United States Patent

Goodwill

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[54] CABLE TYING MACHINE

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[21] Appl. No.: **86,743**

[52] **U.S. Cl.** .....**140/93 R,** 112/121.2, 140/115

[51] **Int. Cl.** **B21f 15/04**

[58] **Field of Search**.....140/93, 93.2, 115, 102, 116, 140/117, 122; 100/14, 27, 28; 112/121.2

[56] **References Cited**

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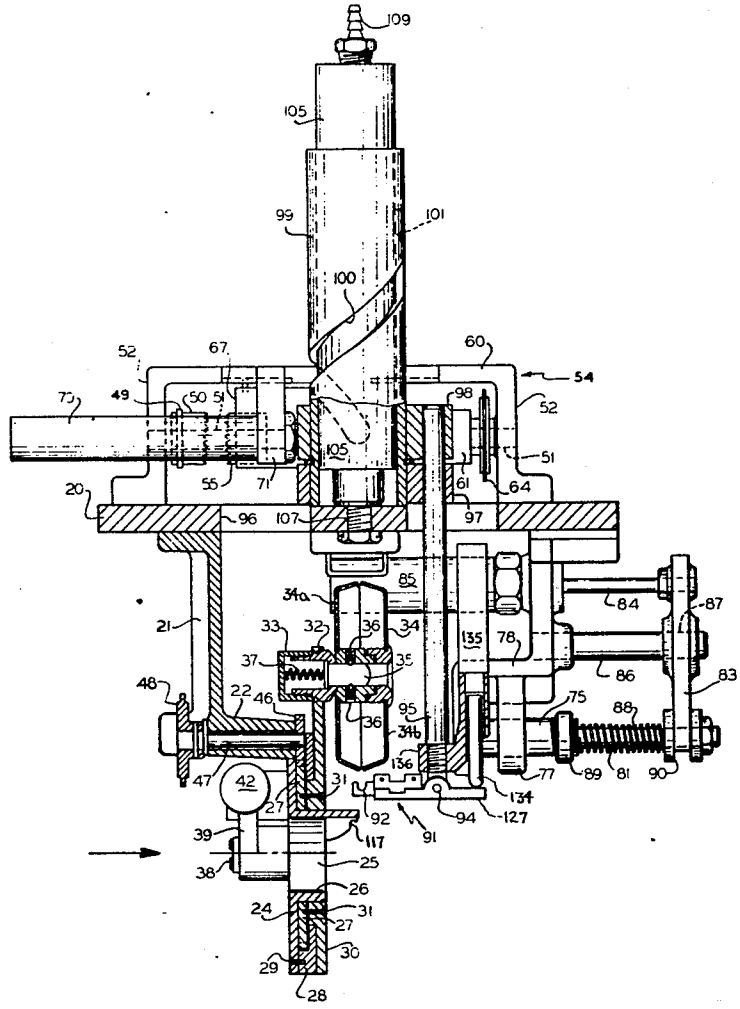
Primary Examiner—Lowell A. Larson

Attorney—Bruns & Jenney

[57] **ABSTRACT**

A machine for automatically putting ties on a multi-strand cable at spaced intervals therealong. The ties are made with a single, continuous piece of lacing which extends longitudinally along the cable between the ties. At each point at which a tie is to be made the machine passes the lacing around the cable and then knots the lacing, after which either the cable or the machine is moved to the next tie point. In passing the lacing around the cable, the machine forms a loop in the lacing through which a bobbin carrying the lacing passes to form the knot.

