Dec. 6, 1938.

W. H. FURNESS

2,139,011

APPARATUS FOR PRODUCING STEEL CABLES

Filed July 15, 1936

2 Sheets-Sheet 1

Fig. 1.

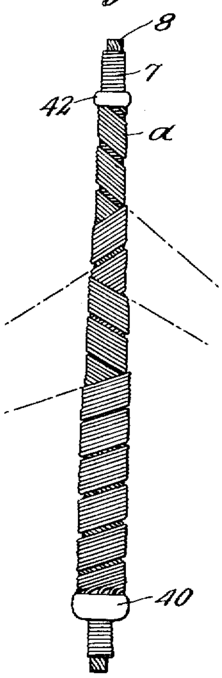


Fig. 2.

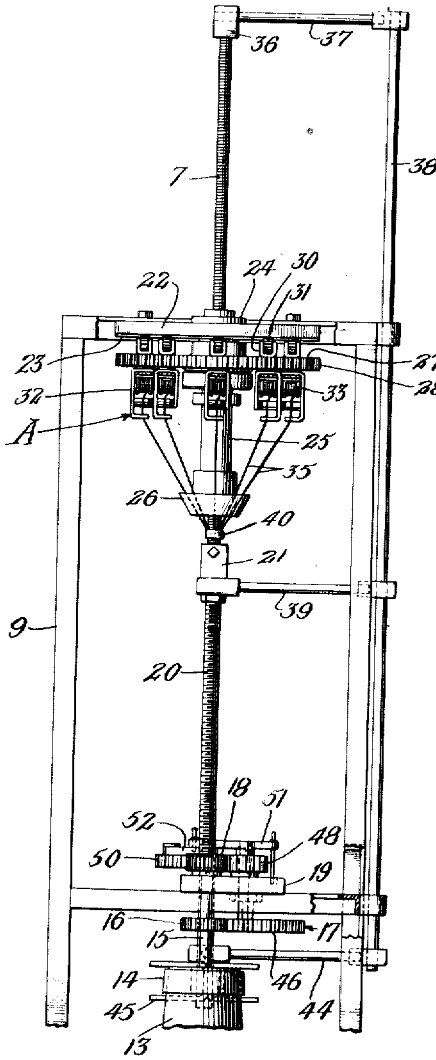
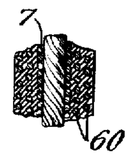


Fig. 8.



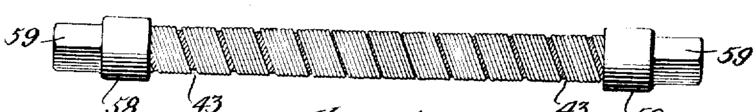


Fig. 7.

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Fig. 3.

