Oct. 16, 1962 C. L. WELLINGTON 3,058,684

AUTOMATIC WINDING MACHINE AND METHOD

Filed July 10, 1957 6 Sheets-Sheet 1

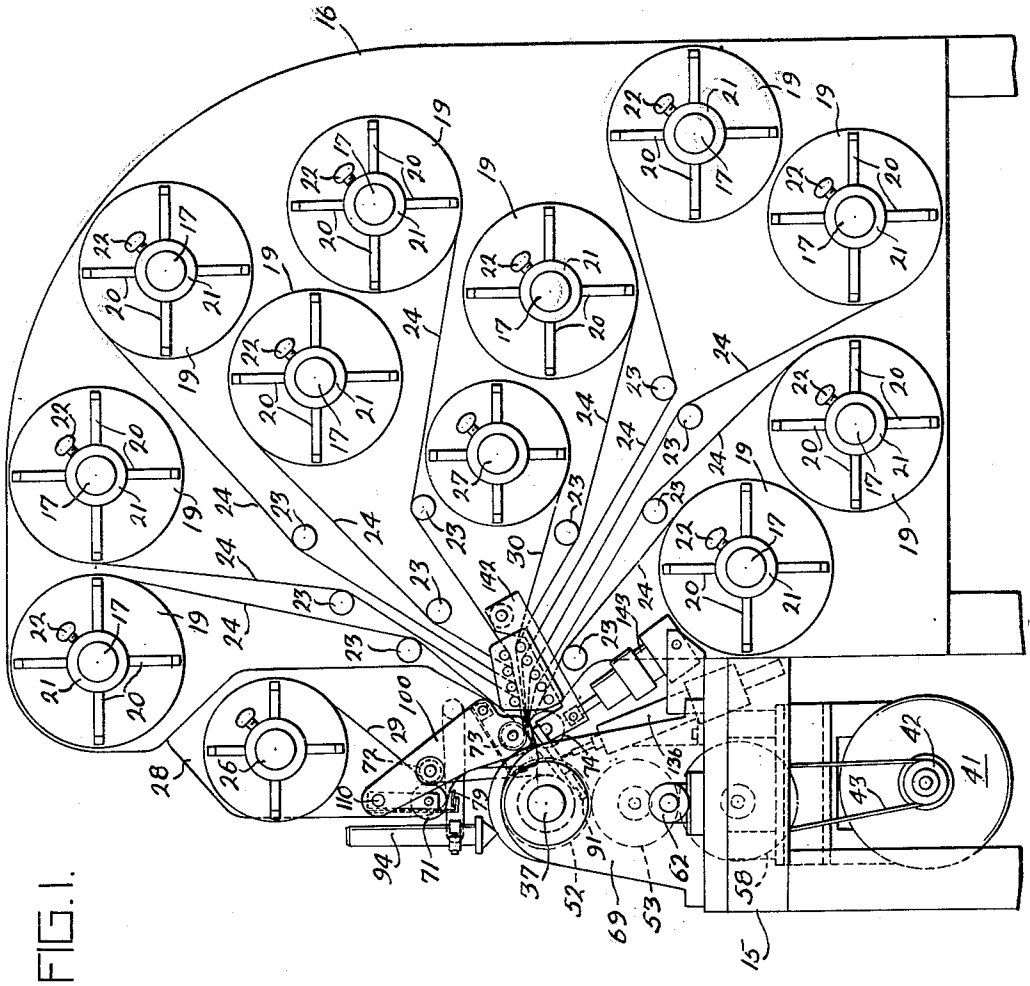


FIG. 1.

INVENTOR:
CARY L. WELLINGTON
BY
Howson & Howson
ATTYS.

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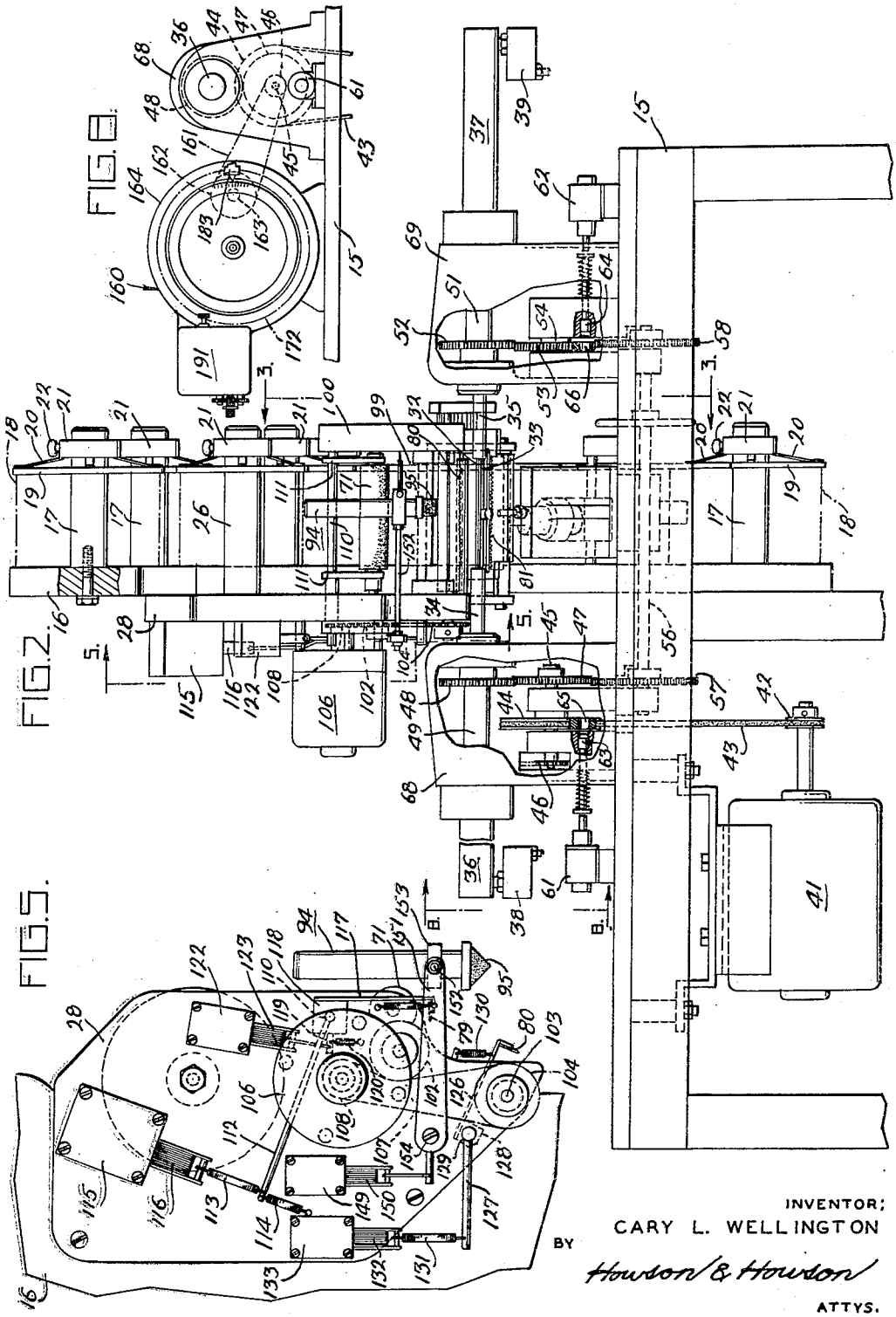


FIG. 2.

