

Oct. 29, 1963

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3,108,429

APPARATUS FOR WINDING PACKAGES OF ROVING AND THE LIKE

Original Filed Oct. 23, 1959

3 Sheets-Sheet 1

FIG. 1

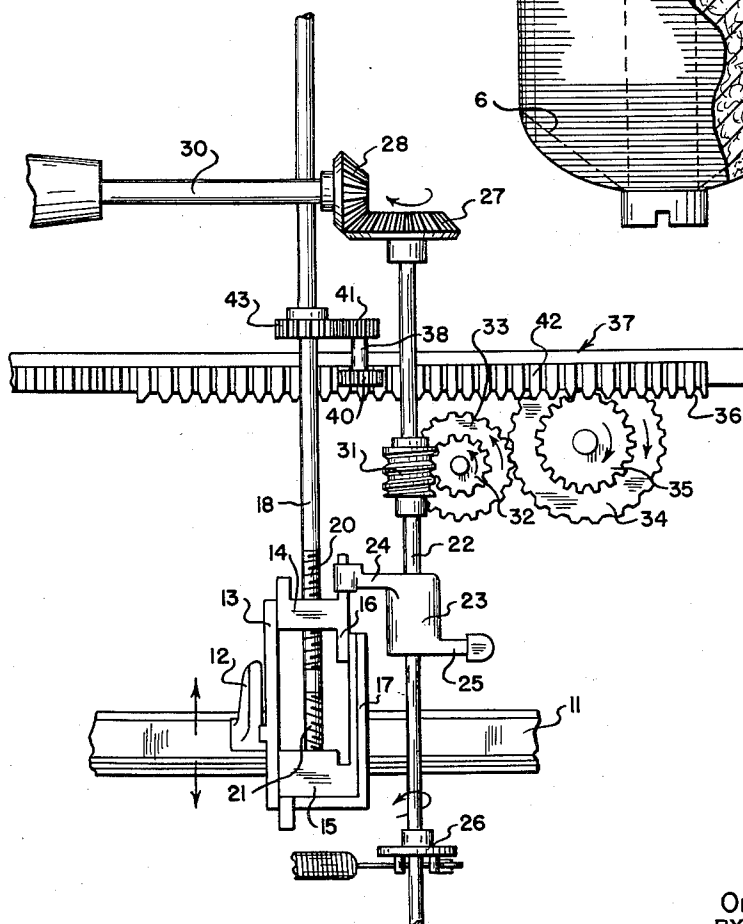
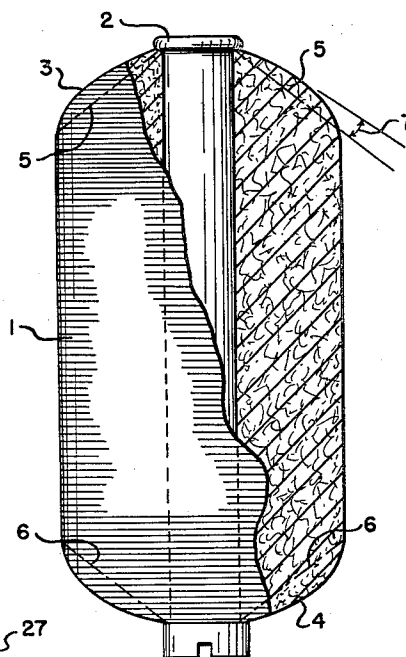


