July 29, 1969 A. P. MEYERS 3,457,580

SEWER CLEANING APPARATUS

Filed Nov. 6, 1967

Fig. 1.

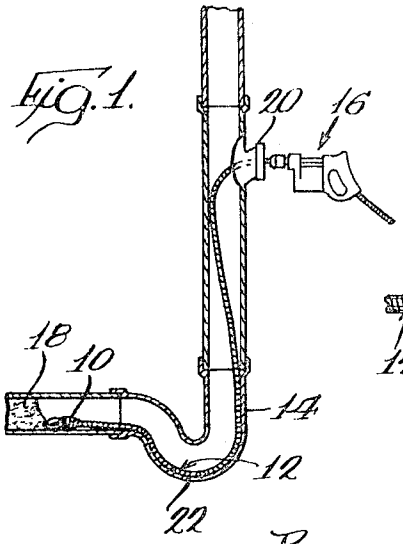


Fig. 2.

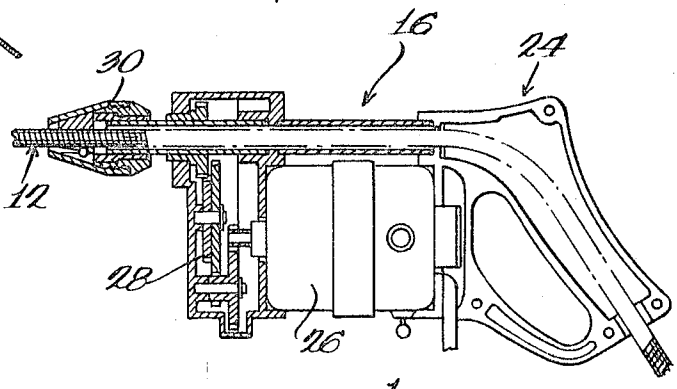


Fig. 3.

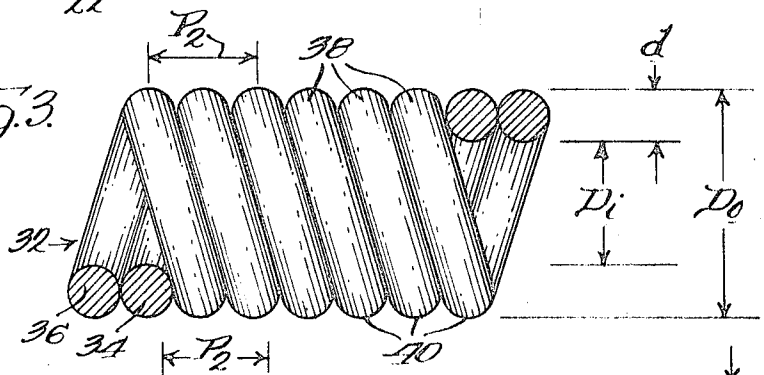


Fig. 4.

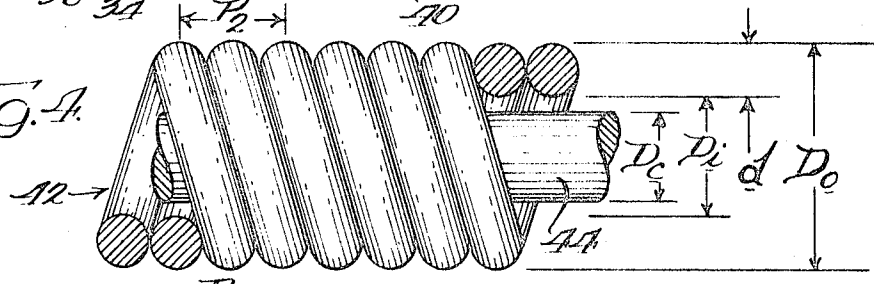
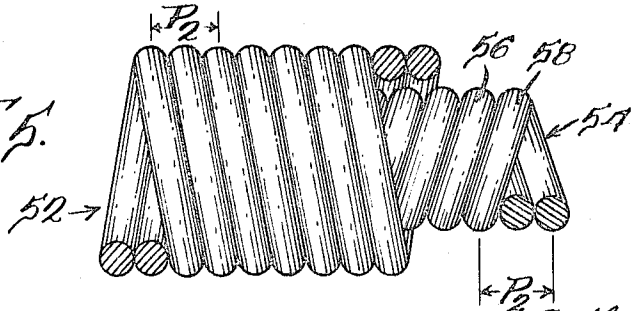


Fig. 5.



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SEWER CLEANING APPARATUS

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U.S. Cl. 15—104.3 8 Claims

ABSTRACT OF THE DISCLOSURE

A sewer cleaning apparatus including a tool adapted to clear obstructions from a pipe, a flexible cable secured to the tool for driving the same and adapted to be fed through a pipe by grasping or otherwise engaging its outermost portion with a drive means, means for rotating the cable with the improvement wherein the outermost portion of the cable is formed of a double wound coil with adjacent convolutions of the coil being in substantial abutment with one another.