10 Claims, 16 Drawing Figures



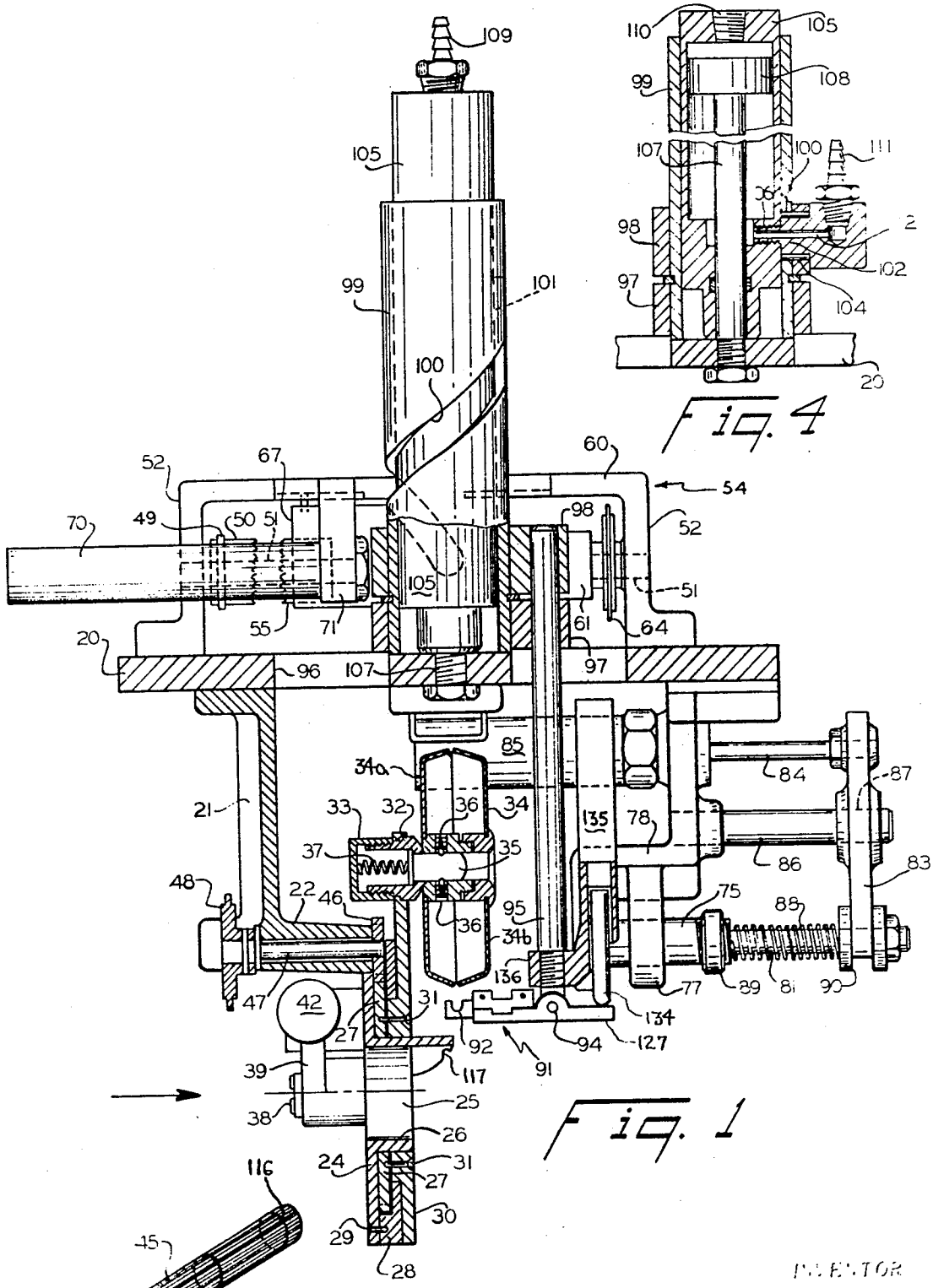


Fig. 1

Fig. 4

Fig. 1A

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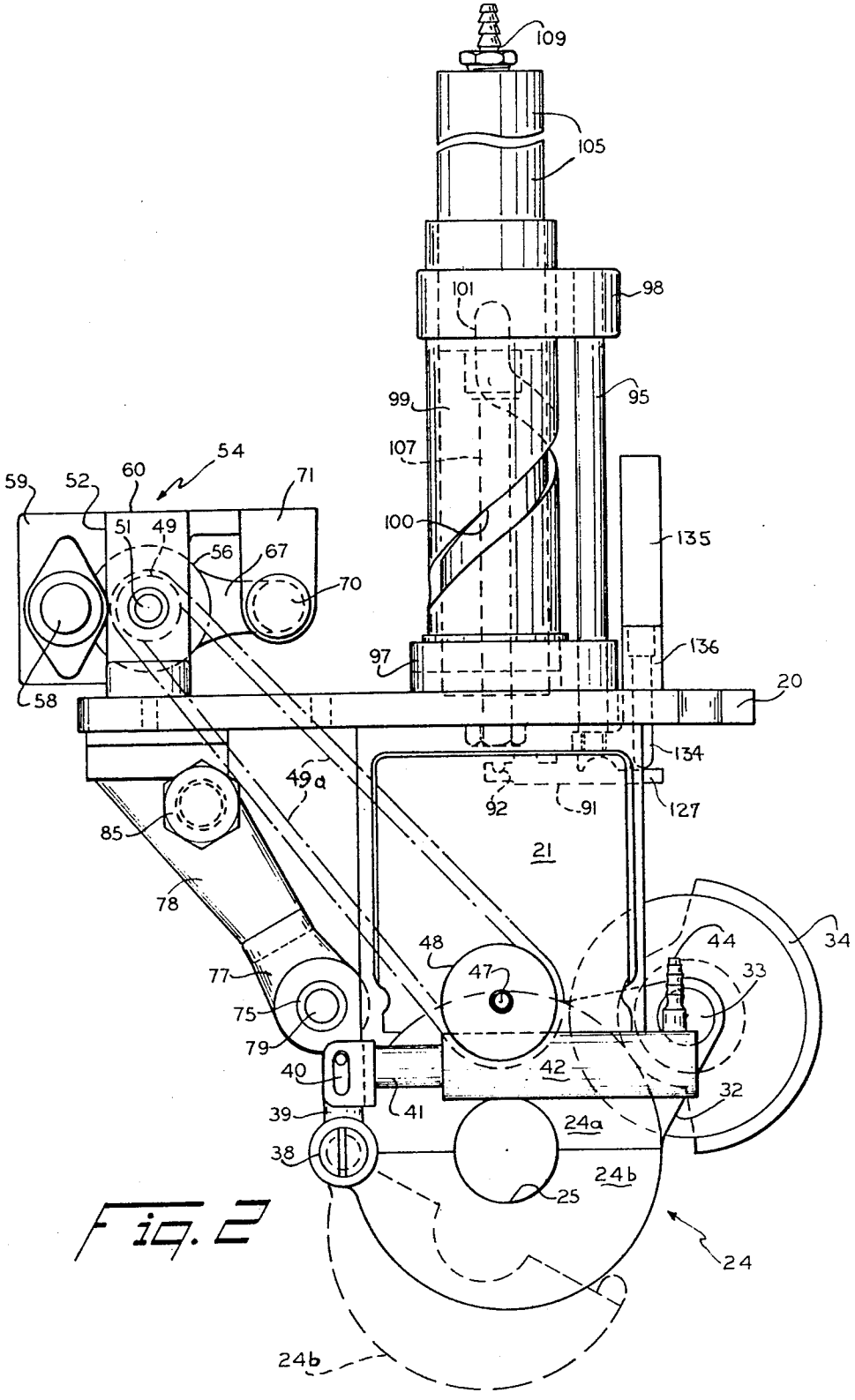
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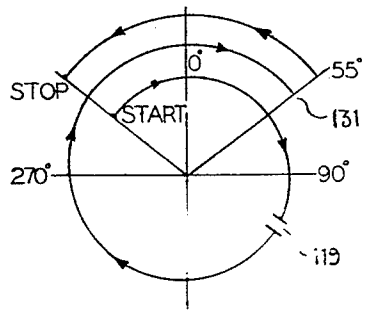
Fig. 2


