Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 1

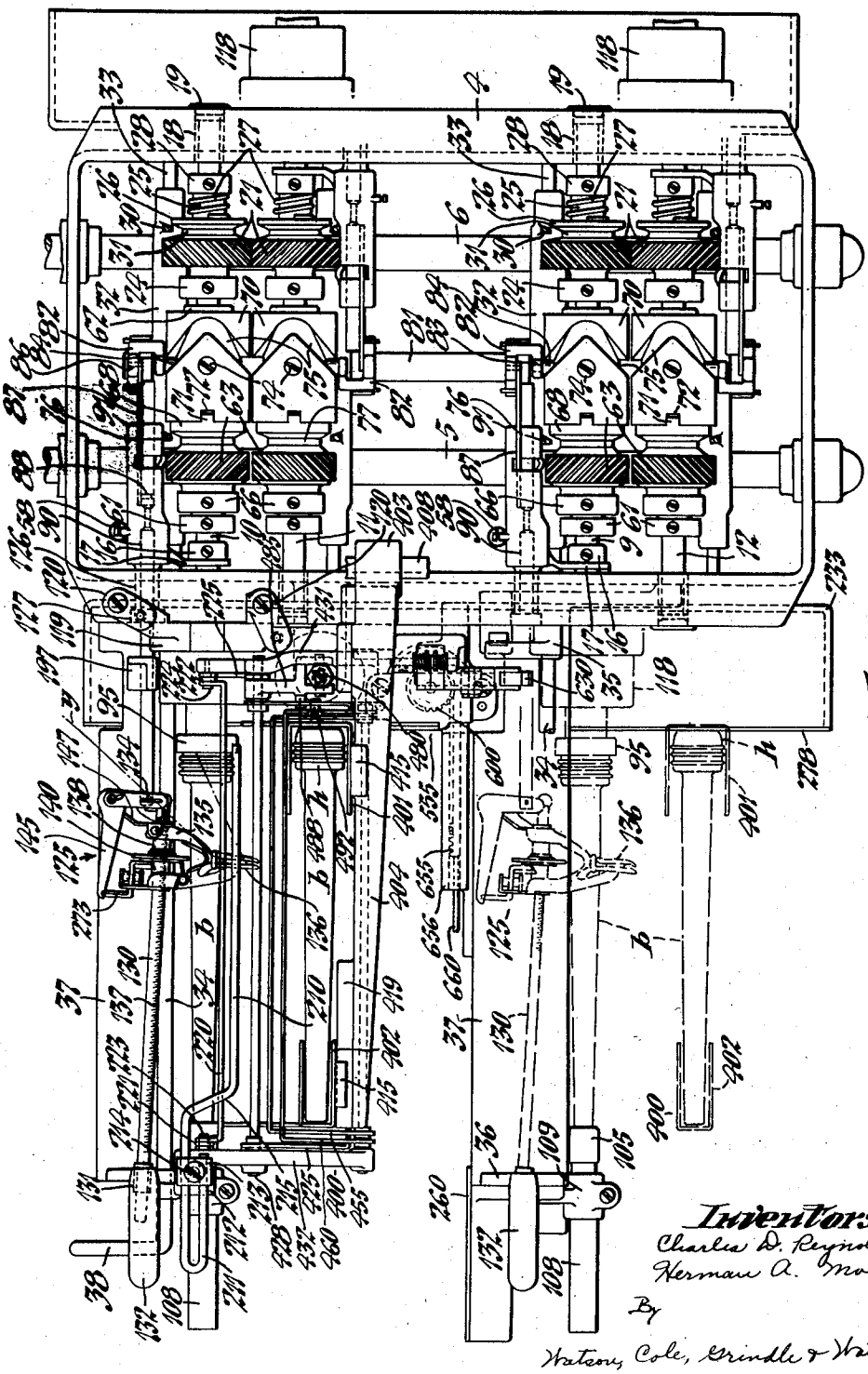

Fig. 1.

Inventors:
Charles D. Reynolds
Herman A. Moe
By
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 2

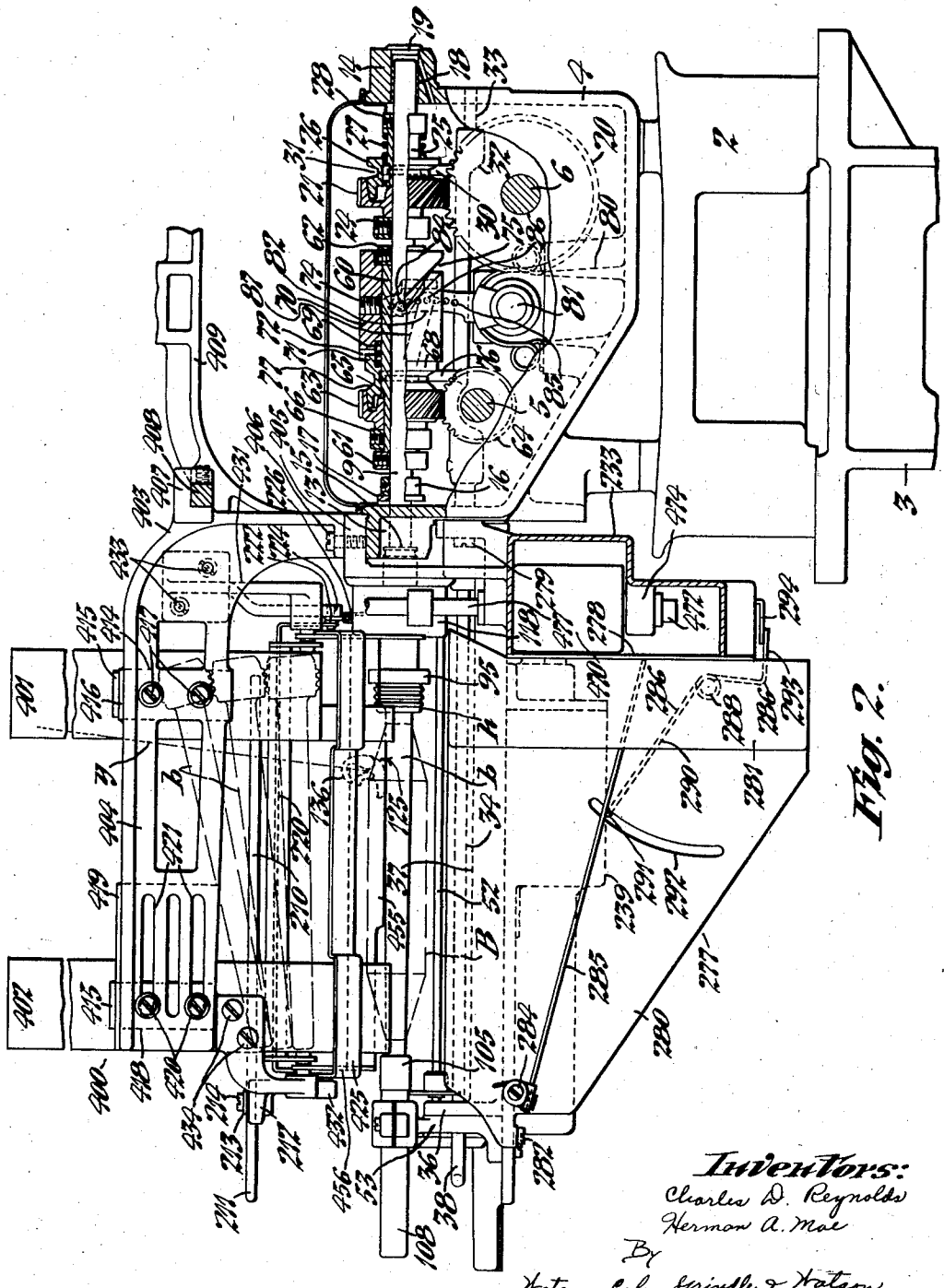

Fig. 2.

Inventors:
Charles D. Reynolds
Herman A. Mae
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 3

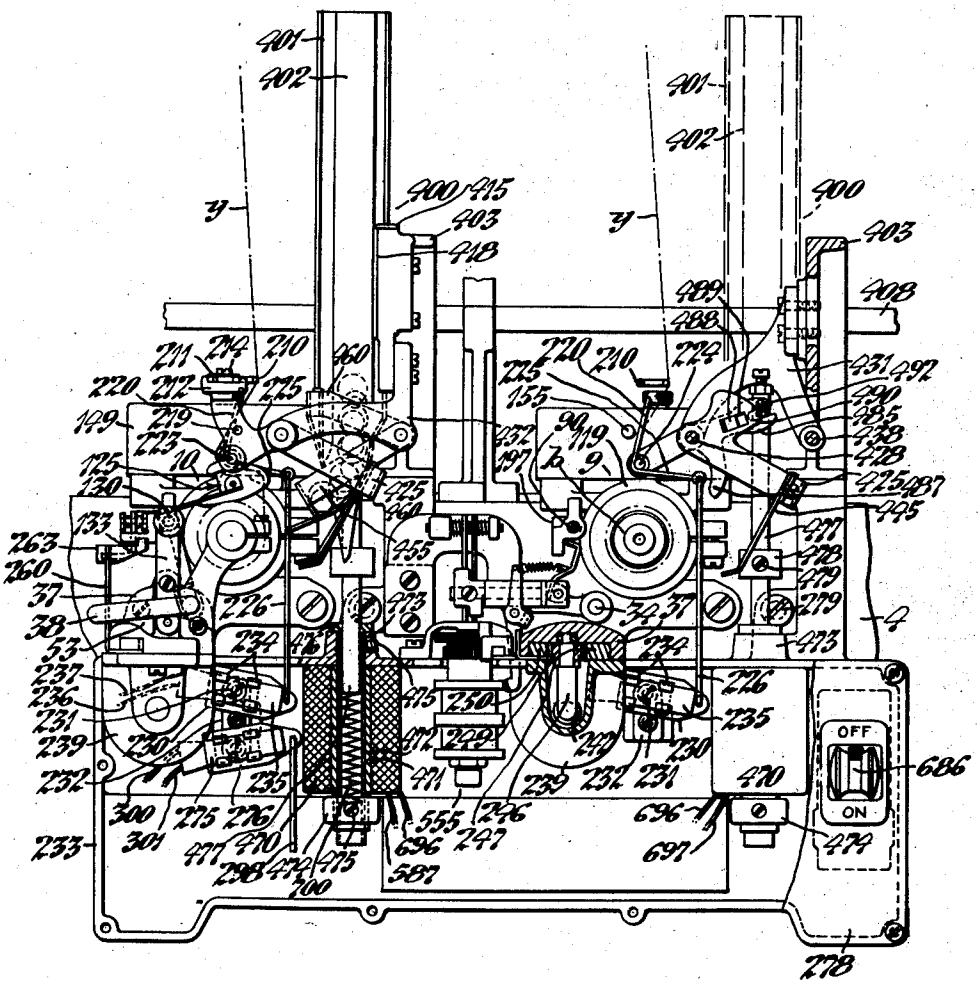

Fig. 3.