FIG. 2

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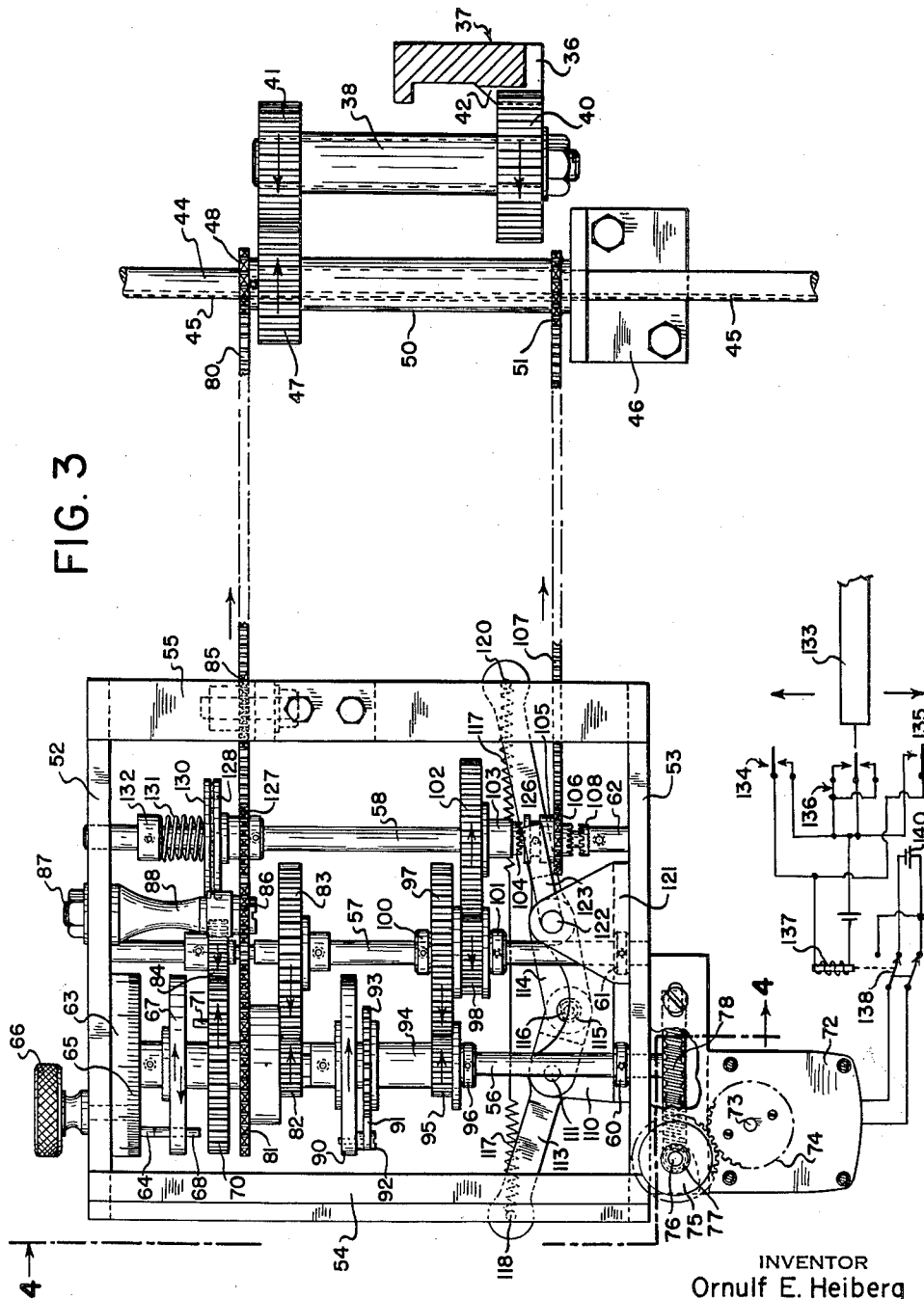
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# APPARATUS FOR WINDING PACKAGES OF ROVING AND THE LIKE