FIG. 3.

FIG. 5.

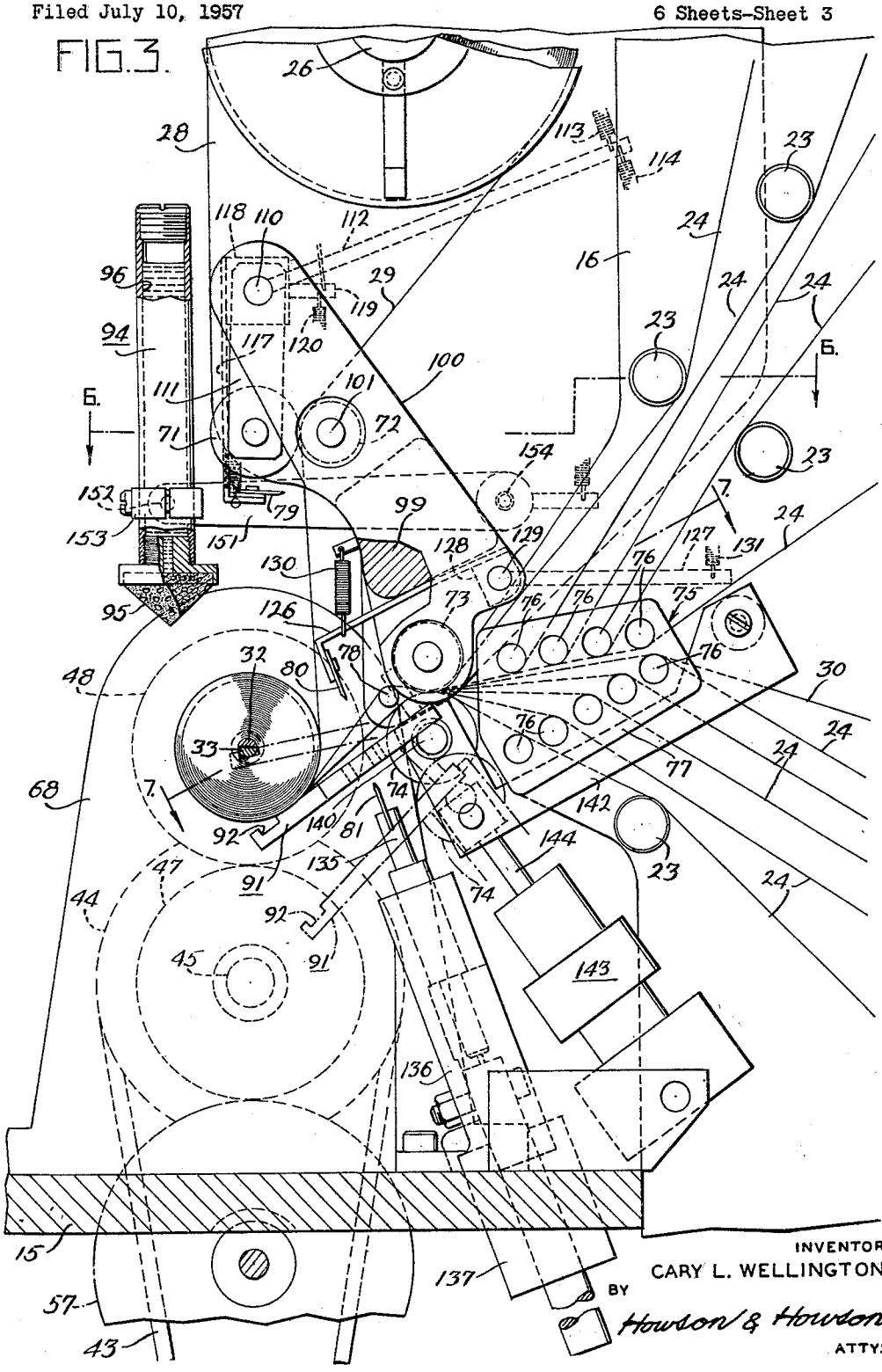
INVENTOR;
CARY L. WELLINGTON
BY Howson & Howson
ATTYS.

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AUTOMATIC WINDING MACHINE AND METHOD

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FIG. 3.



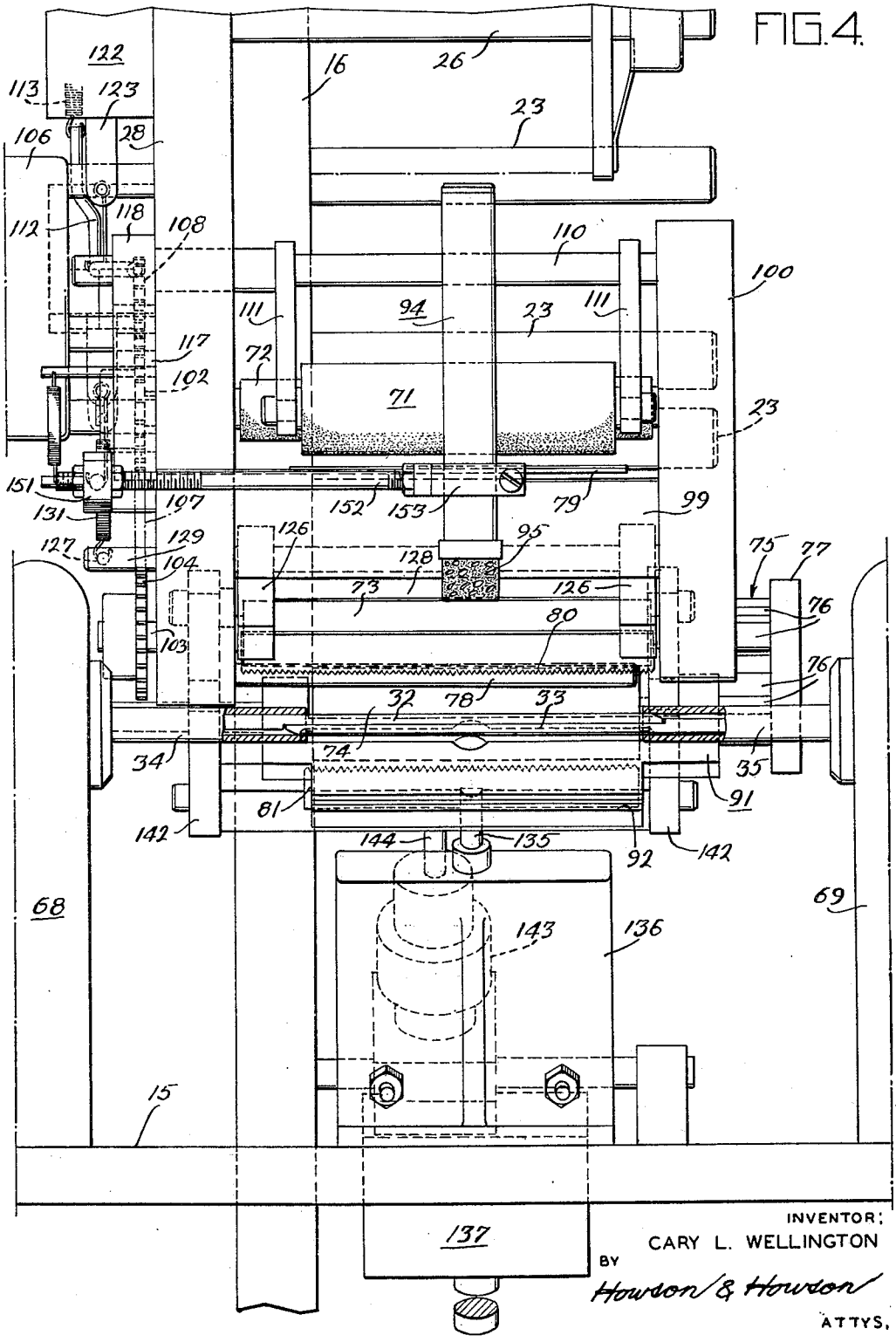
INVENTOR:
CARY L. WELLINGTON
BY
Howson & Howson
ATTYS.

