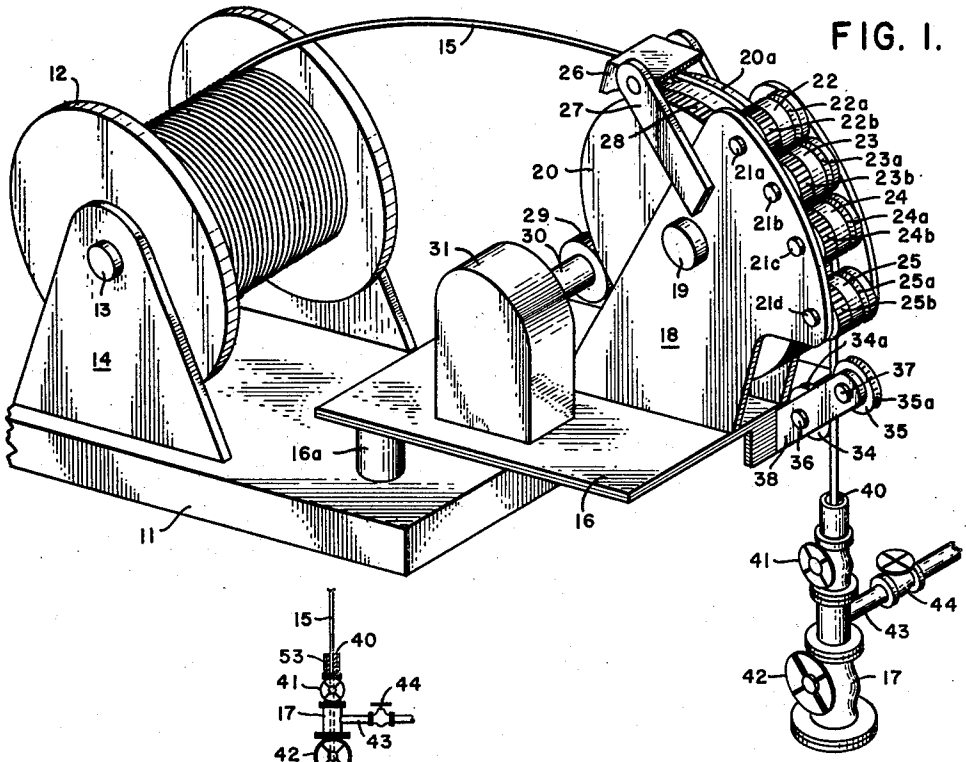
Jan. 7, 1964 P. R. McSTRAVICK 3,116,793

COMPLETION AND WORKING OVER OF WELLS

Filed March 29, 1961

FIG. 1.



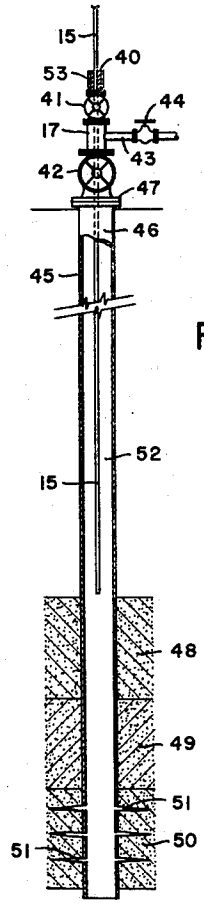


FIG. 2.

INVENTOR.
PETER R. McSTRAVICK,
BY

ATTORNEY.

United States Patent Office 3,116,793
Patented Jan. 7, 1964

3,116,793

COMPLETION AND WORKING OVER OF WELLS

Peter R. McStravick, Tomball, Tex., assignor, by mesne assignments, to Jersey Production Research Company, Tulsa, Okla., a corporation of Delaware

Filed Mar. 29, 1961, Ser. No. 99,237
8 Claims. (Cl. 166—21)

The present invention is directed to a method for completion and working over of wells. More particularly, the invention is concerned with the employment of a continuous length of coiled tubing in well completion and workover operations without killing the well. In its more specific aspects, the invention is concerned with a method in which a coiled tubing is straightened and run into a well under pressure for use in flowing a fluid therethrough.

The present invention may be briefly described as a method for completing and working over a well under pressure in which a continuous length of coiled substantially rigid or inflexible tubing free of joints is employed. In the practice of the present invention, the tubing is uncoiled and a sufficient force is applied peripherally to the tubing to straighten the tubing and the straightened tubing is then forced into the wall under pressure. Thereafter, fluid is flowed through the straightened tubing. After fluid has been flowed through the straightened tubing, the tubing may be withdrawn from the well under pressure and then recoiled for subsequent use in completion and working over operations.

The present invention will be further described with respect to the drawing in which:

FIG. 1 is an isometric view of an apparatus for uncoiling the coiled tubing, straightening it, and forcing the straightened tubing into the well; while

FIG. 2 is a partial cross-sectional view of a well having the straightened tubing run thereinto.

