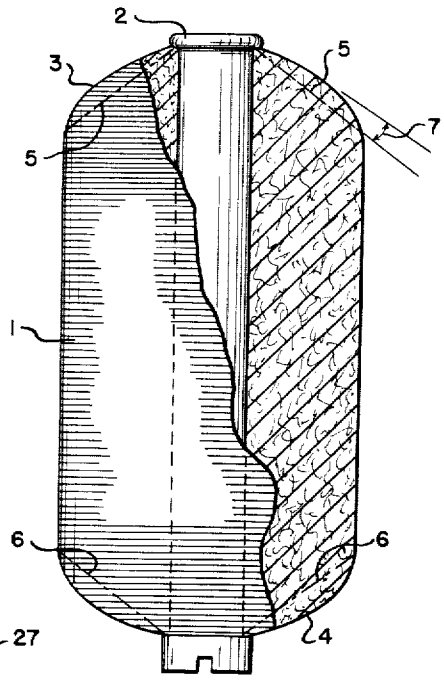
July 9, 1963 O. E. HEIBERG 3,096,611

METHOD FOR WINDING PACKAGES OF ROVING AND THE LIKE

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FIG. 1



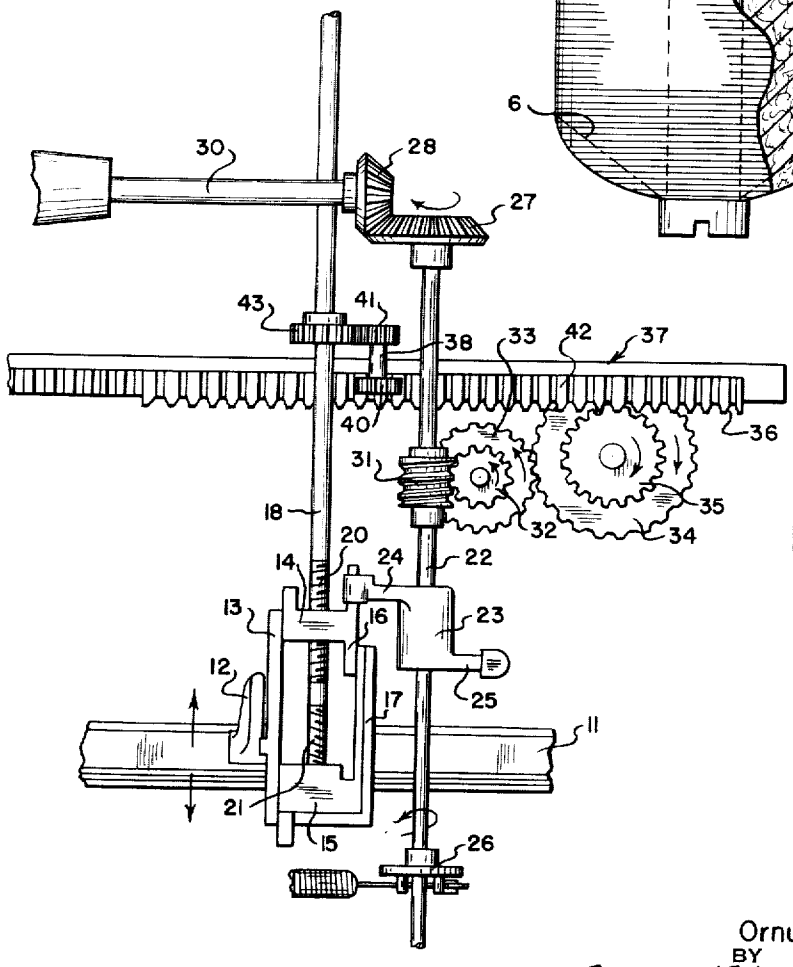


FIG. 2

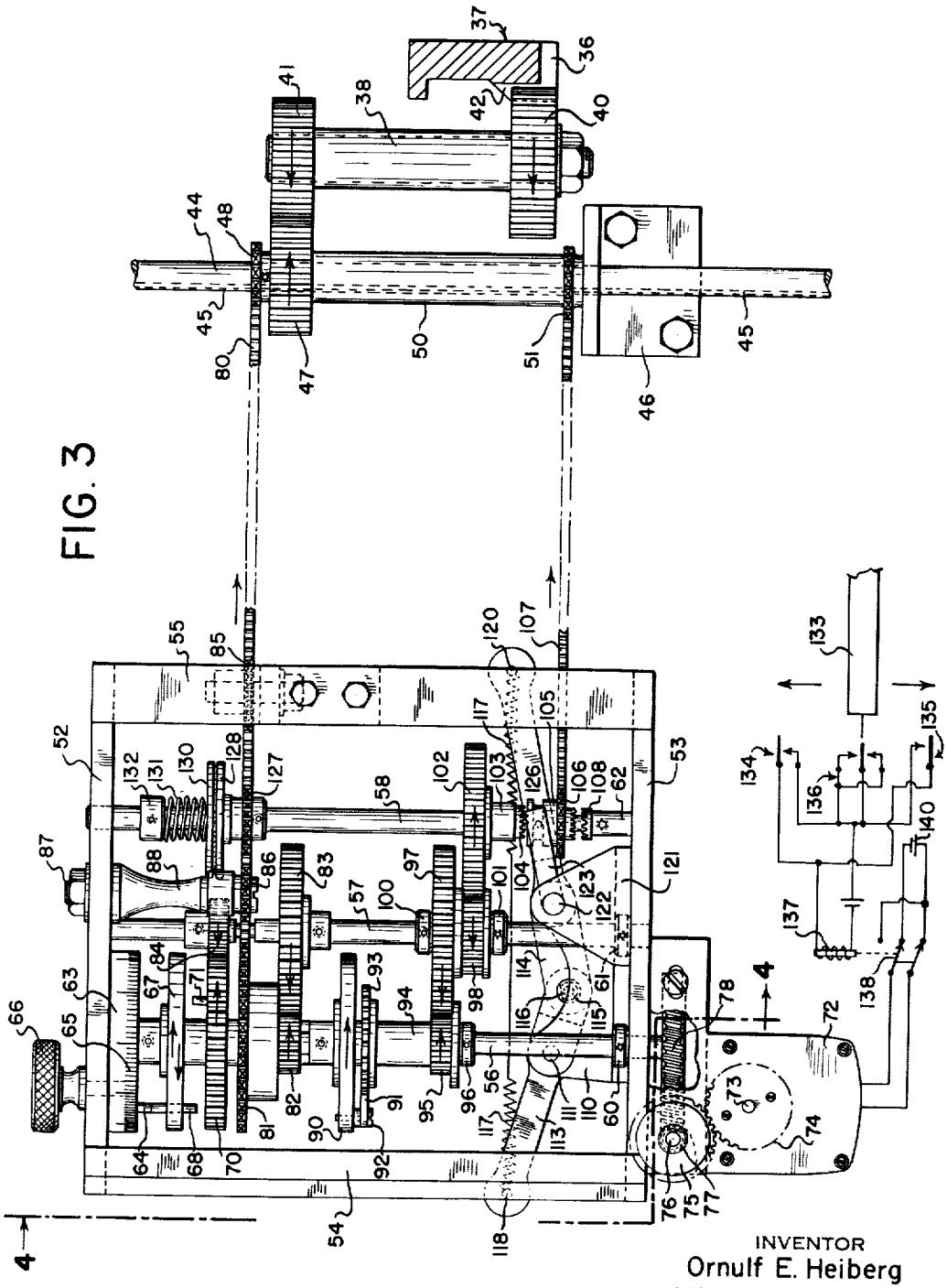
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FIG. 3



