Oct. 6, 1953 G. W. BOGDANFFY ET AL 2,654,210

APPARATUS FOR CABLING THREADS

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FIG. 1.

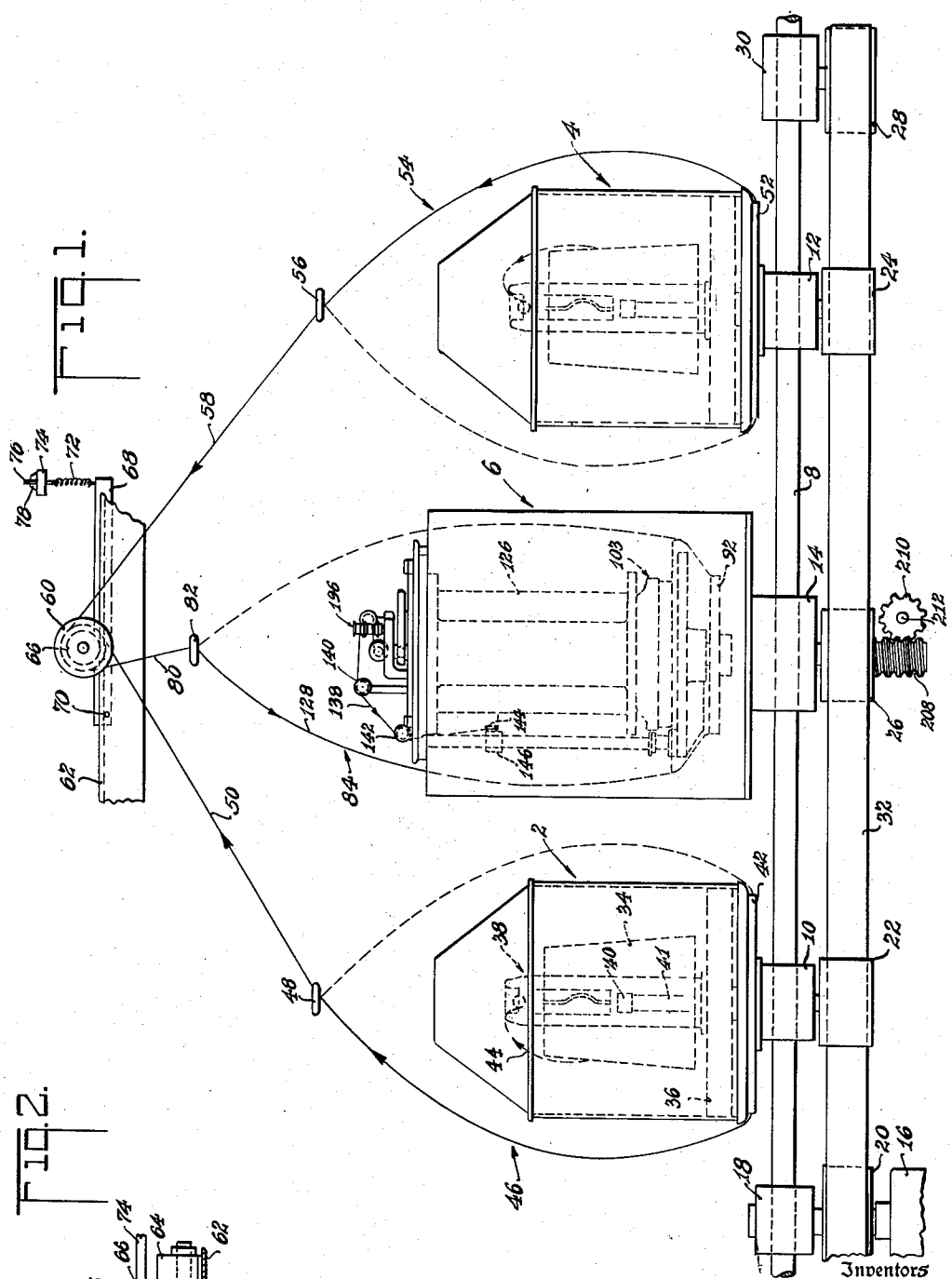


FIG. 2.

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APPARATUS FOR CABLING THREADS

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Fig. 3.