0°
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STOP
START
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270°
90°
119

Fig. 5

109
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Fig. 3

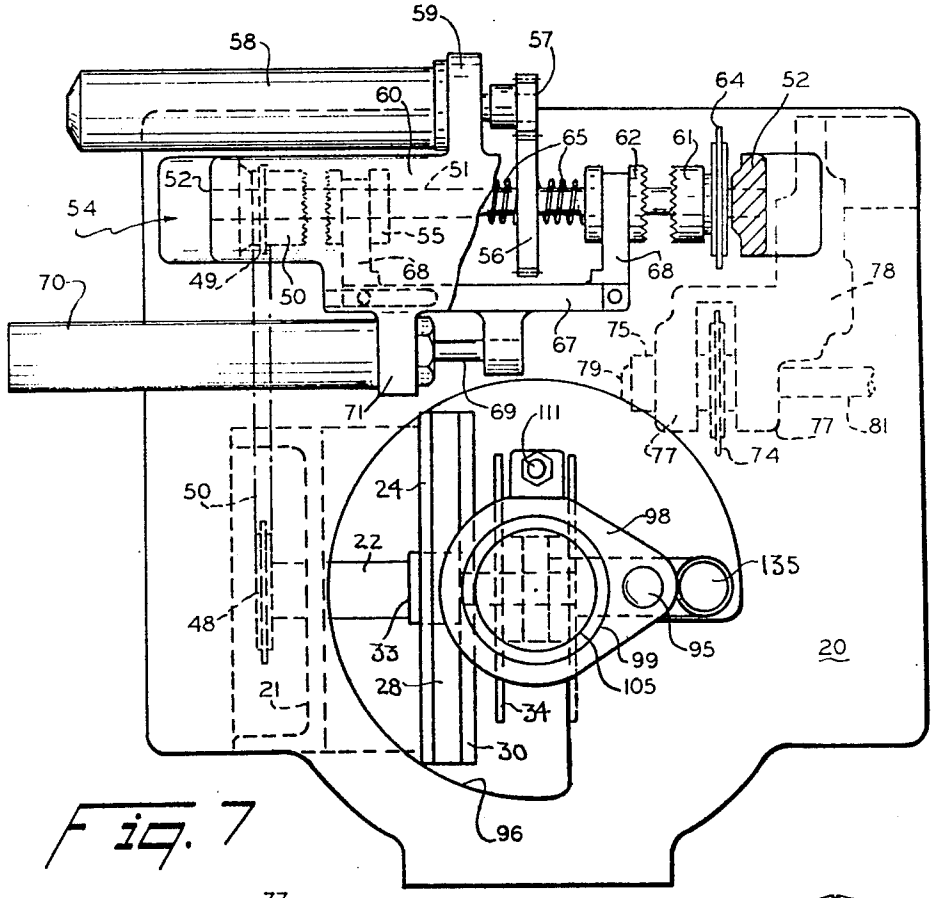

Fig. 7

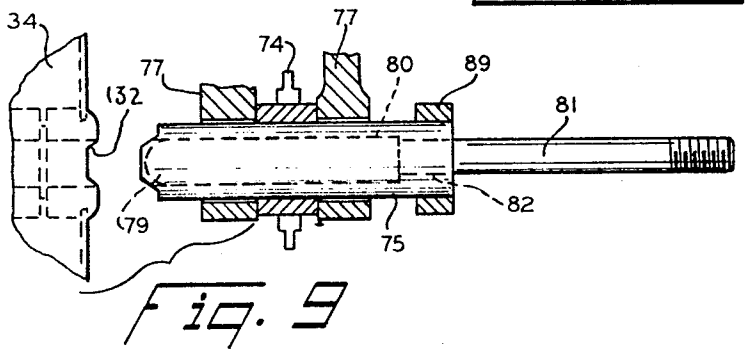

Fig. 9

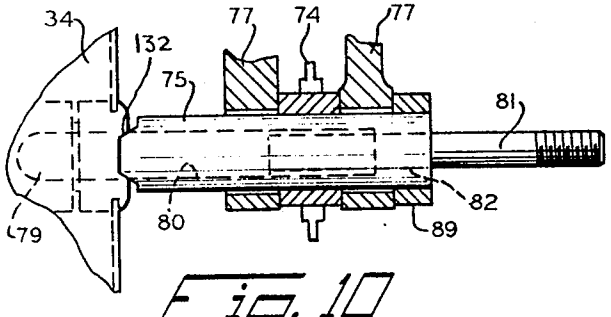

Fig. 10

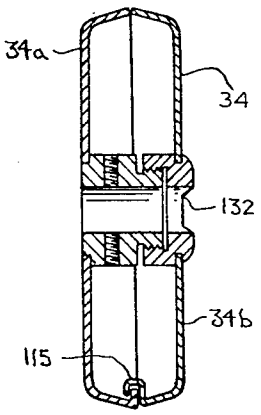

Fig. 8

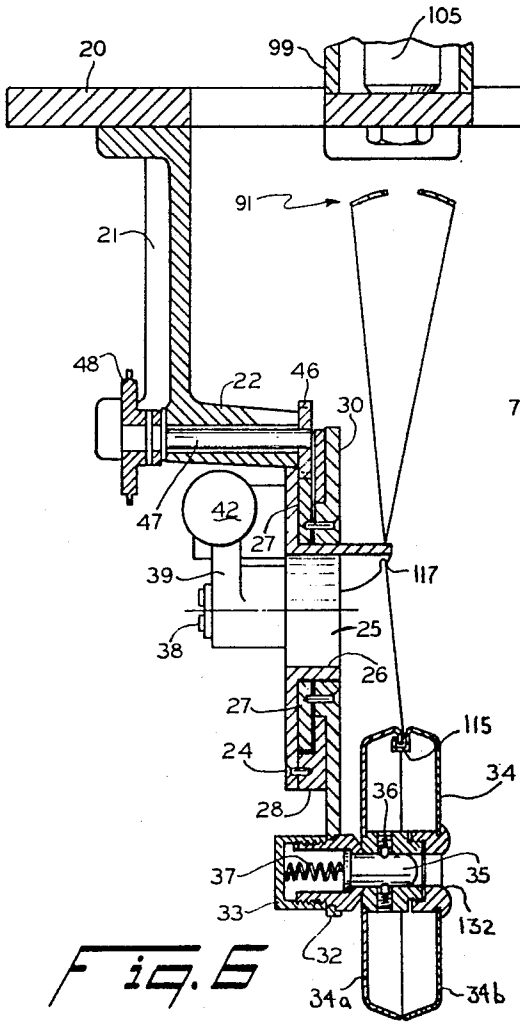

Fig. 6

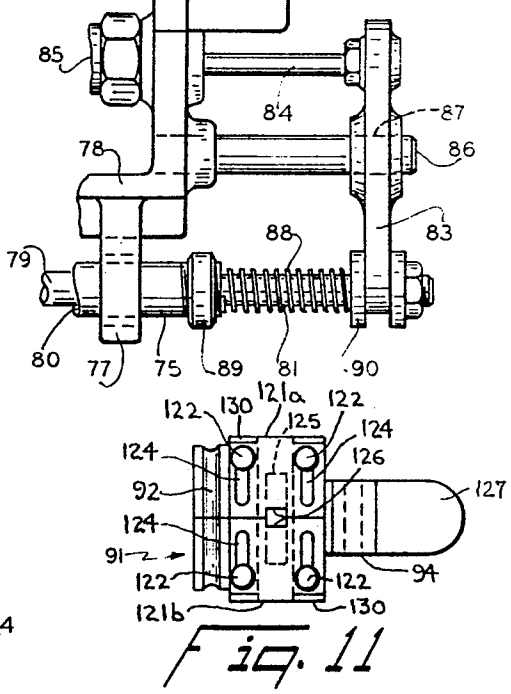

Fig. 11

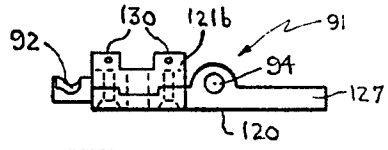

Fig. 12

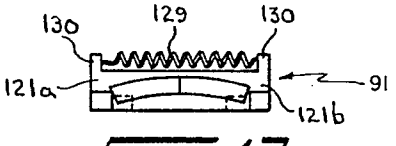

Fig. 13

Fig. 15

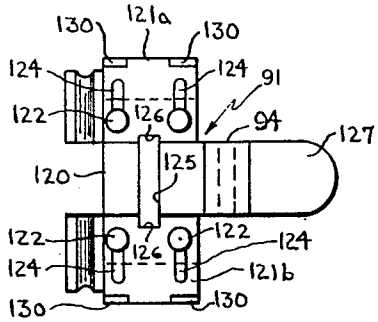

Fig. 14

CABLE TYING MACHINE

BACKGROUND OF THE INVENTION

This invention relates generally to binder applying mechanisms, and has particular reference to a novel machine for automatically tying together a group of elongated objects by applying ties at spaced points therealong with one continuous piece of lacing or cord.

The machine is particularly adapted to tie together a plurality of electrical conductors to form a single, multi-conductor cable. Such cables are widely used in aircraft, data processing equipment and many other installations, and it is required that the cables have ties at predetermined, relatively short intervals from end to end. At the present time this is done manually, with an individual tie at each tie point, and this of course is laborious and adds to the expense of the finished cable.

To the best of applicant's knowledge, there have not heretofore been any machines for automatically knotting a continuous lacing at spaced points over the full length of a cable or similar elongated article. Machines have been developed for tying sausage casings or the like and for tying rolled meat but, insofar as the applicant is aware, the tying material is severed between each tie. Equipment has also been developed for applying short lengths of wire to elongated articles and twisting the wire ends to form individual ties but this has not proved satisfactory for multi-conductor cables.