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FIG. 6

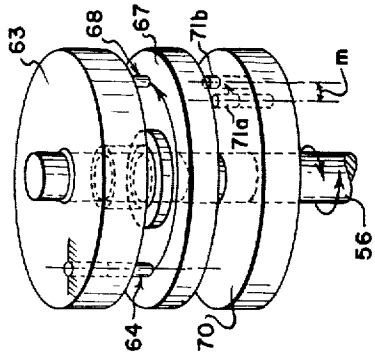


FIG. 8

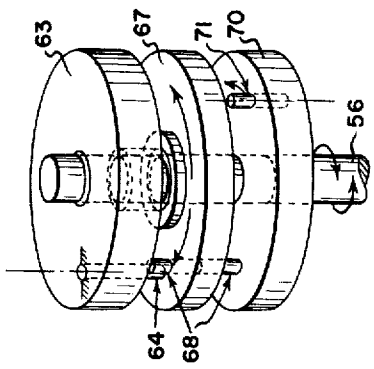


FIG. 5

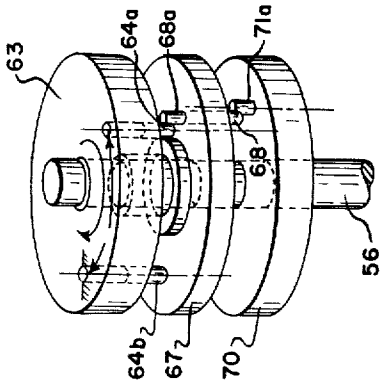


FIG. 7

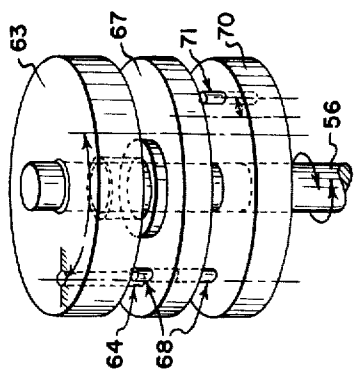
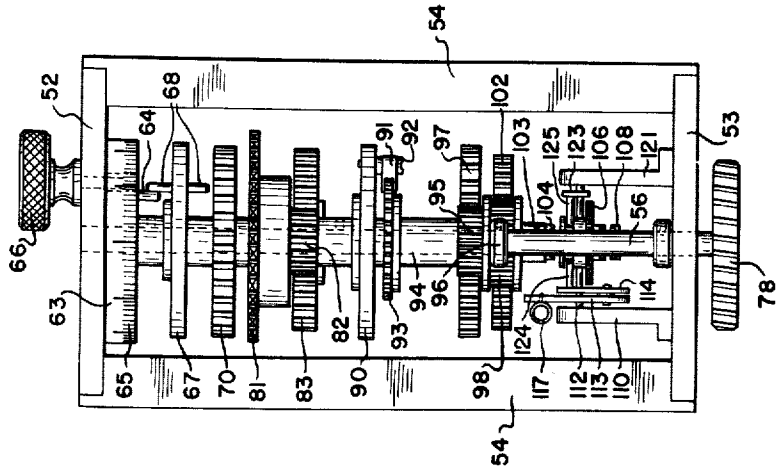


FIG. 4



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METHOD FOR WINDING PACKAGES OF ROVING AND THE LIKE

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Filed Oct. 23, 1959, Ser. No. 917
5 Claims. (Cl. 57—156)

This invention relates to the production of textile yarns and more particularly to a method for increasing the density and stability of packages of roving and the like.

For many, many years it has been the practice in the textile industry to build packages of roving by winding the roving on bobbins in successive, closely wound layers so that the fully wound bobbin is substantially cylindrical with conical ends to provide stability for the package, that is, to prevent the end coils of the layers of the wound bobbin from breaking down and becoming tangled so that the package must be discarded.

Ideally, the conventional method of winding the package would result in a straight conical taper at each end, for that method consists of shortening each succeeding layer by a constant amount. This shape imposes very definite limitations on the amount of roving that can be wound on a bobbin of given size. There is a maximum cone angle—measured between the axis of the bobbin and an element of the cone—for which the roving is stable on the bobbin. This maximum angle varies with the amount of tension with which the roving is wound on the bobbin; that is, there is a greater tendency for the tapered ends to break down as the winding tension is increased so that the taper angle must be decreased to insure stability. Moreover, as a practical matter, a true straight taper is difficult to realize because, as the winding progresses, the underlying layers are compressed by varying amounts which results in an irregularly concave and convex profile along the taper which is quite uncontrollable. Overruns and end breaks are more frequent as winding tension increases.