Inventors:
Charles D. Reynolds
Herman A. Mc
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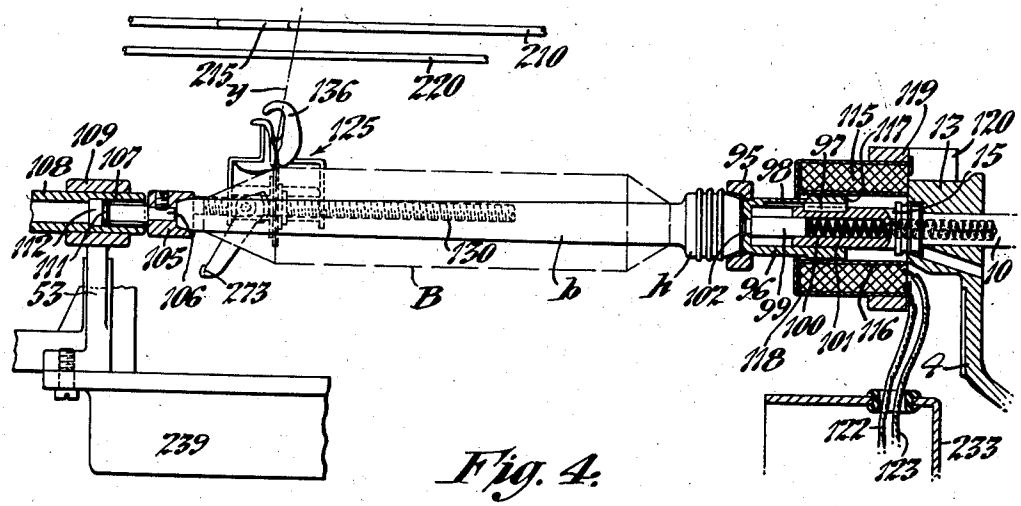
Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 4



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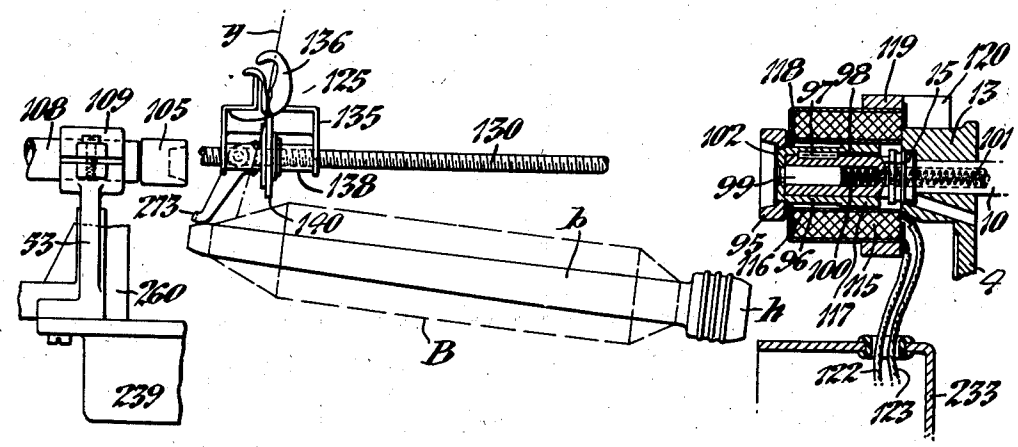

Fig. 5.

Inventors:
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Herman A. Moe
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 5

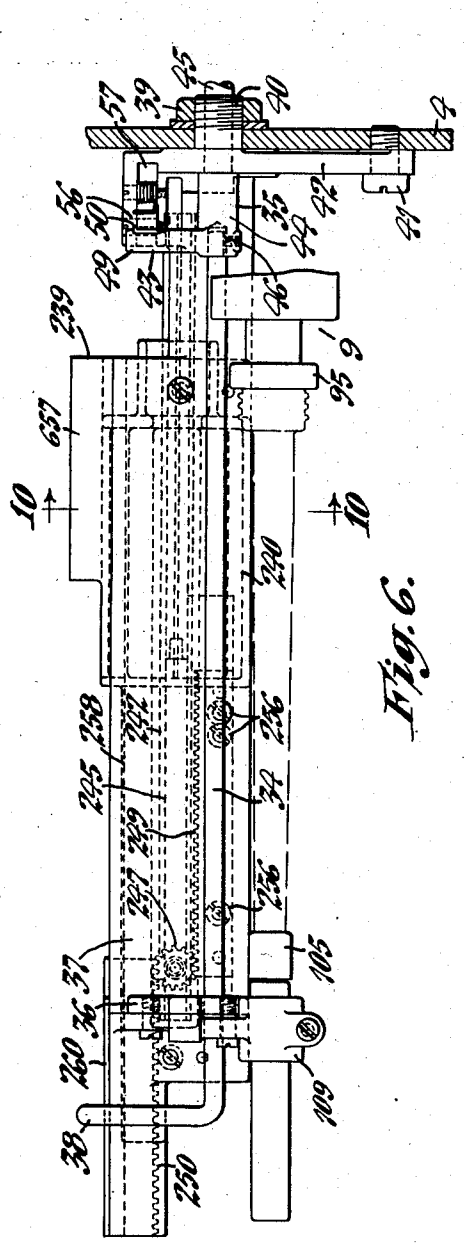

Fig. 6.

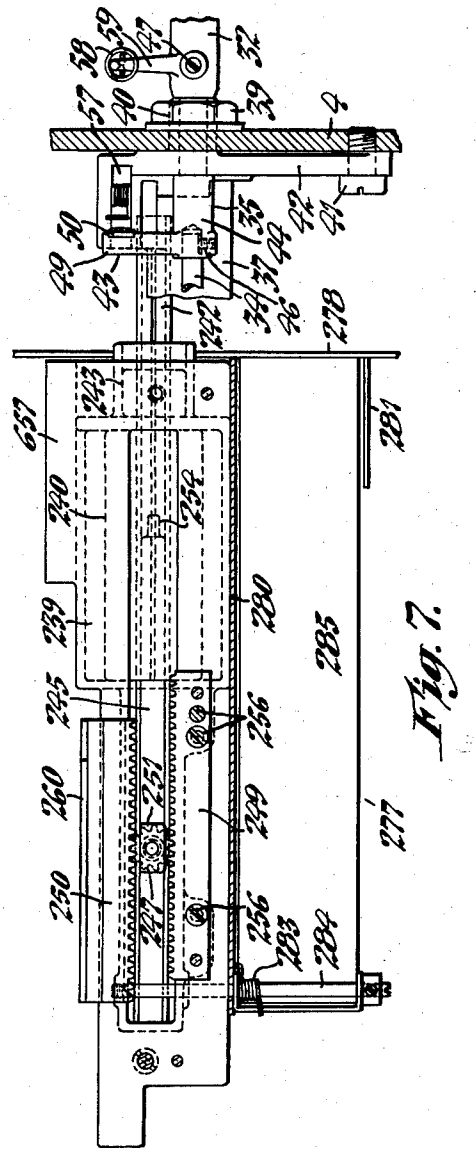

Fig. 7.

Inventors:
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 6

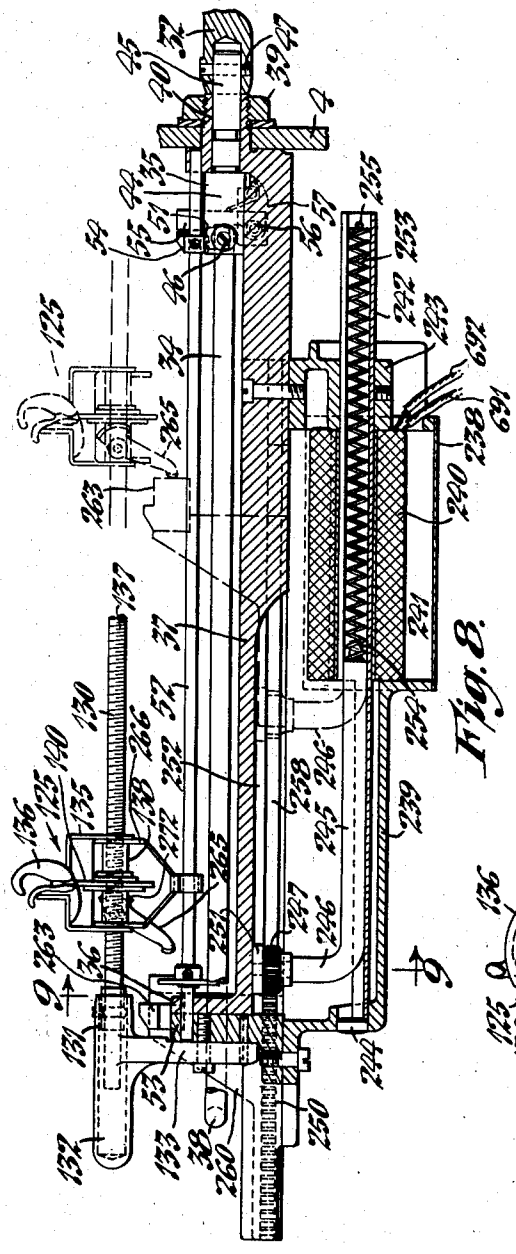

Fig. 8.

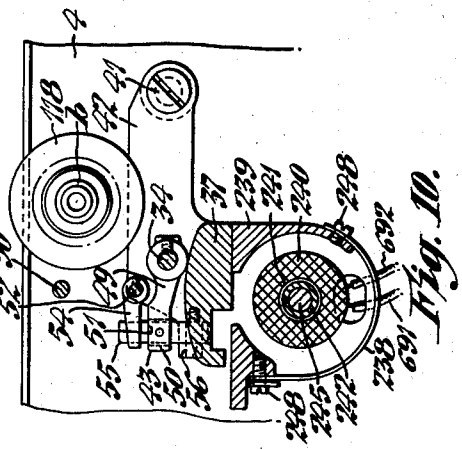

Fig. 10.

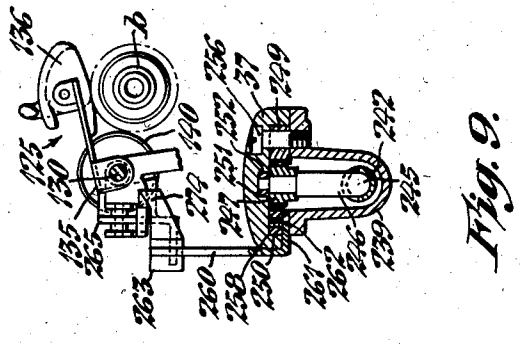

Fig. 9.