SUMMARY OF THE INVENTION

In the cable tying machine of the invention, the cable is held by jaws at the point where the tie is to be made and a bobbin carrying the lacing is revolved around the cable. This causes the lacing which pays out from the bobbin to be passed around the cable and at the same time the lacing is laid on a loop forming mechanism located adjacent the cable in the path of the lacing. Thereafter, as the bobbin continues to travel around the cable, the loop former is elevated and simultaneously rotated through 270° whereby the lacing is formed into a loop with the lacing twisted about itself at the loop bottom. At the end of the loop former rotation, the loop is positioned so that its opening is in the path of the revolving bobbin and the latter passes through it forming a loose knot in the lacing.

After passing through the loop, the bobbin continues to travel a short distance and then stops. At this point, the bobbin is disengaged from its revolving mechanism and engaged by another mechanism which positively rotates the bobbin so that the excess lacing is wound back on it and the knot is tightened about the cable, the lacing having in the meantime been released from the loop former. After the knot has been tightened, the cable is advanced to the next tie point or, in the alternative, the cable can remain stationary and the tying machine moved relative to it.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevation of a cable tying machine embodying the invention with parts being shown in section;

FIG. 1A is a fragmentary perspective view of a multi-conductor cable tied by the machine of the invention;

FIG. 2 is a left side elevation of the machine of FIG. 1;

FIG. 3 is a right side elevation thereof;

FIG. 4 is a vertical section through the loop former actuating cylinder;

FIG. 5 is a diagram illustrating the manner in which the bobbin travels relative to the cable;

FIG. 6 is a fragmentary front elevation, partly in section, corresponding to FIG. 1 but showing the machine with the loop formed in the lacing;

FIG. 7 is a top plan view of the machine with parts broken away for clarity;

FIG. 8 is an enlarged cross-sectional view of the bobbin;

FIGS. 9 and 10 are enlarged cross-sectional views of a portion of the knot tightening mechanism with the bobbin engaging spindle being shown in inoperative and operative positions, respectively;

FIGS. 11–13 are enlarged top, side and front elevations, respectively, of the loop former;

FIG. 14 is an enlarged top plan view of the loop former in expanded position; and

FIG. 15 is an enlarged, fragmentary side elevation of the expander element for the loop former.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and with particular reference to FIGS. 1–3, 20 is a suitably supported base plate on which the components of the machine are mounted. Secured to the under side of plate 20 is a bracket 21 and at the bottom of the bracket is an integral, inwardly projecting post 22. A depending cable and bobbin support plate 24 having a center opening 25 is secured to the inner end of post 22, and this plate is cut horizontally to form separable halves or jaws 24*a*, 24*b* as best shown in FIG. 2.

Plate 24 is provided with an inwardly projecting flange 26 surrounding its center opening 25 and a gear 27, also formed in two halves, is rotatably mounted on this flange, the gear halves being retained on the flange by a plate 28 secured to plate 24 as by bolts 29. A substantially circular bobbin carrier plate 30 is also rotatably mounted on flange 26 and is secured to gear 27 as by bolts 31. The bobbin carrier is also formed in two halves which are respectively secured to the gear halves.

Bobbin carrier 30 is formed with a radial projection 32 which supports a cylinder 33 on which the bobbin 34 is mounted. Thus, a spindle 35 in the cylinder projects into the center hole of the bobbin and is held there by ball detents 36. The spindle is movable axially relative to the cylinder and is normally biased into its outwardly projecting position by a spring 37. With this arrangement, it will be understood that bobbin 34 is revolvable about the center line of the support plate opening 25 through its connection with gear 27.

The two halves of the support plate 24 are hinged at 38 and the lower half or jaw 24*b*, FIG. 2, has a lever arm 39 that is connected as by a pin and slot connection 40 to the end of an air cylinder piston 41. The air cylinder 42 is mounted on the fixed upper jaw 24*a* and when air is supplied to the cylinder through the fitting 44, the piston is moved outwardly to the position shown in FIG. 2 to hold the jaws in closed position. When the air is released from the cylinder, the piston moves to the right and rocks the arm 39 clockwise so that the lower jaw is moved into open position shown in dash lines in FIG. 2. This allows the cable, indicated by the reference number 45 in FIG. 1A, to be positioned in the support plate center opening after which air is again applied to the cylinder 42 to close the jaws.

Gear 27 meshes with a pinion 46 on the inner end of a shaft 47 journalled in the post 22. The outer end of the shaft carries a sprocket 48 that is connected as by a roller chain to a sprocket 49, the chain being indicated by phantom lines at 49*a* in FIG. 2. The sprocket 49, FIGS. 1 and 7, is part of a clutch assembly mounted on the back of base plate 20 and is formed integrally with one half 50 of a toothed clutch. The clutch half 50 is free on a shaft 51 journalled at its ends in the side walls 52 of a bracket 54 that is secured to the base plate.