Economic considerations dictate that as much roving yardage as is practical be wound on each bobbin. First, the roving frame may be run longer without shutdown to change bobbins if more roving can be wound on each bobbin; hence, fewer operators are required to attend a given number of spindles. Second, the machinery which subsequently takes the roving from the packages can be kept running longer without shutdown to replace empty bobbins with full ones.

Because roving frames are limited to winding roving to a certain maximum diameter on the bobbin the only obvious way to increase the yardage of roving in a package has been to wind the roving under greater tension so that the roving is compressed to a greater degree, and, therefore, makes room for more layers to be wound on the bobbin. As previously stated, however, if the wound roving is to be stable at these higher densities the taper angle must necessarily be reduced. This has worked directly contrary to the purpose of winding with greater tension because the volume of the wound bobbin decreases as the taper angle is decreased. For these and other reasons the attempts of various mills to increase the yardage of roving in a package merely by increasing the winding tension in otherwise conventional winding methods has met with indifferent success.

I have invented a new method of winding roving bobbins which permits the use of winding tensions which are much greater than are normally used, thereby increasing the density of roving on the bobbin and simultaneously resulting in a wound bobbin which has substantially greater volume at the higher density. Furthermore, extensive tests have shown that full bobbins wound according to my new method are more stable than bobbins which are wound with conventional straight tapered ends.

The method according to my invention comprises winding roving on a bobbin in successive layers, the innermost layer on the bobbin being the longest as is conventional. In direct contrast to the conventional method, however, each successive layer is decreased in length, not by uniform increments which results in a conventional straight taper, but in progressively greater increments. In my method the increments by which the lengths of the early layers are reduced are less than the increments conventionally used which results in an initially large taper angle—again measured between the axis of the bobbin and tangent to the end of the roving wound on the bobbin. This results in a curved contour of relatively large radius at the start of the winding. Then, as the winding progresses, the increments by which successive layers after the early layers are reduced become progressively greater so that the taper angle is decreased and the radius of the curve is decreased. In practice, the initial large taper angle approximates the conventional straight taper for about one half the final taper length. However, the winding tension in the latter half of the package, particularly with the higher than normal winding tension which may be used with my method, causes pressure to build up on the layers of the former half of the package so that the approximately straight taper first produced becomes convex and the overall final tapered profile approximates a parabolic curve. The maximum taper angle is nearest the bobbin and the minimum taper angle is at the layer most remote from the bobbin. For an illustration of a bobbin wound in accordance with this new method the reader is referred to FIG. 1 which shows roving **1** wound on a bobbin **2**. There it is seen that the profiles of the opposite ends **3** and **4** of the fully wound package have a pronounced convex type. The straight conical tapered profile of a conventionally wound package is shown in dotted outline as at **5** and **6** to provide a graphic comparison of the substantial increase in volume of the package wound according to my method. In FIG. 1 it can also be seen how, because of the greater taper angle **7** nearest the bobbin and the thereafter decreasing taper angle, the ends of a package wound according to my new method are more stable.

The new apparatus for automatically building packages of roving in accordance with my new method is used in conjunction with a conventional roving frame which, as is well known, comprises a plurality of drafting rolls for stretching each of a large number of ends of roving so that the individual fibers are straightened. The ends of roving are then passed to another part of the frame which puts a substantially uniform twist per unit length in the roving and then winds each end onto its own bobbin. The winding operation consists in laying the end of roving on a bobbin in successive layers, each layer consisting of a plurality of relatively closely spaced coils wound about the bobbin.

As is also well known the twisting and winding are both accomplished by the differential rotation between the rotating bobbin and a so-called flyer which rotates about the same axis as the bobbin. The roving is led by the flyer to the bobbin and in order that the coils be laid on the bobbin side by side and in successive layers the roving frame is provided with means which cause the bobbin to reciprocate axially with respect to the flyer. The conventional roving frame is also provided with means which reduce the amplitude of each successive reciprocation of the bobbin with respect to the flyer by a fixed and constant amount so that successive layers of roving laid on the bobbin have shorter lengths.

The apparatus by which the amplitude of reciprocation of the bobbin with respect to the flyer is governed

is called the "builder," the construction of which is well known. Ordinarily, the "builder" is actuated by and in direct proportion to the motion of the tension gearing. According to my invention I provide variable transmission means interposed between the tension gearing and the builder so that the variable transmission means is driven by the tension gearing and, in turn, drives the builder. I utilize the conventional mechanism of known roving frames by which the tension gearing is driven a constant amount at the end of each layer wound on the bobbin. These successive and constant displacements of the tension gears are utilized in the apparatus of my invention as input displacements which are changed to a sequence of output motions for turning the conventional screw of the builder mechanism through angular displacements which are successively and disproportionately greater than the input displacements of constant amplitude.

The transmission of the apparatus comprises a fixed stop and a stepping stop, the latter being driven away from the fixed stop by successive uniform increments which are proportional to the successive displacements of the tension gearing occurring at the ends of the several layers of roving being wound on the bobbin.

A metering member is driven from the fixed stop to the stepping stop after each advancement of the stepping stop and the displacement of the metering member is utilized to control means for turning the builder screw through angular displacements which are proportional to the displacement of the metering member. Each successive displacement of the metering member is the sum of its next preceding displacement and the increment by which the stepping stop was advanced after the preceding displacement and before the instant displacement.

A complete description of a preferred embodiment of an apparatus for carrying out my invention is given below. In the course of the description reference is made to the accompanying drawing, in which:

FIG. 1 is an elevation of a package of roving;

FIG. 2 is a schematic illustration of the builder mechanism of a typical conventional roving frame;

FIG. 3 is a side elevation, partly in section, of a variable transmission according to our invention;

FIG. 4 is an end view of the transmission shown in FIG. 3; and

FIGS. 5–8 are illustrative of the function of the transmission of FIG. 3.