Oct. 16, 1962 C. L. WELLINGTON 3,058,684

AUTOMATIC WINDING MACHINE AND METHOD

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FIG. 4.



INVENTOR:
CARY L. WELLINGTON
BY
Howson & Howson
ATTYS.

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AUTOMATIC WINDING MACHINE AND METHOD

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FIG. 6.

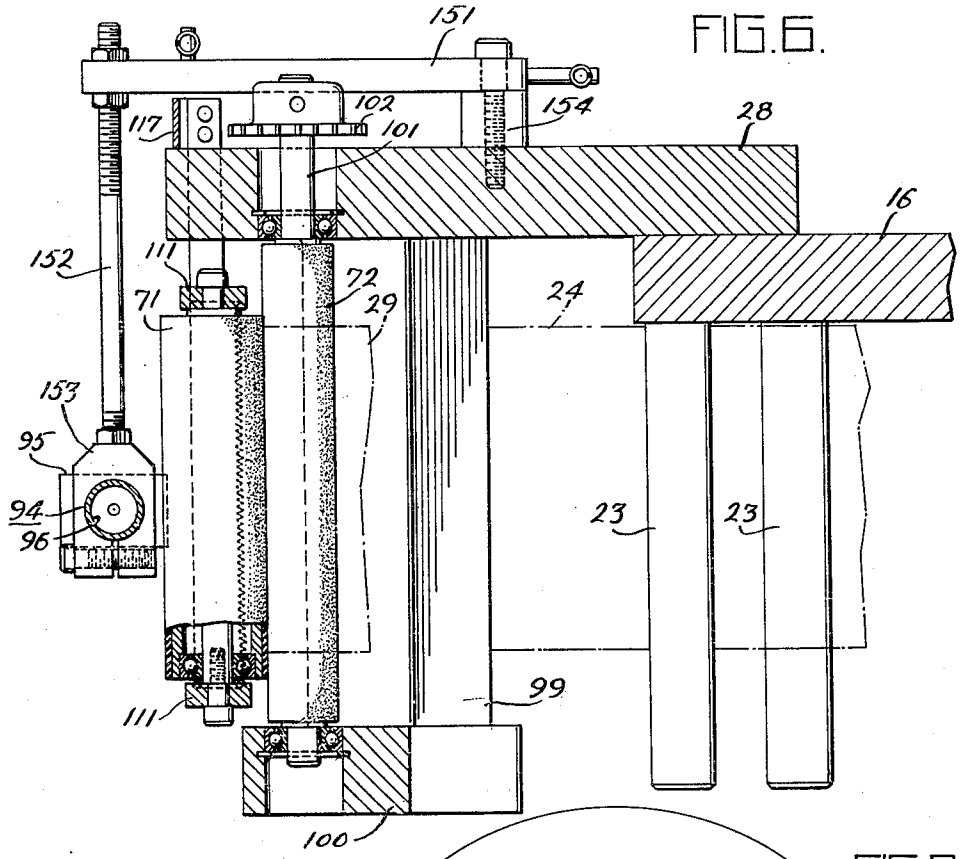


FIG. 9.

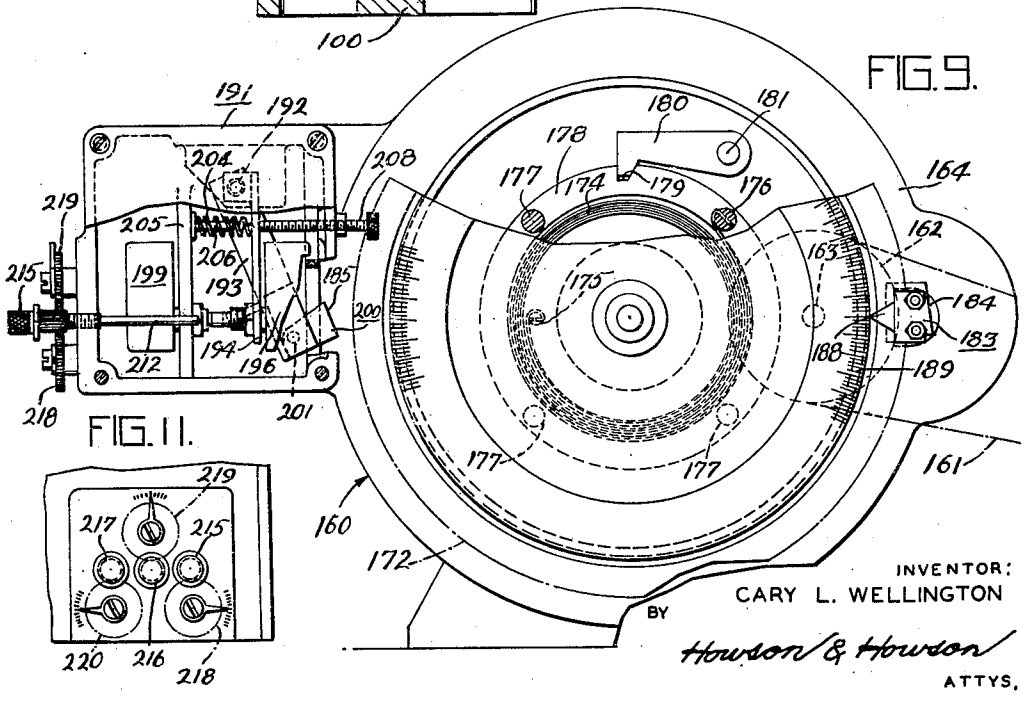


FIG. 11.

INVENTOR:
CARY L. WELLINGTON
BY
Howson & Howson
ATTYS.

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FIG. 7.