The clutch half 50 is engageable by a mating clutch half 55 that is slidable on the shaft 51 but is keyed to it for rotation therewith. A gear 56, FIG. 7, is fixed on the shaft and this gear is driven by a pinion 57 on the shaft of a reversible air motor 58 supported by a rear extension 59 of the bracket top wall 60. On the right end of shaft 51, as viewed in FIG. 7, there is a second pair of clutch halves 61 and 62, the half 61 being free on the shaft and having a sprocket 64 formed integrally therewith and the half 62 being slidable on and keyed to the shaft like clutch half 55. The driving clutch halves 55 and 62 are held in a neutral position, disengaged from their mating halves, by springs 65 on the shaft 51 but either half can be moved into engagement with its mating half by a shifting fork 67 having rearwardly projecting arms 68 operably connected to the halves 55, 62. The fork is mounted on the end of the shaft 69 of an air cylinder 70 supported by an extension 71 on the front of the bracket top wall 60.

The sprocket 64 is connected as by a roller chain 72, shown in phantom lines in FIG. 3, to a sprocket 74 that is slidably mounted on and keyed to a sleeve 75, the sleeve forming a part of the knot tightening mechanism the operation of which will be described hereinafter. The sleeve is supported with a free sliding fit in horizontally aligned bores 76 through a pair of spaced legs 77 which project at an oblique angle from a bracket 78 secured to the under side of base plate 20, FIGS. 1, 7 and 9. As best shown in FIGS. 7 and 9, the sprocket 74 is positioned on the sleeve between the legs 77.

A spindle 79 is slidably mounted in a bore 80 in the sleeve 75, and at its outer end the spindle is connected to a shaft 81 which projects outwardly from the sleeve through a communicating bore 82 of reduced diameter. The outer end of shaft 81 is connected to one end of a link member 83, FIGS. 1 and 3, the other end of which is connected to the shaft 84 of an air cylinder 85 mounted on bracket 78. A guide shaft 86 projects from the bracket and is received with a sliding fit in a bore 87 through the connecting link 83 between its connections with shafts 81 and 84. A spring 88 is positioned on the shaft 81 between a nut 89 on the end of sleeve 75 and an adjustment nut 90 adjacent the connecting link.

As best shown in FIGS. 1 and 3, a loop former device, generally indicated by reference number 91, is initially positioned so that it is above the cable held by the jaws 24*a*, 24*b* but below the bobbin 34 as the latter revolves about the cable. An arcuate groove 92 on the inner end of the loop former is in vertical alignment with the vertical centerline of the bobbin so that the lacing carried by the bobbin will be laid in this groove as the bobbin travels around it.

The loop former is pivotally connected at 94 to the lower end of a rod 95 that extends up through a cut-out 96 in the base plate, FIGS. 1 and 7. Above the base plate, the rod passes with a free fit through a collar 97 and is secured in a bore in a second collar 98, both collars encircling with a free fit a cam cylinder 99 that is secured in fixed relation to the base plate. The cam cylinder is formed with a helical cam slot 100 which starts at its lower end on the back of the cylinder (as viewed in FIG. 1) and traces a helical path 270° around the cylinder to the right side thereof where it terminates in a vertical leg 101, FIGS. 1 and 3.

Collar 98 is provided with a cylindrical interior lug 102, FIG. 4, that projects into the cam slot and operates as a cam follower, the lug being provided with a roller 104 to reduce friction between the follower and the edges of the cam slot. Inside the cam cylinder 99 there is another cylinder 105 with closed ends, and the lug 102 has an inner extension 106 that is threaded into this cylinder as indicated in FIG. 4. A rod 107 having an O-ring seal passes through a bore in the lower end of cylinder 105 and terminates at its upper end in a piston 108 which divides the cylinder interior into two sections. At its lower end, the rod is fixed to the base plate 20 so that the piston is also fixed.

The inside cylinder 105 is provided at its top with an air hose fitting 109, FIG. 1, which communicates with a passage 110 to permit air to be introduced into the cylinder above the piston 108. Similarly, collar 98 has an air fitting 111 which communicates with a passage 112 through the cam follower lug 102 and extension 106 for introducing air into the cylinder below the piston. With this arrangement, air introduced into the cylinder above the piston will cause the cylinder to rise because the piston is fixed. Conversely, when the cylinder is in its elevated position, air introduced through the collar fitting will force the cylinder back down.

When the inside cylinder 105 is forced upwardly, it carries collar 98 with it and the cam follower follows the helical slot in the fixed cam cylinder 99 which causes the inside cylinder and collar to be rotated 270° as they are being elevated. As a result, the loop former 91 on the lower end of rod 95 moves from its initial position shown in FIGS. 1 and 3 to its elevated and rotated position shown in FIGS. 2 and 6.

The operation of the machine is as follows: The air cylinder 42 is actuated to open the lower jaw 24*b* and the end of the cable 45 is positioned between the jaws after which the air cylinder is actuated to close the jaws and hold the cable in position for the tying operation. As indicated in FIGS. 1A, the cable comprises a plurality of electrical conductors 114 but it will be understood that the machine can be utilized to tie other elongated articles of various types. The tying material (not shown) is wound on the bobbin 34 which is made in two mating halves 34*a*, 34*b*, the two halves having a clip device 115, FIGS. 6 and 8, at one point on the bobbin circumference. The tying material is paid out through this clip on the vertical centerline of the bobbin so that it is in alignment with the groove 92 in the loop former 91.