Background of the invention

When drain tiles, sewers or the like are obstructed thereby preventing free flow of any liquid or sewage therein, the obstructions are typically removed by means of a so-called "plumber's snake" which is an apparatus that essentially consists of a tool which may include cutting blades and which is mounted on the end of an elongated cable. The apparatus also includes a motor means for rotating the cable and may include a means for feeding the cable through the drain tile or the sewer pipe to move the tool to the point where it will encounter the obstruction so that the rotation of the tool by the cable and the motor means will cause the tool to cut or otherwise clear the obstruction. If such a feeding means is not provided, the cable may be hand fed.

A typical problem encountered in the use of such apparatus is the movement of the same to a location in which it is to be operated due to the extremely heavy weight of the apparatus. In this respect, the weight of the elongated cable alone contributes substantially to the weight of the overall apparatus. For example, a three-quarter inch cable having a length of over one hundred feet weighs in excess of one hundred pounds. In many cases, it has been utterly impractical to reduce either the diameter or the length of the cable to achieve a weight reduction because the length may be required to enable the cable to be fed to a remote obstruction and a reduction in the diameter of the cable would result in the shearing thereof due to the substantial torsional forces and torque asserted within the cable during the rotation thereof when the tool is in engagement with the obstruction in attempting to remove the same.

Summary of the invention

It is the principal object of the invention to provide a new and improved sewer cleaning apparatus.

More specifically, it is an object of the invention to provide a new and improved sewer cleaning apparatus having a materially reduced weight and yet capable of performing comparably with prior art devices heretofore known.

Another object is the provision of a sewer cleaning apparatus including a tool adapted to clear obstructions from a pipe, a flexible cable secured to the tool for driving the same, a motor for rotating the cable, the cable being fed by engaging the outermost portion of the cable with a feeding means or by hand and including the weight reducing improvement wherein the outermost portion of the cable is formed of a double wound coil.

A further object is the provision of a sewer cleaning apparatus such as that set forth above wherein the coil is wound about a core.

A still further object is the provision of a sewer cleaning apparatus such as that set forth in the preceding paragraph wherein the core is formed of a second coil double wound in the opposite direction of the first named coil, the second coil having a hollow center.

Another object is the provision of a sewer cleaning apparatus such as that set forth above wherein the cable consists entirely of the double wound coil.

Yet another object is the provision of a sewer cleaning apparatus such as that set forth above wherein adjacent convolutions of the double wound coil are in a substantial abutment with one another.

Other objects and advantages will become apparent from the following specification taken in conjunction with the accompanying drawings.

Description of the drawings

FIG. 1 is a side elevation of a sewer cleaning apparatus in operation cleaning an obstruction from a pipe, with parts broken away for clarity;

FIG. 2 is a side elevation of a portion of the sewer cleaning apparatus including a fragment of the cable, a feeding means and a motor means;

FIG. 3 is a plan view of a portion of one form of a cable intended for use with a sewer cleaning apparatus made according to the invention;

FIG. 4 is a plan view of a portion of a second form of cable; and

FIG. 5 is a plan view of still another form of the cable.

Description of the preferred embodiments

One form of a sewer cleaning apparatus made according to the invention is shown in operation in FIG. 1 and is seen to comprise a tool **10** secured to the end of an elongated cable, generally designated **12**, which is rotated and fed within a sewer pipe **14** by a driving means generally designated **16**. As shown, the tool **10** has encountered an obstruction **18** within the pipe **14** which typically may consist of roots or solid material which wholly or partially obstruct the flow of liquid through the pipe **14**. Typically, when an obstruction **18** is present in the pipe **14** the tool **10** is introduced into the pipe **14** at any suitable opening such as at a T **20** and is advanced through the pipe by paying out and feding the cable **12**.

Before the tool **10** encounters an obstruction **18** within the pipe **14**, very little force is exerted internally within the cable **12** except for that required by cable flexure when the same must pass around bends **22** in the pipe **14**. However, when the tool **10** encounters the obstruction **18**, the obstruction **18** will tend to resist further feeding of the tool into the pipe as well as rotation of the latter by the cable **12** in response to actuation of the driving means **16**. At this time, sizable forces within the cable **12** will be present.

Turning now to FIG. 2 the driving means **16** is seen to comprise a hand-held tool, generally designated **24**, including a rotary motor means **26** which operates through a gear box, generally designated **28**, to drive a chuck **30** which engages the outermost portion or periphery of the cable **12**. The construction of the split nut **30** is such that it will impart rotation to the cable **12** from the motor means **26** via the gear box **28**.

