United States Patent [19]
Bozeman

[11] **3,841,407**
[45] **Oct. 15, 1974**

[54] **COIL TUBING UNIT**

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[22] Filed: **Jan. 2, 1973**

[21] Appl. No.: **320,051**

[52] **U.S. Cl.** **166/315,** 166/77, 226/173, 242/86.1, 254/175.5

[51] **Int. Cl.** **E21b 33/03,** B65h 75/00

[58] **Field of Search** 166/315, 75, 77; 226/172, 226/173; 175/103; 254/175.7, 175.5; 242/86.1; 198/162, 165

[56] **References Cited**

UNITED STATES PATENTS

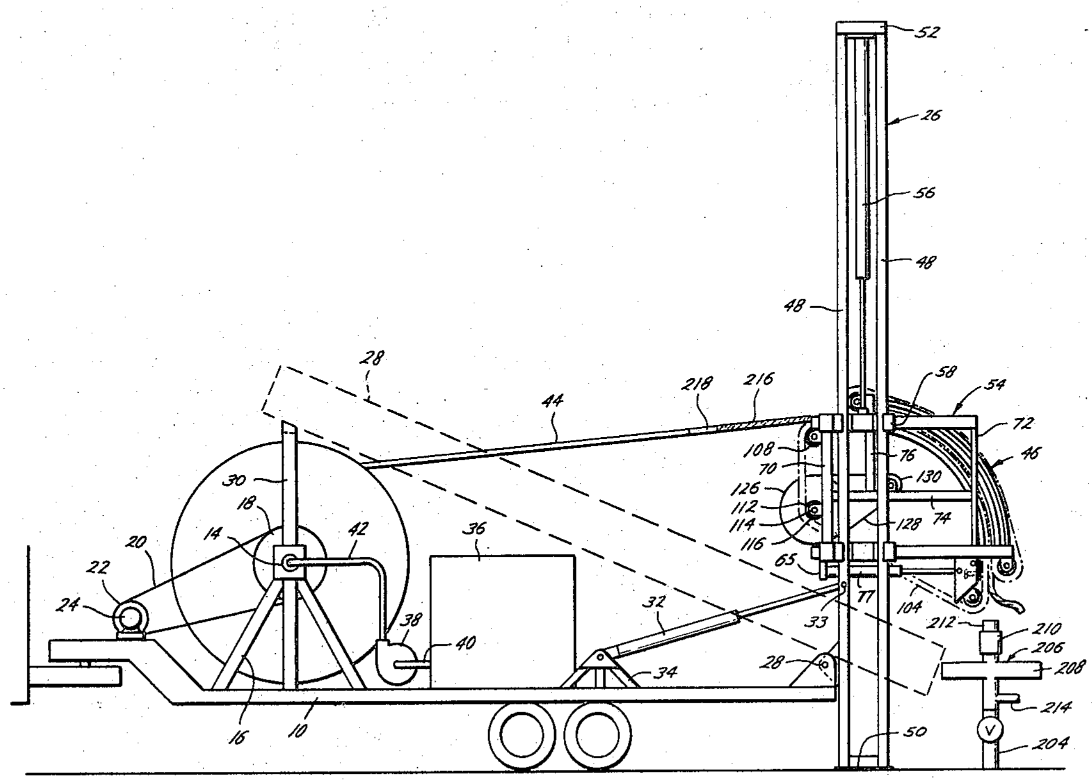
2,548,616	4/1951	Priestman et al.	175/103
2,567,009	9/1951	Calhoun et al.	166/77
3,116,781	1/1964	Rugeley et al.	166/77
3,116,793	1/1964	McStravick	166/77
3,285,485	11/1966	Slator	166/75
3,363,880	1/1968	Blagg	166/77
3,373,818	3/1968	Rike et al.	166/77
3,658,270	4/1972	Slator et al.	242/86.51
3,667,554	6/1972	Smitherman	166/77
3,690,136	9/1972	Slator	166/77

Primary Examiner—James A. Leppink
Attorney, Agent, or Firm—Murray Robinson; Ned L. Conley; David Alan Rose

[57] **ABSTRACT**

Apparatus and method for running a continuous length of coiled substantially inflexible tubing into a well wherein the coiled tubing is pulled from a reel by means of a feeding unit which includes opposed roller chains moving along an arcuate path formed by a frame, with one of the roller chains being powered and provided with gripping elements for gripping the tubing, and the other roller chain being pressed into engagement with the tubing by fluid pressure in a hose which provides uniform pressure along the arcuate path; the tubing being straightened at the outlet of the arcuate path by a straightening device.