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3 Sheets-Sheet 2



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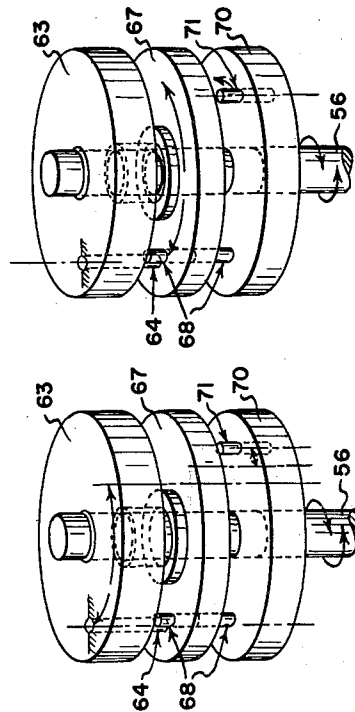
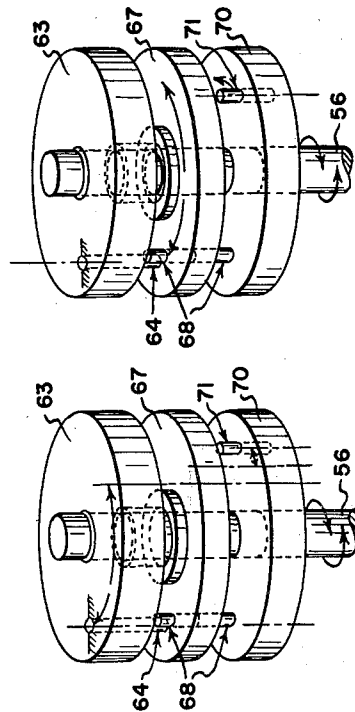