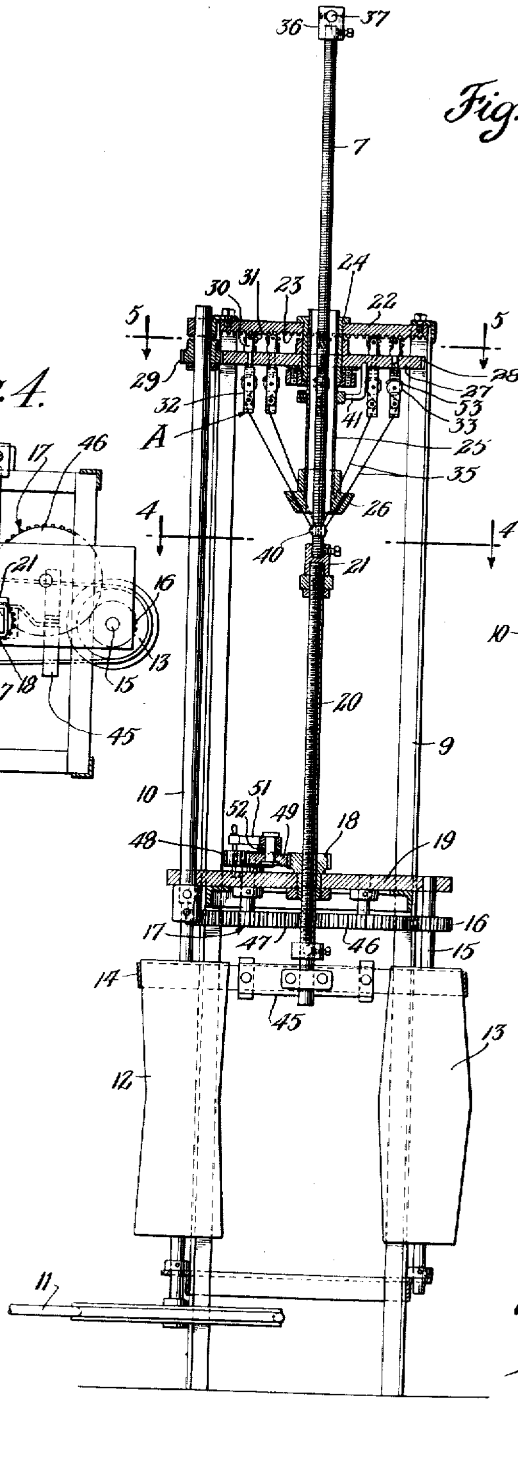


Fig. 4.

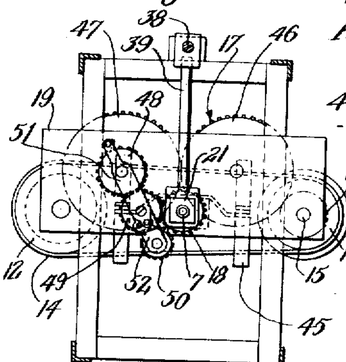


Fig. 5.

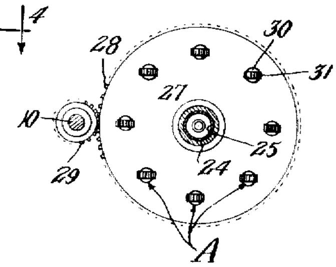
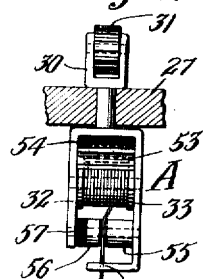


Fig. 6.



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Patented Dec. 6, 1938 2,139,011

UNITED STATES PATENT OFFICE

2,139,011

APPARATUS FOR PRODUCING STEEL CABLES

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4 Claims. (Cl. 117—34.6)

This invention relates to steel cables as an article and to their production. It is especially useful for driving purposes, such for example, as the driving members or shafts, so to speak, of a front wheel drive automobile, in which use, it obviates the need for universal joints which are expensive and have a relatively short life.

While the cable is suitable for a variety of uses, it will be described in connection with front wheel drive automobiles.

For use in a front wheel drive, the cable must obviously be flexible, and should preferably have increasing flexibility from the central portion outwardly; it should preferably have no "wind-up" in either direction, forward or reverse; should not develop heat and thereby lose its temper; preferably should not whip; preferably should bend on a large, rather than a small, radius; and should be relatively cheap to manufacture and have a long life. My cable, in its best embodiment, has these and other advantages.

Referring to the drawings, Figure 1 illustrates the preferred manner of laying up the cable;

Figure 2 is a side elevation of one form of machine for laying up the cable in accordance with my invention;

Figure 3 is a vertical central section through machine of Figure 1;

Figure 4 is a section taken on the line 4—4 of Figure 3;

Figure 5 is a section taken on line 5—5 of Figure 3;

Figure 6 is an enlarged fragmentary view illustrating the detail of the invention;

Figure 7 illustrates a completed cable drive shaft; and

Figure 8 is a sectional view illustrating a modification of my invention.

The cable, generally considered, consists of successive layers of wire, each layer being wound in the form of a helix, the alternate layers being wound in opposite directions. The angle of spiral (the angle of the spiral with reference to the cross-sectional axis of the cable) decreases from the center outwardly, each successive layer, outwardly, decreasing in angularity or obliquity. In other words, the axial advance of the innermost layer is very susbtantial, the axial advance of the next layer is less, and so on until for the outermost layers the axial advance is very small. In this way, the inner layers function more to prevent whip than they do to drive; the successive layers, outwardly, functioning less and less to prevent whip and to take more and more of the driving load, until finally the outermost layers function almost wholly to take load. The cable increases in flexibility from the center radially outwardly. Since the outermost layers of wire function almost wholly for transmission of load, and since they are opositely wound, and since the stress is longitudinal of the wires, there is substantially no wind-up in either direction of running.

Since all of the layers are in the form of a helix, there is no tendency to overheating even when the cable arcs, as when the car takes curves, this being true over long periods of time. Thus no heat develops such as would remove temper.