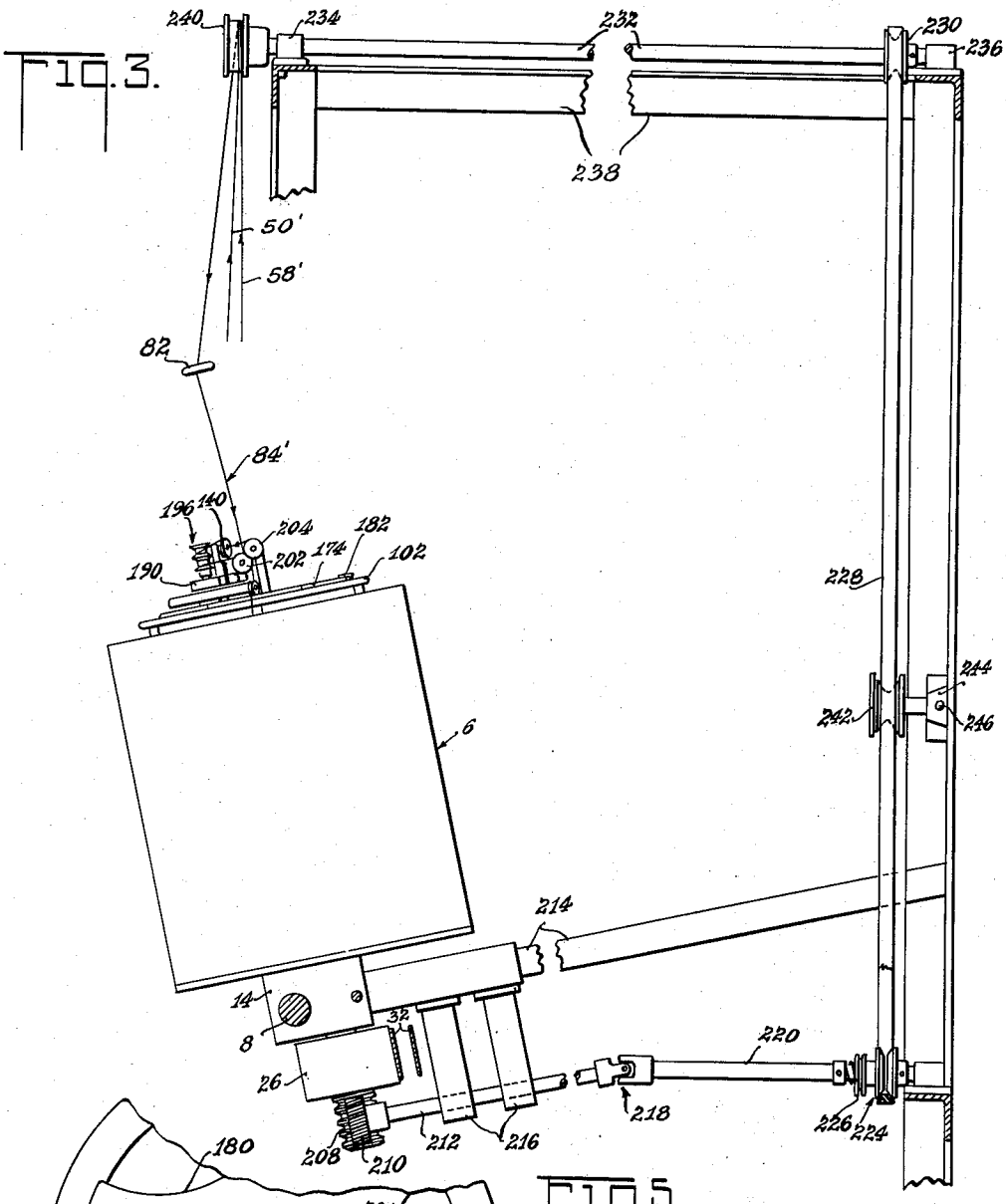
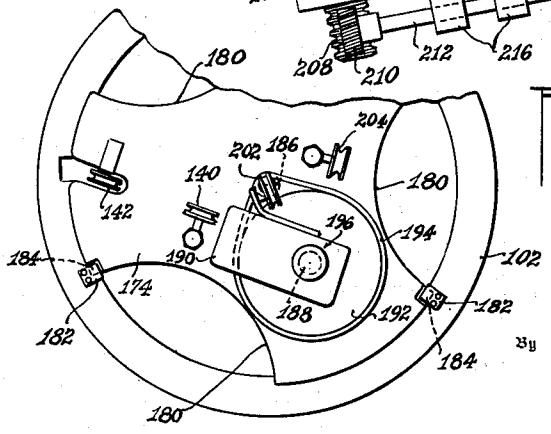


Fig. 5.