While the details of the driving means **16** are believed to be well known in the art, they may be ascertained by reference to U.S. Patent No. 2,630,590 to J. V. O'Brien.

Although the exemplary embodiment of the invention utilizes a driving means **16** in the form of that illustrated in the above cited O'Brien patent which utilizes a chuck construction to transmit rotation to the cable, those skilled

in the art will recognize that the invention is susceptible to use in other known constructions utilizing means other than a chuck for imparting rotation and/or power feeding the cable and the invention is not to be limited to use with a chuck construction except as set forth in the appended claims. Similarly, the invention is not limited to either a device requiring hand feeding of the cable or power feeding of the cable.

Turning now to FIG. 3, one form of the cable **12** for use in the invention is illustrated and is seen to consist entirely of a multiple wound helical coil **32**. The multiple wound helical coil **32** is preferably double wound and formed of two intermeshed wire strands **34** and **36** which are preferably arranged such that their adjacent convolutions **38** are in substantial abutment with each other, i.e., "close wound." When the cable **32** is used in sewer cleaning apparatus, the arrangement is such that the outer portion **40** of the cable **32** is engaged by the feeding means **30**.

With reference to FIG. 4, a modified form of the cable **12** is illustrated. The modified form illustrated in FIG. 4, generally designated **42** is, in all respects, identical to the form **32** illustrated in FIG. 3 with the exception that the center of the coils forming the cable **42** is occupied by a core **44** which may be formed in any suitable manner.

Still another form of a cable made according to the invention is illustrated in FIG. 5 and includes a cable, generally designated **52** which is in all respects identical to the cable **42** except that, in place of the core **44**, a modified core **54** is utilized. The core **54** consists of a multiple wound coil, specifically, double wound, formed by intermeshing two wire strands **56** and **58**. Furthermore, the nature of the double wound coil forming the coil **54** is such that it is double wound in the opposite direction from the direction of winding of the double wound coil **52**.

It has been found that a form of cable illustrated in FIG. 3 identified as **32** weighs about twenty-seven percent less than a conventional cable having the same strength. Similarly, the form of cables shown in FIG. 4 and FIG. 5 designated **42** and **52**, respectively, weigh about twenty-one percent less than conventional cables having the same strength. Thus by use of cables made according to the invention, a sizeable reduction in the overall weight of the apparatus can be achieved.

The weight reduction achieved by use of cables made according to the invention coupled with the retention of strength is illustrated by the following analysis.

It has been found that the stress produced within the wired coils when the cable is subjected to a torsional load is inversely proportional to the cube of the wire diameter. Using subscripts 1 and 2 to denote a single wound and double wound cable respectively, the stress is given by

$$S_1=\frac{C_1}{d_1^3} \tag{1}$$

and

$$S_2=\frac{C_2}{d_2^3} \tag{2}$$

where d_1 and d_2 are the wire diameters of the cable, and C_1 and C_2 denote constants.

Since two wires are available to carry the torque load with a double wound cable and since C_1 is found to nearly equal C_2, then

$$S_2=2S_1 \tag{3}$$

Substituting,

$$\frac{1}{d_2^3}=\frac{2}{d_1^3} \tag{4}$$

or

$$d_2=\frac{d_1}{\sqrt[3]{2}}=0.794\ d_1 \tag{5}$$

Hence a cable using two wires, each of whose diameter is 0.794 times the diameter of a single wire cable will have equal strength.

For a typical conventional cable construction which utilizes a single wound coil, the weight per foot of coil length is given by

$$W_s=\frac{12}{P}\left[\frac{\pi^2 d^2 D_{mY}}{4}\right] \tag{6}$$

while the weight per foot of core is given by

$$W_c=12\pi D_c^2 Y/4 \tag{7}$$

where:

d=wire diameter, in.
p=pitch, in.
D_o=outer coil diameter, in.
D_i=inner coil diameter, in.
D_m=mean coil diameter, in.
D_c=core diameter, in.
Y=weight density in pounds per cubic inch of the material (about .284 lb./in.^{3} for a typical steel).