The last mentioned advantage is secured to the greatest degree when the cable is built up on a central foundation or core so that it is, in effect, a tube. To this end, in the preferred practice of my invention, I employ as a foundation or core member an ordinary coil spring 7 (see Figure 1) having very slight axial advance and corresponding very much to the ordinary screen door spring. Within this I may locate a wick 8, which may be an ordinary cotton cord or the like, impregnated with a suitable lubricant and which will serve to lubricate the cable from the inside out. Upon the foundation 7, I lay up the successive layers or helices to form the completed cable. Each layer preferably has the same number of turns to the inch but, as the diameter of the cable increases, it will be seen that the angle of spiral or axial lead will progressively diminish, automatically. This is shown by the dot and dash lines in Figure 1.

As wire suitable for the purpose I may employ what is known as "piano wire", a carbon steel wire of very small diameter. In winding up the wires, there is a tendency to impart twist to the wire around its longitudinal axis. This is undesirable especially in some uses. Therefore I propose to so lay up the wires as to prevent this twisting of the wire on its longitudinal axis. In this respect, my method consists in rotating the wire, on its longitudinal axis and in the same direction as the winding of the helix tends to put twist into the run of the wire and in an amount equal to the twist that would otherwise be imparted, whereby no twist is put into the run of the wire, it is taken out, as it were, as fast as it is put in.

I will now describe the machine and the preferred manner of laying up the cable.

The machine comprises a suitable upright frame 9 on which is mounted a vertical drive shaft 10, driven from any suitable source of power, as by the cable drive 11. The drive shaft 10 has a driving pulley 12 tapering inwardly from its ends toward the middle. This pulley 12 in turn drives another pulley 13 through the medium of a belt 14. The pulley 13 is reversely bevelled, decreasing in diameter from the middle toward the ends in an amount such that the belt 14 is kept tight. The pulley 13 is mounted on a driven shaft 15 which shaft carries a pinion 16, adapted to drive the gear train 17 having a reversible take off to be hereinafter described. This gear train rotates the nut 18 one way or the other, as will be described. The nut is rotatably carried in the plate 19, secured to the framework and, when it is turned in one direction, it causes the screw threaded rod 20 to move downwardly and when rotated in the other direction to move upwardly. The screw rod 20 is shown in its uppermost position in Figures 2 and 3. It is provided at its upper end with a chuck 21.

At the top of the frame is mounted a plate 22, this plate having parallel gear teeth 23 extending across the lower face thereof. The plate 22 is non-rotatably carried by the frame and is provided with a downwardly extending bearing sleeve 24. Within this sleeve, is mounted a second sleeve or tube 25 extending therebelow for a substantial distance and having at its lower end a head 26.

Rotatably supported on the bearing sleeve 24, is a disk 27 having gear teeth 28 adapted to mesh with the pinion 29 on the upper end of the drive shaft 10. When the shaft 10 rotates, it drives the disk 27, rotating it on the sleeve 24. The disk 27 carries a plurality of spindles indicated as a whole by the reference letter A. These spindles are arranged in a circle and each is rotatably carried in the disk. The upper end 30 of each spindle is a yoke in which is revolvably mounted a toothed roller 31, the teeth of which are adapted to engage the teeth 23 on the plate 22. By this arrangement although there is relative rotative movement between the spindles A and their bearings in the disc 27 equal to one revolution for every revolution of the disc, the spindles do not rotate except relatively to the disc. It should be noted, however, that as the disc rotates, any circumferential point on the spindle describes a complete imaginary circle on the disc for each revolution of the disc, the circle being described in the opposite direction to the direction of rotation of the disc. In other words, the rollers 31 and the tooth plate 22 constitute a one-to-one drive, in either direction of rotation of the disk 27. This drive is of the same character as shown in my issued Patents No. 2,017,656 and No. 2,019,669.

The lower portion of each of the spindles is also in the form of a yoke 32 in which the spool of wire 33 is adapted to be mounted. The yoke 32 has an eye 34 for the run of the wire 35 from the spool.

To start laying up a cable, a foundation coil spring 7 of the desired length is introduced through the sleeve 25 and its lower end is fastened in the chuck 21. The upper end thereof is fastened in the chuck 36 which is carried by the arm 37, in turn secured to the top of the slide bar 38. This bar is slidably mounted in the framework and has a middle arm 39 which in turn forms a support for the chuck 21 and the upper end of the screw rod 20. The chuck 21 does not revolve. It merely moves up or down with the screw rod.