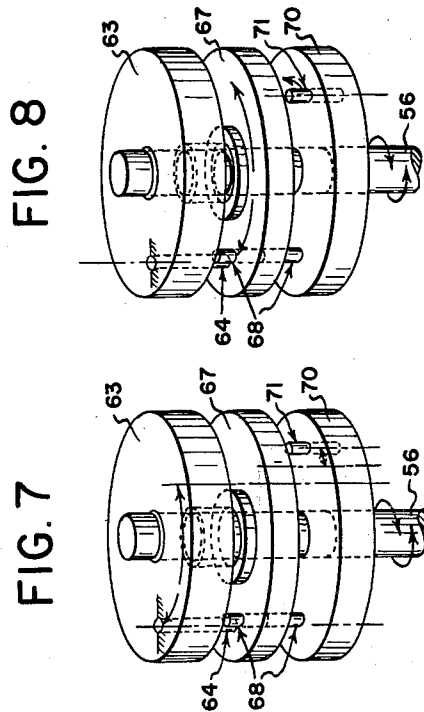
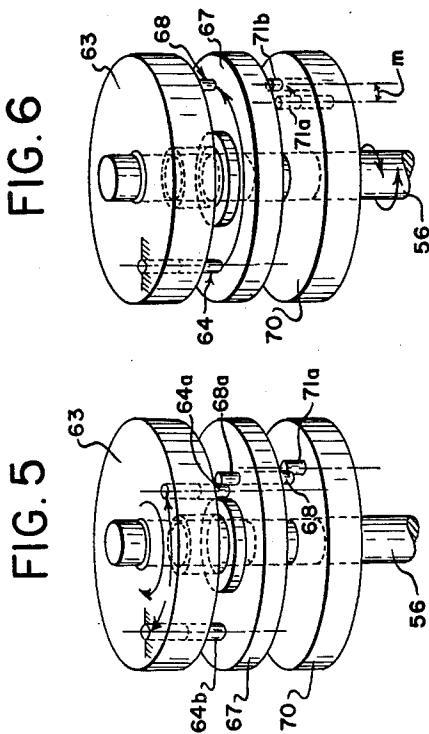
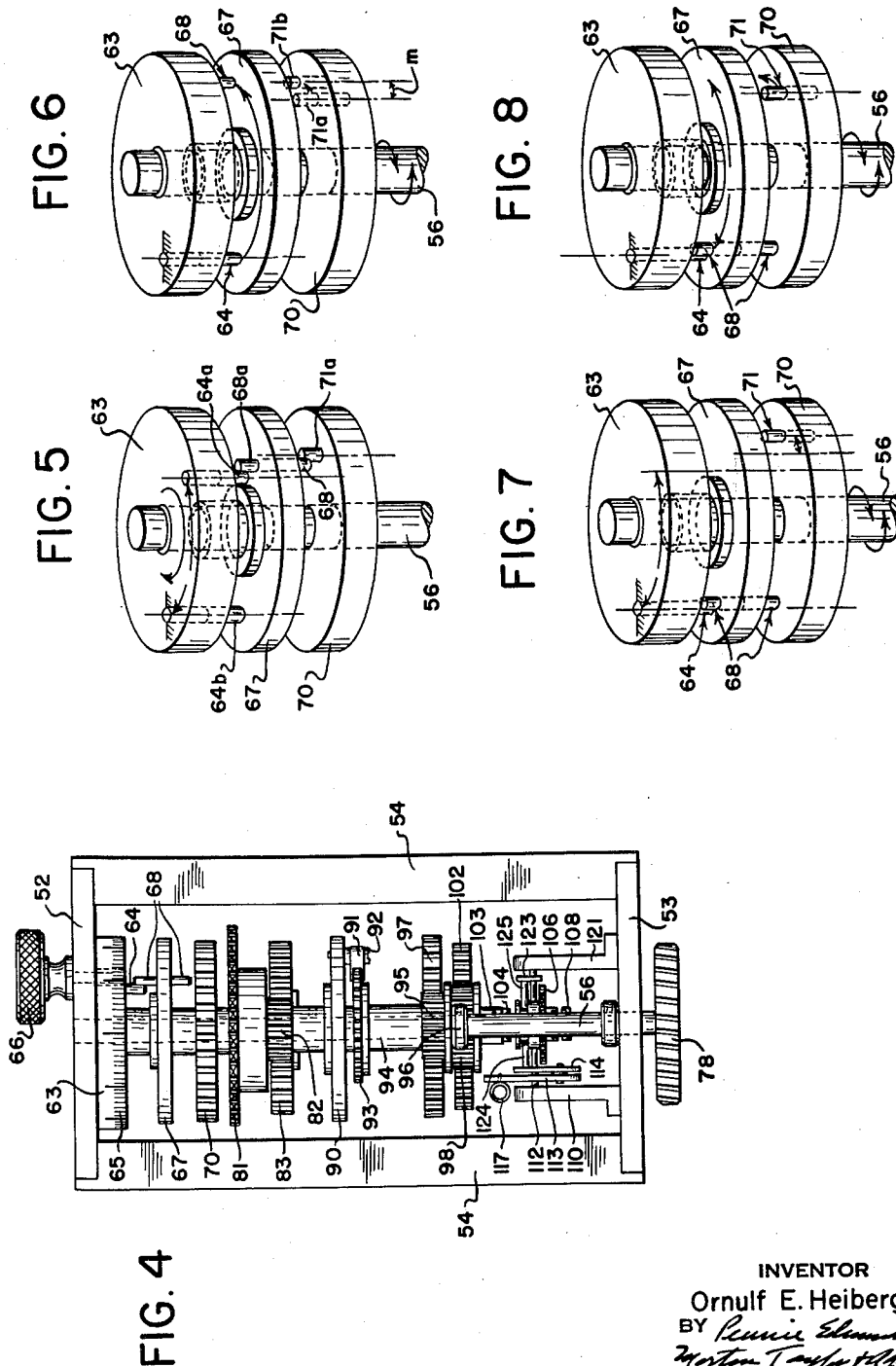
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# APPARATUS FOR WINDING PACKAGES OF ROVING AND THE LIKE