Since for a single wound cable, the pitch is equal to the wire diameter, then

$$Ws_1=3\pi^2 D_m d_Y \tag{8}$$

$$Wc=3\pi D_c^2 Y \tag{9}$$

The weight per foot of a double wound cable having the same coil inside diameter (I.D.) as conventional ½-in. cable will be given by

$$W_{s_1}=\frac{12}{d_2}\left[\frac{\pi^2 D_{m2} d_2^2 Y}{4}\right] \tag{10}$$

or

$$W_{s_2}=3\pi^2 D_{m2} d_2 Y \tag{11}$$

The I.D. of each cable is given by

$$D_{i1}=D_{m1}-d_1 \tag{12}$$

and

$$D_{i2}=D_{m2}-d_2 \tag{13}$$

Since $D_{i1}=D_{i2}$

$$D_{m2}=D_{m1}-d_1+d_2 \tag{14}$$

Substituting into Equation 11 and using Equation 5, the weight is,

$$W_{s_2}=3\pi^2(D_{m1}-d_1+0.794D_1)0.794d_1 Y \tag{15}$$

For a one-half inch cable, $D_{m1}=0.353''$ and $d_1=0.140''$ solving Equation 15

$$W_{s_2}=3\pi^2(0.353-0.140+0.111)(0.111)(0.284)$$

$$W_{s_2}=0.302 \text{ lb./ft. of cable}$$

The value of coil weight for a double wound cable can be compared to the coil weight for a one-half inch single wound coil which is 0.4155 pound per foot. Thus,

$$W_s1/W_S=0.3020/0.4155=0.727 \tag{16}$$

Therefore, if no core is used, a twenty-seven percent weight reduction cable weight can be achieved by the use of double wound cable with smaller wire diameter without a loss in stress carrying capacity. More specifically, the outside diameter of the double pitch cable will be approximately 0.324 versus 0.493 inch (nominally one-half inch).

By means of empirical data acquired during laboratory tests, it has been found that the core will increase the ultimate cable strength approximately fifty percent. Utilizing Equation 7 for a typical core employed with conventional one-half inch, the core weight per foot is about 0.1038 lb./ft.

If a conventional core is used, and the weight would remain unchanged in a double wound cable having the same I.D. as a single wound cable, then the weight ratio of a double wound cable to a single wound cable, both utilizing a core is

$$\frac{W_{s_2}}{W_{s_1}}=\frac{0.3020+0.1038}{0.4155+0.1038}=0.781 \tag{17}$$

In other words, a twenty-one percent weight reduction is obtained.

Additionally a further weight reduction coupled with strength retention is expected when the conventional core is replaced with a core consisting of a double wound coil which is wound in the opposite direction of the outer coil such as is illustrated in FIG. 5. In such a case, the coils are suitably brazed together at each end such that an external torque applied to the cable would cause a decrease in the diameter of the outer coils and a simultaneous increase in the diameter of the inner coils. In this way, the inner and outer coils oppose each other and the external torque applied is shared by both set of coils.

Because the cable in such an embodiment includes a hollow center, namely the center of the innermost set of double wound coils, an additional weight reduction is obtainable.

From the foregoing, it will be apparent that the use of a conventional core increases the weight of a double wound cable approximately thirty-three percent but increases the strength thereof approximately fifty percent. Accordingly, since the core contributes only about one-fourth of the total cable weight but increases the cable strength fifty percent, the use of a core is generally desirable where high strength cable is required. On the other hand, where greater cable strength is not required, but a premium is placed on cable flexibility for ease of negotiating bends in a sewer pipe, the core may be omitted. One skilled in the art may select a given cable made according to the invention depending on the requirements of the job and no matter whether the cable selected includes a core or lacks a core, it will be appreciated that a substantial weight savings is achieved.

I claim:

1. In a sewer cleaning apparatus including a tool adapted to clear obstructions from a pipe, a flexible cable of substantial length secured to the tool for driving the same and having an outermost portion adapted to be engaged for feeding the cable through a pipe, means for feeding the cable through a pipe, and motor means for rotating the cable, the improvement wherein said outermost portion of the cable is formed of a multiple wound coil so that the weight per unit length of said cable

is significantly reduced over that of a cable having a single wound coil as its outermost portion and having the same load carrying capacity.

2. The sewer cleaning apparatus of claim 1 wherein said coil is wound about a core.

3. The sewer cleaning apparatus of claim 2 wherein said core consists of a second coil, multiple wound in a direction opposite of the winding of said first-named coil, said second coil having a hollow center.

4. The sewer cleaning apparatus of claim 1 wherein said cable consists entirely of said coil.

5. The sewer cleaning apparatus of claim 2 wherein adjacent convolutions of said multiple wound coil are in substantial abutment with one another and said core is solid.

6. The sewer cleaning apparatus of claim 1 wherein said multiple wound coil comprises a double wound coil.

7. The sewer cleaning apparatus of claim 3 wherein both said multiple wound coils are double wound.

8. A sewer cleaning apparatus comprising:

(a) tool means for cleaning obstructions from a pipe;

(b) an elongated cable of substantial length and having an end secured to said tool means, said cable including an outer layer comprised of a double wound coil formed of two strands and having adjacent convolutions in substantial abutent; and

(c) means for rotating said cable;

(d) said outer layer being adapted to be engaged for feeding said cable through a pipe.

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U.S. Cl. X.R.

57—145