Inventors:
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 7

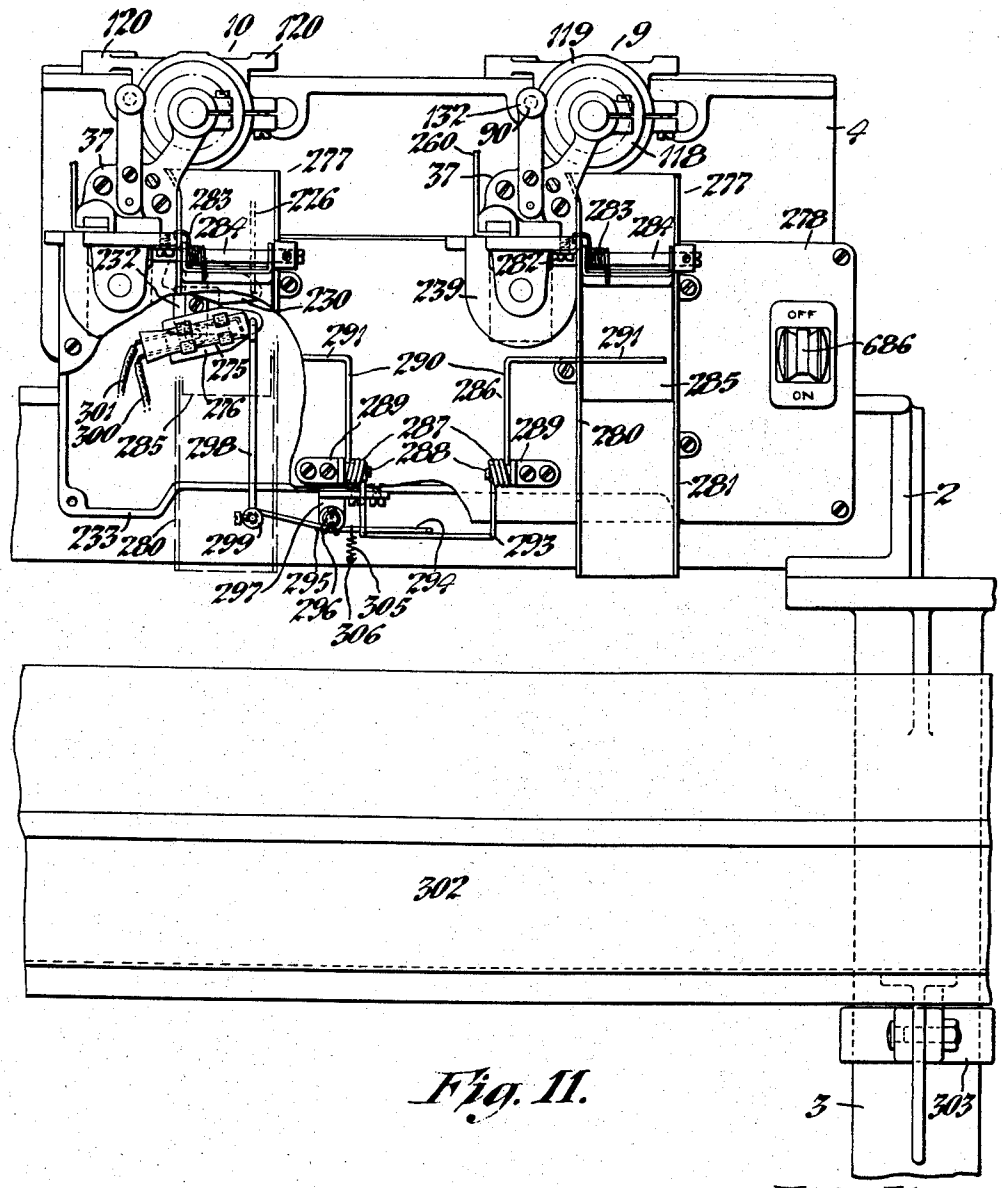

Fig. 11.

Inventors:
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Attorneys.

Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 8

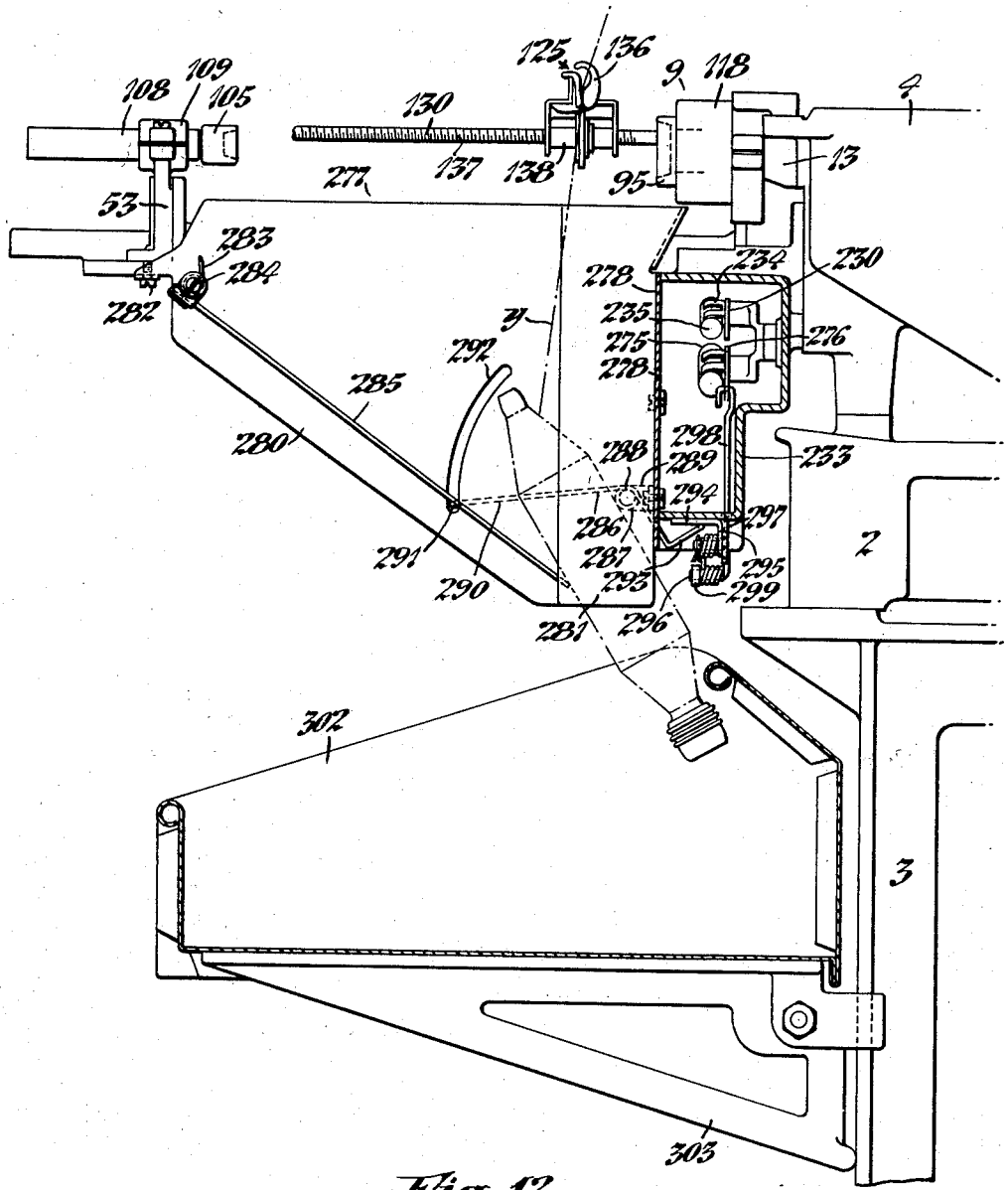

Fig. 12.

Inventors:
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 9

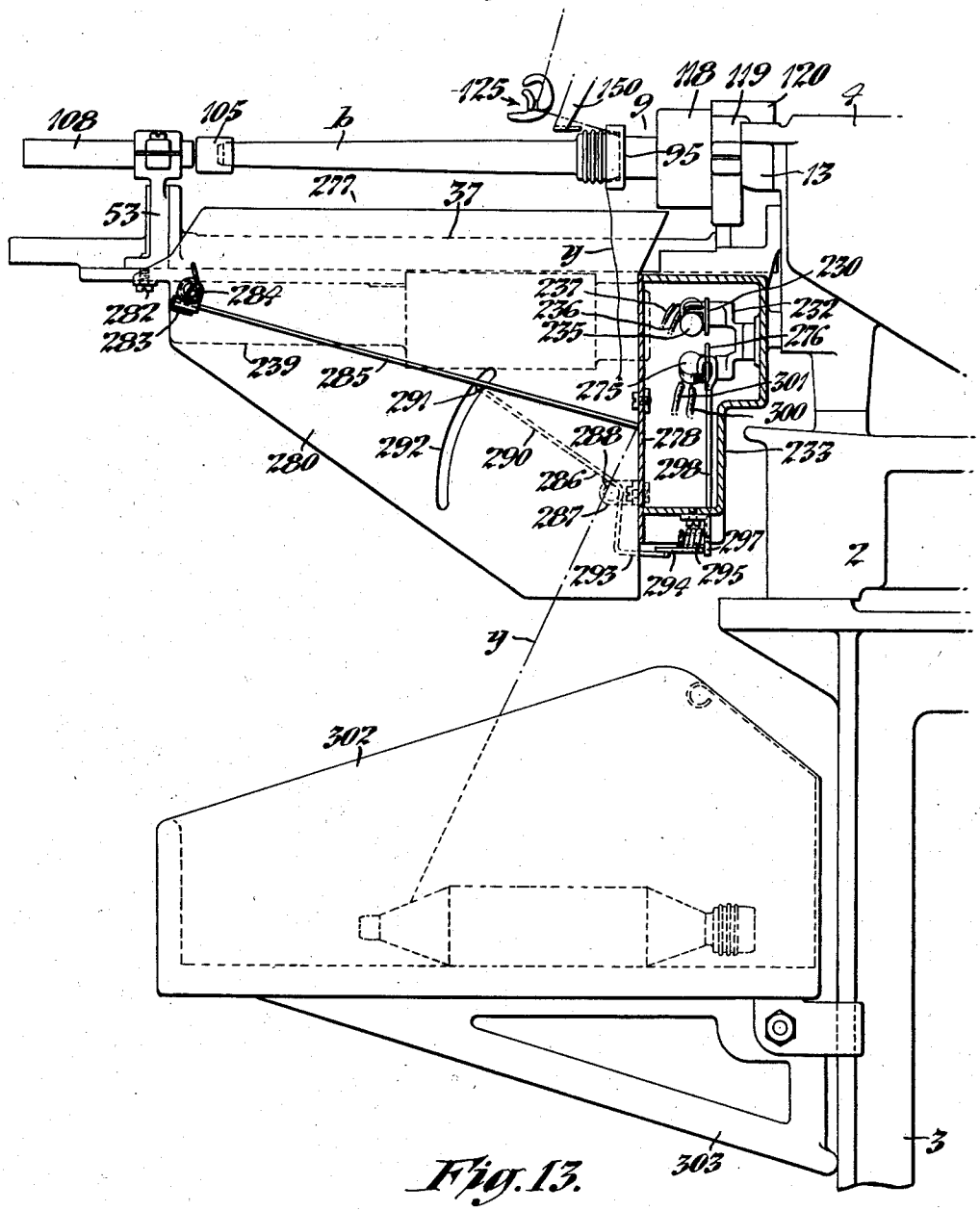

Fig. 13.

Inventors:
Charles D. Reynolds
Herman A. Mae
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 10

Fig. 14.

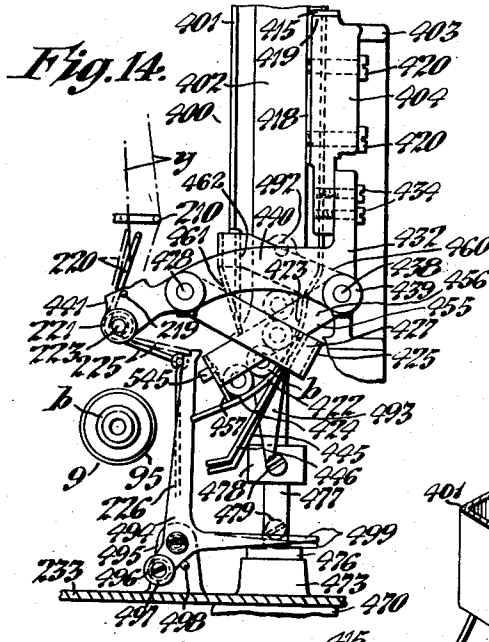
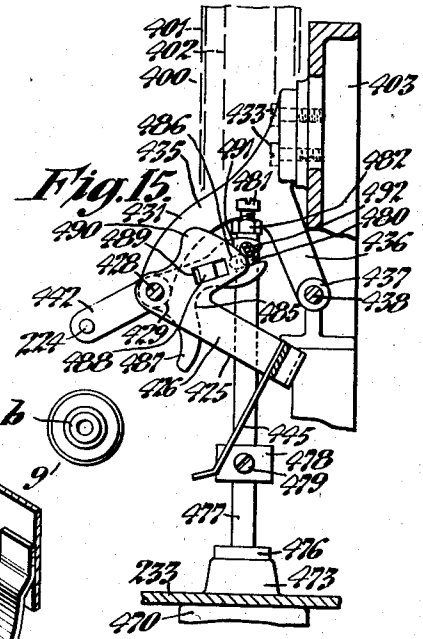


Fig. 15.