Original Filed Oct. 23, 1959

3 Sheets-Sheet 3



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3,108,429

## APPARATUS FOR WINDING PACKAGES OF ROVING AND THE LIKE

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Original application Oct. 23, 1959, Ser. No. 917, now Patent No. 3,096,611, dated July 9, 1963. Divided and this application Mar. 22, 1963, Ser. No. 273,252

9 Claims. (Cl. 57—99)

This invention relates to the production of textile yarns and more particularly to a new automatic apparatus for winding roving and the like on bobbins to produce packages of roving and the like of increased density and stability.

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 apparatus for 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 apparatus according to my invention winds 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 apparatus, 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 apparatus, the rovings are so wound that 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. 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 apparatus, 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 the new apparatus, 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 shape. 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 apparatus. 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 apparatus are more stable.

The new apparatus for automatically building packages of roving in accordance with my new apparatus 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.

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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 my 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 consists 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 mech-

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anism 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.

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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 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

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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 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 reciprocally 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 surfaces 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 63. This disc and its pin will be called the stepping stop.

The three discs are spaced along the shaft 56 and the pins 64, 63 and 71 are long enough so that when shaft 56 rotates in one direction the end of the pin 63 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 63 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 63 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 gear train provided with a 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 gear 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, 63 and 71 are all in contact in the positions indicated as 64a, 63a and 71a. 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 64b 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 63 contacts the pin 64 in its fixed position

64b. Since the pin 63 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 63 moves away from pin 64 at 64b in FIG. 5 and moves toward pin 71 at 71b as shown in FIG. 6. The clutch 75 will not transmit enough torque to the motor 72 to cause pin 63 to drive pin 71 to its position at 71b 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 gear elements connecting the disc 67 and the output sprockets 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 63 moved from its position of contact with pin 64 at 64b in FIG. 5 to its position 63b in contact with pin 71 at position 71b 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 63 is again moved rapidly back to contact pin 64. As previously explained when the shaft 56 is turning in the counterclockwise direction the unidirectional gear 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 63 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 of 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 shows 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 periphery 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 proportionately 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 the 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 133 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 133 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 43 -----  | 15                  |
| Sprocket 51 -----  | 15                  |
| Gear 70 -----      | 45                  |
| Worm 77 -----      | } Reduction 10 to 1 |
| Gear 73 -----      |                     |
| 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 166 ----- | 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.

This application is a division of my application Serial No. 917, filed October 23, 1959, now Patent No. 3,096,611.

#### I claim:

1. In a roving frame comprising a tumbler shaft rotatably driven through successive substantially equiangular displacements and a builder screw shaft mounted for rotation, the improvement which comprises an input member and an output member, means operatively connecting said tumbler shaft to said input member and adapted to displace said input member through a series of displacements proportional to the displacements of a tumbler shaft, a stepping stop adapted to be moved along a predetermined line of motion, a fixed stop positioned along said predetermined line of motion, means operatively connecting said stepping stop to said input member for displacing said stepping stop along the line of motion in response to motion of said input member, a metering member adapted to be driven between said fixed stop and said stepping stop, means operatively connecting said metering member to said output member for displacing said output member in response to motion of said meter-

ing member as the latter is driven between said fixed and stepping stops, and means operatively connecting said output member to said builder screw shaft for driving said builder screw shaft through angular displacements proportional to the displacements of said output member.

2. In a roving frame comprising a tumbler shaft rotatably driven through successive substantially equiangular displacements and a builder screw shaft mounted for rotation, the improvement which comprises a transmission for rotating said builder screw shaft through successive displacements in response to the successive displacements of the tumbler shaft, each successive one of said displacements of said builder screw shaft having an amplitude which is disproportionately greater than the next preceding displacement of said builder screw shaft, which transmission comprises a stepping stop member mounted for rotation about an axis, a fixed stop member positioned adjacent the axis of rotation of said stepping stop member, a metering member mounted for rotation about the axis of rotation of said stepping stop member and provided with means for engaging said fixed and stepping stop members and for limiting the rotation of said metering member to the angular separation between said fixed and stepping stop members, means operatively connecting said tumbler shaft to said stepping stop member for rotating the latter through an angular displacement which is proportional to the displacement of the tumbler shaft upon each successive displacement thereof, means for driving said metering member about said axis during the intervals between successive displacements of said tumbler shaft such that the engaging means on said metering member is moved from engagement with said fixed stop to engagement with said stepping stop, and means operatively connecting said metering member to said builder screw shaft for moving the builder screw shaft through displacements having amplitudes which are proportional to the displacements of said metering member as the engaging means thereon is moved from engagement with said fixed stop to engagement with said stepping stop member.