At the start of the operation, the tying material, which for a multi-conductor cable is preferably waxed nylon lacing, is drawn from the bobbin and the first tie 116 at the end of the cable is made manually. The cable is then advanced a predetermined distance to the point on the cable for the next tie, and the lacing which has followed longitudinally along the cable during the advance now extends up from the cable surface through a notch 117 in an upper extension of the flange 26 to the bobbin, the notch serving to hold the lacing on the cable at the point at which the tie is to be made. At this time the bobbin is positioned approximately 55° in front of the vertical centerline of the bobbin carrier plate 30 as shown in FIG. 2 and indicated by the point 118 in FIG. 3. The starting position of the bobbin is also shown in the diagram of FIG. 5 which traces the travel of the bobbin during the tying operation.

With the bobbin in its starting position, the air motor 58 is actuated to start the shaft 51 rotating through pinion 57 and gear 56, and the shifting fork 67 is moved by air cylinder 70 to the left as viewed in FIG. 7 to engage the clutch halves 50, 55. This initiates rotation of the bobbin carrier plate 30 through sprockets 48,49 and gears 46 and 27, and the bobbin 34 starts to revolve clockwise around the cable as viewed from the right side of the machine, FIGS. 3 and 5. At the start of the bobbin travel the loop former 91 is in its lower position between the cable and path of travel with its arcuate groove 92 in line with the lacing that is paid out from the bobbin, see FIGS. 1 and 3.

As the bobbin revolves it lays the lacing in the loop former groove and when it has travelled about half way around the cable, well past the loop former, to an approximate point indicated at 119 in FIG. 5 an air switch (not shown) is actuated to introduce air into cylinder 105 above piston 108 causing the loop former to be raised and rotated through 270° to the position shown in FIGS. 2 and 6. The vertical leg 101 at the upper end of the cam slot 100 insures that at the end of its rotation the loop former will be elevated high enough to be above the bobbin as the latter continues its rotation around the cable. The loop former, due to its width as best shown in FIG. 11, forms a loop in the lacing and also twists the lacing adjacent the flange notch 117 as best shown in FIG. 6. The loop opening is presented to the bobbin which passes through it at the top of its path, at 0° in FIG. 5, and thus forms a loose knot in the lacing.

The loop former 91, FIGS. 11–14, in the embodiment disclosed is a three piece construction comprising a base 120 and a pair of mating slide members 121*a*,121*b* overlying the base and secured thereto by headed pins 122 which project from the base through slots 124 in the slide members. The base is formed with a transverse slot 125 and the inner edges of the slide members have opposed rectangular cut-outs 126, FIGS. 11 and 14 which register with the slot. The base is also formed with a narrower tailpiece 127 which projects outwardly from its point of connection 94 with rod 95 for a purpose to be described. When the loop former has formed a loop in the lacing as shown in FIG. 6, the slide members 121*a*,121*b* can be spread apart to insure that the loop will be large enough to allow the bobbin to pass through. This is accomplished by a wedge element 128, shown greatly enlarged in FIG. 15, that is pressed down into the slide cut-outs 126 to force the members apart as shown in FIG. 14, the wedge being mounted in the machine above the loop former in its elevated position in a manner not shown. Springs 129, shown only in FIG. 13, extend between two pairs of upstanding ears 130 on the slide members to normally hold them together.

After the bobbin passes through the loop in the lacing it continues its clockwise travel for approximately another 55° from the 0° position, FIGS. 3 and 5, which brings its center opening into alignment with the spindle 79 in sleeve 75 on the right side of the machine, FIGS. 1, 3 and 6. This point is shown at 131 in the FIG. 5 diagram. At this time, the shifting fork 67 is moved by air cylinder 70 to the right as viewed in FIG. 7 which stops the drive to the bobbin carrier plate 30 and by engagement of the clutch halves 61,62 transfers the drive to sprocket 74 causing sleeve 75 to rotate. As soon as the drive is shifted from the left to the right side of the machine, air cylinder 85 on bracket 78 is actuated to pull in its shaft 84 and move the connecting link 83 to the left, FIGS. 1 and 6.

As best shown in FIGS. 9 and 10, when the connecting link is shifted to the left, the sleeve 75, which has a shouldered inner end, is moved into engagement with a notched boss 132 surrounding the bobbin center opening whereby the driven sleeve causes the bobbin to rotate also. Simultaneously, the inner spindle 79 is thrust into the bobbin center opening pushing the spindle 35 back into the cylinder 33, FIG. 1. With this arrangement, as the bobbin rotates it takes up the excess lacing and tightens the knot on the cable. The tension exerted by the bobbin, and thus the tightness of the knot or tie, can be regulated by adjusting the nut 90 to vary the force exerted by spring 88. Thus, after the bobbin has been rotated enough to obtain the desired tightness, the spring will permit the shouldered sleeve end to slip in and out of the boss 132 on the bobbin without transmitting further rotation to it.

To enable the bobbin to take up the excess lacing and tighten the knot, the lacing must be pulled out of the groove 92 in the loop former 91 and this is facilitated by means such as an air sensor (not shown) which causes a pin 134 that normally bears against the loop former tailpiece 127 to be retracted, FIGS. 1 and 2. This allows the inner grooved end of the loop former to drop down by its own weight whereby the lacing is easily pulled from the groove. The pin 134 is retracted into an air cylinder 135 having a support 136 that is threaded on the rod 95 above its pivotal connection with the loop former. The retraction of pin 134 occurs at the same time that the sleeve 75 is moved into engagement with the bobbin.