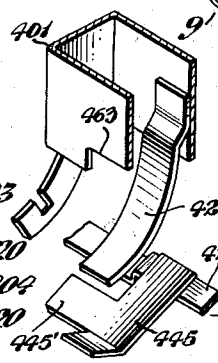


Fig. 18a.

Fig. 16.

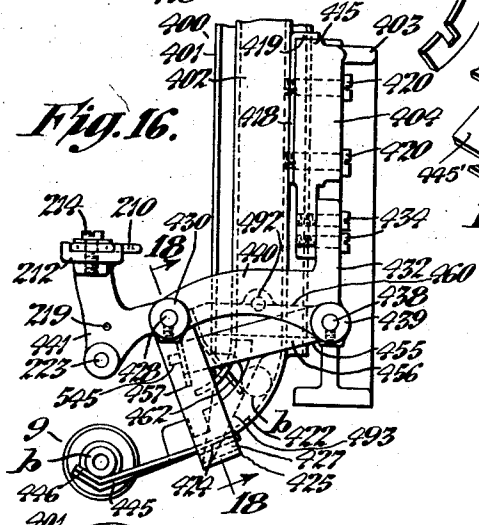


Fig. 17.

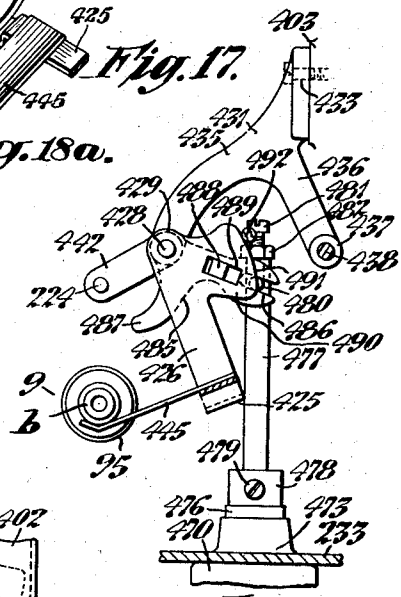
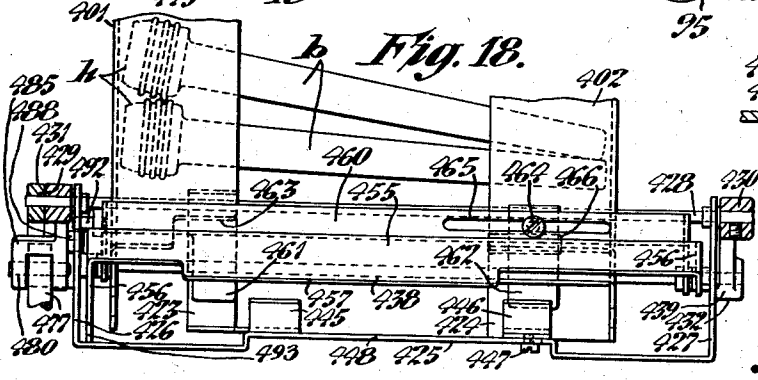


Fig. 18.



Inventors:
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 11

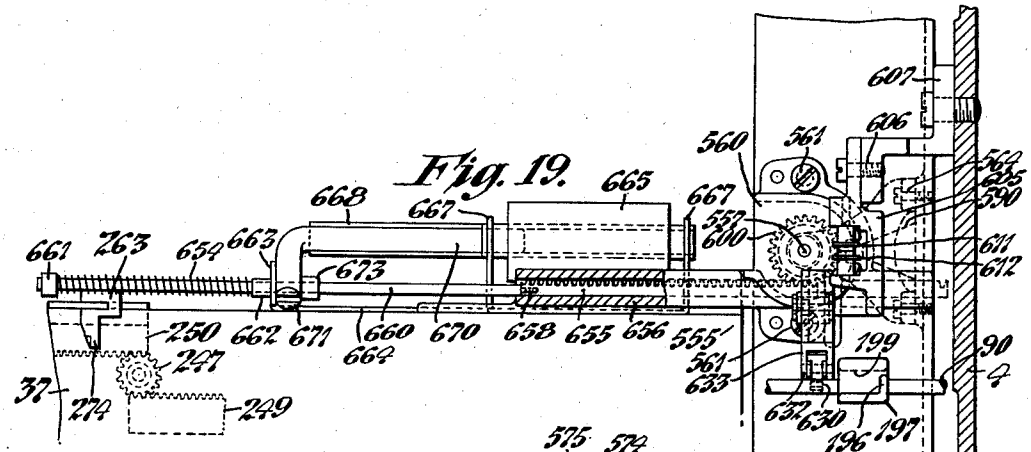
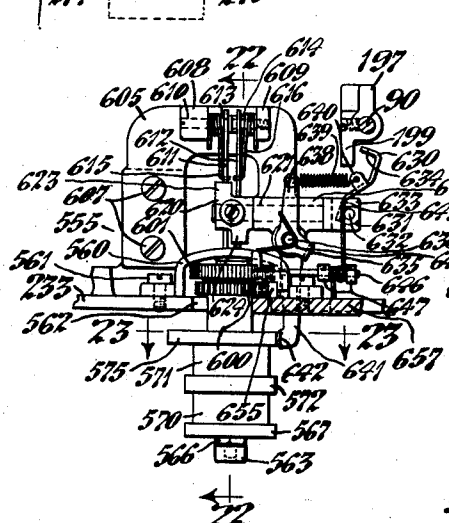


Fig. 19.



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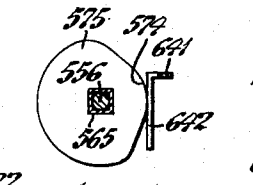

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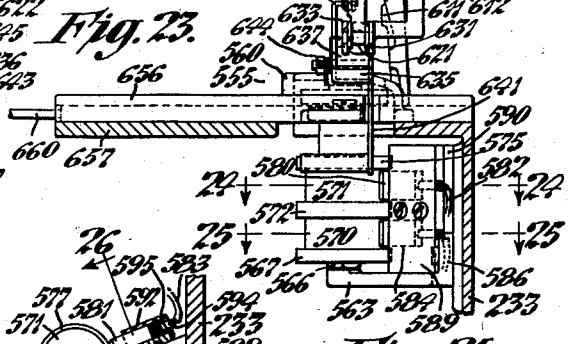
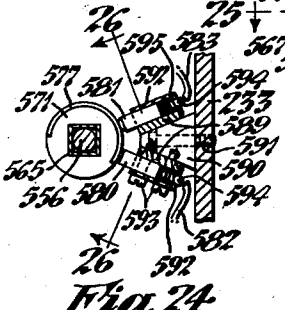


Fig. 21.



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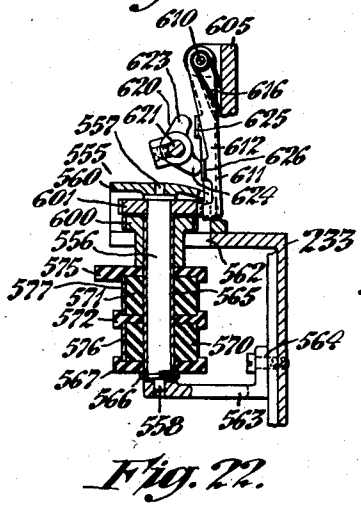

Fig. 22.

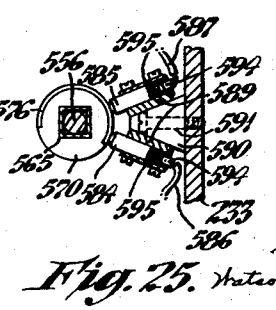

Fig. 25.

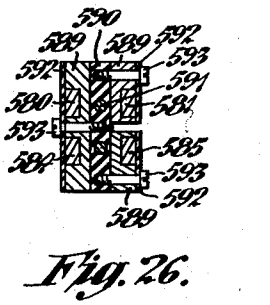

Fig. 26.

Inventors:
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Attorneys.

Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 12

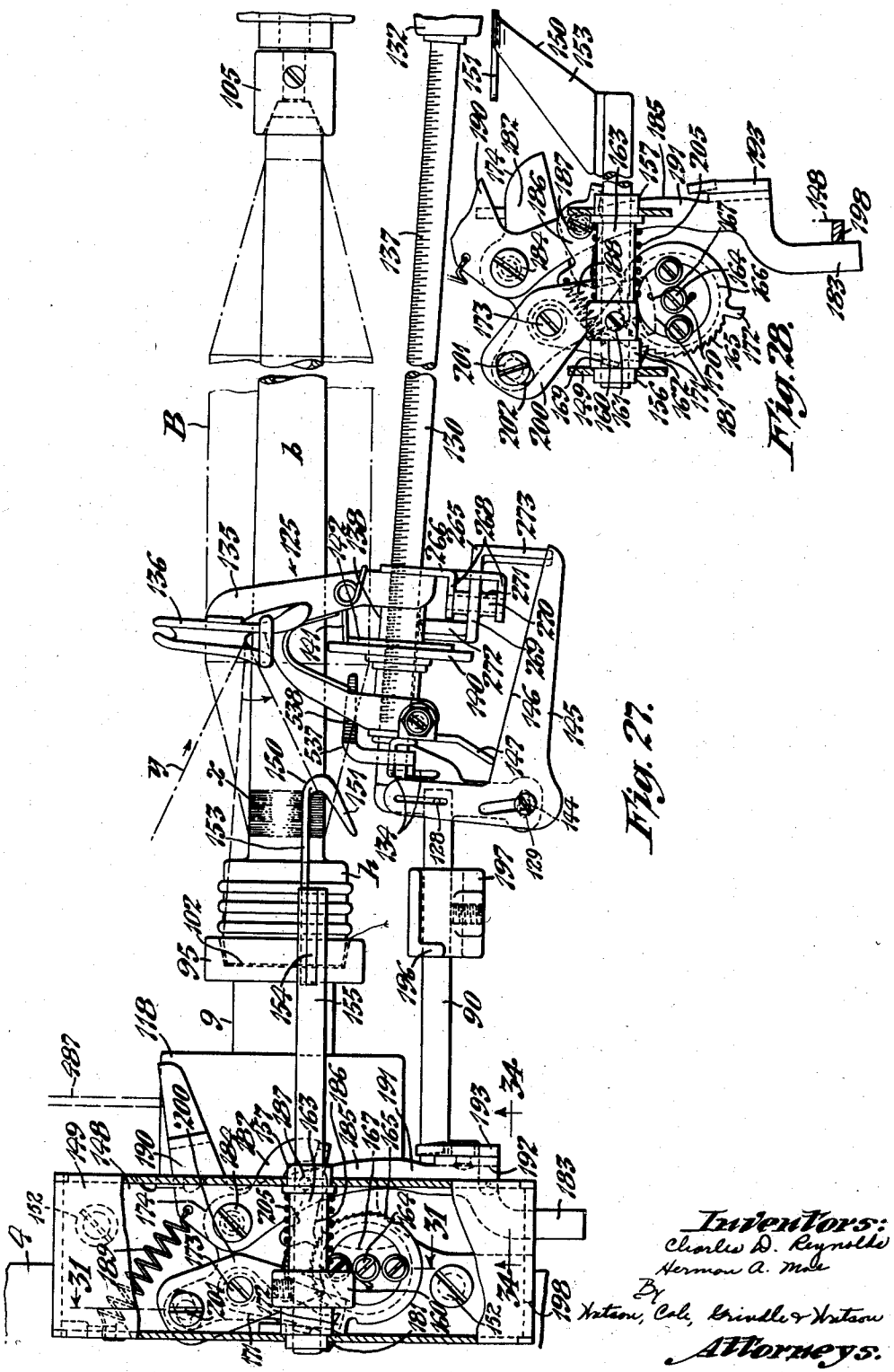

Fig. 27.