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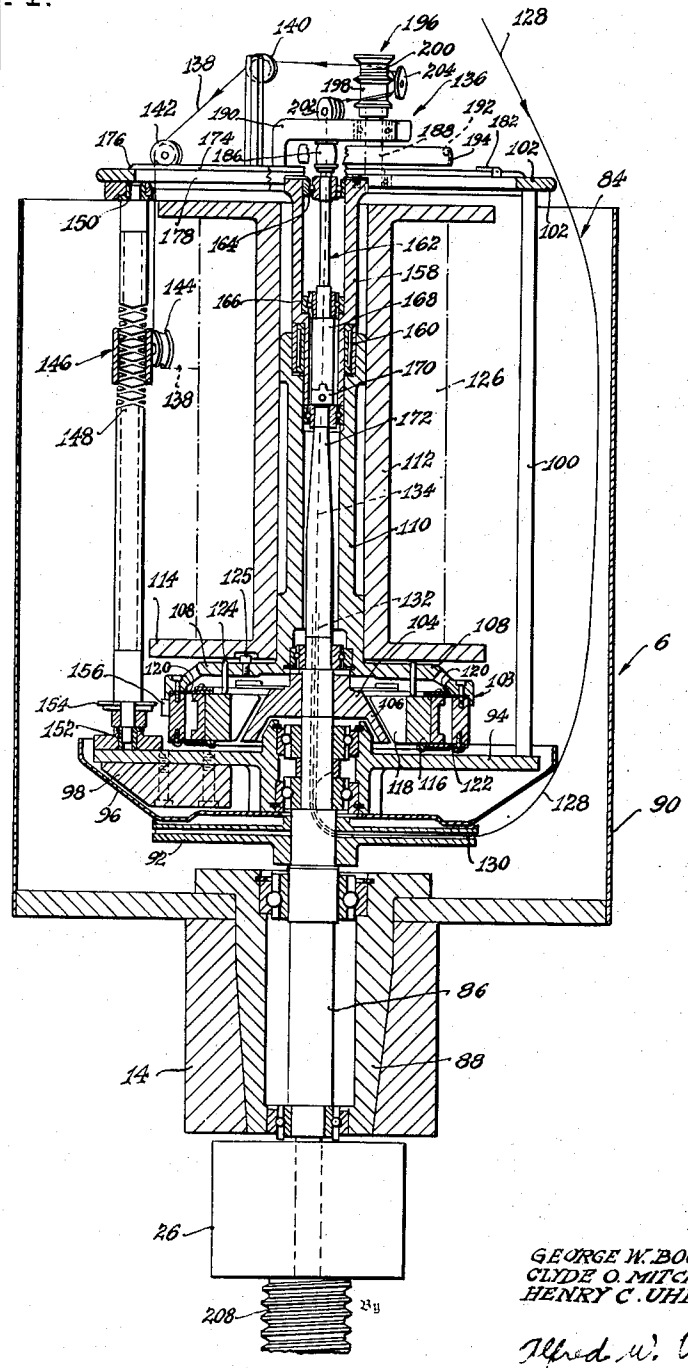
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APPARATUS FOR CABLING THREADS

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Fig. 4.



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UNITED STATES PATENT OFFICE

2,654,210

APPARATUS FOR CABLING THREADS

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Application November 10, 1948, Serial No. 59,392

3 Claims. (Cl. 57—58.55)

1

This invention relates to apparatus for cabling elongated, flexible materials, such as threads, to form cords, to apparatus including such cabling device as an element thereof for forming cords from yarns in one continuous operation, and to a method of forming cords by continuously twisting yarns and then cabling together the threads thus formed to form cords.

The invention has among its objects the provision of an improved cabling spindle of the type creating and maintaining a balloon in the material leading thereto, the spindle being of such construction that the material entering and passing through it is under complete control both in the balloon leading to the cabling spindle and in the portion of its travel in which it is wound.

The invention has a further object the provision of a novel combination of a cabling device, of the type above indicated, with yarn twisting spindles of the type creating and maintaining balloons in which the rate of withdrawal of yarn from the latter spindles is governed by the cabling spindle, the exactness of control of the material in the cabling spindle creating a desired balance of tensional forces in the material throughout the system.

Yet another object of the invention lies in the provision of a method of forming cord from yarns in one continuous operation with the material traveling continuously, wherein the forces acting on the material throughout the various operations are governed primarily during the cabling operation, whereby predetermined desired tension conditions throughout all the operations, including the yarn twisting, the cabling of the resulting threads, and the reeling of the resulting cord, are attained.

These and further objects of the invention will be more readily apparent in the following descriptions of preferred embodiments of the apparatus and the method of the invention.

In the drawings appended hereto and forming a part of the specification:

Figure 1 is a fragmentary, somewhat schematic, view of the general combination of apparatus of the first described embodiment of the invention, such embodiment employing a retarded thread gathering capstan, the view being taken in elevation from a plane parallel to the axes of the yarn twisting and thread cabling spindles;

Figure 2 is a fragmentary view in end elevation of the thread gathering capstan and its retarding mechanism employed in such first embodiment;

Figure 3 is a fragmentary view in end elevation of a second embodiment of the apparatus of the invention employing a driven thread gathering and forwarding capstan;

Figure 4 is a view in axial section through the cabling spindle of the invention, such spindle being employed in both embodiments of the general combination of apparatus in accordance with the invention, and

Figure 5 is a fragmentary view in plan of the cabling spindle shown in Figure 4.

The combination of yarn twisting spindles of the type creating and maintaining balloons in the delivered thread with a cabling spindle of the type creating and maintaining a balloon in the gathered cords delivered thereto is disclosed and claimed in the application of Henry C. Uhlig, Serial No. 765,577, filed August 1, 1947, now Patent No. 2,487,837, and entitled "Method of and Apparatus for Twisting Yarn." The apparatus and method of the present invention represent improvements in the general combination, the cabling spindle, and the method of forming cords of the said Uhlig patent, in that the present invention permits closer control of the cord at the cabling spindle and separates the control of the cabling spindle balloon from the control of the reeling tension. The present invention not only improves the operation of the cabling spindle itself, but also improves the operation of the combination of elements of the apparatus as a whole, since control of the yarns delivered from the yarn twisting spindles is exercised by the cabling spindle, wholly in the first described embodiment and partially in the second.