Referring now to the drawing which represents a preferred mode and particularly to FIG. 1, numeral 11 designates a suitable support such as the bed of a truck on which is arranged a reel or spool 12 having an axle 13 carried by a yoke 14. Arranged on the reel or spool 12 is a coil 15 of substantially rigid or inflexible ferrous metal or other metallic tubing. The support or truck bed 11 has a platform 16 arranged on upstanding supports 16*a* which may be several in number, the platform protruding from the support 11 such that it may be positioned adjacent wellhead 17. Mounted on the platform 16 is a yoke 18 which carries on axle 19 a large first drum 20 and which carries on axles 21*a*, 21*b*, 21*c* and 21*d* a plurality of smaller drums 22, 23, 24 and 25, respectively. Drum 20 is grooved with groove 20*a* to receive the tubing 15 and drums 22, 23, 24 and 25 are also provided, respectively, with grooves 22*a*, 23*a*, 24*a* and 25*a*, which are aligned with groove 20*a* to engage with the tubing 15. Guide means, such as block 26, guides the tubing 15 onto drum 20 to fit in groove 20*a*. Means 26 may be carried by a yoke 27 mounted on yoke 18. The drum 20 has attached thereto or has formed thereon a gear 28 which meshes with a gear 29 carried on shaft 30 and which is connected to a power means such as a hydraulic motor 31. The gear 28 meshes with gears 22*b*, 23*b*, 24*b* and 25*b* of drums 22, 23, 24 and 25, respectively, to cause drums 22, 23, 24 and 25 to rotate in a direction opposite to the rotation of drum 20 on operation of the power means 31. The tubing 15 is carried over the drum 20 and under the drums 22, 23, 24 and 25, and then is forced between tandemly arranged straightening rollers 34 and 35 which are rotatably mounted by axles 36 and 37 on yoke 38 which is attached to the platform 16.

Passage of the tubing 15 over the drum 20 and under

the drums 22, 23, 24 and 25 and between the rollers 34 and 35 which are spaced apart a sufficient distance such that the grooves 34*a* and 35*a* will accommodate passage of the straightened tubing 15 between the rollers 34 and 35 causes the tubing 15 to be forced downwardly.

The straightened tubing propelled by drum 20 through the straightening rollers 34 and 35 is then forced through the opening 40 of the wellhead 17 which is provided with valves 41 and 42 and a flow line 43 provided with a valve 44. This force or pressure is exerted by the drum 20 on the straightened pipe. The wellhead 17 is connected into the well 45, as shown in FIG. 2, which may suitably be cased with a casing 46. The well 45 is under pressure and is suitably closed in with a closure means 47 attached to the wellhead 17. The well 45 pierces a plurality of subsurface earth strata, sands, intervals, zones, or formations 48, 49, and 50, which may contain hydrocarbons or other valuable earth fluids such as gas, crude petroleum, helium, carbon dioxide, and the like. The casing 46 has been pierced in interval 50 to form perforations 51 through which hydrocarbons may flow into the casing 46, thence to the well head either through the tubing 15 or through the annulus 52 and thence by way of flow line 43 to suitable storage as may be desired. The straightened tubing 15 is sealed in the opening 40 by sealing means 53 and may have connected thereto control means, not shown, such as a valve such that the straightened continuous tubing 15 may be used for injection of fluid, for example, into any of the subsurface formations as may be desired. It may be expedient to seal the perforations 51 and this may be accomplished by lowering the tubing 15 to the region of the perforations 51 and flowing a slurry of a fluid such as a slurry of cementitious material into the perforations. Thereafter, excess cementitious material in a fluid condition may be removed by reverse circulation with fluid flowing down through the flow line 43, the annulus 52, and up through the tubing 15 to the earth's surface. Other well completion fluids may be employed such as emulsions, cementitious materials, slurries, stimulating agents, gases, liquids, surface active agents, and the like, acids, gels, fluid-containing corrosion inhibitors, and other servicing fluids such as lost returns control agents, sand consolidation chemicals such as resins, and the like, fresh or salt water, hydrocarbons, and fracturing fluids. The fluid may be a liquid or a gaseous or vaporous fluid, as may be desired.

Means for injecting fluid through a tubing arranged on a reel for running into a well are well known and are shown in the Priestman et al. Patent 2,548,616. Briefly, the end of the tubing on the reel is connected to the hollow core element of the reel which, in turn, is connected through a suitable connection to a source of fluid. Valve means are suitably used to close the tubing to hold well pressure.

Thus, the present invention enables the accomplishment of well completion and workover and servicing operations by utilizing coiled tubing instead of the jointed tubing, which is currently in use. The coiled tubing is wound on a spool or reel and is then uncoiled, straightened and forced into the well under pressure as has been described and then may be retrieved and reused. Alternately, the tubing may be left in the well to facilitate operations which may occur frequently such as injection of hot oil or corrosion inhibitor. Likewise, the tubing may be left in the well for use permanently as a production tubing for flow of hydrocarbons and the like therethrough or for control of the well.