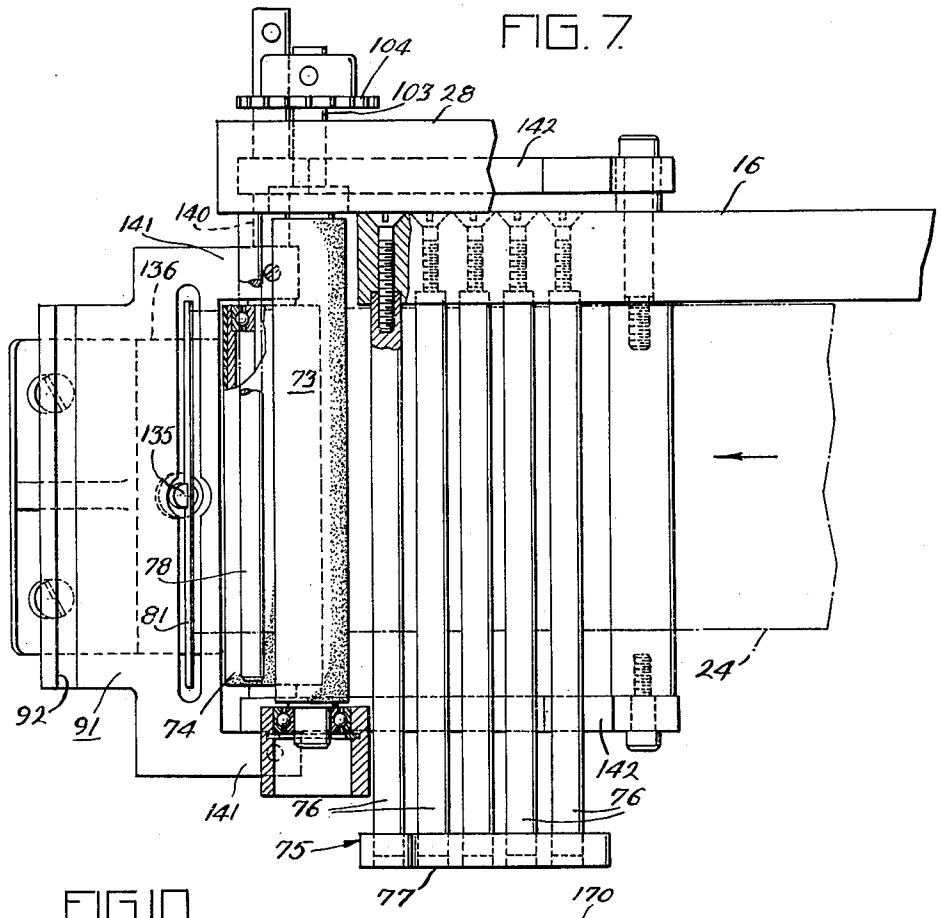
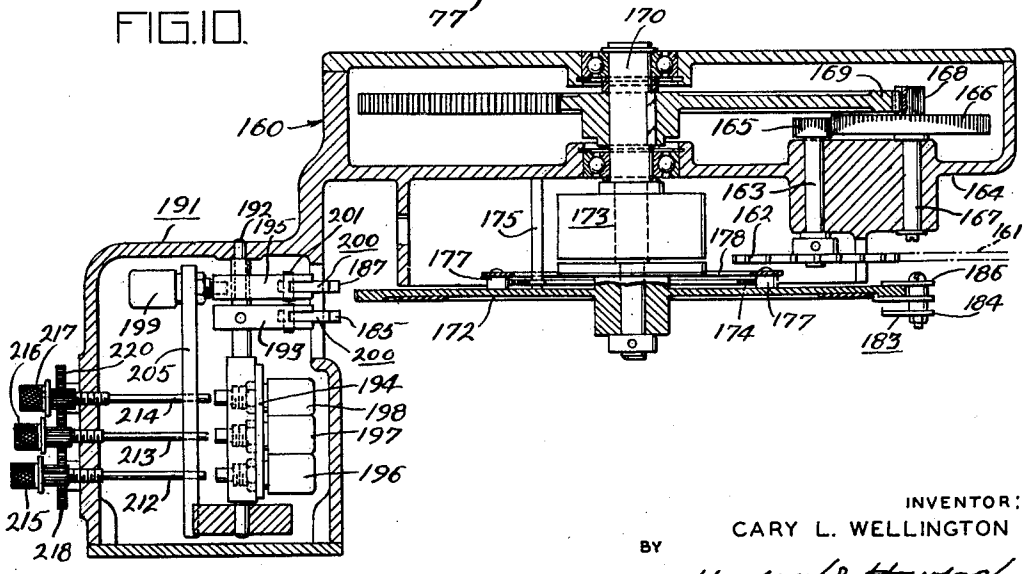


FIG. 10.



INVENTOR:
CARY L. WELLINGTON

BY Howson & Howson
ATTYS.

United States Patent Office

3,058,684
Patented Oct. 16, 1962

3,058,684

AUTOMATIC WINDING MACHINE AND METHOD

Cary L. Wellington, Englewood, N.J., assignor to Wellington Electronics, Inc., a corporation of New York

Filed July 10, 1957, Ser. No. 670,937
11 Claims. (Cl. 242—56.1)

This invention relates to a winding machine which may be made to operate automatically. More specifically, this invention relates to a winding machine for winding a plurality of tapes together into a spiral package having tape groups the ends of which are staggered in the package. The invention also concerns a method of winding tape packages of this sort. In addition, it concerns an arbor which facilitates automatic operation and a counter which initiates the various actions of the machine.

The present invention is particularly adapted to the winding of electrical condensers. In electrical condensers of the wound type the capacitor body is formed by winding together a spiral package consisting of at least two metallic foil plates or electrodes and as many strips of insulating material as desired arranged to separate the plates from one another.

Heretofore, a number of means have been available for reloading the arbor or arbors of a winding machine after the tapes being wound have been severed between the arbor and the tape supplies and the tape package is completed and removed from the arbor. A device of this sort having but a single arbor is the subject matter of my copending application Serial No. 594,861, filed March 29, 1956. However, in such devices no provision has been made for staggering the cut ends of the tapes. Consequently, severing the tapes leaves their ends together rather than staggered. Therefore, if the tape package being wound is a condenser body the opportunity of shorting between the plates of the capacitor has been relatively great.

The present invention provides a means for cutting off continuous tapes of metal and insulator material being wound into a condenser body in such a way that their severed ends are staggered in such a way that the opportunity for shorting is reduced. In accordance with the present invention groups of tapes are separately severed between the package wound on the arbor and the tape supplies so that the ends of the groups are staggered and at least two groups terminate at different distances from the arbor. The staggering of the tape ends is such that when the tape package is completed, an insulator will be interposed between the two plates and extend beyond at least one of them so that one plate will not be in danger of contacting the edge of the other plate. This arrangement permits both the edges of the tape completing the package being wound and the edges of the tapes to be fed to the arbor for reloading to be staggered.

More precisely the present invention concerns a winding machine for winding a plurality of tapes together into a spiral package having tape groups the ends of which are staggered. This machine includes supplies for each of the tapes and a rotating arbor for engaging the ends of the tapes and winding all of the tapes together into a package. Separate drive means is provided for at least two of the tape groups together with means for actuating the drive means to cause them to pull tape from their supplies. Separate cut-off means is provided for each tape group between the drive means for that group and the arbor. Finally, there is an arbor reloading means for collecting together the severed ends of the tapes in the various groups and feeding them to the arbor for reloading.

The method of the present invention applies to a machine for winding tape packages by drawing tape from

tape supplies and concerns the method of successively winding electrical condensers having at least two plates composed of conductive tapes insulated from each other by insulator tapes. The tapes are divided into tape groups and each group is separately severed between the arbor and their supplies in such a way that the severed ends are staggered. Pull is then exerted on the severed tapes between their severed ends and their supplies to draw sufficient extra length from the supplies to permit the severed ends to reach the arbor while keeping these ends staggered. These ends are collected together in their staggered relationship and fed to the arbor which in the meantime has completed the previous tape package and had it removed. Then, the severed ends are attached to the arbor and a spiral package of tape is wound.

The severing operation can be accomplished in one of two ways or by a combination of them. The first way involves cutting the tapes at different distances from the arbor, or the package being wound on the arbor. The second way involves sequencing the cutting actions in time so that the ends are staggered.