The general combination of apparatus disclosed, that is, the yarn twisting spindles in combination with the cabling spindle to which they deliver the threads which they produce, is capable of use to advantage, as will be explained, in the formation of cords formed from a plurality of yarns in one continuous operation in which the yarns, threads, and resulting cord travel continuously. Such cords are useful, for example, as the reinforcing elements in V belts and in automobile tires, rayon being a typical material for forming the cords for such latter use. It is to be understood that the apparatus and method of the invention may be employed in making cords from yarns composed of various fibers including the synthetic continuous filaments such as those of rayon or nylon, and also yarns made of natural fibers such as cotton. The method and apparatus of the invention may also be used advantageously in forming cords from fine wire. Thus the words "yarn," "thread" and "cord," as used in the

present specification and claims, are broadly construed to include the above materials, although the invention will be particularly described in its first embodiment with the twisting of rayon yarn, and in its second embodiment with the twisting of yarn made of cotton fibers, to form cords.

It is also to be understood that the invention includes the novel cabling spindle per se, as well as the combination of it with the yarn twisting spindles and other attendant mechanisms. The cabling spindle of the invention obviously may be used to advantage in cabling and reeling threads from other sources than those of the yarn twisting spindles of the general combination.

In the drawings, as above explained, Figures 1 and 2 show the general combination of the apparatus in the embodiment thereof adapted for the formation of cords from yarns of synthetic fibers such as rayon. In Figure 3 there is shown a second embodiment of the general combination which is particularly useful in the treatment of yarns formed of cotton and the like. The cabling spindle, shown generally in Figures 1 and 3 and more specifically in Figures 4 and 5, is substantially the same as that shown and described in both embodiments of the general combination.

Considering first the general combination of the first embodiment, there is shown in Figure 1 a first yarn twisting spindle **2** and a second yarn twisting spindle **4**, there being a cabling spindle **6** positioned equidistant therebetween, the axes of all such spindles lying in the same plane. The spindles are supported in a frame of which only fragments are shown, the direct support for the spindles being the horizontal rod **8** which extends longitudinally of the frame. Secured to rod **8** is the supporting member **10** for spindle **2**, the supporting member **12** for spindle **4**, and the supporting member **14** for spindle **6**. Also suspended on rod **8** is the supporting member **18** from which the electric motor **16** is hung. Motor **16** has on its driving shaft the pulley **20** which is connected to the driving pulley **22** of spindle **2**, the driving pulley **24** of spindle **4**, and the driving pulley **26** of spindle **6** by means of the belt **32**, such belt being supported at its end remote from the motor by means of the idler pulley **28** depending from supporting member **30**. Belt **32** has the two runs thereof on the opposite sides of pulleys **22** and **24**, and has both runs on the rear side of pulley **26**, as shown in Figure 3, so that spindles **2** and **4** are driven in the same direction and spindle **6** in the opposite direction, all in timed relation to each other.

Spindles **2** and **4** are generally shown as being of the type shown in Figure 1 of the application of Agresti et al., Serial No. 52,994 filed October 6, 1948, now Patent No. 2,492,778, entitled "Yarn Twisting Apparatus and Method." It is to be understood, however, that other twisting spindles, although preferably of the 2 for 1 type, which create and maintain balloons in the delivered material, may be substituted in the general combination of the apparatus for those shown at **2** and **4**.

Spindle **2** includes the cake or package of rayon yarn **34** supported on package support **36**, member **36** being floatingly mounted on the driven shaft of the spindle so as to be maintained substantially in one angular position. Yarn **44**, which is of the "flat yarn" type, that is, it has a rectangular cross section with the width materially exceeding the thickness, is fed from the package **34** through the yarn tensioning and twist barrier device, generally designated **38**, whence it issues into the driven twisting guide **40** on the driven shaft **41** of the spindle. The first twisted yarn then passes downwardly through an axial passage (not shown) in shaft **41**, and thence outwardly through a radial passage, not shown, in disc **42**, the disc being keyed for rotation with shaft **41**. Yarn issuing from the passage in disc **42** passes upwardly to the guiding eye **48** positioned axially of and above the spindle, as shown. The yarn so treated by spindle **2** is given a first twist in that portion of its travel below device **38** and above the twisting guide **40** and a second twist in that portion of its travel from the outer end of the passage in disc **42** to the guiding eye **48**. By reason of the high speed of rotation of the disc **42** the thread issuing therefrom, designated **50**, is thrown into a balloon **46** about the spindle.

Spindle **4** has parts similar to those of spindle **2** and the yarn treated thereby is subjected to the same steps. The balloon in the thread **58** issuing from the spindle and in the zone between twisting disc **52** of spindle **4** and eye **56** axially thereabove is designated **54**. When pulleys **22** and **24** are of the same diameter, when the yarns at the two spindles **2** and **4** are substantially identical, and when the tensions imposed upon the yarns at each of the spindles are likewise substantially identical, threads **50** and **58** will be subjected to substantially the same tension as they travel upwardly beyond their respective guiding eyes.