Fig. 28.

Inventors:
Charles D. Reynolds
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 13

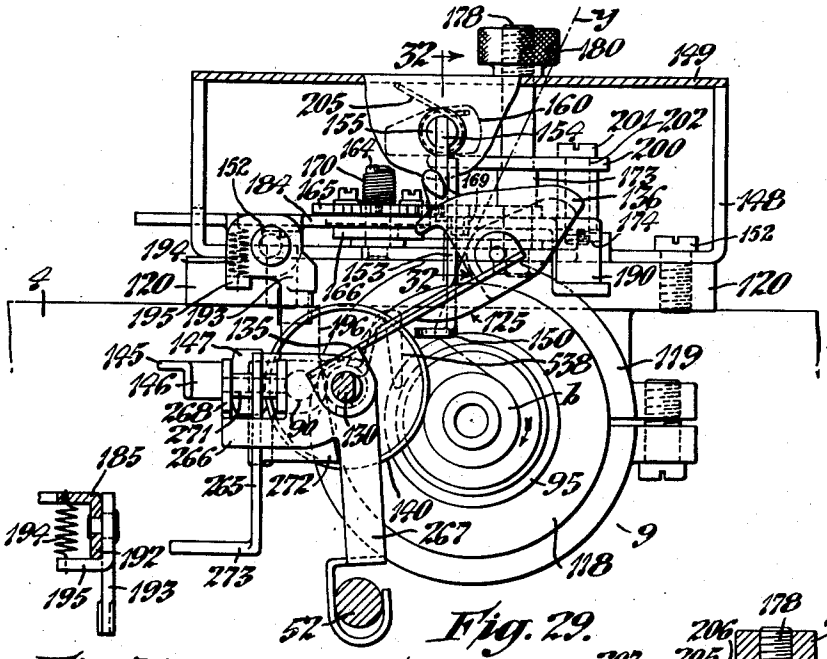

Fig. 29.

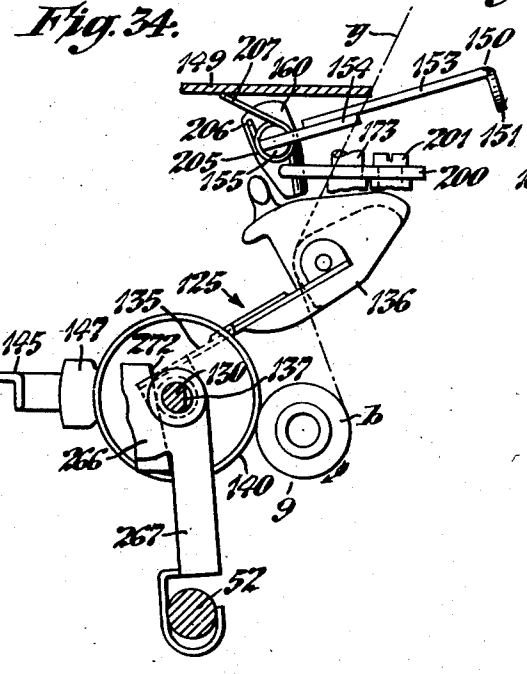

Fig. 30.

Fig. 34.

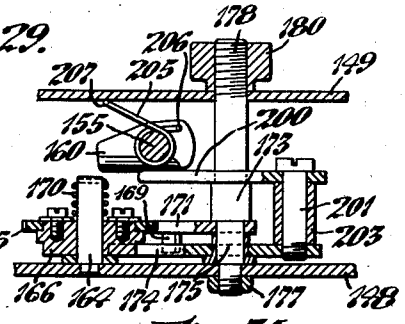

Fig. 31.

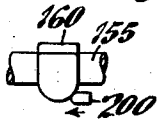

Fig. 32.

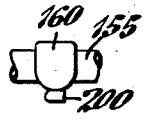

Fig. 33.

Inventors:
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 14

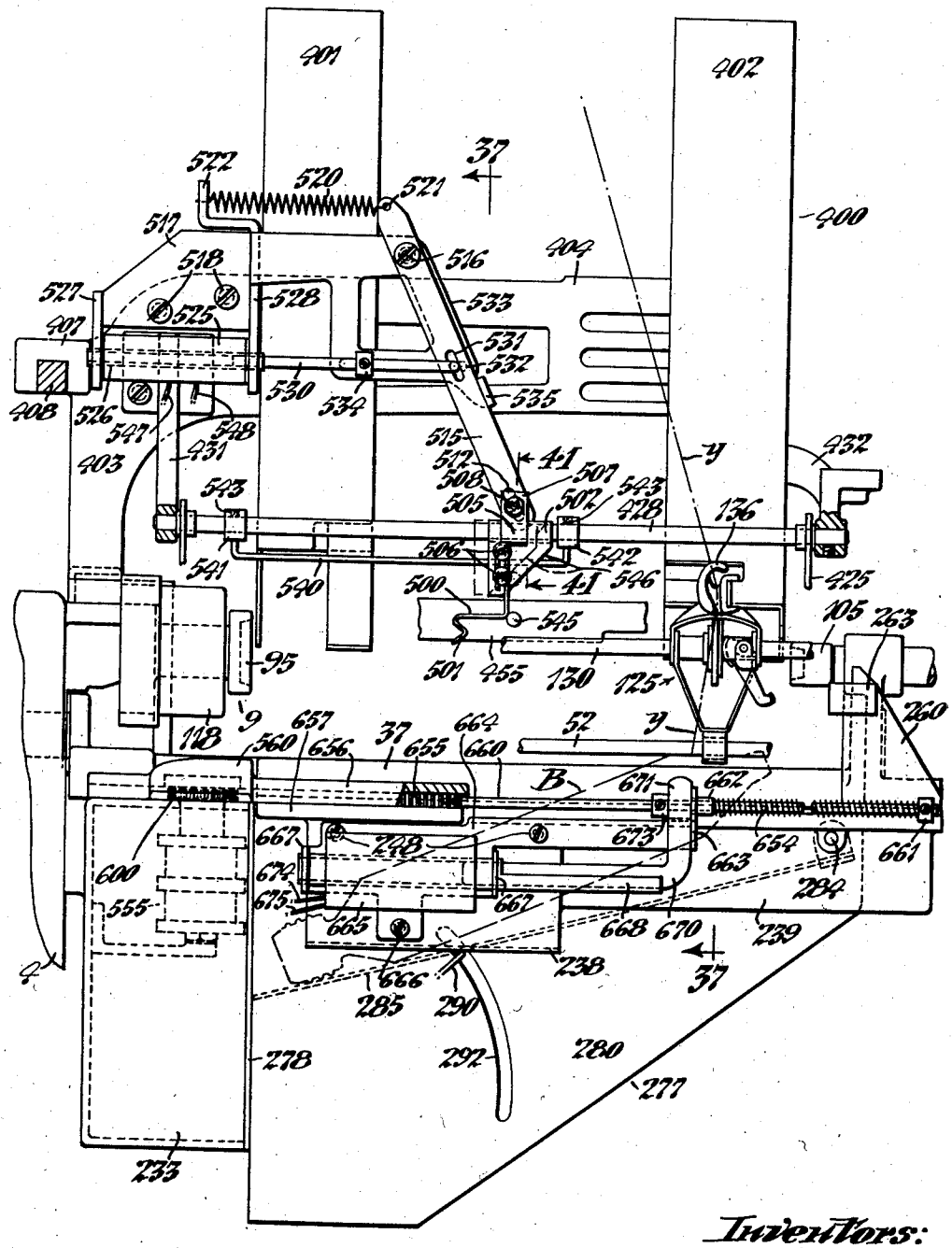

Fig. 35.

Inventors:
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Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 15

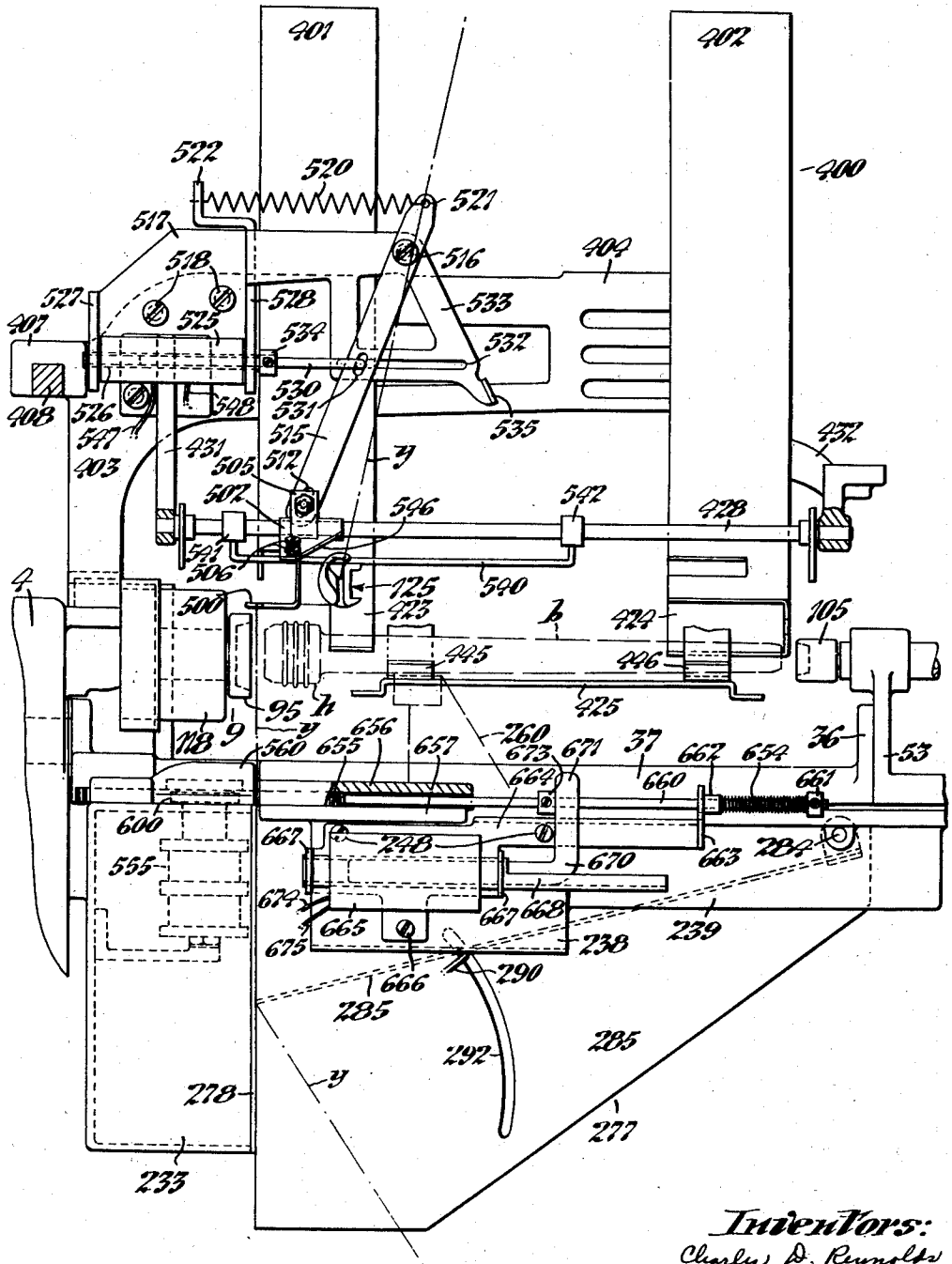

Fig. 36.