Inasmuch as the construction and operation of conventional roving frames are well known it will not be necessary to describe the entire machine to illustrate the operation of apparatus according to my invention. A typical roving frame is fully described and illustrated in Hill: Cotton Drawing, Combing and Fly Frame Processes, published by International Textbook Company of Scranton, Pennsylvania. Accordingly, I will describe here only so much of a typical roving frame as is necessary to enable those skilled in the art to comprehend the details and features of a preferred embodiment of the apparatus I have invented.

In FIG. 2 there is shown at **11** a portion of the bobbin rail of a roving frame which, as is well known, carries the bobbins and the bobbin rotating mechanism. Also, as is well known, the bobbin rail and all the mechanism mounted on it is driven up and down so that the bobbins on which roving is being wound are reciprocated axially with respect to the flyers. The flyers rotate with respect to the bobbins to put a uniform twist per unit of length in the roving and then lay it on the bobbin in successive layers, each of which consist of closely wound coils.

In order that the successive layers of roving wound on the bobbins are each shortened by a predetermined amount to form the appropriate tapered ends necessary to stability of the finished package of roving a conventional mechanism known as a builder is used. There are actually two distinct types of builders, but the so-called

"American builder" most commonly used in the United States is the type to which the apparatus of the present invention is applicable. An American builder comprises a suitable bracket **12** mounted on the bobbin rail **11**. This bracket has a vertical portion **13** in which there are suitable tracks or other guiding means for an upper jaw **14** and a lower jaw **15**. These jaws have substantially parallel, elongated camming surfaces **16** and **17**, respectively.

A shaft **18**, called the builder screw, is provided with two oppositely threaded portions **20** and **21**. The upper jaw **14** is provided with internal threads which mate with the threaded portion **20** on the shaft **18** and the lower jaw **15** is provided with internal threads which mate with the threaded portion **21**. Thus, because the threads on the portions **20** and **21** are oppositely directed, rotation of the shaft **18** in one direction or the other will either close or open the jaws upon each other to the extent permitted by the length of the threaded portions **20** and **21**.

Adjacent and parallel to the shaft **18** there is a tumbler shaft **22** suitably mounted for rotation about its axis on a stationary part of the machine frame. A builder dog, indicated at **23**, is fixed to the tumbler shaft and has oppositely extending arms **24** and **25** which are of sufficient length in a radial direction so that the one turned toward the builder shaft may engage the vertical camming surfaces **16** and **17**. It should also be noted here that the arms **24** and **25** are axially spaced from each other on the body of the dog **23**.

The tumbler shaft is also provided with a spring-loaded camming mechanism **26** arranged to urge the tumbler shaft to rotate in a counterclockwise direction as viewed from the bottom of FIG. 2, thereby insuring that one or the other of the arms on the builder dog will bear on the camming surfaces.

The tumbler shaft **22** is also positively, but intermittently, driven by the bevel gear **27** fixed to the upper end of the shaft **22** and the bevel gear **28** fixed to the main drive shaft **30** of the roving frame. As is well known the gear **27** is a sector gear having teeth in two opposite sectors and having no teeth in the other two opposite sectors. The gear **27** is so oriented on the tumbler shaft **22** that, when, by the cooperative action of the camming mechanism **26** and the gears **27**, **28**, one or the other of the arms on the builder dog is rotated into position to engage the camming surfaces on the builder jaws, a toothless sector on the gear **27** is adjacent or under the gear **28** on the main drive shaft so that there is no driving torque transmitted to the tumbler shaft.

Now, as the bobbin rail **11** is driven upward or downward to the end of its stroke the arm of the builder dog in engagement with the camming surfaces on the jaws will overrun the end of the camming surface so that there is no longer any resistance to the turning moment exerted on the tumbler shaft by the spring-loaded camming mechanism **26**. This mechanism then causes the tumbler shaft to turn enough to bring a toothed sector of the gear **27** into engagement with the gear **28** and the tumbler shaft is positively and rapidly driven through nearly a half revolution before the next toothless sector of the gear **27** comes under the gear **28**. By this time, however, the spring-loaded camming mechanism **26** is again in control of the tumbler shaft **22** and causes the shaft to complete the half revolution and bring the other arm of the builder dog to bear on the camming surfaces of the builder jaws. Thus, to illustrate, if the bobbin rail is being driven downward while the arm **24** engages the camming surfaces the tumbler shaft cannot turn until the arm **24** overruns the end of the camming surface **16** on the upper jaw **14**. The mechanism **26** and the gears **27** and **28** will then cooperate to turn the tumbler shaft through 180 degrees so that the other arm **25** on the builder dog, which is axially

displaced with respect to the arm 24, engages the cam surface 17 on the lower jaw 15.

Those who are acquainted with textile machinery know that the half revolutions of the tumbler shaft also actuate a mechanism which determines the direction in which the bobbin rail is driven. At the same time that the arm 24 overruns the end of the surface 16 and the tumbler shaft 22 turns through a half revolution, the driving mechanism of the bobbin rail is reversed by conventional means so that the bobbin rail is then driven upward. The upward travel will continue until the arm 25 on the builder dog overruns the lower end of the surface 17 on the lower jaw 15, whereupon the tumbler shaft will again be turned by the camming mechanism 26 and the gears 27 and 28. The bobbin rail driving mechanism will be reversed and the bobbin rail will again be driven downwardly.

As is apparent, these changes in direction of the bobbin rail travel result in the bobbins on all the spindles of the roving frame being driven up and down with respect to their respective flyers which are axially stationary. With each reversal of direction of travel of the bobbin rail as a new layer of roving is wound on each of the bobbins.