Threads **50** and **58** are gathered, in the first described embodiment of the apparatus, by the gathering capstan **60**, which is positioned above and substantially equidistant from the upper ends of the balloons created and maintained by each of the yarn twisting spindles. Because, as it will later appear, when the apparatus is treating materials such as rayon the tension in the balloon of the cord entering the cabling spindle exceeds the sum of the tensions in the threads issuing from the yarn twisting spindles, the thread gathering capstan **60** is retarded. In this embodiment, capstan **60**, more clearly shown in Figure 2, is mounted on the horizontal top frame member **62** through the medium of the pillow block **64**. The capstan has non-rotatably attached thereto a brake drum **66** with which the brake lever **68** cooperates. Lever **68** is pivotally connected to frame member **62** by the pivot pin **70**, the brake drum engaging portion of the lever being maintained in contact with the brake drum by means of an adjustable brake lever operating mechanism. Such mechanism includes the support **74** which may conveniently be a part of the machine frame, a rod **76** having a threaded upper end which extends through a hole in member **74**, a wing nut **78** screwed upon the upper end of rod **76**, and a coil spring **72** connected to the outer end of the brake lever **68** and the bottom of rod **76**, as shown. The force with which the brake lever engages the brake drum and thus the amount of retardation of capstan **60** may readily be varied by adjusting the position of rod **76** and thus the tension on spring **72** by means of nut **78**. The braking mechanism is adjusted so that, under constant speed conditions, the tension in the balloon in the cord entering the cabling spindle equals the sum of the tensions in the threads issuing from the spindles **2** and **4** and gathered at the capstan

plus the retardation upon such threads imposed by capstan 60.

Threads 50 and 58, which are gathered at the capstan 60 into generally parallel relationship, are led around the capstan in that condition two or three times and then are directed downwardly through the guiding eye 82 which is positioned axially above the cabling spindle 6. The gathered and substantially parallel threads, as yet untwisted on each other, are designated 80 in that portion of their travel above eye 82. From eye 82 the gathered threads are fed downwardly into a radial passage in the driven twisting disc 92 at the bottom of spindle 6. The gathered threads are given a first twist in the balloon 84 between eye 82 and disc 92, the thus first twisted cord being designated 128.

The structure of the cabling spindle 6 employed in both embodiments of the general combination of the apparatus will be more clearly understood by a consideration of Figure 4. The spindle 6 includes the driven shaft 86 which is positioned, as are the driven shafts of spindles 2 and 4, at a small angle to the vertical as, for instance, 12°, as indicated in Figure 3. Such angularity of position of the spindle shafts has the function of maintaining the bobbin supports of the yarn twisting spindles and the cord laying mechanism supporting cage of the cabling spindle in substantially one angular position. Shaft 86 is supported at its lower end in bearings in the sleeve member 88, such sleeve member being supported in the member 14 previously described. Supported on member 14, as shown, is a spindle encircling closure member 90, which confines the balloon 84 and prevents it from becoming entangled with balloons 46 and 54 before the device has reached steady operating condition.

The improved cabling spindle of the invention is illustrated in that embodiment thereof providing means whereby the threads entering it and passing therethrough are given a 2 for 1 twist on each other before they are reeled upon the bobbin carried thereby. The improvement in the cabling spindle of the invention resides in the provision of means engaging the cord, in that portion of its travel in the spindle from the entering end of the radial passage in the twisting disc to the cord laying device, for positively forwarding the cord, such means being positively driven in synchronism with the driven shaft of the spindle. As a result of such construction, the power necessary for pulling the cord inwardly from the bottom of its balloon is supplied by the means at the spindle positively engaging and forwarding the cord, the slip driving connection such as a variable magnetic clutch, which is preferably employed between the driven shaft of the spindle and the bobbin support, being relied upon only to impel the cord from such last named means to the cord laying device and to wind it upon the bobbin. As a result of such construction the slip driving connection no longer performs both the functions of pulling the cord from the balloon and of reeling it and thus more accurate control is possible of both the cord balloon and of the reeling operation.

The structure of the preferred illustrative embodiment of the cabling spindle shown in Figure 4 at the bottom portion thereof immediately above sleeve 88, and also the traversing cord laying device of the spindle are substantially similar to those described in the application of Agresti, Serial No. 15,394, filed March 17, 1948, now Patent No. 2,534,496, and entitled "Constant Tension Elongated Material Handling Mechanism." It is to be understood, however, that the improvement in the cabling spindle of the invention may be used to advantage in spindles having other types of bobbin driving mechanisms and cord laying devices. Such spindle includes the twisting disc 92 keyed on shaft 86 immediately above sleeve 88, a cage supporting flange 94 floatingly mounted on shaft 86, and an upwardly dished guard 96 affixed to the disc 92 and rotatable therewith. A weight 98 eccentrically secured to the bottom of flange 94 maintains such flange and the cage structure carried thereby in substantially one angular position. The cage is formed by a plurality of spaced upstanding rods 100, positioned around the edge of flange 94 and parallel to shaft 86. A ring 102 is secured to the tops of rods 100. Such cage structure forms the support for the traversing cord laying mechanism and for the auxiliary cord driving capstan presently to be described.

