12 makes it possible to insert various kinds of well servicing apparatus. In FIG. 5 an insert 43 is shown which may be introduced through the tubing 11 to pass through and around any bends therein. In the embodiment shown, the insert 43 is used to enclose a granular material 44 within the liner 12. In this modification of the flexible structure, which is for use with explosive materials, the closely wound helix wires 16 surround the liner 12 but are themselves enclosed within a jacket 46, the ends of which are closed off by the cap members 47. The jacket 46 is provided so that the pressure influences at the bottom of a well will not be able to compact the explosive granular material 44 within the liner 12. It has been found that the wires 16 are effective in resisting external pressures as well as internal pressures when covered with a pressure distributing layer such as the jacket 46. If the insert 43 is used in conjunction with the directional drilling features possible with use of the turbine drill 37, it would be practical to drill many openings out into a formation and to successively pull back and plant a plurality of explosive inserts 43 in spaced positions in such openings as necessary to completely fracture an oil bearing structure.

A modified type of sucker rod or pump rod 50 is shown in FIGS. 6 and 7 where a plurality of longitudinal tension wires 49 are disposed in bundle arrangement within a plastic tubing 51. This simplified structure will provide a well pump or sucker rod 50 useful in the manner described in my copending application Ser. No. 792,143. For this usage the wires 49 may be provided with a coating 52 or may be used bare if desired. If at least the exterior wires of the bundle are coated, abrasion of the interior surface of the tubing 51 will be minimized. The sucker rod 50 may be left within the tubing 11 to be reeled therewith during well servicing operations.

In all of the embodiments of the invention shown and described, it should be noted that each element of the combined structure is a separate piece in itself which, though joined with other elements for cooperative action,

still has individual freedom. With this arrangement each element is free to act independently of the other elements under the influence of forces directed against such element. This freedom of independent action has been found to be highly beneficial, inasmuch as displacement or tearing of one element due to forces acting on and moving another element is minimized.

While each element has the freedom of independent action, the bundled type cooperative structure obtained is able to utilize and develop the full strength of each of the separate elements. In the unity there is strength to withstand the stresses of usage; and the resultant strain is absorbed by movement and deformation of the individual elements of the structure without the necessity of corresponding deformation of the other elements of the structure.

While uses of the present structure have been described in the field of oil production and fluid flow, it should be realized that the tubing structure has many other additional and potential uses. A structure similar to that shown in FIG. 5 for the explosive insert 43 has been utilized for a carrier of granular or powdered metals. Further, tests have been made on a structure in which the granular material illustrated is a highly compacted powdered metal and in which the end cap members 47 are of electricity conducting type material. This modified structure may be used in long lengths as an electrical conductor suitable for above-ground or below-ground usage.

While separate embodiments of the invention and methods have been shown and described, it is apparent that the present invention is adaptable to various modifications and changes. All such modifications as come within the scope of the hereunto appended claims are deemed to be a part of this invention.

I claim:

1. An elongated element for carrying the heavy tension loads of oil well pumping equipment and the like comprising a plurality of separate substantially straight tension wires of high tensile strength material each having a protective covering of plastic material securely bonded thereto, and means for retaining said wires in a closely bundled configuration while affording at least limited relative movement of the wires with respect to one another substantially throughout their lengths thereby tending to equalize the tension and utilize the full strength of all the wires.

2. An elongated element as set forth in claim 1 wherein said retaining means has a surface of plastic material thereon and frictionally engages the plastic covering of said tension wires adjacent thereto.

3. An elongated element as set forth in claim 1 wherein said retaining means comprises a tube of plastic material enclosing said plurality of wires.

4. An elongated element as set forth in claim 1 wherein said retaining means includes a helically wound wire

having a covering of plastic material bonded thereto and wound about said tension wires in frictional engagement therewith.

5. An elongated member for carrying the heavy tension loads of oil well pumping equipment and the like comprising a plurality of separate substantially straight elements of high tensile strength material coextensive with the length of the member, each of said elements having a smooth outer surface of plastic material, and means for retaining said elements in a closely bundled configuration while affording at least limited relative movement of the elements with respect to one another and substantially throughout their lengths thereby tending to equalize the tension and utilize the full strength of all the elements.

6. An elongated member as set forth in claim 5 wherein said retaining means has a surface of plastic material frictionally engaging the surface of the ones of said tension elements adjacent thereto.

7. A flexible sucker rod or the like for carrying the heavy tension loads of oil well pumping equipment and the like comprising a plurality of longitudinally arranged wires of high tensile strength material, each having a coating of smooth plastic material throughout its length and said wires being bundled together to provide a substantially round core structure, and a covering of plastic material surrounding said structure and retaining said wires in their closely bundled round core configuration, said plastic material providing relatively low friction surfaces on said wires and on said covering, and said wires being free for at least limited relative movement with respect to one another whereby said wires may adjust their positions and equalize their loads upon bending of said rod.

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