As has been previously described each successive layer of roving wound on the bobbin by a conventional roving frame is shortened by a predetermined and constant amount so that when the bobbin is fully wound the ends of the bobbin have a straight tapered shape. In conventional roving frames this is accomplished by turning the builder shaft by a predetermined amount in the direction which causes the upper and lower jaws 14 and 15 to close upon each other, thus bringing the upper and lower ends of the camming surfaces 16 and 17 closer together. Obviously, the upward and downward strokes of the bobbin rail are then shortened by a corresponding amount, for either the arm 24 will overrun the upper end of the surface 16 sooner than before or the arm 25 will overrun the lower end of the surface 17 sooner than before and cause the direction of travel of the bobbin rail to be reversed.

The conventional way of turning the builder screw by the necessary amount is to drive the builder screw from the tumbler shaft through a gear train which causes the builder screw to rotate through an angle which is in fixed and direct proportion to the angle through which the tumbler shaft rotates. This gear train, known collectively as the tension gearing, comprises in order a worm gear 31 fixed to the tumbler shaft and spur gears 32, 33, 34 and 35. The gear 32 in engagement with the worm 31 is fixed to a shaft which is common to the gear 33. This latter gear engages the gear 34 which is fixed to a shaft common to the gear 35. The gear 35 engages the teeth 36 on the underside of an elongated rack gear 37. The rack gear is mounted on suitable guides so that it may be moved from side to side in FIG. 2. Merely to orient the reader it is well to state here that this rack gear is also the driving element of a belt shipper mechanism for an endless belt which runs between the two conical pulleys in the power train of the roving frame. The purposes of this power train are not directly relevant to this invention and need not be described in detail. However, the rack itself is also an element in the train of gears between the tumbler shaft and the builder screw.

A suitably mounted vertical shaft 38 carries gears 40 and 41, the former of which engages the teeth 42 along the side of the rack 37 as seen in FIG. 2. The other gear 41 engages a gear 43 fixed to the builder screw shaft 18.

A mechanism of this kind can build bobbins having only straight tapered ends. While the taper angle may be changed by changing the various gear ratios within the mechanism the machine is incapable of making other than straight tapers.

According to the disclosed apparatus I use a conventional roving frame, but the gear train through which the builder screw is driven by the tumbler shaft is interrupted and there is interposed my new transmission mechanism which is capable of progressively and disproportionately increasing the incremental angle through which the builder screw shaft is turned in response to unit angular displacements—that is, the successive half-revolutions—of the tumbler shaft. That is to say, for each succeeding half revolution of the tumbler shaft the builder shaft is turned through an angle which is disproportionately larger by a predetermined amount than the angle through which it was last turned by the next preceding half revolution of the tumbler shaft. The effect of this is to build a bobbin having a continuously decreasing taper angle which results in a wound bobbin having convex tapers.

FIGS. 3 and 4 illustrate apparatus for carrying out the method of my invention and FIGS. 5–8 illustrate the function of the apparatus. The rack gear 37 having lower teeth 36 and side teeth 42 is reciprocably driven through the train of gears 32, 33, 34 and 35 as in the conventional mechanism previously described in connection with FIG. 2. A gear 40 carried on the shaft 38 engages the side teeth 42 and drives the gear 41 also fixed to the shaft 38. The builder screw shaft as it is utilized in apparatus according to my invention is shown at 44. It drives the jaws of a conventional builder mechanism such as that illustrated in FIG. 2 and it moves up and down as in a conventional frame. The shaft is provided with a longitudinal keyway 45 and is guided by a bracket 46 fixed to the roving frame at any convenient place. As shown, the shaft 45 passes through a bearing in the bracket.

The gear 41 drives a gear 47 which is loose on the shaft 45 and is not keyed thereto. A sprocket 48 is fixed to gear 47. A spacer sleeve 50 holds the gear 47 and sprocket 48 at the correct distance above the bracket 46. At the bottom of this spacer sleeve is a second sprocket 51 which is separate from the sleeve and is keyed to the builder screw shaft. Since the builder screw shaft must move up and down with the builder mechanism which is mounted on the bobbin rail, the sprockets 48 and 51, the sleeve 50 and the gear 47 must be fitted so that the shaft may slide freely back and forth through them. To facilitate this description it will be convenient to regard the first sprocket 48 as the input sprocket and the second sprocket 51 as the output sprocket inasmuch as they have input and output relations to the transmission mechanism.

A preferred transmission system according to my invention comprises a suitable frame having top plates 52 and bottom plates 53 and end members 54 and 55. There are three vertical shafts 56, 57 and 58 journaled adjacent their opposite ends in the top plate 52 and the bottom plate 53 of the frame. A convenient way of axially positioning these shafts within the frame is to fix to each shaft a collar which bears on the upper surface of the lower plate 53. Thus, the shaft 56 has a collar 60, the shaft 57 has a collar 61 and the shaft 58 has a collar 62.

In this embodiment the essential elements of the transmission mechanism which determine the successive increments by which the angle through which the builder screw is turned in response to unit angular displacements of the tumbler shaft are three discs carried by the shaft 56. The first of these is disc 63 which is free to be rotated independently of shaft 56. A pin 64 is mounted in the lower face of this disc at some convenient radial distance from the axis of the shaft 56. The cylindrical surface of the disc is also provided with suitable graduations indicated at 65, the purpose of which will be described in connection with FIGS. 5–8. The knob 66 has a threaded shaft which extends through the upper plate 52 and engages the disc 65 so that the disc may be locked in any desired angular position with respect to the shaft 56. The pin 64 will be generally regarded as a fixed stop, although its fixed position is obviously adjustable.

Another of the three discs, namely disc 67, is mounted on the shaft 56 below the disc 63 and is provided with a pin 68 which extends from both the top and bottom sur-

faces of the disc at the same radial distance from the axis of the shaft as the pin **64** on the disc **63**. The disc **67** is fixed to the shaft **56** so that it rotates with the shaft. It will be generally regarded as the metering member.