Connection between shaft 86 and the bobbin support is effected by means of the magnetic slip clutch generally designated 103. Such clutch includes a rotor member 104 keyed to shaft 86, such rotor member being made of magnetic material such as soft iron, and having a depending skirt 106, the outer face of the skirt lying on the frustum of a cone. The bobbin support consists of a flange 108 and an upstanding central tubular portion 110 both made of non-magnetic material, such bobbin support being floatingly mounted on the upper end of shaft 86. The bobbin core 112, in this instance, is cylindrical, such core having a transverse bottom flange 114, the bobbin core also being made of non-magnetic material. The bobbin core is slidingly received over portion 110 of the bobbin support, the weight of the bobbin core and of the cord 126 wound thereon being sustained by the three non-magnetic pins 124 slidingly mounted in flange 108. The bobbin core is keyed for rotation with the bobbin support by the driving connection generally designated 125.

The bottom ends of pins 124 rest upon the upper surface of the outer rotor member 116 of the magnetic clutch. Member 116, which is a strong permanent magnet, is provided with a plurality of radially directed poles 118, the inner faces of which lie on the frustrum of a cone the elements of which are parallel to those of the skirt 106. The outer magnetic clutch member 116 is supported from the outer edge of flange 108 through the medium of the upper and lower non-magnetic annular springs 120 and 122, respectively. As increasing pressure is imposed upon pins 124 as a consequence to the building up of cord upon the bobbin core, magnetic clutch part 116 is depressed and thus the air gap between parts 106 and 116 is decreased. The angles of the cones on which the confronting faces of parts 106 and 116 of the clutch lie, and the characteristics of spring members 120 and 122 are so chosen that the torque transmitted through the magnetic clutch varies substantially directly with the increase in weight of the bobbin core and the material wound thereon, whereby yarn is wound upon the bobbin under a substantially constant tension, when the bobbin core is cylindrical, regardless of the instantaneous diameter of the reel on which it is wound.

The cord 128 is withdrawn from the balloon

84 of the cabling spindle through passage 130 in twisting disc 92 from which it travels upwardly in the axial passage 132 in the upper end of shaft 86. The cord in such latter portion of its travel is designated 134. In the described embodiment, the means at the spindle positively engaging and forwarding the cord, generally designated 136, takes the form of an auxiliary capstan supported at the upper end of the cage structure and positively driven from the upper end of shaft 86. The finally twisted cord 138, after emergence from its path axially of shaft 86, and after its engagement by the auxiliary capstan 196, which will be more particularly described hereafter, is led around guide sheave 140 down around the further guide sheave 142 to the cord laying and guiding sheave 144 on the traversing cord laying mechanism, generally designated 146. From sheave 144 the cord 138 is laid upon the bobbin.

As above indicated, the traversing cord laying device 146 is similar to that shown and described in the Agresti Patent No. 2,534,496. Such device includes the driven double worm 148, supported for rotation in the upper bearing 150 at the upper end of the cage and in the lower bearing 152 on flange 94. Worm 148 is rotated intermittently in timed relation with the rotation of the bobbin support, and thus of the bobbin, by means including a ratchet wheel 154 keyed to worm 148 and a single lobe cam 156 positioned on the lower edge of flange 108, the cam cooperating with a ratchet operating lever (not shown) supported on flange 94, to rotate ratchet wheel 154 at each passage of the cam lobe by the ratchet lever.

The auxiliary capstan device 196 includes a sleeve member 158, the bottom end of which is reduced in diameter and telescopes within the needle bearing 160 positioned in a counterbore in the upper end of part 110 of the bobbin support. Sleeve 158 furnishes support for the auxiliary hollow shaft 162, such shaft being supported at the top in bearing 164 in the sleeve 158 and at the bottom in bearing 166. The bottom end of the hollow driven shaft 162 is enlarged at 168, the lower end of such enlargement having on the edges of its sidewalls slots complementary to the projections on the sidewalls of the male clutch part 170, part 170 being affixed on the upper end 172 of the driven shaft 86. Sleeve 158 and shaft 162 are attached to the supporting plate 174 so as to be removable as a unit from the spindle with the plate. Plate 174 has an overhanging rim 176 and an inwardly projecting body 178 of such dimensions that the body fits within ring 102 and the rim overlies the ring. As shown in Figure 5, plate 174 has three openings 180 around its edge. The leading outer edges 184 of the plate adjoining the openings 180 are tapered in thickness so that the plate may be temporarily locked in place by positioning it on the ring 102 and then turning it counterclockwise (in Figure 5) so that the edges 184 frictionally engage the inwardly projecting portions of clips 182 affixed to ring 102.