After the knot in the lacing has been tightened as described above, the air cylinder 85 is actuated to shift connecting link 83 back to the right disengaging sleeve 75 and spindle 79 from the bobbin and allowing spindle 35 to re-enter it by the action of spring 37. Immediately thereafter, the air cylinder 70 is actuated to move shifting fork 67 back to the left to disengage clutch halves 61,62 and engage clutch halves 50,55. At the same time, the air motor 58 is reversed. This causes the drive to the bobbin carrier plate 30 to move the bobbin back to its start position at which point the air motor is stopped and reversed again in preparation for the next tying operation.

With the bobbin back in its start position and drive mechanisms stopped, the lower jaw 24*b* is opened so that the cable can manually or automatically be advanced to the point at which the next tie must be made or, in the alternative, the cable can remain stationary and the machine moved relative to it as by slidably mounting the machine on an elongated support arm (not shown). While not shown, it is contemplated that the timing and actuation of the various machine operations in each tying cycle will be carried out by known types of pneumatic sensing devices and air switches, and the sequence of operations can be programmed and controlled by computer, if desired.

From the foregoing description, it will be apparent that the invention provides a unique and very useful machine capable of rapidly applying ties to a cable or the like with uniform tension throughout and with a substantial saving in labor costs. As will be understood by those familiar with the art, the invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof.

I claim:

1. In a cable tying machine: means for holding the cable adjacent the point at which a tie is to be made, a bobbin adapted to carry lacing material for making the ties, support means for the bobbin operable to revolve it in a circular path around the cable whereby lacing payed out from the bobbin is passed around the cable, loop forming means initially disposed between the cable and path of the bobbin so that the lacing is deposited thereon as the bobbin revolves around the cable, means to move the loop forming means away from its initial position to form a loop in the lacing through which the bobbin passes as it continues to travel around the cable, and means cooperable with the bobbin after it has passed through the loop to take up the excess slack in the lacing and tighten the knot that was formed when the bobbin passed through the loop.

2. A machine as defined in claim 1 wherein the means for moving the loop forming means away from its initial position also rotates the forming means to twist the loop that is formed thereby.

3. A machine as defined in claim 2 wherein the means for moving the loop forming means includes a helical cam slot and a cam follower operably connected to the loop forming means.

4. In a cable tying machine: releasable means for holding the cable adjacent the point at which a tie is to be made, a bobbin carrying lacing material for making the ties, support means for the bobbin forming a part of the cable holding means, the support means being operable to revolve the bobbin around the cable so that lacing payed out from the bobbin is passed around the cable, a loop former having lacing receiving means, the loop former being initially positioned between the cable and path of the bobbin so that the lacing is deposited thereon as the bobbin revolves around the cable, means to move the loop former away from its initial position to form a loop in the lacing through which the bobbin passes as it continues to travel around the cable, and means engageable with the bobbin after it has passed through the loop and operable to rotate the bobbin so that it takes up the excess slack in the lacing and tightens the knot that was formed when the bobbin passed through the loop.

5. A machine as defined in claim 4 wherein the means for moving the loop former away from its initial position includes a helical cam slot and a cam follower operably connected to the loop former whereby the latter rotates as it moves and twists the lacing as it forms the loop therein.

6. A machine as defined in claim 5 together with drive and shiftable clutch means, the drive means being operable when the clutch means is in a first position to drive the bobbin support and revolve the bobbin around the cable and being operable when the clutch means is in a second position to drive the bobbin rotating means.

7. A cable tying machine comprising releasable means for holding the cable adjacent the point at which a tie is to be made, a bobbin carrying member rotatably mounted on the cable means with its center of rotation coinciding with the longitudinal axis of the cable, a bobbin adapted to carry lacing for making the ties, the bobbin being rotatably mounted on the carrying member at a point adjacent its periphery so that rotation of the member causes the bobbin to revolve around the cable, means for holding a free portion of the lacing at a point on the surface of the cable whereby the lacing on the bobbin is payed out therefrom and passes around the cable as the bobbin revolves, a loop former having lacing receiving means, the loop former being initially positioned between the cable and path travelled by the bobbin so that the lacing is deposited thereon as the bobbin revolves around the cable, means to move the loop former away from its initial position after the lacing has been deposited thereon, the loop former movement forming a loop in the lacing through which the bobbin passes as it continues to travel around the cable, and means engageable with the bobbin after it has passed through the loop and operable to rotate the bobbin so that it takes up the excess slack in the lacing and tightens the knot that was formed when the bobbin passed through the loop.

8. A machine as defined in claim 7 wherein the means for moving the loop former away from its initial position is a fixed

first cylinder having a helical cam slot in its side wall, a second cylinder mounted with a free fit inside the first cylinder, a cam follower disposed in the cam slot and connected at its inner end to the second cylinder and at its outer end to the loop former, and means to move the second cylinder axially relative to the first cylinder whereby the cam follower and loop former are moved longitudinally and rotated relative to the first cylinder, said movement causing the loop former to twist the lacing as it forms the loop therein.

9. A machine as defined in claim 7 together with drive and shiftable clutch means, the drive means being operable when the clutch means is in a first position to drive the bobbin carrying member and revolve the bobbin around the cable and being operable when the clutch means is in a second position to drive the bobbin rotating means.

10. A machine as defined in claim 9 wherein the bobbin engaging and rotating means is a rotatable sleeve operably connected to the drive means so as to be driven thereby when the clutch means is in its second position, and means for shifting the sleeve into and out of engagement with the bobbin.

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