The third of these discs, namely disc **70**, is mounted on the shaft but is not fixed thereto so that it may be independently rotated about the axis of the shaft. This disc is provided with spur teeth so that it is also a gear. A pin **71** extends from the upper face of the disc **70** at the same radial distance from the axis of the shaft as the pin **68**. This disc and its pin will be called the stepping stop.

The three discs are spaced along the shaft **56** and the pins **64**, **68** and **71** are long enough so that when shaft **56** rotates in one direction the end of the pin **68** extending from the upper face of the disc **67** will be intercepted by the pin **64** on the disc **63**. Similarly, the lower end of the pin **68** extending from the lower face of the disc **67** will be intercepted by the pin **71** extending from the upper face of the disc-gear **70** as the shaft **56** is rotated in the other direction.

The shaft **56** is driven by a reversible electric motor **72** which is mounted below the bottom plate **53**. The shaft **73** of the motor carries a gear **74** which drives a slip clutch **75** mounted on a shaft **76** journaled below the bottom plate **53** of the frame. A worm **77** also mounted on the shaft **76** drives a gear **78** fixed to the lower end of the shaft **56**. Thus, the shaft **56** may be reversibly driven through the clutched gear train as will be described in greater detail in connection with FIGS. 5–8. Whenever the pin **68** is actually driven against the pin **64** or the pin **71** the clutch **75** will slip even though the motor **72** continues to run. The circuits for energizing the motor will be described in due course.

At this point it is well to consider the cooperative relation of the discs **63**, **67** and **70** before beginning a detailed description of the driving trains for the discs. The purpose of each train and the description of its elements will then be more easily understood. Consider, then, that the disc **70** is driven in a clockwise direction viewed from the bottom of FIG. 3 by a train of gears from the input sprocket **48**. Thus, every time the tumbler shaft rotates through 180 degrees the disc **70** and its pin **71** will be stepped around through some small angle, the magnitude of which will be determined by the overall ratio of the train between the tumbler shaft and the disc **70**. Recall at this point that the disc **70** is loose on shaft **56** so that its motion is not transmitted to any of the other discs. Also consider that the disc **67** which is fixed to the shaft **56** drives the output sprocket **51** which is keyed to the shaft **44** through a train provided with unidirectional element such that the output sprocket **51** is driven when the disc **67** is rotated in the clockwise direction viewed from the bottom of FIG. 3 and is not driven when the disc **67** is rotated counterclockwise as viewed from the bottom of FIG. 3. The rotation of the output sprocket and hence the rotation of shaft **45** will be proportional to the angular displacement in the clockwise direction of the disc **67**, the proportion being determined by the elements of the train.

Consider now FIGS. 5–8 and assume that the roving frame is fully prepared to begin winding on the bobbins. The discs **63**, **67** and **70** are first adjusted as shown in FIG. 5 so that the pins **64**, **68** and **71** are all in contact in the positions indicated as **64***a*, **68***a* and **71***a*. This adjustment is permitted by means which will be described later.

The disc **63** is rotated in a counterclockwise direction so that the pin **64**—the fixed stop—is in some position indicated by **64***b* in FIG. 5 and is locked in place by the locking screw **66**. The winding operation is begun with the first layer of roving being laid on the bobbin beginning at one end. Assume that the first layer is started at the lower end of the bobbin so that the bobbin rail is traveling downward. At any convenient time while the rail is traveling the disc **67** is rapidly turned backward by the motor **72** until the pin **68** contacts the pin **64** in its fixed position **64***b*. Since the pin **68** cannot pass the pin **64** the clutch **75** will slip. The winding of the first layer will continue until the tumbler shaft is turned one half revolution as its arm overruns the camming surface on the builder jaws. As previously explained, this causes the travel of the bobbin rail to be reversed so that it starts up. The half revolution of the tumbler shaft turns the input sprocket **48** and accordingly the disc **70** and its pin **71**—the stepping stop—is stepped ahead or clockwise, as viewed from the bottom of FIG. 3, by some predetermined increment m as indicated in FIG. 6. As the bobbin rail reverses its direction of travel the motor **72** is also reversed and begins to drive the disc **67** forward so that pin **68** moves away from pin **64** at **64***b* in FIG. 5 and moves toward pin **71** at **71***b* as shown in FIG. 6. The clutch **75** will not transmit enough torque to the motor **72** to cause pin **68** to drive pin **71** to its position at **71***b* which is in FIG. 6. As previously explained, disc **67** is fixed to shaft **56** and when shaft **56** is turning in the clockwise direction the unidirectional train of elements connecting the disc **67** and the output sprocket **51** will turn the builder shaft **44** through an angle which is proportional to the angle $g+m$, the displacement of the disc **67** as the pin **68** moved from its position of contact with pin **64** at **64***b* in FIG. 5 to its position **68***b* in contact with pin **71** at position **71***b* in FIG. 6.

This turning of the builder shaft will cause the jaws of the builder to close by an amount which is proportional to the angle through which the shaft is turned. Accordingly, the amount by which the jaws are closed is also proportional to the angle $g+m$.

The winding of this layer of roving on the bobbin will continue until the dog arm riding on the camming surfaces at this time again overruns the end of the camming surface, whereupon the tumbler shaft will turn through 180 degrees to reverse the direction of travel of the bobbin rail so as to begin a new layer of roving. At the same time the direction of motor **72** is reversed and the pin **68** is again moved rapidly back to contact pin **64**. As previously explained when the shaft **56** is turning in the counterclockwise direction the unidirectional train does not turn the output sprocket **51** and the jaws are not further closed at this time. However, the turning of the tumbler shaft again turns the input sprocket so that the disc **70** and its pin **71** is stepped around in the clockwise direction by another incremental angle m and the sequence of operations by which the disc **67** commences again at the pin **64** to meter a new displacement is repeated. In FIG. 7 the disc **70** is shown after it has been stepped ahead through three incremental angles m so that the distance the pin **68** must travel from the pin **64** to overtake the pin **71** is now $g+3m$. This sequence of operations is repeated for each layer of winding on the bobbin and, as is now evident, the length of each layer of roving on the bobbin will be diminished by a disproportionately increasing increment with the result that the tapers on the ends fo the bobbins will have a continuously decreasing slope. This will form a bobbin having convex tapered ends. Having described the essential elements and the operation of the transmission mechanism I will now describe in detail the presently preferred driving trains between the input sprocket **48** and the disc **70**. I will also describe the driving train between the metering disc **67** and the output sprocket **51**. In general, the arrows shown on the various elements in FIG. 3 show the direction these elements will run during the sequence of operations which transmit the motion of the tumbler shaft to the builder screw.