Above plate 174 shaft 162 is provided with a small pulley 186. Spaced from shaft 162, as more clearly indicated in Figure 5, and journaled in plate 174 and the overarm 190 attached to plate 174, is the capstan shaft 188, which is positioned parallel to shafts 86 and 162. A large pulley 192 is keyed on shaft 188 between the plate and overarm. Connection between pulleys 186 and 192 is afforded by belt 194, so that the capstan shaft is driven at reduced speed but in synchronism with shaft 86. Shaft 188 carries, keyed thereto at its upper end, a capstan 196 having a first, bottom step 198, and a second, top step 200. Cord traveling upward through the axial passage in the upper end of shaft 86 and through hollow shaft 162 passes over the guide sheave 202, affixed to plate 174, and onto the first step 198 of the capstan. The cord passes around such first step several times, and is then led to the transfer sheave 204, supported on plate 174, from which it passes to the second step 200 of the capstan. After passing around such second step several times, the cord is led to guide sheaves 140 and 142, both supported on plate 174 as shown, and thence to the sheave 144 of the cord laying device, as previously described.

When the apparatus is used for making cords of materials such as rayon, the primary purpose of the auxiliary capstan is positively to engage the cord to furnish the power necessary to withdraw it from the balloon of the cabling spindle. It also functions as the governer of both the twisting and cabling operations, since the peripheral speed of the auxiliary capstan bears a definite, predetermined, relation to the speeds of rotation of the yarn twisting spindles and to the speed of rotation of the twisting disc of the twisting spindle. In a typical auxiliary capstan for use with materials such as rayon, the upper step 200 of the capstan will exceed the bottom step 198 thereof in diameter by one-half percent. Each step of the capstan is preferably tapered to increase in diameter an upward direction, a typical included angle of taper, in this example, being 4°. As a result of such construction, the cord is very firmly gripped and is also slightly stretched, thereby giving it a substantially permanent lay.

The apparatus of the first described embodiment may, with slight modification, be adapted for the more efficient forming of cords from yarns of materials such as cotton. Because, in some cases, it is desired that one device be used in the treating of both materials such as rayon and those such as cotton, there is shown in the embodiment of Figure 1 a driving connection from spindle 6 consisting of the worm 208 positioned on the bottom of the driven shaft of the spindle and the worm gear 210, supported on shaft 212, meshing therewith. When the apparatus is employed with a retarder gathering capstan 60 the driving connection on shaft 212 beyond gear 210 is disconnected at the universal joint 218 (Figure 3). However, when materials such as cotton are treated, it is desirable that the gathering capstan shall be driven. Figure 3 shows the apparatus of the second embodiment, such apparatus being identical with that above described except for the substitution of a positively driven gathering capstan 240, and the driving mechanism therefor, for the retarded capstan 60.

In Figure 3 the cabling spindle 6 and the parts thereof are identical with those shown in Figures 1 and 4 and thus are designated by the same reference characters. The threads, however, formed by twisting spindles as in the first embodiment, are designated 50' and 58', such threads being gathered at the driven capstan 240 from which they are fed downwardly into the balloon 84' of the cabling spindle. With threads formed of material such as cotton the sum of the tensions therein, as they are fed from their individual twisting spindles, exceeds the tension in the balloon of the cabling spindle. It is therefore necessary, in order to secure balanced conditions throughout the system with balloons of the desired character at both the yarn twisting and

cabling spindles, to drive the gathering capstan. In Figure 3 such drive is provided from the shaft 212, such shaft being supported by members 216 depending from the transverse frame member 214. The drive includes the universal joint 218, the cross shaft 220, the V belt 228 running over pulleys 224 and 230, and the upper cross shaft 232 journaled in pillow blocks 234 and 236. In order to vary the peripheral speed of capstan 240 a change speed driving mechanism is employed between shafts 220 and 232. In the embodiment shown, such speed change mechanism is provided by means of the split pulley 224, one part of which is shiftable relative to the other, to vary the effective diameter of the pulley, by means of conventional mechanism, including the shifting flange shown at 226, the groove of which is engaged by an adjustably positioned yoke, not shown. In order to maintain belt 228 in the desired taut condition there is provided an adjustable belt tightening idler pulley 242 which engages one reach of the belt, pulley 242 being adjustable transversely of the run of the belt by reason of its mounting on the slide 244, which is adjustable horizontally by the worm 246.

The change speed driving connection between shafts 220 and 232 is adjusted, in the described manner, so that under steady running conditions the balloons in the threads delivered from the individual twisting spindles and the balloon 84' leading to the cabling spindle have the desired spans. Under such conditions the tension in balloon 84' plus the tension imposed upon threads 50' and 58' by driven capstan 240 equals the sum of the tensions in the balloons of the individual yarn twisting spindles. The auxiliary cord engaging capstan 196, in this embodiment as in the first, permits separation of the controls of the balloon 84' and of the reeling operation.

When the apparatus of the second embodiment is employed in treating material such as cotton the auxiliary capstan 196 may be modified as to its capstan step dimensions so that such capstan performs the further step of substantially normalizing the cabled thread and therefore reducing subsequent length variations therein. A typical auxiliary capstan for such purpose has both the upper and lower steps tapered, as in the first described embodiment, with an included angle of 4°, for example, but the upper step exceeds the lower step in diameter by three or four percent. In this embodiment, therefore, in the passage of the cord from the lower to the upper step, the cord is subjected to substantial tension in the reaches thereof from the bottom step 198 of the capstan to the sheave 204, and from such sheave to the upper step 200 of the capstan.