Inventors:
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Watson, Cole, Grindle & Watson
Attorneys.

Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 16

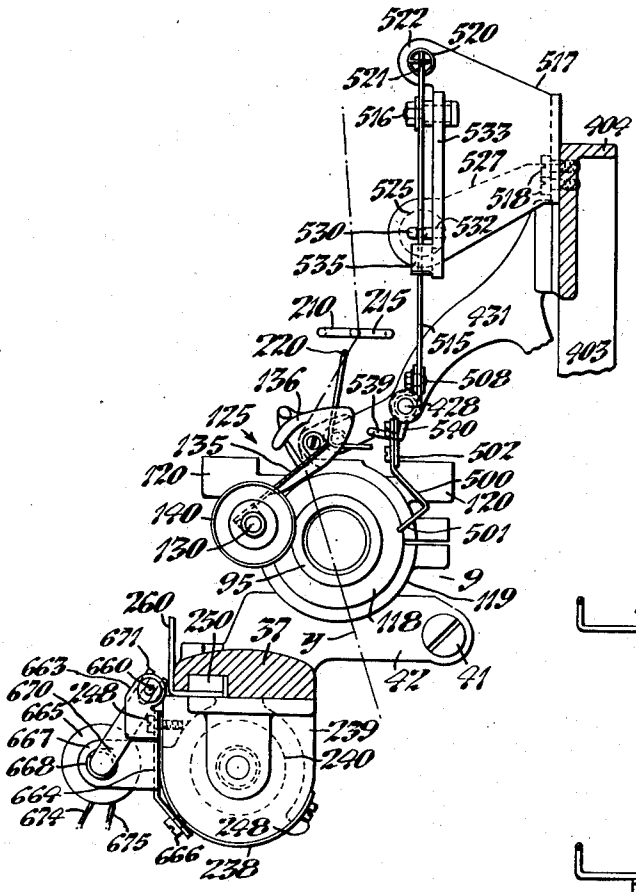

Fig. 37.

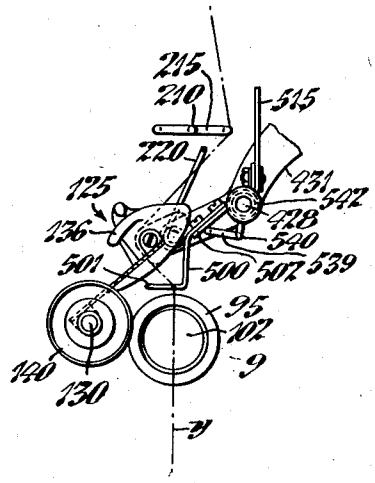

Fig. 38.

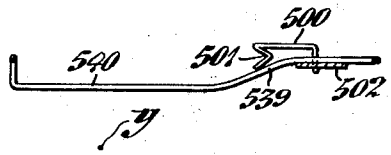

Fig. 39.

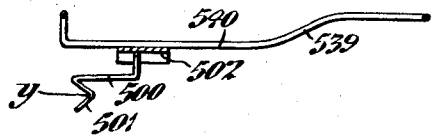

Fig. 40.

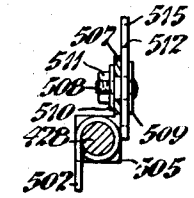

Fig. 41.

Inventors:
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Attorneys.

Sept. 30, 1941. C. D. REYNOLDS ET AL 2,257,651

WINDING MACHINE

Filed Sept. 21, 1938 17 Sheets-Sheet 17

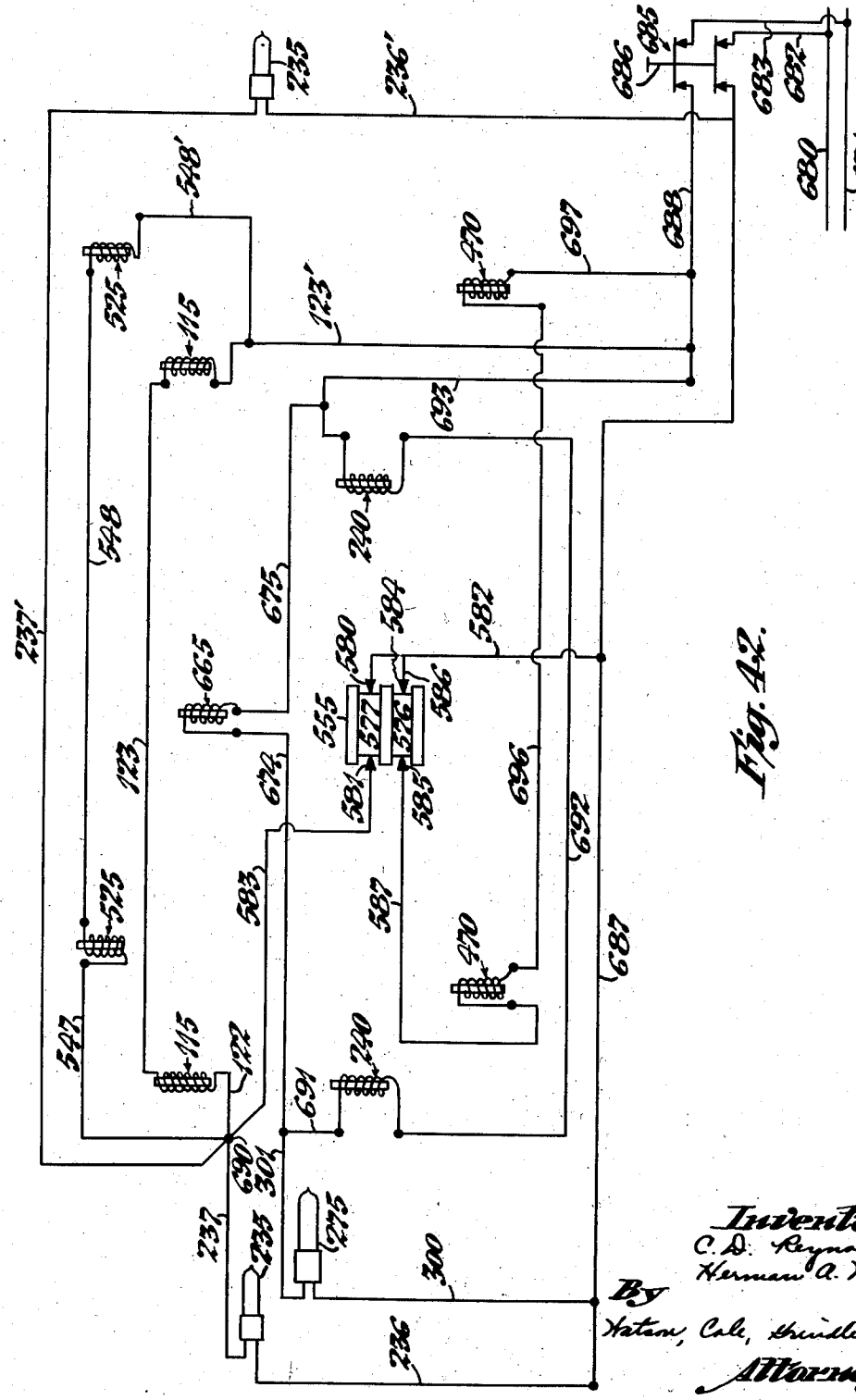

Fig. 42.

Inventor:
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Herman A. Moe
By
Watson, Cole, Grindle & Watson
Attorneys.

Patented Sept. 30, 1941 2,257,651

UNITED STATES PATENT OFFICE

2,257,651

WINDING MACHINE

Charles D. Reynolds and Herman A. Moe, Cranston, R. I., assignors to Universal Winding Company, Boston, Mass., a corporation of Massachusetts

Application September 21, 1938, Serial No. 231,044

60 Claims. (Cl. 242—32)

This invention relates to winding machines for winding cops, bobbins, pirns and other forms of textile packages, for example, bobbins of yarn to be used as filling or weft in the shuttles of looms.

In the present specification and claims the term "bobbin" or "wound yarn-carrier" is employed for convenience of description to apply to any usual form of textile package and the term "yarn" is intended to designate all types of strand materials.

A particular object of the invention is to provide a machine of the type indicated which is entirely automatic in operation, requiring no attention on the part of the operator during its normal operation except to replenish the supplies of yarn and fill the magazines with yarn-carriers or empty bobbins.

Another object of the invention is to provide a machine of the type indicated having automatically-operated means for doffing completed bobbins from the winding-spindles and replacing them with empty bobbins or yarn-carriers.

Another object of the invention is to provide a machine of the type indicated in which the bobbin-donning and -doffing mechanisms are electrically operated whereby to accelerate the operations and reduce the number of mechanical elements to a minimum.

Another object of the invention is to provide a machine of the type indicated in which the winding units are arranged in groups, preferably in pairs, with both units of each pair simultaneously starting and completing the winding of the bobbins.

Another object of the invention is to provide a machine of the type indicated in which both bobbins of each pair are doffed simultaneously from their respective spindles and replaced by fresh bobbins when either of the winding bobbins reaches a predetermined size.

Another object of the invention is to provide a machine of the type indicated having separate donning and doffing mechanisms for each spindle of the group with the operation of the individual mechanisms timed and controlled by an electrical device common to both.

Another object of the invention is to provide a machine of the type indicated having means adjacent each spindle of the group of winding units and adapted to be engaged and moved by the winding strand when the bobbin reaches a predetermined size to initiate the donning and doffing operations of the winding units of such group.

Another object of the invention is to provide a machine of the type indicated in which the donning and doffing mechanisms are actuated by electromagnetic means whereby to simplify the construction of the machine by eliminating mechanical elements liable to become deranged or to get out of order.

Another object of the invention is to provide a machine of the type indicated having improved driving mechanism capable of operating the winding units at a higher rate of speed than is possible with similar machines of previous types.

Another object of the invention is to provide a machine of the type indicated in which the spindle-drive and thread-guide reciprocating means are operated continuously during the winding, doffing and donning operations whereby to further increase the efficiency and output of the machine.

Another object of the invention is to provide a machine of the type indicated which is adjustable to adapt it for winding cops, bobbins, pirns and other forms of textile packages of various dimensions.