26 Claims, 11 Drawing Figures



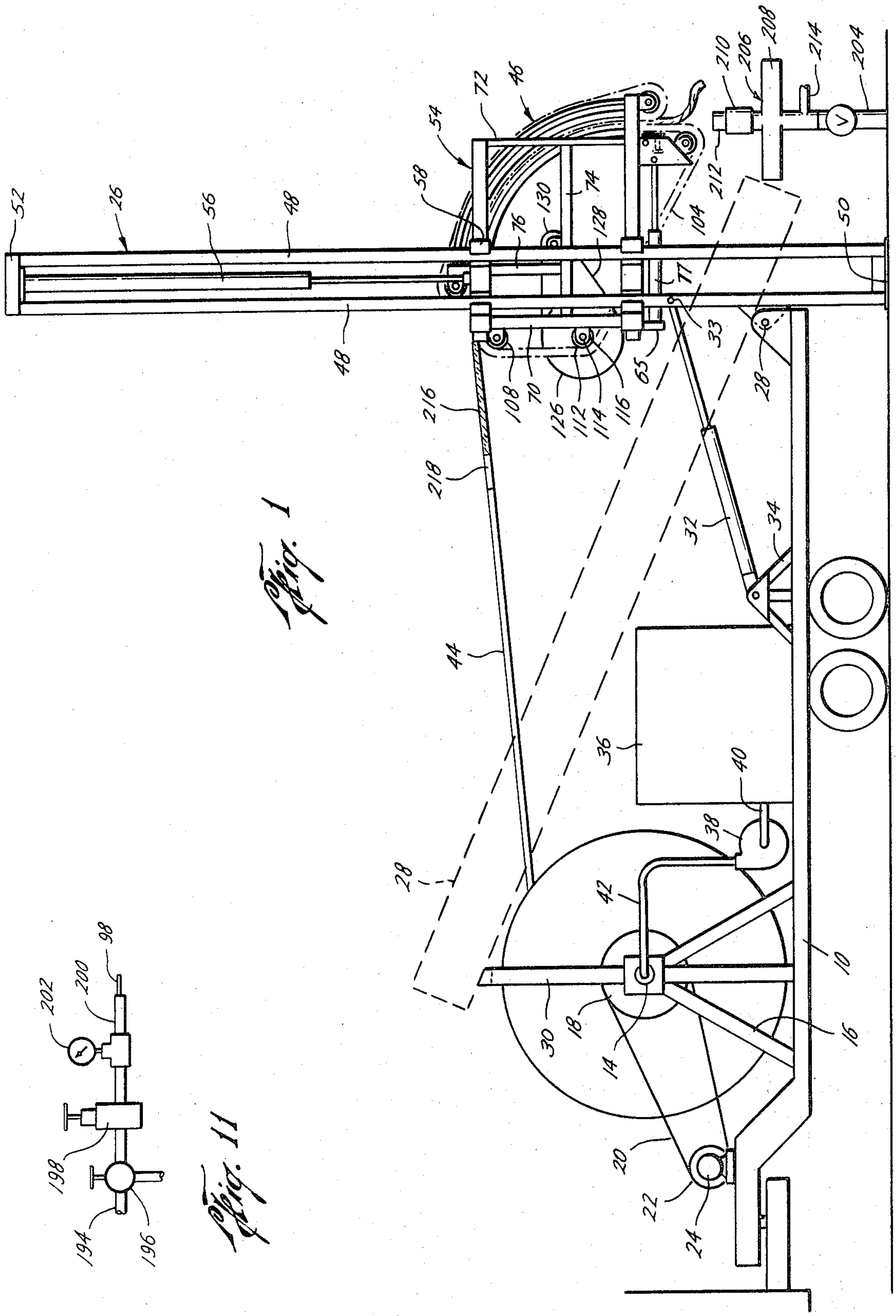


Fig. 1

Fig. 11

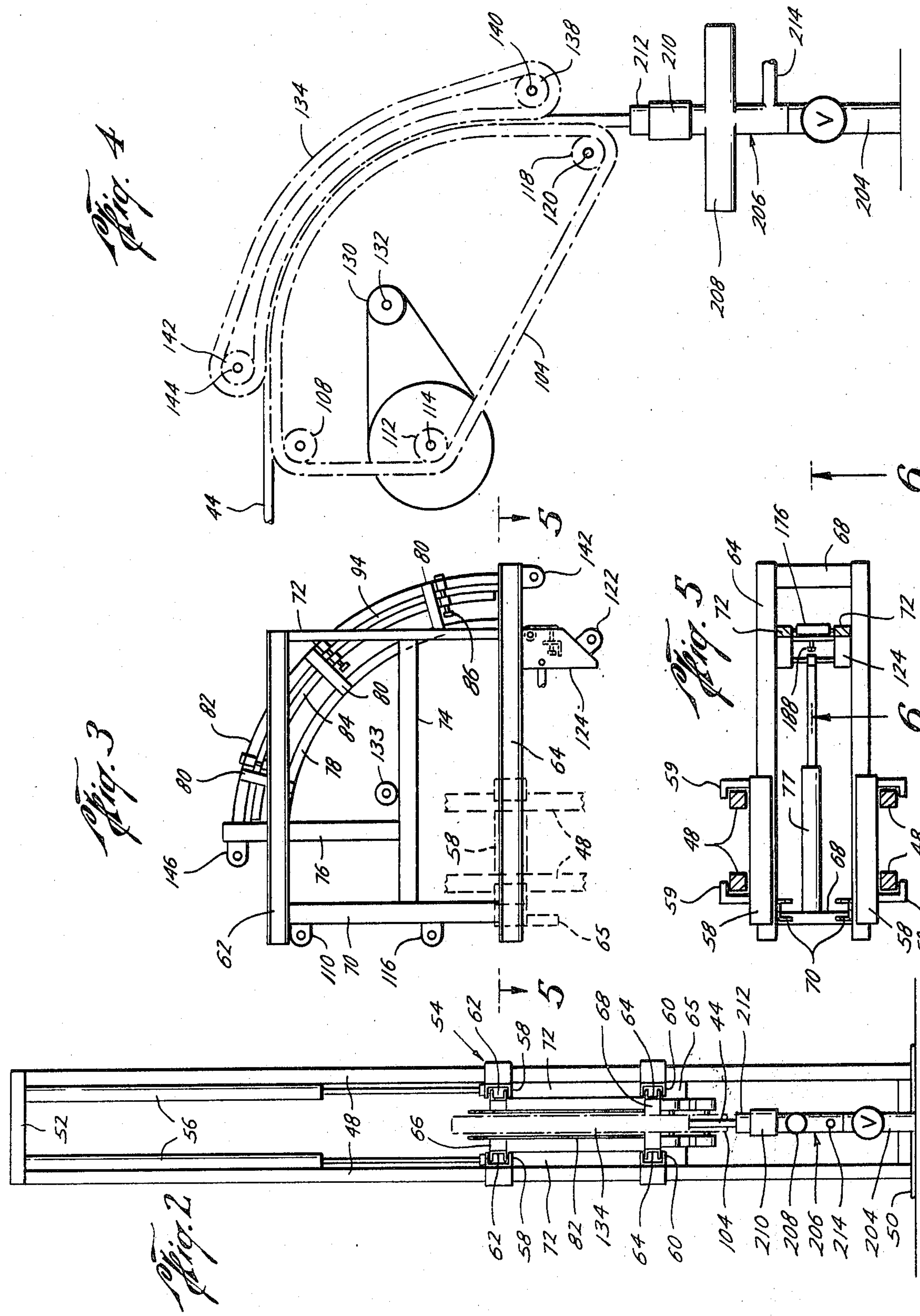
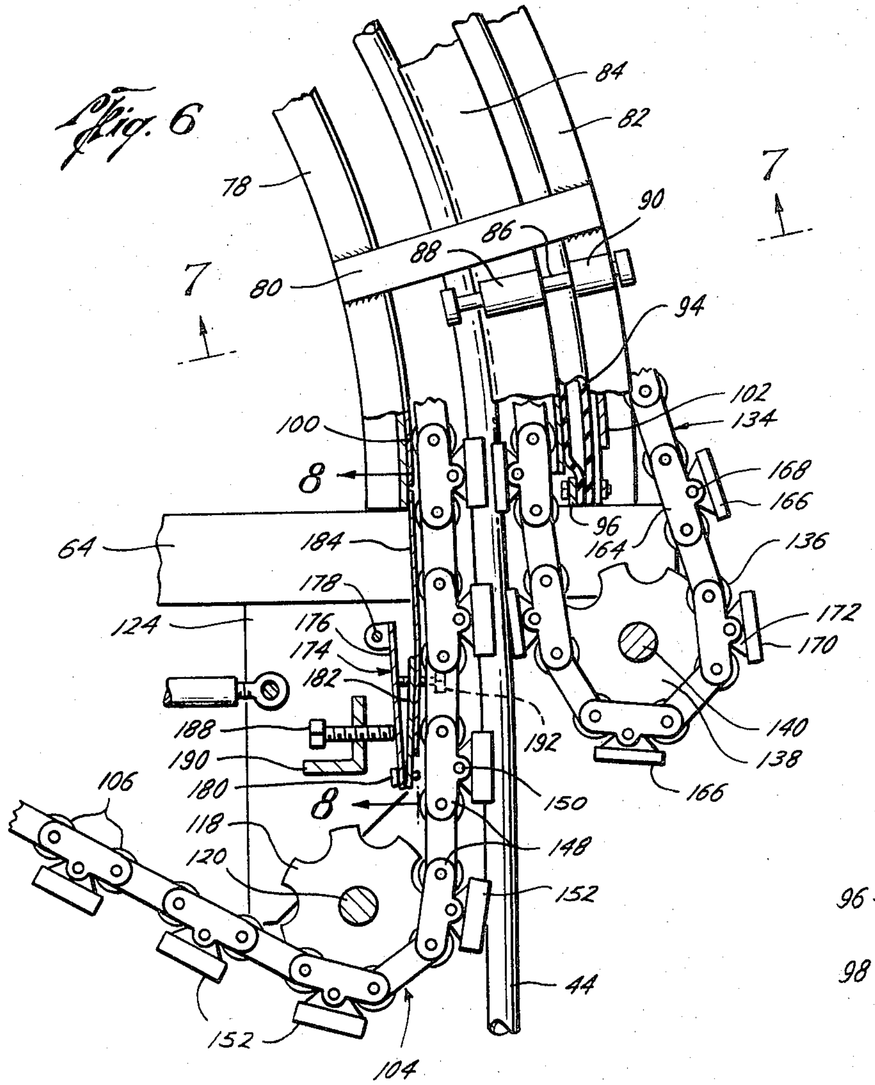


Fig. 2
Fig. 3
Fig. 4
Fig. 5

Fig. 6



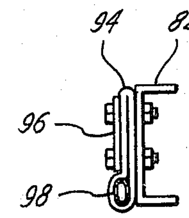
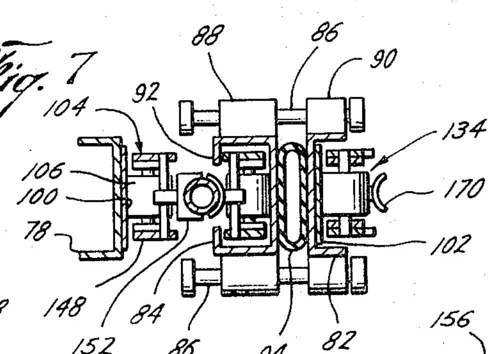


Fig. 10

Fig. 7



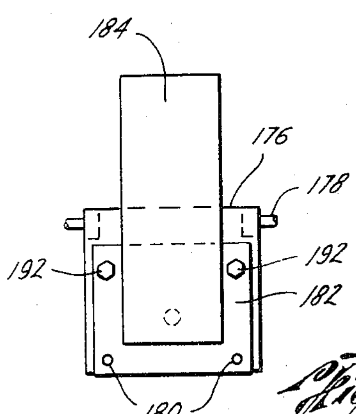


Fig. 8

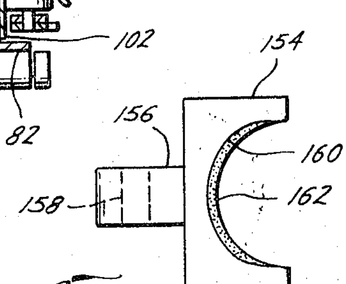


Fig. 9

COIL TUBING UNIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to equipment and method for feeding coiled substantially inflexible tubing into a well.

2. Description of the Prior Art

In completing and in working over oil wells it is sometimes necessary or desirable to inject fluids into the production tubing at a level well below the surface of the ground. For example it may be desirable to inject liquid corrosion inhibitors into the well flow stream far down the production tubing in the well. Other fluids which may be injected include cement slurries, emulsions, stimulating agents, gases, liquids, surface active agents, acids jells, lost returns control agents, sand consolidation chemicals such as resin 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.