Whereas we have described and illustrated preferred embodiments of the apparatus for and method of cabling threads in accordance with our invention, it is to be understood that such embodiments are illustrative only. The invention is capable of considerable variations as to details, and accordingly it is defined by the scope of the following claims.

We claim as new the following:

1. Apparatus for twisting and reeling elongated flexible material such as cord, which comprises a rotary driven spindle shaft disposed at a small acute angle to the vertical, a bobbin support mounted on the upper end of such spindle shaft, a slip driving connection between the spindle shaft and the bobbin support, a thread guide supporting cage surrounding the bobbin support and floatingly mounted on the spindle shaft so as to be maintained in a relatively stationary position, means for maintaining the cage structure in such position including an eccentrically located weight attached thereto, a twisting device mounted on the spindle shaft, the twisting device including a twisting disc mounted below the cage structure for rotation with the spindle shaft, the spindle shaft having an axial passage in its upper end, the twisting disc having a substantially radial passage therethrough connected with the passage in the spindle shaft, the cage having a cord guiding and loading device thereon, the cage having a supporting structure located thereon, the supporting structure spanning the spindle shaft above the upper end of the spindle shaft, a capstan rotatably carried by said supporting structure, the axis of the capstan being parallel to the axis of the spindle shaft, an auxiliary shaft drivingly engaged with the upper end of the spindle shaft, a speed reducing driving means between the auxiliary shaft and the capstan, whereby the capstan is driven at reduced speed and in synchronism with the spindle shaft, the capstan having a cord engaging step thereon, means for guiding the cord issuing from the spindle shaft to and around the capstan step, and means for guiding the cord from the capstan step to the cord guiding and loading device, whereby cord fed from a point spaced above the upper end of the spindle shaft and coaxial therewith through the passageways in the twisting disc and the spindle shaft, around the capstan step as recited, to the guiding and loading device, and thence to the bobbin, in that order, is given a double twist when the spindle shaft is rotated and the cord is wound on the bobbin.

2. Apparatus for twisting and reeling elongated flexible material such as cord, which comprises a rotary driven spindle shaft disposed at a small acute angle to the vertical, a bobbin support mounted on the upper end of such spindle shaft, a slip driving connection between the spindle shaft and the bobbin support, such slip driving connection comprising a magnet attached to one of the group of elements consisting of the spindle shaft and bobbin support, and a rotor attached to the other element of such group, the magnet and rotor being located in spaced relationship so as to induce electric current in the rotor upon relative motion between the spindle shaft and the bobbin support, a thread guide supporting cage surrounding the bobbin support and floatingly mounted on the spindle shaft so as to be maintained in a relatively stationary position, means for maintaining the cage structure in such position including an eccentrically located weight attached thereto, a twisting device mounted on the spindle shaft, the twisting device including a twisting disc mounted below the cage structure for rotation with the spindle shaft, the spindle shaft having an axial passage in its upper end, the twisting disc having a substantially radial passage therethrough connected with the passage in the spindle shaft, the cage having a cord guiding and loading device thereon, the cage having a supporting structure located thereon, the supporting structure spanning the spindle shaft above the upper end of the spindle shaft, a capstan rotatably carried by said supporting structure, the axis of the capstan being parallel to the axis of the spindle shaft, a hollow auxiliary driving shaft telescoping and drivingly engaged with the upper end of the spindle shaft and coaxial therewith, a speed reducing driving means between the hollow shaft and the capstan, where-

by the capstan is driven at reduced speed and in synchronism with the spindle shaft, the capstan having at least two axially spaced cord engaging steps thereon, one such step somewhat exceeding the other step in diameter, means for guiding the cord issuing from the spindle shaft and the hollow auxiliary driving shaft to and around the smaller capstan step, means including a guide sheave spaced from the capstan for transferring the cord from the smaller step of the capstan to the larger step thereof, and means for guiding the cord from the larger capstan step to the cord guiding and loading device, whereby cord fed from a point spaced above the upper end of the spindle shaft and coaxial therewith through the passageways in the twisting disc, the spindle shaft, and the hollow auxiliary driving shaft, around the capstan steps as recited, to the guiding and loading device, and thence to the bobbin, in that order, is given a double twist when the spindle shaft is rotated and the cord is wound on the bobbin.

3. In combination, in a strand-forming machine comprising a plurality of singles twisters, means for doubling a plurality of strands into a plied strand, said doubling means having a hollow rotatable spindle shaft, tension-producing means positioned between the singles twisters and the doubling means for collecting strands passing from the twisters to the doubling means into a group and discharging the group under uniform tension, a rotatable thread-advancing roll for drawing the plied strand into the doubling means, said roll mounted on the doubling means and disposed to receive the plied strand from the bore of the hollow spindle shaft, a hollow axial extension of the spindle shaft, and means connecting the roll and the spindle shaft extension in positive driving relationship.

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CLYDE O. MITCHELL.
HENRY C. UHLIG.

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