Automatic operation requires proper sequencing of the operable parts of the machine and in preferred embodiments, the action of the parts is initiated at least by electrical means which may be responsive to the closing or opening of a switch. In order to obtain automatic operation, then, it is necessary to supply means for automatically actuating these switches in proper sequence, and this is the action of the counter of the present invention.

The counter of the present invention comprises a wheel adapted to be driven by the system of the rotatable part, the rotations of which are to be counted. This wheel is adapted to make one revolution for a selected number of revolutions of the rotatable part. A lever system is supported on the structure relative to which the wheel rotates, and means attachable to the wheel contacts and actuates the lever system after a part of a revolution determined by the position of the attachable means on the wheel. Cooperating switches or actuator are carried interchangeably on the lever system and a portion of the frame relative to which the lever system moves whereby the switches are actuated at successive times representing different positions of the rotatable structure.

Smooth functioning automatic operation is facilitated by an arbor structure which is axially withdrawn from winding position in accordance with the teaching of my U.S. Patent application Serial No. 503,923, filed April 26, 1955. A novel modification of this form of arbor is particularly useful in the machine of the present invention.

This arbor like those of my above application has its winding portion composed of two elongated cooperating parts between which the ends of the tapes to be wound into a tape package are held. These parts are supported on separate axially movable mounting means. Support is provided by a fixed frame relative to which rotates rotatable members which support, in turn, the axially movable mounting means. The rotatable members in this case are supported on opposite sides of the winding position of the arbor parts. Means is provided for simultaneously and synchronously rotating the rotatable members while maintaining relative rotational position of the arbor parts. Means are also provided for separately withdrawing each of the arbor supporting members in order to withdraw each of the arbor parts.

As previously mentioned, the present invention presently has its widest application in the field of the electrical capacitors and therefore an electrical capacitor winding machine adapted for automatic winding will be described together with a counter particularly adapted for use with this machine. Such a machine is illustrated in the accompanying drawings, in which:

FIG. 1 is a side elevational view of a preferred winding machine in accordance with the present invention;

FIG. 2 is a front elevational view partially broken away and partially sectioned showing the machine of FIG. 1;

FIG. 3 is a side view taken along line 3—3 of FIG. 2 showing in greater detail the region of novelty of the machine;

FIG. 4 is a front elevational view of the region of novelty;

FIG. 5 is a sectional view taken along line 5—5 of FIG. 2;

FIG. 6 is a sectional view taken along line 6—6 of FIG. 3;

FIG. 7 is a sectional view taken along line 7—7 of FIG. 3;

FIG. 8 is a side elevational view from the side taken on line 8—8 of FIG. 2;

FIG. 9 is an enlarged view of the counter shown partially in section;

FIG. 10 is a sectional view of the counter of FIG. 9 from above; and

FIG. 11 is a plan view of the fine adjustment of the counter switch actuators.

Referring first to FIGS. 1 and 2, it will be seen that the machine illustrated has a frame or support structure which consists in part of a table **15** for supporting the arbor, counter, drive means and the like and a tape supply support board **16** arranged generally vertically or perpendicular to the horizontal surface of the table **15**. The support board **16** supports a plurality of spindles **17** on which are supported spiral rolls of paper or other insulator material. These rolls **18** are held in place by disk walls **19** which confine the rolls between the surface of board **16** and the disk forms sort of a reel. In addition to providing a bounding wall, the disk **19** is preferably urged by spring arms **20** toward the roll **18** in order to provide a sort of braking action on the withdrawal of the continuous material from the spiral roll. The spring arms **20** are fixed to a hub **21** whose position can be adjusted relative to the shaft and which is held in place by a thumb screw **22**.

In order to provide a generally constant direction to the tape paths as they approach the arbor, pins **23** are provided as guides. Each pin keeps the direction of the tape which it guides constant between them and the arbor regardless of how full or empty a particular supply may be. These pins also preferably provide an alignment function in accordance with the teaching of my copending application Serial No. 503,924, filed April 26, 1955.

The spindles **17** support insulator tapes **24** whereas the spindles **26** and **27** support the metallic foils **29** and **30**, respectively. These metallic foils are intended to provide the electrodes of the capacitor and are essentially like the spindles **17** and the rolls of foil that they support and are treated in much the same way as the rolls of paper supported by the spindles **17**. However, the roll **26** is preferably supported on a member **28** whose supporting surface is offset to one side of the spindle supporting surface of the support member **16**. The purpose of offsetting this metal foil from the insulators is to cause it to extend beyond the insulators on one side to afford access to one condenser plate at one side of the roll. The amount of off-set may be relatively small but it is effective to facilitate attachment of a lead to the plate.

It will be observed in this case that the tapes employed are relatively wide, being of a width of four or more inches in many cases.

The arbor in this machine is a novel structure having particular advantages with wide tapes. Bascially it is an arbor within the scope of my above mentioned U.S. patent application in that it has axially movable mating parts **32** and **33** between which the ends of material to be wound are secured. However, in this case, the arbor part **32** is attached to a support **34** on one side of its winding position and the arbor part **33** is attached to a similar support **35** on the other side of its winding position. Each of these arbor part supporting members is axially withdrawable away from winding position to retract its arbor part therefrom. Advantageously, the arbor parts **34** and **35** are coupled to and able to rotate relative to the piston rods having their pistons within cylinders **36** and **37**. Cylinders **36** and **37** are preferably air cylinders actuated by solenoid controlled valves **38** and **39**, respectively, to control the introduction of air to opposite sides of the pistons and, hence, to determine the position of its associated arbor part whether in withdrawn or winding position. The arbor parts **32** and **33** are advantageously made so that each of their tips is associated with and accepted by a recess in its opposite number's supports **34** and **35** so that they may be firmly held together during rotation.

Rotation is imparted by means of a motor drive **41** supported by suitable support means beneath the support table. A sheave **42** on the shaft of the motor drives a belt **43** which, in turn, drives the pulley sheave **44** on the stub shaft **45** rotatably supported relative to the frame. On this same shaft **45** are supported a sprocket wheel **46** which is connected to the counter in a way which will hereafter be described and a gear **47** which meshes with gear **48** on cylinder **49**. Cylinder **49** is rotatably supported on the frame and, in turn, supports member **34**, slidably housed in but secured against rotation relative to cylinder **49** as by a pin member engaged in a slot in cylinder **49**. Thus, arbor part **32** is caused to rotate by means of power supplied from motor **41**.

In a similar manner, the arbor supporting part **35** supporting arbor member **33** is slidably supported within cylinder **51** which is rotatably mounted relative to the support table **15** and which is driven by a gear **52**. Gear **52** meshes with a gear **53** on a stub shaft **54** rotatably supported on the frame. Between gears **53** and **47** extends a coupling member, shaft **56** which carries gears **57** and **58** at its ends to mesh with gears **47** and **53**. Gears **47** and **53** and gears **48** and **52** are preferably all the same size so that the arbor parts are driven in synchronism. Indexing occurs by means of either one or both of a pair of solenoids **61** or **62** whose cores act to drive plungers **63** or **64** against spring loading into sockets **65** or **66** on pulley sheave **44** or gear **53**, respectively. Either one or both of these devices, because of the rigid gear connection, can stop both arbor parts from rotating without stoppage of motor **41** due to the slippage between belt **43** and sheave **44**. Winding rotation is, of course, resumed by withdrawal of pins **63** and/or **64** from sockets **65** and/or **66**. As will later appear, the arbor is stopped in only one position relative to the frame and thus indexed therewith so that the arbor parts **32** and **33** will be in proper position relative to the frame for reloading. Housings **68** and **69** are provided to protect the gears and other rotating parts.