It has been known for some time that such fluids may be injected into a well by means of a substantially inflexible coiled tubing which is pulled from a reel and pushed down into the production tubing to the desired location in the well. Such tubing may be of steel, stainless steel, other metals, or various substantially rigid plastic materials. Means for injecting fluid through such a tubing arranged on a reel are shown for example in the Priestman et al US. Pat. No. 2,548,616. In that structure 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. The coiled tubing is uncoiled from the reel, straightened and forced into the well. Such wells are often under pressure, and it will be appreciated that in such a case a substantial force may be required to push the tubing into the well against pressure. After the tubing is inserted into the well a desired distance, fluids may then be injected. After the injection the tubing may be retrieved and coiled back up on the reel for reuse. Alternatively the tubing may be left in the well to facilitate operations which may occur frequently, or it 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.

Brown Oil Tools, Inc. of Houston, Texas has used a coil tubing feeding unit having a curved track on which rollers carrying grippers for the tubing are carried. A roller chain is also carried on the rollers, and is powered to move the rollers along the track. The tubing is held in contact with the grippers by grippers carried on an oppositely facing roller chain which is held in tension in order to apply pressure to the grippers. To straighten the tubing after it leaves the feeding unit, a straightening unit similar to that shown in U.S. Pat. No. 3,116,793 to McStravick is used.

Other apparatus and methods for feeding coiled tubing into a well are shown in U.S. Pat. Nos. 2,567,009 to Calhoun et al., 3,116,781 to Rugeley et al., 3,116,793 to McStravick, 3,658,270 to Slator et al and 3,667,554 to Smitherman.

The prior art just described is, in the opinion of the applicant, the closest to the invention known by him.

SUMMARY OF THE INVENTION

This invention provides a novel means and method for feeding coiled tubing into a well, wherein the tubing is gripped along an arcuate path with a substantially uniform gripping force along the path, and is pulled along this arcuate path and then pushed into the well. Preferably a straightening means is used to straighten the tubing at the end of the arcuate path. The invention also contemplates, in a preferred embodiment, novel means for starting the tubing into the gripping means, comprising a flexible line which may be attached to the end of the tubing and pulled along the arcuate path by the gripping means.

Other features of the invention pointed out in the claims can best be set forth in the following detailed description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWING

A preferred embodiment of the apparatus of this invention, suitable for practicing the method of this invention, is shown in the drawing, wherein

FIG. 1 is an elevational side view of one embodiment of the invention;

FIG. 2 is an elevational view of the right end of the mast as shown in FIG. 1;

FIG. 3 is an elevational view of the framing structure of the tubing feeding unit shown in FIG. 1;

FIG. 4 is a somewhat schematic view showing the wellhead into which the coiled tubing is being fed and the arrangement of roller chains and sprockets in the feeding unit for feeding the tubing;

FIG. 5 is a horizontal sectional view of the framework of FIG. 3, taken at line 5—5 of FIG. 3;

FIG. 6 is an enlarged elevational view, with parts broken away for clarity, of the outlet end of the feeding unit;

FIG. 7 is a horizontal sectional view of the structure shown in FIG. 6, taken at Line 7—7 of FIG. 6;

FIG. 8 is an elevational view of the straightening device shown in FIG. 6;

FIG. 9 is an elevational view of one embodiment of gripping element according to the invention;

FIg. 10 is an end view of the pressure hose used in the feeding unit; and

FIG. 11 is a layout of fluid supply means for the pressure hose.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The rig illustrated in FIG. 1 of the drawing is portable, being mounted upon a support comprising a trailer **10** on which is carried a reel **12** having a hollow shaft **14** mounted on a yoke **16**. The reel has a diameter of 6 feet or more, preferably 7 to 8 feet. A sprocket **18** is mounted on the shaft **14** and is arranged to be driven through a chain **20** by means of a sprocket **22** mounted on the shaft of a suitable motor **24**, which is preferably hydraulic but may be electric. At the other end of the trailer a suitable mast **26** is pivotably mounted at **28**. The mast may be moved between the vertical working position shown and the transport position indicated in broken lines at **28** in which it rests upon a support **30**, the movement being accomplished by means of a fluid cylinder **32** connected to the mast at **33** above the pivot **28** and to the trailer bed through a yoke **34**. A suitable tank **36** is also mounted on the trailer to provide liquids for injection into the well. Such liquids are removed from the tank by means of a pump **38** connected to the tank by a pipe **40** and connected to the hollow shaft **14** of the reel by pipe **42.** Fluid provided by the pump may be pumped into the tubing **44** by means of the hollow shaft **14** and tubing connections as shown for example in the aforesaid Priestman et al. patent.

A coil of substantially rigid or inflexible tubing **44** is coiled onto the reel. The tubing may be made of low carbon steel or other suitable material and typically is a continuous length of tubing several thousand feet long. Tubing up to one inch diameter, and in some circumstances even larger, is readily coiled on the reel by rotating the reel by means of motor **24.** The tubing is pulled from the reel by means of the tubing feeding unit indicated generally at **46,** which is mounted on the mast **26.**

In the embodiment shown the mast **26** comprises vertical standards **48** mounted on a ground engageable base **50** and having a header **52** thereon. A frame **54** is adjustable vertically on the mast by means of fluid cylinders **56** mounted on the header **52** and having their piston rods connected to upper guide channels **58** which are vertically slideable on the standards **48.** Upper guide channels **58** and lower guide channels **60** are provided with vertical ways **59** to slideably receive standards **48,** and with horizontal ways therein for slideably receiving upper horizontal frame members **62** and lower horizontal frame members **64** of the frame **54.** The lower guide channels **60** are connected together by a cross-beam **65.** The upper frame members are connected together by cross frame members **66** and the lower frame members are connected together by cross frame members **68.** Vertical frame members **70** and **72** provide connection between the upper and lower frame members. The frame is also provided with horizontal support beam **74** and vertical support member **76.** A fluid cylinder **77** is connected between cross-beam **65** and a support bracket **124** which extends downwardly from frame member **64.**

The vertical support member **76** extends above the horizontal beams **62** and provides means for supporting the upper end of an arcuate track **78** which may, as shown in FIG. 7, be formed of structural steel channel. In the embodiment shown the track **78** lies in a vertical plane and is approximately 90 degrees in length, being tangent, or nearly so, with a horizontal line at its upper or inlet end and tangent, or nearly so, with a vertical line at its lower or outlet end. However, depending upon the relative position of the feeding unit and the reel, the track may be substantially more than **90** degrees long, greater lengths providing more possible gripping area for the tubing.