Further objects of the invention are set forth in the following specification which describes a preferred form of construction of the machine, by way of example, as illustrated by the accompanying drawings. In the drawings:

Fig. 1 is a plan view of a pair of correlated winding units showing the driving mechanism for the winding-spindles and thread-guide traversing means;

Fig. 2 is a part-sectional side elevation of the same showing the hopper or magazine for the yarn-carriers or empty bobbins and the chute for receiving the doffed wound bobbins;

Fig. 3 is a part-sectional front view of the pair of correlated winding units of a multi-spindle machine showing the position of the automatic donning and doffing mechanism during the winding operation;

Fig. 4 is an enlarged longitudinal sectional view through the bobbin-supporting and driving means showing the position assumed by the bobbin during the winding operation;

Fig. 5 is a similar view illustrating the manner in which the wound bobbin is doffed from the winding-spindle;

Fig. 6 is a plan view of the mechanism for returning the thread-guide to initial position after doffing a wound bobbin with the parts shown in inoperative position;

Fig. 7 is a similar view showing the upper portion of the enclosing casing removed to illustrate the position of the parts during the return of the thread-guide;

Fig. 8 is a longitudinal sectional view of the guide-returning mechanism shown in Figs. 6 and 7 taken in a vertical plane;

Fig. 9 is a transverse sectional view through the guide-returning mechanism taken on line 9—9 of Fig. 8;

Fig. 10 is a transverse sectional view taken on line 10—10 of Fig. 6 showing the solenoid for operating the guide-returning mechanism;

Fig. 11 is a partial front elevation of the pair of winding units showing the chutes through which the doffed bobbins fall and the means actuated by the passage of either of the wound bobbins therethrough for operating an electrical switch for closing the electrical circuit to the means for returning the thread-guides;

Fig. 12 is a side elevational view of the same illustrating the manner in which the passage of a full bobbin operates the circuit-closing means for the guide-returning means with the thread-guide shown in initial position;

Fig. 13 is a similar view showing the length of yarn from the doffed bobbin clamped in the chute and illustrating the manner in which the thread is broken between the clamping means and the fresh empty bobbin replacing the wound bobbin in winding position;

Fig. 14 is a front elevational view of the bobbin-magazine or hopper showing the means for transferring fresh bobbins from the magazine to the winding-spindle;

Fig. 15 is a similar view showing the means for operating the bobbin-transferring means which is illustrated in inoperative position;

Fig. 16 is a view similar to Fig. 14 showing the transferring mechanism in position to deliver a fresh bobbin to the winding-spindle;

Fig. 17 is a view similar to Fig. 15 illustrating the operating means in action;

Fig. 18 is a transverse sectional view taken on line 18—18 of Fig. 16 and illustrating the bobbin-transferring means in detail;

Fig. 18*a* is a perspective view showing the co-operative relationship of the runway from the magazine chute and the ramp-finger of the bobbin-feeding frame;

Fig. 19 is a part-sectional plan view of the timing device for synchronizing the operation of the bobbin-doffing and bobbin-delivering means;

Fig. 20 is a front elevation of the same;

Fig. 21 is a side elevation of the same;

Fig. 22 is a vertical sectional view taken on line 22—22 of Fig. 20;

Fig. 23 is a sectional plan view of the timing device shaft taken on line 23—23 of Fig. 20 and showing the cam for setting the device for actuation by the thread-guide traversing means;

Fig. 24 is a transverse sectional view of the timing device taken on line 24—24 of Fig. 21 and illustrating the cooperating contact-element and brushes for energizing the spindle-retracting means;

Fig. 25 is a similar view taken on line 25—25 of Fig. 21 and showing the cooperating contact-element and brushes for energizing the bobbin-delivery means;

Fig. 26 is a vertical sectional view taken on line 26—26 of Fig. 24 and illustrating the mountings for the contact-brushes in detail;

Fig. 27 is a further enlarged part-sectional plan view of the bunch-builder showing the parts thereof in operative position during the forming of the bunch or reserve winding;

Fig. 28 is a partial plan view of the operating mechanism of the bunch-builder showing the parts in inoperative position;

Fig. 29 is a front elevational view of the bunch-builder with the parts shown in the same position as in Fig. 27;

Fig. 30 is a partial front view of the same with the parts shown in the same position as in Fig. 28;

Fig. 31 is a transverse sectional view through the bunch-builder taken on line 31—31 of Fig. 27;

Fig. 32 is a detailed sectional view taken on line 32—32 of Fig. 29 and illustrating the manner of rotating the yarn-retaining means;

Fig. 33 is a view similar to Fig. 32 showing the yarn-retainer operating means rotated to the full extent;

Fig. 34 is a cross-sectional view through the main operating element of the bunch-builder taken on line 34—34 of Fig. 27;

Fig. 35 is a side elevational view of the donning and doffing mechanism viewed in the direction opposite to that of Fig. 2 and showing the timing device-resetting means and yarn-retrieving means in inoperative position;

Fig. 36 is a view similar to Fig. 35 showing the timing device-resetting means as having completed its action and the yarn-retriever as having been operated to carry the end of the yarn into position to be gripped between the spindle-cup and the fresh bobbin;

Fig. 37 is a transverse sectional view taken on line 37—37 of Fig. 35 showing the yarn-retriever in inoperative position;

Fig. 38 is a partial front elevational view showing the yarn-retriever in operative position;

Fig. 39 is a plan view of the means for tilting the yarn-retriever showing the latter in inoperative position;

Fig. 40 is a view similar to Fig. 39 showing the yarn-retriever in operative position;

Fig. 41 is a cross-sectional view of the yarn-retriever supporting means taken on line 41—41 of Fig. 35; and

Fig. 42 is a diagrammatic view showing the electrical circuits for energizing the individual operating means for the donning and doffing mechanisms.

The present improved winding machine comprises, in general, means for winding bobbins or the like, including bobbin-rotating means and yarn-traversing means, means actuated by the yarn or thread being wound when the bobbin reaches a predetermined length for initiating the doffing of the completed bobbin, means controlled by the released wound bobbin for returning the thread-guide to initial position, a magazine or hopper for containing a supply of empty bobbins, means operable after the thread-guide has reached its initial position for transferring a fresh bobbin from the magazine to winding position, means for rotatably gripping the fresh bobbin, means for severing the yarn leading from the previously wound bobbin, means for retrieving the yarn and clamping it to the fresh bobbin, means initially set by movement of the bobbin-transferring means and actuated by the yarn-traversing mechanism of the winding unit for winding a bunch on the bobbin, and means for releasing the yarn from the bunch-building means to cause the thread-guide to traverse it for the service winding.

More specifically, the present embodiment of the invention comprises a series of pairs of winding units arranged along a frame, each unit of the pairs consisting of a continuously rotated spindle-cup for receiving the butt end of the bobbin or yarn-carrier and a freely rotatable stub-spindle for supporting the tip end thereof. Continuously reciprocating traversing means actuate the thread-guides, one for each unit, with means for advancing the guides along the bobbins as the latter are wound. Means engaged by the yarn when either bobbin of the pair reaches a predetermined length operate to close an electrical circuit, common to both winding units, to energize means for shifting the spindle cups axially to release the bobbins and permit them to drop into chutes arranged below the winding-spindles. Means within the chutes are actuated by one or the other of the falling bobbins to close a second electrical circuit, also common to both winding units of the pair, the latter circuit serving to energize electromagnetic means for returning both thread-guides to initial position. An electrical time-control unit in the form of a spring-actuated rotary drum-switch controls the action of the electromagnetic means for operating the spindle-cups and the means for transferring fresh bobbins from the magazines or hoppers to the respective spindles. Through an escapement device actuated by the constantly reciprocating yarn-traversing means the spring-actuated drum-switch is permitted to rotate to again open the circuits. When the electromagnetic means for withdrawing the spindle-cups are deenergized the cups are caused to rotatively grip the fresh bobbins and thereafter the bobbin-transferring means are shifted into inoperative relationship. The yarns trailing from the thread-guides to the previously wound bobbins are gripped between the spindle-cups and the end of the bobbins and are also clamped at a point between the fresh bobbins and the previously-wound bobbins so that as the fresh bobbins are rotated the threads or yarns are severed. Means are provided for withholding the yarns from traversing movement with the reciprocating thread-guides at the start of the winding whereby to wind so-called bunches or reserve lengths of the yarn, the bunch-building means being set in initial position by the actuation of the bobbin-transferring means and caused to release the yarns by the operation of an escapement mechanism actuated by the yarn-traversing mechanism. In the following detailed description of the machine the various cooperating mechanisms are described under separate headings.

It is customary in winding machines now in use to employ a plurality of winding units arranged in gang form along either side of the machine frame. In the present machine the winding units are provided at both sides of the frame but are arranged in separate groups, in this instance, in pairs of units, with each unit of the pair embodying individual donning and doffing mechanisms with the mechanisms of both actuated simultaneously. Since the several pairs of winding units are identical in construction and arrangement only one pair is herein shown and described.

Winding units and drive therefor

Referring first to Figs. 1, 2 and 3 of the drawings, the winding units of the machine are carried by a horizontal bed 2, usually supported from the floor by legs or standards 3. Mounted upon the bed 2 are trough-like casings 4 in which the various driving elements are enclosed. Journaled in bearings in the opposite end walls of the casing 4 are two drive-shafts 5 and 6 which may be rotated by suitable means located at one end of the machine frame, but not herein shown. The shafts 5 and 6 drive the individual winding-spindles 9 and 10 which are journaled in bearings in the side walls of the casing 4 and project laterally therefrom. In the present drawings four spindles 9, 10, 11 and 12 are shown as journaled in the casing 4, one pair of spindles 9 and 10, projecting from the left-hand wall, as viewed in Fig. 1, and the spindles 11 and 12 of the opposite pair projecting from the opposite wall. Since all the spindles are of the same construction and arrangement only one pair (9, 10) will be herein described. The spindles 9 and 10 are journaled in bearing bosses 13 and 14 on the sides of the casing 4, the bearings being shown in detail in Figs. 2 and 4. An annularly-grooved enlarged head 15 at the forward end of each spindle forms a shoulder which abuts the recessed end of the bearing 13 and a collar 16 at the opposite end of the bearing abuts the side of an arm 17, formed as a part of a bracket 91 to be described later, to take the axial thrust of the spindle in opposite directions. The rearward end of each spindle is journaled in a bushing 18 in the boss 14 and the end of the boss is closed by means of a plug or cap 19.

The drive-shaft 6 carries a series of helical gears 20 which mesh with smaller similar gears 21 freely rotatable on the spindles 9 and 10, see Fig. 2. The gears 21 are held against axial movement in one direction by collars 24 secured to the spindles and against movement in the opposite direction by sleeves 25, also secured to the spindle. Keyed to each sleeve 25 and arranged for axial sliding movement thereon is a clutch-member 26 having a tapered periphery adapted to engage with a similarly-shaped interior face on the gear 21. The clutch-member 26 is normally urged forward into frictional engagement with the gear 21 by means of a helical spring 27 surrounding the sleeve 25 with one end bearing against the side of the clutch-member 26 and its opposite end bearing against an abutment 28 at the end of the sleeve.

The clutch-member 26 may be shifted manually to release it from engagement with the gear 21 by means of a curved finger 30, see Fig. 2, having its side formed with an inclined edge, shown in Fig. 1, engageable with the side of a substantially V-shaped annular groove 31 in the clutch-member. The finger 30 is formed integral with a rockable member 32, shown most clearly in Fig. 2, having its rearward end journaled on a stud 33 in the side wall of the casing 4. The forward end of the member 32 is joined to a horizontal rod 34 by means of a coupling 35 shown in detail in Fig. 8. The forward or outer end of the rod 34 extends through a bearing in the upright arm 36 of a bracket 37, to be described later, and is bent at right-angles to form a handle 38 for rocking the clutch-control member 32. The bracket 37 is attached to the casing 4 by means of a nut 39 screwed onto the threaded extremity of a tubular boss 40 projecting through a hole in the side of the casing and set up against a washer on the inner side thereof. A bolt 41 passing through a hole in a lateral arm 42 of the bracket 37 and screwed into the side of the casing 4, see Figs. 6, 7, 8 and 10, holds the bracket from turning.