3. In a roving frame comprising a tumbler shaft rotatably driven through successive substantially equiangular displacements and a builder screw shaft mounted for rotation, the improvement which comprises a transmission for rotating said builder screw shaft through successive displacements in response to the successive displacements of the tumbler shaft, each successive one of said displacements of said builder screw shaft having an amplitude which is disproportionately greater than the next preceding displacement of said builder screw shaft, which transmission comprises a stepping stop member mounted for rotation about an axis, a fixed stop member positioned adjacent the axis of rotation of said stepping stop member, a metering member mounted for rotation about the axis of rotation of said stepping stop member and provided with means for engaging said fixed and stepping stop members and for limiting the rotation of said metering member to the angular separation between said fixed and stepping stop members, means operatively connecting said tumbler shaft to said stepping stop member for rotating the latter through an angular displacement which is proportional to the displacement of the tumbler shaft upon each successive displacement thereof, means for driving said builder screw shaft during the intervals between successive displacements of said input member, and means operatively connecting said metering member to said builder screw shaft such that the displacement of said builder screw shaft by said driving means is limited to amplitudes which are proportional to the displacement of said metering member as said engaging means on said metering member moves from engagement with said fixed stop to engagement with said stepping stop.

4. Apparatus according to claim 2 in which the fixed stop member may be adjustably positioned about the axis of rotation of the stepping stop member.

5. Apparatus according to claim 2 in which the fixed stop member is a disc mounted to be adjustably positioned about the axis of rotation of the stepping stop member, and in which the stepping stop member and the metering member are discs and in which the engaging means on said metering member is a member protruding from the opposite faces of said disc constituting the metering member to intercept protrusions on said discs constituting said fixed stop and said stepping stop members.

6. Apparatus according to claim 2 in which the means operatively connecting said tumbler shaft to said stepping stop member comprises a train of gears, and in which the means operatively connecting the metering member to the builder screw shaft comprises a train of gears and a ratchet and pawl arranged to transmit motion of said metering member to said builder screw shaft only when said engaging means on said metering member is moving from engagement with said fixed stop member to engagement with said stepping stop member.

7. In a roving frame comprising rotatably driven flyers and rotatably driven bobbin spindles, said bobbin spindles also being mounted to be reciprocally driven axially of said flyers, a builder screw shaft mounted for rotation in a member of said frame which reciprocates in synchronism with said bobbin spindles, the axis of said screw shaft extending in the direction of reciprocation of said member, said screw shaft having two oppositely threaded portions thereon and a pair of builder jaws, each of which has a threaded aperture therein for engaging one of said threaded portions on said screw shaft such that the jaws are opened and closed upon each other by rotation of said screw shaft, a camming surface on each of said jaws and extending in the direction of reciprocation of said frame member, a tumbler shaft mounted in said frame for rotation about its axis and having mounted thereon for rotation therewith a builder dog provided with a pair of oppositely extending arms adapted to alternately engage the camming surfaces on said jaws upon each successive half-revolution of said tumbler shaft, means controlled by the rotational position of said tumbler shaft for reversing the direction of motion of said bobbins and frame member upon each half-revolution of said tumbler shaft, and means for driving said tumbler shaft through a half-revolution upon either of said arms overrunning the end of a camming surface, the improvement which comprises means driven by the rotational motion of said tumbler shaft for imparting rotational motion to said builder shaft which motion is variably disproportionate to the rotational motion of said tumbler shaft.