An endless chain **80** engages the input sprocket **48** and a sprocket **81** mounted on, but capable of turning independently of, the shaft **56**. A gear **82** fixed to sprocket **81** drives a gear **83** mounted on and fixed to shaft **57**. A gear **84**, also mounted on and fixed to shaft **57** at a position above gear **83**, engages the gear teeth on the periph-

ery of the disc **70** and drives the disc in the clockwise direction as shown by the arrow.

In this preferred embodiment the dimensions of the frame and gears, the positions of the shafts and the clearances required by the chain are such that it is necessary to provide an idler sprocket **85** mounted on the side member **55** of the frame. It is also necessary to provide a second idler sprocket **86** which is rotatably mounted on a stud **87** which is bolted at one end to the top plate **52** of the frame. A spacer **88** positions the sprocket on the stud at the proper distance below the top plate. These two idler sprockets guide the chain **80** around the other elements to prevent interference and to insure the proper angle of contact between the chain and the sprocket it engages.

In the foregoing description of the train of sprockets and gears it is seen that every unit displacement or half revolution of the tumbler shaft will cause the disc **70** to step around through an angle which is proportionately related to the half revolution of the tumbler shaft by the overall ratio of the sprockets and gears.

The train of elements which drives the builder screw **45** proportionally to the angles through which the metering disc **67** turns as the pin **68** moves forward from contact with pin **64** to contact with pin **71** comprises a ratchet disc **90** which is fixed to shaft **56**. This disc carries a pawl **91** which is rotatably mounted on a bolt **92** threaded into the disc **90**. This pawl is conventionally spring-loaded and engages a ratchet **93** which is fixed to the upper end of a sleeve **94**. This sleeve has a gear **95** fixed to its lower end and the entire assembly of ratchet, sleeve and gear turns freely on shaft **56**. The assembly is held in its proper axial position with respect to the disc **90** by a separate collar **96** fixed to the shaft **56**. The pawl **91** is so arranged that when the shaft **56** and disc **90** turn clockwise as viewed from the bottom of FIG. 3 the pawl will engage the ratchet **93** and turn the gear **95**. On the other hand, when the shaft **56** is turned in the counterclockwise direction the pawl does not drive the ratchet and no motion is transmitted to the gear **95**.

A pair of gears **97** and **98** are fixed together and mounted to turn freely on shaft **57**. They are held in position along the shaft **57** by separate upper and lower collars **100** and **101** so that the gear **97** engages the gear **95**. A gear **102** is mounted on shaft **58** to turn freely thereon and to engage gear **98**. Extending downwardly from gear **102** and fixed thereto is a tubular part **103** on the lower end of which is an upper clutch jaw **104**. A sliding clutch member **105** is mounted to turn freely on shaft **58** and to slide along that shaft so that it may be selectively moved into and out of engagement with the upper clutch part **104**. This sliding clutch member carries a sprocket **106**. This sprocket drives the output sprocket **51** which is keyed to the builder shaft **45** through an endless chain **107**.

This completes the description of the train of elements by which the builder screw is turned by the motor **72** through angles which are successively metered by the pin **68** on the disc **67** as that pin moves from contact with the pin **64** to the stepping pin **71**.

As previously stated the shaft **58** is positioned within the frame of the transmission by a collar **62** at the lower end of the shaft. This collar is fixed to the shaft **58** and carries at its upper end a lower clutch jaw **108**. Sliding clutch member **105** may engage either the upper clutch jaw **104** or the lower clutch jaw **108** and is moved between and held in these alternate engagements by a spring-loaded actuating mechanism having two stable positions.

An upright bracket **110** is fixed to the bottom plate **53** of the frame and on this bracket there are two spaced pivot points **111** and **112**. A short lever **113** is pivoted at a point intermediate its ends at the point **111** and a long lever **114** is pivoted at a point intermediate its ends at the point **112**. The adjacent ends of the two levers are connected by a sliding pivot, i.e. a floating slot **115** in the short lever **113** which is engaged by a pin **116** mounted on the long lever. A spring **117** is connected in tension between pins **118** and **120** in the remote ends of the levers. Thus, when the levers are in the up position as shown in FIG. 3 the spring will hold them in that position and when one or the other of the levers is pushed downward the levers will pivot about the points **111** and **112** respectively to the extent permitted by the pivot point connecting the levers together at their adjacent ends. Again, the spring will hold the levers in this downward position.

An upright bracket **121** also fixed to the bottom plate **53** of the frame provides a bearing for a shaft **122** which is journaled at its opposite ends in the brackets **110** and **121**. Shaft **122** is fixed to lever **114** so that it is rotated as the lever pivots about the point **112**. An arm **123** extends radially from the shaft **122** in a direction which is substantially parallel to the lever **114** as shown in FIG. 4. The lever **114** extends to one side of shaft **58** while the arm **123** extends on the opposite side of the shaft. The lever and the arm are provided with pins **124**, **125** which engage an annular slot **126** in the sliding jaw clutch member **105**. Thus, when the levers are in the up position the pins hold the sliding member **105** in engagement with the lower clutch jaw **104** so that the sprocket **106** on the sliding member is turned by the gear **102**. On the other hand, when the levers are in the down position the sliding member is disengaged from the jaw **104** but is engaged with the lower jaw **108**.