Spaced radially outwardly from the track **78,** and rigidly connected thereto by means of plates **80** is an outer arcuate frame member **82,** which, in the embodiment shown, also extends approximately 90 °, although somewhat shorter than track **78,** about the same center as the arc of track **78.** An arcuate compression member **84** is positioned intermediate track **78** and the outer frame member **82** and is connected for radial movement relative to the track and outer frame member by means of a plurality of bolts **86** (see FIGS. 7 and 7) which are loosely received in sleeves **88** and **90** mounted in alignment with each other on the compression member and outer frame member.

As best seen in FIG. 7 the outer arcuate frame member **82** may be formed, similarly as the track **78,** from a structural steel channel, having its web turned toward the compression member **84.** The compression member in turn is, in the embodiment shown, formed of a C-section structural member, having inturned lips **92** on the legs thereof, and having its web facing toward the outer frame member. There is received between the webs of the compression member and the outer frame member a fluid impermeable flexible tubular member **94,** such as a fire hose or the like, extending substantially the full length of the arcuate members. A clamping block **96** clamps the lower end of the hose **94** to the outer frame member **82,** thereby closing the lower end of the tube. The upper end of the hose is closed by a similar clamping block **96,** as shown in FIG. **10,** but at this end a piece of small, partially flattened, copper tubing or the like, indicated at **98,** is inserted in one edge of the hose to provide means for feeding pressurizing fluid into the hose.

The term "fluid impermeable" as used herein is not intended to mean that the hose is absolutely pressure tight. As will be shown, means are provided for maintaining a desired fluid pressure within the hose, even though small leaks may exist. Thus, it is only necessary that the impermeability of the hose be such that under the conditions of operation a desired pressure can be maintained.

The outer web surface of the track **78** is provided with a wear plate **100,** which may be welded or otherwise fastened to the track, and which extends the full length of the track. A similar wear plate **102** is provided in the channel forming the outer arcuate frame member **82.** This wear plate is fastened by means which allow shimming under it to compensate for chain looseness from wear. The compression member web is, in the embodiment shown, preferably made of hardened steel, although a wear plate to protect the web may also be used. A power driven roller chain **104** rides on the wear plate **100,** with the rollers **106** thereof engaging the wear plate. At the upper end of the track the roller chain passes around a sprocket **108** mounted on a shaft journaled in a bearing **110** which is mounted on the vertical frame member **70.** The chain then passes substantially vertically downwardly and is engaged by a power sprocket **112** mounted on a shaft **114** which is journaled in a bearing **116** mounted on the vertical frame member **70.** At the lower or outlet end of the track the roller chain is engaged by a sprocket **118** mounted on a shaft **120** which is journaled in a bearing **122** mounted on a support bracket **124** extending downwardly from horizontal frame member **64.**

Also mounted on the shaft **114** is a drive sprocket **126** which is driven through a chain **128** from a sprocket **130** mounted on the shaft **132** of a reversible drive motor **133,** which may, for example, be a hydraulic motor.

A second, non-powered roller chain **134** circumscribes the outer frame member **82** and the compression member **84,** its rollers **136** riding on the wear plate **102** of frame member **82,** and being carried within the compression member and riding on its web. At the lower end of these members the chain engages a sprocket **138** which is mounted on a shaft **140** journaled in bearings **142** mounted on a forward extension of the horizontal frame member **64.** At the upper end the chain engages a sprocket **142** mounted on a shaft

144 which is journaled in a bearing 146, mounted on an upward extension of the vertical frame element 76.

Alternatively, chain 134 may also be powered. If so, a separate hydraulic motor drive is used for this chain, so that it is possible to take advantage of slippage in the motors to coordinate chain velocities.

The links 148 of the powered chain 104 are provided with pivot pins 150 which have gripping devices 152 pivotally mounted thereon. As seen in FIG. 9, each of the gripping devices comprises an elongate channel member 154 having a flange 156 thereon with a bore 158 therein to recieve the pivot pin 150. The channel member is provided with an approximately semi-circular groove 160 which, in the embodiment shown, is partially filled with a hard gripping material 162, such as tungsten carbide. In this form the groove has a width of substantially the diameter of the tubing to be handled, and a depth of substantially one-half of that width, so that the gripping member will extend around 180° of the tubing and will provide substantially 180° contact. As a practical matter, however, because of tolerances it is impossible to insure a full 180° contact. A relatively high degree of contact is provided in the embodiment shown. Where the gripping element is intended to grip one inch diameter tubing the groove 160 is made one inch nominal width and approximately five-eights inch deep, utilizing a radius of one-half inch. Then the bottom of the groove is filled with tungsten carbide material, as by welding, and this material is tapered out to a thin edge near the top of the groove. The tungsten carbide is preferably left rough. Although this is the preferred structure, excellent gripping may be attained by other means well-known in the art. For example, the groove may be knurled and the grippine element heat-treated.

With such a design, the side-walls of the tubing are restrained against expanding when the tubing is subjected to compression loading in the feeding unit, and is being curved in feeding through the unit, so that flattening of the tubing is less of a problem.

The roller chain 134 carries on its links 164 tubing engaging elements 166, which are pivotally mounted on pivot pins 168 extending through the links. The purpose of these tubing engagement elements is to hold the tubing in contact with the gripping elements 152. Since the chain 134 is not powered it is not necessary that the elements 166 grip the tubing and therefore no gripping surface is provided. Thus the elements 166 may be formed of short sections 170 of a pipe segment of somewhat less than 180°, with a flange 172 welded thereon and having a hole therein for pivotable engagement with the pivot pins 168. If, however, the chain 134 is powered, gripping surfaces are desirable on the elements 166.