Referring now to FIGS. 3 and 4 in particular, it will be observed that all of the tapes are fed between one of two sets of drive rollers **71—72** and **73—74**. The division is not equal, and in fact one set **71—72** of the roller receives only metal foil **29** whereas the other set **73—74** receives the balance of the tapes including foil **30** and insulator tapes **24**. Nevertheless metal foil constitutes a tape group in the sense that it is used herein, i.e., all the tapes acted upon by the same means beyond their supply and guide means and between these and the arbor. The movable roller of each pair is out of contact normally with the other and urged together only when needed pull cannot be supplied by the arbor. At least one roller of each pair is driven.

Associated with and immediately preceding the drive rollers **73—74** along the tape path is a guide member generally designated **75** which consists of a plurality of guide rods **76** supported at one end on a recessed region of the support structure **16** and at the other end in a plate **77**. This structure may be seen by reference to FIGS. 3, 4 and 7.

Associated with the drive rolls 73—74 and closely spaced to them is a diversion pin 78 which effectively divides the tapes passing between the rolls 73—74 into two groups by diverting one or more insulator tapes above it in such a way that their tape path is slightly longer than the tape path of the rest of the tapes passing between roller 73—74. This division also serves to permit the tape groups to be separately cut off from their supplies to complete each tape package, thus permitting staggering of the ends of the tapes. Staggering of the ends can be accomplished then by selective placement of knives at varying distances from the arbor or by controlling the sequence of operation of the knives to achieve the same effect or by a combination of the spacing and sequencing techniques.

Movable knife blade 79 is located along the tape path passing between drive rollers 71—72 to cut off that tape group which consists in this case of only foil 29. Movable knife blade 80 is positioned between pins 78 and the arbor and above the tape group passing between drive rollers 73—74 and over diverting pin 78. Knife blade 81 is movable upwardly into the tape path which passes beneath diverting pin 78 between the drive rollers 73—74 and the arbor. Actuation of the knives will be discussed hereafter.

A tray 91 provides the collection and arbor feed means. It is positioned so that the severed ends of the tapes cut by the knives 79, 80 and 81 are all collected by the tray. This collection means also serves to collect the severed leading edges of all the tapes as they are drawn from their supplies by rollers 71—72 and 73—74. Its position at this time is preferably such that the tapes will continue as they are driven by the rollers to move along the tray so that relative positioning of the tape groups is maintained. For example, if the severed edge of the tape group passing through rollers 73—74 and above diverting rod 78 is ahead of the severed edge of foil 29, their relative positions will be maintained. The tray is also adapted to be raised against the arbor. It, therefore, functions as a loading means for the arbor since it functions to hold the severed ends of the tapes against the upper part 32 of the arbor when it is in winding position but part 33 is withdrawn so that part 33 thereafter can be axially slid into place beneath the tapes to engage the severed ends. The groove 92 is intended to accommodate arbor part 33 as it is moved axially into place beneath the tapes during loading.

Tape packages are completed by daubing glue onto the package as it is being wound in a position which will be contacted by the outside layer. In accordance with the present invention, this may be done mechanically by employing an applicator 94 which consists of a sponge 95 which does the actual application of the fluid glue and communicates with a cylindrical storage chamber 96.

Structurally the elements recited are supported primarily on the support structure 16 or alternatively on the table 15. A heavy cross support 99 extends laterally from the support board 28 to carry a support plate 100 which is parallel to support 16 and fixed portion of the frame on which members requiring support on both ends may be mounted. As can be seen in FIG. 3, it is between board 28 and plate 100 that the fixed driven rollers 72 and 73 of each pair are supported. As seen in FIG. 6, roller 72 is ball-bearing supported to freely rotate relative to support members 28 and 100 and is extended by shaft 101 to a sprocket drive 102. Similarly, roller 73, as shown in FIG. 7, is ball-bearing mounted between frame portions 28 and 100 and has a shaft extension 103 terminating in sprocket 104. As seen in FIG. 5, motor 106 drives rollers 72 and 73 through sprockets 102 and 104 by endless chain 107 which is driven by sprocket 108 on the motor shaft.

As shown in FIGS. 3 and 4, also extending between supports 100 and 28 and journaled therein for rotation is a shaft 110 on which are revolvably supported by straight lever arms 111 the shaft ends of movable roller 71. As can be seen in FIG. 3, shaft 110 and arms 111 are fixed relative to each other and, in turn, shaft 110 is fixed to a lever arm 112 which is urged by spring 113 into a position in which roller 71 is pressed against roller 72. The tension of spring 114 is opposed by a solenoid which is connected to lever 112 by spring 113. However, as can be visualized from FIG. 5, when pull is exerted by solenoid 115 upon its core 116 to which the spring 113 is attached, the roller 71 will be moved away from roller 72 in order to separate the rollers so that no drive will be imparted to the tape 29 which passes between them.

Also supported to rotate about shaft 110 is a crank arrangement having lever arms 117 and 119 and a bearing block 118 in an arrangement in which L-shaped arm 117 supports serrated knife 79. Spring 120 acts on short lever arm 119 to urge knife supporting arm 117 away from the tape path, as can be seen in FIG. 5. The solenoid 122 when energized produces a pull on its core 123 which is connected to the lever arm 119 against the action of spring 120. This pull moves the knife blade through the path of tape 129 against the tension in the tape to sever the foil between the drive and the arbor.

The knife 80 is also supported by a crank arrangement 126—127 which, as can be seen in FIGS. 3 and 5, includes a bearing block 128 which surrounds rod 129 between support members 100 and 28. Connected between the L-shaped knife support 126 and support connection member 99 is a spring 130 which urges support 126 against connection 99 and away from the path of the tape group which passes rod 86. As can be seen in FIGS. 3 and 5, lever 127 is connected by spring 131 to core 132 of solenoid 133. Upon the energization of the solenoid, the pull on lever arm 130 will cause knife 80 to move against the pull of spring 130 and to cut through the tape passing over the rod 78.

Cutter 81 is supported on a rod 135 which is journaled to slide in a plate 136. Plate 136 also provides a bracket for supporting the cutter assembly and its solenoid 137, the core of which is brought to bear against the rods 135. Energization of solenoid 137 drives its core upward urging rod 135 and, therefore, serrated knife 81 upward and through an opening in tray 91 through the path of the tape group beneath rod 78. Suitable stops are provided to limit the movement of each of the knives 80 and 81 and prevent them from moving too far.

As can be seen in FIGS. 3 and 7, the tray 91 is fixed to flat chord surfaces on shaft 140 at opposite ends thereof by ears 141 on the tray. Shaft 140 itself is supported on a bracket 142 which provides bearing surfaces at opposite ends of the shaft permitting rotation. Shaft 140 may be attached at one end to the rotary portion of a rotary solenoid of any desired or preferred construction (not shown) mounted on the bracket 142 and connected in parallel with the actuating solenoid for air cylinder 143 in order to produce rotation to move its tray into the arbor 32 when the roller 74 is raised. Examples of rotary solenoids readily susceptible of use for this purpose are disclosed in such patents as Pratt 2,873,412, Zipper 2,887,883, Leland 2,473,598 and Carpenter 2,531,905. This rotary solenoid or other actuating means may alternatively be connected through the timer to be actuated at the proper time by the closing of a switch in circuit with the rotary solenoid and the power supply. In the latter case the solenoid may be deenergized just as soon as the tape fed by tray 91 is attached to the arbor 32, 33. The shaft 140 also supports ball-bearings for roller 74. Roller 74 is brought to bear against driven roller 73 by air cylinder 143 whose piston rod 144 is terminated in the bracket 142. Actuation of the cylinder is conveniently accomplished by a solenoid controlled valve. This arrangement causes tray 91 to be lowered to the roller position shown dotted in FIG. 3 when roller 74 is withdrawn from contact with roller 73. If the tray

continues to be urged into the tape package as it is wound and as it increases in size, the end of the tray against the package is forced gradually lower. It will be appreciated that in order to accommodate knife **81** in any position of the tray, the slot therethrough must be somewhat enlarged.