With the foundation 7 in place, the free ends of the wires from the spools are led through holes in the block 26 and their ends are soldered or otherwise secured to the foundation, as indicated at 40.

The shaft 10 is now rotated in one direction thereby driving the pulley 12, the belt 14, the pulley 13 and revolving the nut 18 through the reversing gear train 17. The screw rod is thereby caused to move downwardly.

At the same time, the pinion 29 rotates the disk 27 and also the sleeve 25 which is non-rotatably associated with the disk 27 through the pin 41. This rotates the head 26 and winds the wires about the foundation 7 in a layer as shown at *a* in Figure 1. The axial advance is determined by the rate of movement of the chuck 21 downwardly in relation to the revolutions of the disk 27.

Of course, the spindles move with the disk 27 but by virtue of the one-to-one drive afforded by the rollers 31 and the tooth plate 22, each spindle is rotated once for every turn of the disk 27. Thus for every turn of the helix which would tend to impart a complete twist to the run of the wires about their longitudinal axes, the wires are rotated one complete turn about their longitudinal axes in the same direction that the winding into a helix tends to twist the wires, in consequence of which no twist is imparted to the run of the wires.

The shaft 10 is rotated for the full downward stroke of the screw rod 20. Then the wires are soldered to the upper end portion of the foundation 7, as indicated at 42 in Figure 1, after which the wires are cut free. The direction of rotation of the shaft 10 is then reversed and the screw rod again brought to uppermost position, after which the free ends of the wires, after passing through the block 26, are again soldered and the operation repeated, although in this instance the direction of rotation of the parts is reversed with respect to the direction of rotation in laying up the first layer. This necessitates reversing the take-off of the gear train to ensure that the nut 18 will rotate in the right direction, so as to lay the second helix up in an opposite direction. These operations are repeated until the cable has been built up to the desired diameter.

In the machine shown, there are eight spindles and eight wires. The feed of the screw rod 20 in relation to the revolutions per minute of the disk 27 is such that the wires, so to speak, are laid up like a ribbon with an axial advance providing a space between the turns. This is clearly shown in Figures 1 and 7. In order to prevent the cable from flexing on a sharp angle and to distribute the flexing over an extended length of the cable, I prefer to make the cable stiffer in the middle than at the ends. If the cable were to bend on a sharp angle, the flexing would be localized, therefore the extent of flexing would be correspondingly increased and there might be a tendency to develop overheating and whipping. By making the cable stiffer in the middle than at the ends, the cable is caused to bend over a large arc and the extent of flexing of any portion is reduced to a minimum, thereby minimizing the tendency to overheating and whipping. In the preferred practice of my invention, I accomplish this end by gradually diminishing the axial advance to the middle and gradually increasing it. On examination of Figure 7 it will be seen that the resultant spaces 43 gradually diminish toward the middle, from both ends. This is brought about by the provision of the oppositely bevelled pulleys 12 and 13. These operate as a change speed device, as follows. It will be seen that when the screw rod 20 is travelling downwards, it causes the slide rod 38 to move downwardly by means of the arm 39. At the lower end of the slide rod 38 is another arm 44 which affords a support for the lower end of the screw rod. At the lower end of the screw rod is a fixture 45 which engages the belt 14. A downward movement of the screw rod 20 therefore shifts the belt downwardly gradually changing the speed of the pulley 13 with reference to the pulley 12. Downward movement of the belt 14 from the position shown in Figure 3 gradually decreases the revolutions of the pulley 13 until the belt reaches the middle position. Further downward movement gradually increases the revolutions of the pulley 13. This means that the revolutions per minute of the nut 18 are gradually decreased until the screw rod 20 reaches middle position and then again gradually increased. Since the revolutions per minute of the disk 27 are constant this results in gradually putting more turns to the inch toward the middle of the cable, in both directions making the cable stiffer in the middle.

Any suitable form of gear mechanism may be employed. In the gear train shown in the drawings, the pinion 16 engages the gear 46 which in turn engages the gear wheel 47. The shaft for the gear wheel 47 carries the gear 48 which in turn meshes with the take-off gear 49, the latter meshing with the take-off gear 50. The gear 49 is mounted on the arm 51 and the gear 50 is mounted on the arm 52. These arms may each be locked in one of two positions. In one position gear 50 is not in mesh with the nut 18 and gear 49 is in mesh therewith. In another position, gear 49 is out of mesh with the nut 18 and gear 50 is in mesh therewith. Thus, depending upon which take-off gear is in mesh, the nut will rotate in one direction or the other.