Preferably the roller chains 104 and 134 do not have the same pitch, and many of the tubing engagement members 166 are not opposite the tubing gripping members 152. Where the centers of contact of the gripping members and engagement members are not directly opposite each other, the force of engagement of these members causes small deflections of the tubing, thereby increasing the ability of the gripping members to grip the tubing. As an example, the gripping members and engagement members may each be 2½ inches long, with the gripping members on 5 inch centers and the engagement members on 4 inch centers. Preferably these members are of such spacing and have such length as to provide engagement by the gripping members with approximately 50 percent of the length of the tubing. With the design of this invention this is sufficient to insure good gripping without slippage. Thus in one installation as much as 40,000 pounds of radial force may be exerted on the tubing, with a maximum load on the tubing of less than 1,000 pounds per square inch of projected area.

At the lower or outlet end of the tubing feeding device, as best seen in FIGS. 6 and 8, a straightening device indicated generally at 174 is provided. In this device a plate 176 is pivotally mounted on shaft 178, on the support members 124, extending downwardly from the pivot. A pair of pins 180 fastened near the lower edge thereof are loosely received in openings provided in a spring support plate 182 extending upwardly therefrom, the pins 180 thereby acting as hinge means to allow limited pivoting between plates 176 and 182. A spring member 184, curved on a long radius of, for example, 3 to 6 feet, is fastened to the spring support plate 182, as by welding, and extends upwardly substantially byond the pivot 178 on which the plate 176 is suspended, overlapping the end of track 78. The spring member 184 is preferably made of a resilient spring steel, or a steel such as AISI 1,040, heat treated to 300 BHN or more. As seen in FIG. 6, in passing from the lower end of the track 78 to engagement with the sprocket 118 the rollers of roller chain 104 roll along the spring member.

The spring member is laterally and angularly adjustable by means of an adjusting screw 188 mounted in an angle 190 extending between the support members 124, the adjusting screw being adjustable to bear against the back of the plate 176, and thereby pivot it about pivot pin 178, causing the lower end of the spring member 184 to move toward the chain and the upper end to be pivoted away from the chain. Adjusting screws 192 mounted in the spring support plate 182 bear against the plate 176 and may be adjusted to increase or decrease the angle between the spring member 184 and the plate 176. Thus by suitable adjustment of the adjusting screws provided the spring member can be moved to provide force as found necessary to obtain adequate straightening of the tubing as it exits from the tubing feeding device.

In the straightening device of this invention the lowest portion of the feeder unit acts as the pivot about which the straightening moment is applied. Thus the moment about which the straightening force is applied is the distance from the lower end of the feeder unit to the center of contact of the spring member with the rollers of chain 104. No additional pivot means is required, so that the feeder unit may be placed close to the well head, with consequent minimizing of danger of buckling of the tubing as it is forced into the well.

A suitable pressurizing fluid for the hose 94, such as air or other gas or a hydraulic fluid, may be provided from any suitable source as well known in the art. For example, as shown in FIG. 11 air under pressure from a compressor may be supplied through a line 194 through a three-way valve 196 and a pressure regulator 198 to a line 200 provided with a pressure gauge 202, which is connected to the copper tubing 98 held in the end of the hose 94. By such means the pressure of the fluid in the hose 94 can be controlled with great accuracy to maintain a precise desired force on the tubing, thereby greatly minimizing the difficulties encountered with designs heretofore known of having too much pressure on the tubing, thereby damaging it, or too little pressure so that it is impossible to grip the tubing sufficiently to feed it into a well against high well pressure. With this system the force of the tubing can be adjusted to just enough to feed the tubing without slippage. It has been found that a hose pressure of 15 to 120 pounds per square inch is adequate to apply suitable pressure to the tubing.

In the operation of the apparatus of this invention the trailer is moved to a position adjacent the wellhead, indicated at **204** in FIG. **1,** and the mast **26** is elevated by means of the hydraulic cylinder **32.** The mast rests on the ground (blocking under it being provided if necessary) and outriggers may be provided thereon for stability if desired. The fluid cylinder **77** is actuated to move the frame **54** out until the lower or outlet end of the feeding unit is directly over the wellhead. A suitable control device, illustrated at **206,** is then attached to the wellhead and the frame **54** is moved vertically by means of the fluid **56** to a position just above the control device. It is desirable to have the straightening device as close as possible to the flow control device in order to minimize the danger of buckling of the tubing as it is pushed into a well under pressure. The control device may include, for example, one or more blowout preventers **208,** a suitable snubbing rubber **210** and a suitable stripper rubber **212,** as well as a return line **214.** The return line may be connected by means of hoses or the like to return fluids to the tank **36.** In some operations, however, the pump **38** will be used to pump fluids through the return line **214** into the annulus between the well production tubing and the tubing **44,** and returns from the well will be brought up through the tubing **44** and returned, by suitable piping, to the tank **36.** Alternatively fluids may be taken from other sources, and may be returned to other disposal locations.

Once the tubing feeding apparatus is in position a catline **216,** which may for example comprise an ordinary manila rope having a diameter slightly larger than the diameter of the tubing **44,** is fed into the tubing feeding unit, between the gripper element **152** and the tubing engagement element **166.** A suitable pressure is applied to the hose **94** to grip the line. Motor **133** is started to begin driving the roller chain **104,** carrying the line through the feeder apparatus. The line is attached, as by means of a rope socket **218,** of a type well known in the art, to the end of the tubing **44.** As the rope is pulled through the feeding apparatus it pulls the tubing **44** from the reel **12,** bringing it through the feeding unit. During this operation the hydraulic reel drive motor **24** is driven as a pump, acting as a brake to apply tension to the tubing.