The glue applicator **94** is actuated by a solenoid **149** through its core **150** which is connected through its lever arm **151** which is pivotally supported on support member **28**. This lever arm **151** carries a transversely extending rod **152** which terminates in a clamp **153**. Actuation of the solenoid **149** causes retraction of its core **150** producing a rotation of arm **151** about pivot point **154** whereby the sponge portion **95** of the applicator is brought into contact with the periphery of the tape package.

The solenoids producing actuation of the active elements of the machine may be connected to a common power source through their own operation controlling switches. Thus the opening or closing of a switch energizing a solenoid initiates the various operations of the machine. Although the sequencing of the solenoids to control the sequence of operation of the machine may be manually controlled, their manual control normally does not permit the precision that automatic timed control offers, and, therefore, control or actuation of the switches on a counter arranged to actuate switches precisely at critical times to energize or deenergize their variout solenoids in proper sequence is preferred. Such a counter is illustrated in FIGS. 8–11.

As shown in FIG. 8, the counter generally designated **160** is coupled by a drive chain **161** to sprocket wheel **46** on stub shaft **45**. Since stub shaft **45** rotates only when the arbor is rotating the counter is driven only at this time.

As can be seen in FIG. 10, the chain **161** drives a sprocket wheel **162** on a shaft **163** supported on a thickened bearing portion of the counter housing **164**. Shaft **163** supports pinion **165** which, in turn, drives a larger spur gear **166** supported on another stub shaft **167**. Stub shaft **167** also supports pinion **168** which, in turn, drives a large gear **169**. The large gear is designed to move one tooth for each revolution of the arbor. In a counter adapted for use with an arbor making about 300 revolutions to wind a tape package, teeth in excess of 300 would be used, for example. Gear **169** is keyed to a ball-bearing supported shaft **170**. Shaft **170** rotatably supports a gear-like member **172** which has the same number of teeth as gear **169**. Gear-like member **172** is fixed to one plate of an electromagnetic clutch **173**, the other plate of which is keyed to shaft **170**. Therefore, when the clutch is energized so that its plates are held together, gear-like member **172** and shaft **170**, hence gear **169**, rotate in synchronism, but, when it is deenergized, shaft **170** moves relative to gear-like wheel **172**. A spiral spring **174** is interposed between the housing **164** and the gear-like member **172**, as seen in FIG. 9. This spring is connected at its inner end to a post **175** supported on the housing **164** and at its outer end to a post **176** supported on the gear-like member **172**. Other posts **177** similar to the post **176** support a ring **178** which surrounds the spring and prevents it from bulging unevenly and applying uneven forces at different positions of the gear-like member relative to the housing. Ring **178** is provided with a notch which receives a gravity biased pawl or latch mechanism **180**. Pawl **180** is rotatably supported on the housing by pin **181** and is gravity biased downwardly to be engaged by the notch **179**. The pawl provides a shoulder which is engaged by the notch **179** to prevent rotation in the clockwise direction but is beveled to rest against a beveled shoulder so that it will easily ride out of the notch in the course of rotation in the counterclockwise direction. The spring **174** and its supports are preferably arranged so that, when the pawl **180** is engaged in notch **179**, some amount of tension remains tending to urge the gear-like member clockwise.

As the sprocket wheel **162** turns, gear **169** will be driven through the gear train, and, if the clutch **173** is engaged, gear-like member **172** will be driven in synchronism with it against the urging of spring **174**. Thus, it is possible to predict when a particular tooth will be opposite a particular point on the housing after rotation of the gear-like member begins. This being the case, it is possible to provide on the housing or support frame structure of the counter either a switch for direct actuation or a lever system for actuating switches to initiate the various actions of the winding machine or other rotating machinery requiring synchronization. An actuator **183** is attachable to the gear-like member in position to contact the switch or lever system during rotation of gear-like member **172**. Preferably the actuator **183** cooperates with the teeth at the edge of member **172** and fits in one of as many discrete peripheral positions of the gear-like member as there are teeth. It may be held in place by a spring loaded shoulder member which is urged against the gear-like member to latch against an undercut portion thereof which defines a rim of the gear-like member. This actuator provides a cam surface **184** to cooperate with a cam surface **185** on the lever system to produce gradual movement of the lever system. The lever system in the course of its gradual movement can then sequentially actuate a plurality of switches. In fact, a plurality of lever systems, each having cam surfaces opposed by actuator cam surfaces, can be employed. Thus additional actuator cam surface **186**, cooperates with surface **187** on a second lever system. In this case offsetting cam surfaces **183** and **186** circumferentially from one another gives greater range to the period of operational sequencing. The actuator attachment **183** preferably has a pointer **188** which cooperates with calibrations **189** on the gear-like member indicating the number of revolutions the associated rotatable system will make before the actuator reaches its lever system.

The lever system is enclosed in a separate housing **191** which may be an integral part of the main counter housing **164** and wherein is provided a rotatable shaft **192** to which is fixed a lever arm **193** and a plate **194** which constitute a crank system. Lever **195** is similar to lever **193** but is rotatable relative to shaft **192**. Plate **194** supports switches **196**, **197** and **198**. Lever **195** is in position to actuate switch **199** by its movement. Lever arms **193** and **195** are of a special two-piece construction as can be seen in FIG. 9. This construction causes the cam surfaces **184** and **186** of actuator **183** to move lever arms **193** and **195** in moving in the counterclockwise direction in FIG. 9 but not to move them in passing clockwise. As can be seen in FIG. 9, this is made possible by arranging the cam surface on a block **200** which is pivotally supported by pin **201** relative to its lever (**193** or **195**). Each block **200** fits into a channel in its lever arm and is designed to rotate about its pin **201** in this channel. The channel is closed at its back in a wall remote from the actuator and the block **200** is shaped so that when it is in position for actuation, as shown, the block tends to be rotated so that it bears against the wall closing the channel in the lever arm and forces are transmitted through the lever system. However, when struck from below, during clockwise rotation, the block **200** can rotate upwardly and permit the actuator to pass without moving its lever arm **193** or **195**. This construction may be particularly important in a device of this type employing a plurality of actuators so that at least some of the actuators completely pass their cam surface in the lever system while moving counterclockwise. Then, upon reindexing the counter to zero position, no untimely actuation of the switches will occur.

In order to bias the lever arm **193** into position to be moved by the actuator, a spring **204** is provided between

the switch support plate 194 on shaft 192 and a plate 205 fixed relative to housing 191 and supporting spring aligning stud 206. Opposing the movement of plate 194 under the urging of spring 204 is stud 208 which is adjustably supported on housing 191 by virtue of its screw threaded nature.