8. In a roving frame comprising rotatably driven flyers and rotatably driven bobbin spindles, said bobbin spindles also being mounted to be reciprocally driven axially of said flyers, a builder screw shaft mounted for rotation in a member of said frame which reciprocates in synchronism with said bobbin spindles, the axis of said screw shaft extending in the direction of reciprocation of said member, said screw shaft having two oppositely threaded portions thereon and a pair of builder jaws, each of which has a threaded aperture therein for engaging one of said threaded portions on said screw shaft such that the jaws are opened and closed upon each other by rotation of said screw shaft, a camming surface on each of said jaws and extending in the direction of reciprocation of said frame member, a tumbler shaft mounted in said frame for rotation about its axis and having mounted thereon for rotation therewith a builder dog provided with a pair of oppositely extending arms adapted to alternately engage the camming surfaces on said jaws upon each successive half-revolution of said tumbler shaft, means controlled by the rotational position of said tumbler shaft for reversing

ing the direction of motion of said bobbins and frame member upon each half-revolution of said tumbler shaft, and means for driving said tumbler shaft through a half-revolution upon either of said arms overrunning the end of a camming surface, the improvement which comprises means driven by the rotational motion of said tumbler shaft to move the builder jaws carried on the threaded portions of said builder shaft toward each other along said threaded portions by increments which are increasingly disproportionate to successive equal increments of rotational motion of said tumbler shaft.

9. In a roving frame comprising rotatably driven flyers and rotatably driven bobbin spindles, said bobbin spindles also being mounted to be reciprocally driven axially of said flyers, a builder screw shaft mounted for rotation in a member of said frame which reciprocates in synchronism with said bobbin spindles, the axis of said screw shaft extending in the direction of reciprocation of said member, said screw shaft having two oppositely threaded portions thereon and a pair of builder jaws, each of which has a threaded aperture therein for engaging one of said threaded portions on said screw shaft such that the jaws are opened and closed upon each other by rotation of said screw shaft, a camming surface on each of said jaws and extending in the direction of reciprocation of said frame member, a tumbler shaft mounted in said frame for rotation about its axis and having mounted thereon for rotation therewith a builder dog provided with a pair of oppositely extending arms adapted to alternately engage the camming surfaces on said jaws upon each successive half-revolution of said tumbler shaft, means controlled by the rotational position of said tumbler shaft for reversing the direction of motion of said bobbins and frame member upon each half-revolution of said tumbler shaft, and means for driving said tumbler shaft through a half-revolution upon either of said arms overrunning the end of a camming surface, the improvement which comprises a variable motion transmission comprising an adjustable fixed stop, a stepping stop mounted for motion relative to said fixed stop, and a motion metering member, means for reversibly driving said metering member between said fixed and stepping stops, means constructed and arranged to drive said stepping stop away from said fixed stop by increments which are proportional to the angular displacement of said tumbler shaft, and means controlled by said metering member for turning said builder shaft through an angular displacement proportional to the distance between said fixed and stepping stops upon each increment of the distance being added by the driving means for said stepping stop, whereby for each motion of the tumbler shaft the builder shaft is rotated by an amount proportional to the initial separation of the fixed and stepping stops plus the distance  $m \times f$  where  $f$  is the increment added upon each motion of the tumbler shaft and  $m$  is the number of times the increment has been added since the time the fixed and stepping stops were initially separated.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,108,429

October 29, 1963

Ornulf E. Heiberg

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 17, after "bobbin" insert --- and tangent to the end of the roving wound on the bobbins ---; column 8, line 21, for "sprockets" read --- sprocket ---; line 65, for "shows" read --- show ---; column 9, line 21, for "proportionately" read -- proportionally ---.

Signed and sealed this 19th day of May 1964.

(SEAL)

Attest:

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