As the tubing is fed into the feeding unit the gripper elements **152** engage it. During this procedure a suitable pressure is maintained on the hose **94** to maintain sufficient gripping force on the tubing to pull it from the reel. Thus as the chain **104** continues to move the tubing is pulled from the reel and passed downwardly to the outlet end of the feeding apparatus. At this end the roller chain **104** engages the spring member **184** and is urged laterally enough to straighten the tubing. As seen in FIG. **6,** the straightener moves at least one roller of chain **104** laterally from the arcuate path of the track **78.** The sprocket **138** is displaced far enough to allow such movement. One or more rollers following the roller engaged by the straightener may be moved out of contact with the track. Thus the straightening moment has a momentcenter just within the arcuate path, where the tubing is engaged by the lowermost engagement element **166** which applies pressure to the tubing. The position of sprocket **138** is preferably such that the engagement elements **166** on chain **134** which are between the lower end of compression member **84** and the axis of sprocket **138** will act as stops to prevent too much lateral movement of the tubing if there should be a tendency for it to buckle under the force required to push it into a well under pressure.

The tubing is then passed downwardly through the stripper rubber and snubbing rubber and down into the well. If necessary, the pressure in hose **94** may be increased to prevent slippage of the gripper elements as the tubing is forced in against well pressure. As more tubing is fed into the well, the weight of the suspended tubing helps pull the tubing into the well, so that at substantial depths the tubing feeding unit may be used as a brake. When the desired depth is reached, feeding of the tubing is stopped and workover operations are performed, fluid being injected and recovered as desired. At the conclusion of the workover operations the motor **24** is operated in order to rotate the reel to wind up the tubing. Maximum force is required during this operation to pull the several thousand feet of tubing, therefore a high gripping pressure is applied to hose **94,** and motor **133** is operated in a direction to move chain **104** to pull the tubing from the well. When the tubing is fully rewound on the reel, the control equipment **206** may be removed and the mast returned to transport position as shown in broken lines in FIG. **1.**

It will be appreciated that application of fluid pressure to the tube **94** causes the compression member **84** to move radially inwardly toward the track **78.** Only a very small movement is required. Even in a badly worn condition, movement does not exceed about one quarter inch. Furthermore, the compression member has a large radius of four to eight feet or more. Thus despite the fact that the compression member **84** may be fairly rigid, it will provide continuous substantially uniform pressure engagement of the tubing engagement elements **166** with the tubing **44.** However, if desired the compression member may be made more flexible, as by making it in segments or by cutting through the flanges at spaced points along the length of the member.

The feeding unit elements have been described herein as being "arcuate," and the preferred embodiment has been described in terms of an arc of a circle. However, it is apparent that other forms of curves may be used equally well, depending on the requirements of a particular application. Thus the invention may be practiced using a curve which is a segment of an ellipse, a parabola, a hyperbola, or an irregular curve, or one which includes straight sections. The term "curved" as used herein is intended to include any other suitable shape.

Although a preferred embodiment of the invention has been shown and described herein it is apparent to those skilled in the art that many variations may be made in this preferred embodiment, which variations are within the scope of the present invention. Accordingly the invention is not limited to the described embodiment, but includes all modifications thereof included within the scope of the appended claims.

I claim:

1. Apparatus for running a continuous length of coiled substantially inflexible tubing into a well, comprising a reel for carrying said coiled tubing and tubing feeding means wherein the improvement comprises

a curved track lying in a vertical plane, said track having an inlet end opening toward said reel and an outlet end extending substantially vertically downwardly,

powered tubing gripping means movable along said track from said inlet end to said outlet end, and

pressure means overlying said track and having means thereon to engage said tubing to urge said tubing into gripping engagement with said tubing gripping means, said pressure means comprising fluid pressure actuable means adapted to provide substantially uniform pressure of engagement of said gripping means with said tubing from said inlet end to said outlet end.

2. Apparatus as defined by claim 1, wherein said pressure actuable means comprises

a curved flexible fluid impermeable member overlying and spaced away from said track.

3. Apparatus as defined by claim 2 and including

an inner curved compression member free to move radially toward and away from said track, positioned between said fluid impermeable member and said gripping means, and

an outer curved frame member fixed substantially rigidly with respect to said track, overlying said fluid impermeable member.

4. Apparatus as defined by claim 3, wherein said tubing gripping means comprises a plurality of rollers flexibly connected together in a chain, whereby said rollers roll along said track from said inlet end to said outlet end, and gripping devices carried by said rollers to engage the tubing.

5. Apparatus as defined by claim 4, wherein said pressure means includes a plurality of rollers intermediate said compression member and said gripping devices, and means on the pressure means rollers for engaging the tubing.

6. Apparatus as defined by claim 5, wherein said pressure means rollers are flexibly connected together to form an endless roller chain passing around said compression member and said outer curved frame member and lying in the plane of said track.

7. Apparatus for running a continuous length of coiled substantially inflexible tubing into a well, comprising a reel for carrying said coiled tubing and tubing feeding means comprising

a curved track lying in a vertical plane, said track having an inlet end opening toward said reel and an outlet end extending substantially vertically downwardly,

powered tubing gripping means movable along said track from said inlet end to said outlet end, and

pressure means overlying said track and having means thereon to engage said tubing to urge said tubing into gripping engagement with said tubing gripping means, wherein the improvement comprises

tubing straightening means positioned to provide a straightening force on the tubing at the outlet end of said tubing means.

8. Apparatus as defined by claim 7 wherein said tubing straightening means comprises

means for applying a straightening moment about a point substantially at the outlet end of the feeding means.

9. Apparatus as defined by claim 8 wherein said tubing straightening means includes

a resilient plate positioned to form an extension of said track, and

means to adjust said plate laterally and angularly with respect to said track to change the straightening force applied.