In addition to the switches on movable plate 194, one or more switches, like switch 199, may be supported on the fixed plate 205 in position to be directly actuated by the levers 193 and 195 or some extension thereof. However, the convenience of precision adjustment hereafter described in connection with switches 196, 197 and 198 is not as readily available in such cases and, hence, such switches are normally used only where timing adjustment may be coarse and/or the timing of the particular function controlled by such switch will not have to be adjusted.

The sequence of operation of switches 196, 197, 198 is easily readjusted. These switches are preferably plunger actuated types and plungers are aligned with rods 212, 213 and 214, which are threaded through the housing 191 and is supported and aligned by wall 205 so that their proximity to their associated switch plungers may be adjusted. Each of the rods is terminated outside of the housing in a knurled knob 215, 216 or 217 whereby it may rotate to adjust its axial position. Each rod also has pinion means outside of the housing which drives one of the geared pointers 218, 219 and 220 which cooperate with calibrations on the housing indicating adjustment of the positions of the rods 212, 213 and 214 relative to the switches in terms of fractions of a revolution of the associated rotatable system up to 2 or 3 revolutions.

Before operation, the counter is first adjusted by placing the actuator 183 in position to permit winding a capacitor any desired number of turns. The fine adjustment proceeds at knobs 215, 216 and 217. Then in operation, as the member 172 rotates, the cams 184 and 186 will eventually strike cams 185 and 187 and then produce gradual rotation of their lever systems. The full range of movement of a lever system may take three, four, five or more rotations of the rotatable system which drives the counter. Thus, adjustment of the positions of the members 212, 213 and 214 enables a sequencing operation of the circuits which the switches 196, 197 198 control. For example, switch 198 may be adjusted to be the first switch to be actuated and this switch energizes the solenoids which drive the knives to cut each of the tape groups. The same switch may energize the solenoid which effects daubing of the tape package with glue. Next, actuation of switch 197 may be selected to energize the solenoids which cause control of the fluid valves of cylinders 36 and 37 to produce a withdrawal of the arbor parts from winding position to remove the tape package which is meantime completely wound. Return of arbor part 32 to winding position precedes return of part 33 and may be accomplished independent of switch 197 by a switch in series with it in the circuit of the solenoid controlling the valve of cylinder 36. This could be done by a time delay relay which opens the series switch a fixed time after switch 107 closes or a limit switch actuated when arbor support 34 is completely withdrawn from winding position. Next, switch 198 when actuated energizes the solenoids which cause each pair of the drive rollers to move together to engage the severed tapes whereby the rotation of the rollers would pull extra tape from the supplies to feed the arbor. As previously mentioned bringing the rollers 73 and 74 together also raises tray 91, so that the severed ends of the tape are raised against arbor part 32. Finally, switch 199 is closed to energize solenoids 61 and 62 to stop arbor rotation and index the arbor parts 32 in position for arbor part 33 to move beneath the severed ends of the tape held against arbor part 32 and clamp the tapes in position ready for winding. Switch 199 also deenergizes the clutch 173 to return the gear-like member 172 of the counter to zero position to start again, whereupon all the switches are released so that winding can again proceed and the sequence of operation is repeated.

From the above, it will be observed that the steps of the method are automatically followed using the counter. Manual operation of the machine described or entirely different forms of automatic operation are possible. In addition, the winding machine itself may be modified within the scope of the claims. In each case, however, the method involves separate steps of separately severing each tape group so that the severed ends of the groups are staggered, pulling extra tape from the supplies to have sufficient length of tapes to feed to the arbor, collecting the ends together and feeding them to the arbor, which in the meantime has had the previously wound tape package removed, and finally attaching the severed ends to the arbor for winding.

It will be appreciated by those skilled in the art that, although only one arrangement has been suggested, other arrangements of the winding machine, the counter, the arbor structure, and combinations thereof according to the teaching of the present invention are possible. All such modifications within the scope of the claims are intended to be within the scope and spirit of the present invention.

I claim:

1. A winding machine for winding a plurality of tapes together into a spiral package having tape groups the ends of which are staggered, comprising a support frame, tape supplies for each of the tapes, a rotatable arbor on the support frame for winding the tapes, said arbor being aligned with the tape supplies and tape paths so that at least one common plane intersects all supplies, tape paths, and the arbor and said arbor being off center and positioned near one edge of the frame so that it is accessible from a position adjacent said edge, at least two tape drive means at least one of which moves less than all of the tape and at least one of which is located in the vicinity of the arbor, means for actuating each of the drive means to cause them to pull tape from tape supplies, separate cut-off means associated with each tape drive means between the drive means and the arbor, an arbor reloading tray positioned adjacent one of the cut-off means in such position that the severed tape ends will fall by gravity on the tray and so that the tapes will be guided by the tray as they are driven to a position below the arbor, and means including at least part of the actuating means for one of the tape drive means to raise the tray against the arbor so that the tapes may be attached to the arbor.

2. The winding machine of claim 1 in which a separable two piece arbor is employed between the pieces of which the severed ends of tape may be held during winding so arranged that the tray will lift the severed ends against one part of the arbor and hold them in such position that the other part of the arbor can pass beneath the tapes.

3. The structure of claim 2 in which a glue applicator is movably supported relative to the frame and means is provided for moving the applicator into a position to apply glue to a finished spiral package.

4. The structure of claim 1 in which each of the drive means includes a pair of rollers at least one of which is positively driven and through the nip of which at least one tape group is adapted to be driven.

5. The machine of claim 4 in which at least one of the rollers of each pair is movable toward and away from the other, means is provided to urge each pair of rollers together and means is provided to move the rollers apart so that the arbor may freely draw the tapes from their supplies when the arbor is winding.

6. The structure of claim 5 in which means is provided to move each cut-off means relative to the frame and through the path of its associated tape group.

7. A winding machine for winding a plurality of tapes together into a spiral package having tape groups the ends of which are staggered, comprising a support frame, tape supplies on the support frame for each of the tapes, a rotatable arbor having a pair of axially slidable parts on the support frame for winding the tapes, said arbor being aligned with the tape supplies and tape paths so that at least one common plane intersects all supplies, tape paths and the arbor and said arbor being off center and positioned near one edge of the frame so that it is accessible from a position adjacent said edge, at least two pairs of drive rollers at least one of which moves less than all of the tapes and at least one of which is located in the vicinity of the arbor, drive means for rotatably driving at least one of the drive rollers of each pair, means urging the rollers apart, means to overcome the means urging rollers apart to urge the rollers together, separate cut-off means associated with each tape drive roller between the drive rollers and the arbor, actuating means for each cut-off means to cause it to sever tapes, an arbor reloading tray positioned adjacent one of the cut-off means in such position that the severed tape ends will fall by gravity on the tray and so that the tapes will be guided by the tray as they are driven to a position below the arbor and means including at least part of the means urging one pair of the rollers together to raise the tray against the arbor so that the tapes may be attached to the arbor.

8. The structure of claim 7 in which a divider is placed between at least one pair of rollers and cut-off means

to divide the tapes passing between said rollers into two tape groups.

9. The structure of claim 8 in which the nips of each of the two pairs of rollers are directed generally toward the tray and one pair of rollers is higher than the other and its nip is directed between the other pair and the arbor, the lower pair being the one provided with a divider.

10. The structure of claim 7 in which the cut-off means for the lowermost tape group is a knife which passes through an opening in the tray for that purpose.

11. The structure of claim 10 in which cut-off means and the means urging the drive rollers together are solenoid actuated.

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