When the clutch is engaged in the down position the elements of the transmission may be driven to reset the mechanism to wind a new set of bobbins. This is done by means of a crank not shown for turning the rack **37** back to its starting position. The movement of the rack turns the gears **40**, **41** and **47**, the sprocket **48** and the chain **80** in a direction opposite that indicated in FIG. 3. This causes the disc **70** to be rotated counterclockwise to move the pin **71** back to its starting position. It should be noted that shaft **56** is not turning at this time although, if the motor **72** is running the clutch **75** will be slipping inasmuch as pin **68** is usually bearing on pin **64** when the last layer of roving on a bobbin has been completed.

The chain **80** also engages a sprocket **127** which is fixed to a lower clutch plate **128**. These elements are freely rotatable on shaft **58**. An upper clutch plate **130** is forced against the lower clutch plate by a spring **131** which in turn is fixed at its upper end to a collar **132** fixed to the shaft **58**. Thus, the chain **80** will drive the shaft **58** through the plate clutch and, because the levers are in the down position, the shaft **58** will in turn drive the chain **107** in a direction opposite that indicated in FIG. 3 through the jaw clutch associated with sprocket **106**. This reverse motion of the chain **107** will turn sprocket **51** keyed to the shaft **44** and open the jaws of the builder. When the rack **37** is returned to its starting position and the jaws of the builder are fully open the lever **114** or the lever **113** is pulled to its up position and the transmission is prepared to begin its function again.

The direction in which the motor **72** drives the shaft **56** is controlled by a group of switches which are actuated by the bobbin rail or some other member of the roving frame which has corresponding motion. At the bottom of FIG. 3 I have shown at **133** in schematic form a short section of the bobbin rail and the extent of its travel is generally indicated by the arrows. An upper microswitch **134**, a lower microswitch **135** and a center microswitch **136** are arranged adjacent the path of the bobbin rail so that as the bobbin rail starts its downward motion the upper switch **134** is temporarily closed, and when the bobbin rail starts its upward motion the lower microswitch **135** is temporarily closed. The center microswitch is arranged so that when the bobbin rail passes through the midpoint of its travel, whether it is moving up or down, the microswitch **136** is temporarily closed. These switches are connected to the solenoid **137** of a relay switch **138**. This switch is arranged to reverse the connections of

motor **72** to its source of power, such as battery **140**. Thus, if it is assumed that the pin **68** is against the pin **64** at the time that the bobbin rail changes its direction of travel from down to up, the microswitch **135** will be closed to actuate the relay switch. This will connect the motor **72** so that it drives the shaft **56** in the clockwise direction until the pin **68** reaches the pin **71**. Then, as the bobbin rail **133** passes through the midpoint of its travel the solenoid **137** is again energized by the closing of the center microswitch **136** whereupon the relay **138** again changes the connections of the motor so that the shaft **56** is driven in a counterclockwise direction to reset the pin **68** against the pin **64**. Then, when the bobbin rail changes its direction of travel from up to down the microswitch **134** is closed. This will energize the solenoid **137** and again reverse the connections to the motor, whereupon the shaft **56** will be driven in the clockwise direction.

A transmission according to the foregoing description has been constructed for use on a Model FS–2 10″ x 5″ roving frame manufactured by the Saco-Lowell Shops of Biddeford, Maine. In that transmission the gears were as follows:

Reference Number:	Number of Teeth
Gear **40**	18
Gear **41**	16
Gear **47**	16
Sprocket **48**	15
Sprocket **51**	15
Gear **70**	45
Worm **77** } Reduction 10 to 1	
Gear **78** } Reduction 10 to 1	
Sprocket **81**	35
Gear **82**	15
Gear **83**	45
Gear **84**	15
Ratchet **93**	96
Gear **95**	15
Gear **97**	45
Gear **98**	20
Gear **102**	40
Sprocket **106**	15

All other parts of the roving frame are conventional and those gears such as the tension gear which would normally be subject to variation in the conventional roving frame may be varied in the same way in a roving frame utilizing our invention.

This completes the detailed description of the presently preferred embodiment of the apparatus for carrying out my invention. Many variations of the details set forth above will occur to those skilled in the art. Accordingly, the invention is not to be construed as limited to those details but is measured by the scope of the appended claims.

I claim:

1. In the method of forming packages of roving in which the roving is wound on a bobbin in successive cylindrical layers, each layer consisting of closely spaced turns of roving, the improvement which comprises winding on the bobbin a first layer of predetermined length and winding successive cylindrical layers of lengths shorter than the next preceding layer by an amount which progressively increases from layer to layer.

2. In the method of forming packages of roving in which the roving is wound on a bobbin in successive cylindrical layers, each layer consisting of closely spaced turns of roving, the improvement which comprises winding the successive cylindrical layers on the bobbin with their lengths progressively shorter by increasing increments whereby the end profiles of the package so formed are outwardly convex.

3. In the method of forming packages of roving in which the roving is wound on a bobbin in successive cylindrical layers, each layer consisting of closely spaced turns of roving, the improvement which comprises winding the successive cylindrical layers on the bobbin such that their lengths are progressively shorter by increasing increments and such that lines lying in an axial plane of the package and tangent to the end profiles of the package at successively outward layers form progressively smaller angles with the axis of the package.

4. The method of forming packages of roving which comprises the steps of winding on a bobbin an initial layer cylindrical of closely wound turns of roving and of winding a plurality of additional cylindrical layers thereon, the first of said plurality of layers being started inwardly of one end of said initial layer by a first predetermined number of turns and ending inwardly of the other end of said initial layer by the first predetermined number of turns and each successive layer being started inwardly of the end of the underlying layer by a predetermined number of turns for that layer and ending inwardly of the opposite end of the underlying layer by substantially the same predetermined number of turns for that layer, and the predetermined number of turns for one layer being greater than the predetermined number of turns for the next preceding layer, whereby the profiles of the ends of the package in an axial plane of the bobbin are outwardly convex.

5. The method of forming a package comprising the step of successively winding closely bound cylindrical layers of roving on a bobbin with each successive layer being shorter in a progressively increasing amount so that the end profiles of the package are outward convex and the intermediate portion of the package is of uniform density.

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