In order to prevent the spools from unwinding and to reasonably equalize the tension of the wires, each spindle is provided with a friction shoe 53 (see Figure 6) which is yieldingly pressed in engagement with the rim of the spool by means of a washer 54 in the form of leather or rubber or some other material, operating, when placed in position under compression, to press the shoe against the rim of the spool. This may be supplemented by causing the run of the wire, before entering the eye 34 to pass between two rollers 55 and 56, pressed toward one another to frictionally engage the run of the wire by means of a leather or rubber washer 57.

When the cable is completed, any suitable end members may be provided for driving purposes. In Figure 7, I have shown end members 58 having squared heads 59. It will be understood that the particular embodiment of end members will vary depending upon the particular service.

Instead of using steel wires, I may build up the cable with a plurality of layers of cord 60 such as used, for example, in cord tires (see Figure 8). These are vulcanized together in ways well understood in the rubber industry.

In the drawings the machine I have shown is a very simple one intending to illustrate the principle of operation. It lays up only one layer at a time, and only in one direction. It is to be understood, however, that modifications thereof may be made without departing from the spirit of the invention. Likewise, insofar as the method is concerned, this may be performed in other ways than by the particular machine shown. Similarly as to the cable, the size of the wires may be increased or diminished and the character of the turns altered to suit any particular service.

Some of the features which make my cable particularly suitable for the torsion drive purposes, also make it suitable for pulling cables. In both types of cable it is desirable to have increasing flexibility from the center outwardly. For the pulling cable I would, of course, greatly increase the axial advance or lead so that the pull on the inner layers is more nearly longitudinal of the wires. The successive layers would, of course, automatically have their lead reduced so that the flexibility of the cable would increase outwardly, making the pull cable particularly useful where it is subject to reverse bending passing over various pulleys, as is the case, for example, in mining operations.

In both types of cables it is advantageous to lay them up without imparting twist to the run of the wire for the reason that internal strains or forces which would be concomitant to the twist in the wire are avoided. Furthermore, the laying up of the helices in a manner to avoid imparting twist around the longitudinal axes of the wires, makes it possible to secure a balanced cable, either torsion or pull, even though the helices are not opposite wound.

When the cable is made of cords instead of wires it is also advantageous to wind the layers as herein described.

What I claim is:

1. In a machine for forming cables, a combination of a feed or draw member, a revoluble member having a head, a plurality of spindles carried by the revoluble member and adapted to receive spools of wire, means providing a one-to-one drive as between the revoluble member and the spindles, and means on the head to receive the run of wire from the spools, said draw member being reciprocable on the axis of rotation of the revoluble member and the spindles being arranged around said axis.

2. In a machine for forming cables, a reciprocable draw member, a revoluble member carrying a head, the reciprocable member reciprocating in the axis of rotation of the revoluble member, said revoluble member and said head being centrally apertured to permit of the introduction of a foundation, means on the reciprocable member to support an end of the foundation, a support for the other end of the foundation movable with the reciprocable member, a plurality of spindles on the revoluble member arranged about its axis of rotation and adapted to receive spools of wire, and means on the head adapted to receive the run of wire from the spools.

3. In a machine for forming cables, a reciprocable draw member, a revoluble member carrying a head, the reciprocable member reciprocating in the axis of rotation of the revoluble member, said revoluble member and said head being centrally apertured to permit of the introduction of a foundation, means on the reciprocable member to support an end of the foundation, a support for the other end of the foundation movable with the reciprocable member, a plurality of spindles having bearings in the revoluble member, said spindles being arranged about the axis of rotation of the revoluble member and adapted to receive spools of wire, and means on the head adapted to receive the run of wire from the spools, together with means whereby relative rotative movement is imparted between the spin-

dles and their bearings equal to one revolution for every revolution of the revoluble member.

4. In a machine for forming cables, the combination of a rotatable head for laying up wires in the form of a helix, means for leading wires to said head without imparting individual twist to the wires as they are being laid up in helices, said means comprising a plurality of spindles mounted to move in a circle around the axis of said head, spools of wire carried by said spindles, and means for holding said spindles against rotation on their own axes as they move around the axis of said head, a reciprocable feed or draw member and means for altering the rate of movement of the draw member as it reciprocates to alter the axial lead of the helix as the wires are being laid up.

WILLIAM H. FURNESS.