In the present invention, a continuous length of coiled tubing is utilized and the tubing is removed from the coil and straightened for running into a well under pressure. The tubing is secured while running in, removing,

or in a stationary position and the coiled tubing is straightened for use in the well such that undue friction loads against the sides of the casing or tubing in the well are not produced.

In the present invention, the large drum with the smaller drums carried thereon provides means for holding or lifting the tubing, while the rollers, which rotate freely, straighten the tubing as it comes off the large drum. The smaller drums also force the straightened tubing into the well.

The number of peripherally arranged drums may be two or more although four have been shown. It is desirable to provide a plurality of peripherally arranged drums. Likewise, a plurality of pairs of straightening rollers may be used with the straightening rollers spaced vertically below the peripherally carried drums.

It is necessary to provide a suitable resilient seal, such as 53, between the tubing 15 and the wellhead 17 as the tubing 15 enters the opening 40 such that the well may be maintained under pressure.

It is also necessary in the present invention that force be applied to the straightened tubing adjacent the wellhead sufficient to force the straightened tubing into the well. This force must be applied to the straightened tubing about 12 inches from the wellhead for satisfactory results. This force or pressure may be an amount from about 10% to about 25% greater than the pressure of the well. If the force is applied otherwise to the tubing, then the tubing will corkscrew and not enter the pressurized well.

The amount of pressure on the well will ordinarily be formation pressure which may range from about 50 to about 7000 pounds per square inch. Since the well is under pressure, once the casing has been perforated into a hydrocarbon producing zone, such as an oil or gas strata, to inject fluids into such zones, it will be necessary to employ a pressure greater than formation pressure down through the continuous tubing on the fluid to be injected or introduced into the well.

The large drum is suitably sized to provide a large area of contact with the tubing, while the smaller drums provide a small area of contact. The large drum has a diameter in the range from about 5 to about 10 times the diameter of the smaller drums to provide the necessary area of contact. Thus, the large drum may have a diameter measured from the bottom of the groove of about 35.25 inches; whereas, the smaller drums each may have a diameter measured from the bottom of the groove of about 5.29 inches. The gear on the large drum may be about 36 inches in diameter, while the gears on the smaller drums may have diameters of about 6 inches. The smaller drums are suitably mounted on the large drum to provide an angle measured from the center of the large drum of about 60°.

In a specific embodiment with one large and four small drums of a size indicated, the contact area of the large drum with tubing of ¾ inch outside diameter is about 21.962 square inches; whereas, the four smaller drums provide a total contact area of 0.28 square inch, the contact area of each of the smaller drums being 0.070 square inch.

The grooves on the several drums must be of size to accommodate the tubing for passage between the several drums. These gooves may have a depth for ¾ inch tubing of about 0.323 inch.

The method of the present invention is quite advantageous and useful in that wells may be completed and serviced using a continuous tubing string which may suitably be arranged on a coil eliminating most of the manpower ordinarily used and also eliminating the necessity of using numerous lengths of pipe, which heretofore has presented a tremendous problem in handling same. Once the continuous tubing string is run into the well, it may be used for sand washing, circulation, stimulation, or for performing other completion or workover operations by circulating fluid or liquid down the continuous tubing string or by reverse circulation where the fluid or liquid flows upwardly through the continuous tubing.

The nature and objects of the present invention having been completely described and illustrated, what I wish to claim as new and useful and secure by Letters Patent is:

1. A method for completing and working over a well under pressure having a wellhead in which a continuous length of coiled substantially inflexible tubing is employed which comprises uncoiling said tubing, leading said tubing over a continuous curvilinear rotating surface while maintaining peripheral contact of said tubing with said curvilinear surface, driving said curvilinear surface and propelling said tubing tangentially to said curvilinear surface into said well while again applying peripheral contact to said tubing immediately adjacent said wellhead in the absence of driving force, whereby said tubing is straightened as it is propelled into said well such that said straightened tubing extends from the wellhead a selected distance into said well, and then flowing fluid through said straightened tubing.

2. A method in accordance with claim 1 in which the peripheral contact applied to said tubing adjacent said wellhead is about 12 inches from said wellhead.

3. A method in accordance with claim 1 in which a force from about 10% to about 25% greater than the pressure of the well is applied to said tubing by peripheral contact with said curvilinear surface.

4. A method in accordance with claim 1 in which said fluid is cement.

5. A method in accordance with claim 1 in which said fluid comprises a corrosion inhibitor.

6. A method in accordance with claim 1 in which said fluid comprises a stimulation agent.

7. A method in accordance with claim 1 in which the fluid is flowed through said straightened tubing into said well under a pressure greater than the pressure of said well.

8. A method in accordance with claim 1 in which fluid is flowed through said straightened tubing from the well.

References Cited in the file of this patent

UNITED STATES PATENTS

2,548,616	Priestman et al.	Apr. 10, 1951
2,567,009	Calhoun et al.	Sept. 4, 1951