10. Apparatus for running a continuous length of coiled substantially inflexible tubing into a well, comprising a reel for carrying said coiled tubing and tubing feeding means comprising

a curved track lying in a vertical plane, said track having an inlet end opening toward said reel and an outlet end extending substantially vertically downwardly,

powered tubing gripping means movable along said track from said inlet end to said outlet end, and

pressure means overlying said track and having means thereon to engage said tubing to urge said tubing into gripping engagement with said tubing gripping means, wherein the improvement comprises

a substantially flexible line proportioned to be gripped by said gripping means, and

means for attaching said line to the end of the tubing on said reel,

whereby said tubing feeding means can be used to pull said line and thereby pull the tubing off the reel.

11. A process for running a continuous length of coiled substantially inflexible tubing from a reel into a well which comprises

grippingly engaging said tubing with a plurality of gripping elements positioned along a curved path,

applying a resilient radially inwardly directed force to said tubing along said curved path, said force being substantially uniform throughout the length of said curved path, and

applying a force to said gripping elements to move them along said curved path, whereby said tubing is pulled from said reel along said curved path until the tubing at the end of the curved path is substantially vertical, and

pushing said tubing into said well.

12. A process as defined by claim 11 wherein said radially inwardly directed force is applied through elements which engage said tubing intermediate the points of engagement of said gripping elements.

13. A process as defined by claim 11 and including

straightening said tubing at the end of said curved path.

14. A process as defined by claim 12 wherein the moment for straightening the tubing is applied about a moment arm having its moment-center in said path.

15. In apparatus for running a continuous length of coiled substantially inflexible tubing into a well, comprising

a reel for carrying said coiled tubing,

a curved track lying in a vertical plane, said track having an inlet end opening toward said reel and an outlet end extending substantially vertically downwardly, an endless roller chain lying in a vertical plane on said track,

power means connected to drive said chain, whereby its rollers move along said track from its inlet end to its outlet end,

a plurality of tubing gripping elements mounted on said chain and extending radially outwardly from the chain on the track for engagement with tubing overlying said track,

a second, non-powered roller chain overlying the powered roller chain, and

a plurality of tubing engageable elements on said second roller chain extending radially inwardly therefrom toward said powered roller chain,

said tubing gripping elements and said tubing-engageable elements being spaced and proportioned to allow tubing to pass between them,

the improvement which comprises

a compression member overlying the radially inner flight of said second roller chain, and extending substantially the length of said track, free to move radially toward and away from said track,

a curved, flexible fluid impermeable member overlying said frame member,

an outer curved frame member fixed substantially rigidly with respect to said track, overlying said fluid impermeable member,

said compression member and said outer frame member and said fluid impermeable member being mounted within said second roller chain, and

means for applying fluid under pressure to said fluid impermeable member.

16. Apparatus as defined by claim **15** wherein said tubing gripping elements include a substantially 180° groove having a nominal radius the same as that of the tubing positioned to engage the tubing to grip it within the groove.

17. Apparatus as defined by claim **16** wherein said tubing-engageable elements include a groove of substantially less than 180° positioned to engage the tubing to push it into gripping engagement with the gripping elements.

18. Apparatus as defined by claim **15** wherein said gripping elements are spaced apart along the power-driven chain and said tubing-engageable elements are spaced apart along the second chain, the spacings being different so that at least some of the tubing-engageable elements do not engage the tubing directly opposite a gripping element.

19. Apparatus as defined by claim **15** including means to apply a straightening moment to the tubing substantially at the outlet end of said track.

20. Apparatus for running a continuous length of coiled substantially inflexible tubing into a well, comprising a reel for carrying said coiled tubing and a curved feeding unit adapted to grip the tubing to pull it substantially horizontally from the reel and push it substantially vertically into the well, wherein the improvement comprises

means for applying a straightening moment to the tubing substantially at the vertical outlet end of the feeding unit, said means comprising

a pivot within the feeding unit about which the straightening moment is applied.

21. Apparatus as defined claim **20** wherein said staightening means further includes

means within the feeding unit adapted to apply said straightening moment.

22. In apparatus for running a continuous length of coiled substantially inflexible tubing into a well, comprising

a reel for carrying said coiled tubing,

a curved track lying in a vertical plane, said track having an inlet end opening toward said reel and an outlet end extending substantially vertically downwardly,

an endless roller chain lying in a vertical plane on said track,

power means connected to drive said chain, whereby its rollers move along said track from its inlet end to its outlet end,

a plurality of tubing gripping elements mounted on said chain and extending radially outwardly from the chain on the track for engagement with tubing overlying said track,

a second roller chain overlying the powered roller chain, and

a plurality of tubing-engageable elements on said second roller chain extending radially inwardly therefrom toward said powered roller chain,

said tubing gripping elements and said tubing-engageable elements being spaced and proportioned to allow tubing to pass between them,

the improvement wherein said tubing gripping elements include a substantially 180° groove having a nominal radius the same as that of the tubing positioned to engage the tubing to grip it within the groove.

23. Apparatus as defined by claim **22** wherein said tubing-engageable elements include a groove of substantially less than 180° positioned to engage the tubing to push it into gripping engagement with the gripping elements.

24. Apparatus as defined by claim **22** wherein said gripping elements are spaced apart along the power-driven chain and said tubing-engageable elements are spaced apart along the second chain, the spacings being different so that at least some of the tubing-engageable elements do not engage the tubing directly opposite a gripping element.

25. Apparatus as defined by claim **22** and including

means to apply a straightening moment to the tubing substantially at the outlet end of said track.

26. Apparatus for running a continuous length of coiled substantially inflexible tubing into a well, comprising a reel for carrying said coiled tubing and a curved feeding unit adapted to grip the tubing to pull it substantially horizontally from the reel and push it substantially vertically into the well, wherein the improvement comprises

means for applying a straightening moment to the tubing about a point substantially at the vertical outlet end of the feeding unit, said means including

a resilient plate positioned immediately adjacent the outlet end of the feeding unit, and

means to adjust said plate laterally and angularly with respect to said feeding unit to change the straightening force applied.

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