Referring to Figs. 7 and 8, the coupling 35 joining the member 32 and rod 34 consists in a lever 43 having a hub 44 in which the end of the rod is held and a coaxial extension 45 which passes through the bore of the boss 40 on the bracket 37 and is received in a bore in the end of the member 32. A set-screw 46 in the hub 44 binds the rod 34 thereto and a stud 47 passing through the end of the member 32 and the extension 45 of the lever 43 secures the parts together for rocking movement as a unit. A laterally-extending arm 49 on the lever 43 carries a hardened block 50 which, when the lever is rocked in a counterclockwise direction as viewed in Fig. 10, engages with the under side of a shoulder 51 formed at the upper end of a spring-pressed detent-arm or latch 55. The latch 55 is pivotally mounted on a pin 56 extending horizontally across a slot 57 in the bracket 37. The latch 55 may be released manually from engagement with the arm 49 by means of a push-rod 52 slidable in an outboard bearing 53 carried at the forward end of the bracket 37 and in a bearing at the inner end of the bracket. The push-rod 52 may be manually actuated by a suitable finger-piece such as that shown adjacent its left-hand end in Fig. 8 and the push-rod carries an arm 54 at its inner end which engages with the latch 55, see Fig. 10. When the detent-arm or latch 55 is released from the arm 49 a spring 58, shown in Fig. 7, anchored at one end to a stationary part within the casing 4 and attached to a lateral arm 59 on the member 32, tilts the latter to cause its finger 30 to pry the clutch-member 26 away from the gear 21 to arrest the rotation of the spindle 9 or 10, as the case may be.

Rotatable on the spindle 9 is a sleeve 60 which is held in place axially by collars 61 and 62 secured to the spindle and abutting the opposite ends of the sleeve. A helical gear 63 rotatably carried by the sleeve 60 meshes with a helical gear 64 on the drive-shaft 5 from which it is driven. The gear 63 abuts a shoulder 65 on the sleeve 60 and a collar 66 fast on the sleeve abuts the opposite side of the gear to take the axial thrust thereof. A clutch-member or annulus 68 slidably mounted on the sleeve 60 has a tapered periphery normally held in engagement with a similarly-shaped interior face of the gear 63 by a helical spring 69. The spring 69 is pocketed in the counterbore of a traverse-cam 70 and a similar counterbore in the side of the member 68. The clutch-member 68 has a lug or key 71 projecting from its rearward face which engages a slot or keyway 72 in the end of the cam 70 to key the two parts together rotatively. The traverse-cam 70 is held fast on the sleeve 60 by means of a set-screw 74 and is provided with a helical groove 75 in its periphery. A curved finger 76, similar to the clutch-finger 30 previously described, projects upwardly from the clutch-operating member 32 and is provided with an inclined edge engageable with the inclined side of a substantially V-shaped peripheral groove 77 in the clutch-member 68.

Rockably mounted in spaced bearings 80 rising from the bottom of the casing 4 is a rock-shaft 81 carrying arcuate bifurcated levers 82, one for each winding unit. The upper end of each lever 82 carries a stud 83 upon which is rotatably mounted a roller or other follower 84 engaging in the helical groove 75 of the traverse-cam 70. The lever 82 is provided with a series of holes 85 for receiving a pin 86, to which is connected one end of a link 87. The opposite end of the link 87 carries a pin 88 which enters a hole in a traverse-rod 90 slidably mounted in a bracket 91. The bracket 91 has an end portion passing through a hole in the front of the casing 4 and is further held by the arm 17, previously described, which surrounds the spindle 10.

Bobbin gripping and driving means

In the present embodiment of the invention the machine is equipped to wind on wooden yarn-carriers, commonly termed "bobbins," but in other cases it may be adapted for winding packages on other forms of cores such as paper or fiber tubes, quills and the like. As herein shown, the wooden bobbin *b* is held and gripped rotatively to the winding-spindle between cup-like elements engaging its opposite ends. The inner support and driver for the bobbin *b* may be in the form of a cup-member 95 formed with a recess adapted to fit closely around the end of the enlarged butt or head *h* of the bobbin. The cup 95 is attached to a cylindrical sleeve 96 which is slidable axially on the end of the extension or head 15 formed on the forward end of the spindle 10, see Figs. 4 and 5. Preferably, the cup 95 is attached to the sleeve 96 by being screw-threaded thereon whereof to permit its convenient removal for substitution of cups of different shapes and sizes to fit various forms of bobbins. The sleeve 96 carrying the cup 95 is keyed rotatively with the head 15 by means of a key 97 and spline 98, shown in Figs. 4 and 5, to effect a driving connection between the spindle 10 and cup. Projecting axially at the rear of the forward closed end of the sleeve 96 is a plunger-pin 99 which is slidable in a bore 100 in the forward end of the spindle 10. A helical spring 101 is pocketed in the bore 100 in the end of the spindle 10, being arranged to project the cup 95 forwardly to hold it in engagement with the end of the bobbin *b*. Positioned against the inner face of the cup-member 95 is a traction-disk 102 constructed of leather or other resilient material which forms a friction driving surface for engaging the end of the head *h* of the bobbin. The tip end of the bobbin *b* is adapted to be received in a recess in the end of a collar or cup-member 105 which is secured fast on the reduced end of a stub-spindle 106. The larger end of the spindle 106 is journaled on rollers in a bushing 107 held in a tubular bearing 108 which is supported in a hub 109 formed at the upper end of the outboard bearing 53, shown in Figs. 4 and 8 and referred to previously. The stub-spindle 106 has an enlarged head 111 with a rounded or beveled end which bears against a hardened block 112 fast in the tubular bearing 108 to take the end thrust of the bobbin.

In accordance with the present invention the driver-cup 95 is retracted axially to release the carrier *b* for doffing a wound bobbin, indicated by dash-lines in Figs. 4 and 5, by electromagnetic means comprising a solenoid 115. The windings of the solenoid 115 are supported on a cylindrical core 116 within which an enlarged head 117 on the end of the sleeve 96 is adapted to slide. A casing 118 surrounds the solenoid windings with its annular end portion projecting inwardly beyond the bore of the core 116 to provide an abutment adapted to be engaged by the shoulder of the head 117 on the sleeve 96 to limit the forward movement of the sleeve and cup 95 under the action of the spring 101. The solenoid 115 is supported in axial relation to the spindle 10 by means of a bracket or mounting

119 in the form of a split annulus, see Fig. 3, having offset legs 120 screwed to a ledge 13 at the top of the casing 4 as shown in Fig. 1. The solenoid 115 is energized to retract the cup 95 in the manner indicated in Fig. 5 by the closing of an electrical circuit including the wires 122 and 123.

Yarn-traversing means

The means for traversing the yarn longitudinally of the bobbin *b* to wind it in advancing courses thereon comprises a thread-guide 125 of conventional form which is reciprocated from the traverse-rod 90, previously referred to and shown most clearly in Figs. 1, 3, 27 and 29. In accordance with the usual practice the traverse-rod 90 is constructed in two sections, the main section being mounted to slide in a bearing in the quill-like bracket 91, previously referred to, which is fastened in position within the casing 4 by means of its tubular portion 126 inserted through a hole in the side of the casing with a plug 127 forced into its outer end abutting the side of a recess in the casing. Connected to the outer end of the main section 90 of the traverse-rod is a second section 130 arranged to aline with or swing laterally with respect to the main rod. The outer end of the rod-section 130 is supported to slide in a sleeve 131 swiveled to an outboard bearing 132 at the upper end of an arm 133 fastened to the side of the bracket 53, see Figs. 3 and 8, this type of mounting for the traverse-rod being of well-known construction. The inner end of the section 130 of the traverse-rod is linked to the main section 90 with a pin-and-slot connection indicated generally at 134 in Fig. 27. Through this arrangement and method of mounting the parts of the traverse-rod its outer section 130 is adapted to be inclined at an angle to its main portion for a purpose as will appear later.

The outer section 130 of the traverse-rod carries the thread-guide 125 which may be of usual construction comprising a bifurcated arm 135 having its legs pivoted on the rod. The arm 135 carries a grooved element or guide proper indicated at 136 which is adapted to bear against the bobbin being wound and to swing away from the axis thereof as it is traversed up and down the inclined courses of the winding due to the pivotal connection of the arm 135 with the rod-section 130. One side of the traverse-rod section 130 is screw-threaded as shown at 137 in Fig. 27 and a sleeve-like nut 138 mounted between the two legs of the arm 135 is interiorly threaded to engage the partial threads on the rod, see Fig. 30. The nut 138 carries a disk-like contact-wheel 140 whose periphery is adapted to engage with the courses of yarn deposited on the bobbin *b* to cause the wheel and nut to be turned at intervals to advance the thread-guide 125 outwardly along the traverse-rod. The nut 138 is normally held in engagement with the threads of the rod-section 130 by means of a spring-arm 141 engaging the periphery of a flange 142 at the side of the contact-wheel 140. Through this form of construction, which is common in the art, the contact-wheel 140 may be shifted against the action of the spring-arm 141 to release its threads from the rod-section 130 whereby the thread-guide 125 may be slid back into initial position after it has been fed outwardly along the traverse-rod during the winding of the bobbin B.

At the start of winding a bobbin the inner jointed end of the traverse-rod section 130 is pressed toward the axis of the bobbin *b* by means of a former 145 of usual construction. The former 145 is similar to that illustrated and described in United States Letters Patent No. 1,027,277 to F. S. Rand, issued May 21, 1912, and consists in an elbow-shaped arm attached to the end of the main portion of the traverse-rod 90 by means of pin-and-slot connections 128 and 129 and a screw 144, see Fig. 27, to provide for adjusting the angular position of the former to regulate the shape of the bobbin. The former 145 has an inclined cam-face or guiding edge 146 which is engaged by the end of a finger 147 projecting outwardly from one leg of the thread-guide arm 135. As the thread-guide is slid toward the inner end of the rod 130 the finger 147 will ride along the inclined edge 146 of the former 145 to force the end of the rod inwardly, as indicated in Fig. 27, whereof to position the periphery of the contact-wheel 140 adjacent the surface of the bobbin *b* on which the winding is to be performed. As the winding proceeds and the courses of yarn are built up in overlying layers the contact-wheel 140 is forced outwardly away from the axis of the bobbin with the finger 147 riding along the inclined edge 146 of the former 145 until, eventually, the two sections of the traverse-rod are brought into axial alinement; whereafter the contact-wheel will be in position to engage with the periphery of the winding bobbin B at its outside diameter.

Bunch-building device

Bobbins which are used in automatic looms require a "bunch" consisting of a relatively short length of reserve yarn wound at the base of the yarn-carrier before the service winding is commenced. It is therefore usual in bobbin winding machines to provide a device termed a "bunch-builder" which restrains the yarn from being traversed except to a slight extent at the start of winding of a bobbin and after a predetermined length of yarn is wound into a bunch releases the yarn to permit it to be traversed for the service winding. The present improved machine incorporates a bunch-building device which, besides being automatically actuated to release the yarn, is also provided with novel means for automatically catching the yarn to hold it from being traversed by the thread-guide during the initial stage of the winding after a yarn-carrier or empty bobbin has been placed in winding position.

Referring to Figs. 27 to 34, inclusive, the present bunch-building device is of a construction generally similar to that shown in United States Letters Patent No. 1,809,217 to J. M. Quill, issued June 9, 1931, and comprises a box-like casing 148 in which is enclosed a ratchet-escapement and operating mechanism for a yarn-retaining member 150. The casing 148 is fastened to the top of the legs 120 of the bracket or mounting 119 by means of screws 152, see Figs. 27 and 29. The yarn-retaining member 150 is in the form of a laterally extending hook formed at the lower end of a plate-like shank portion 153 and terminating in an arcuate blade or prong 151 as shown most clearly in Figs. 27, 28 and 30. The shank portion 153 of the hook is fastened to a plate 154 held in a slot at the end of a rockable rod or shaft 155. The shaft 155 is journaled in bearings 156 and 157 at the sides of a cover 149 on the casing 148. Between the bearings 156 and 157 is a cam-member 160 secured to the

shaft 155 by a set-screw 161. The cam 160 abuts the side of an enlarged boss 162 formed as a part of the bearing 156 and a spacer sleeve 163 between the cam and the opposite bearing 157 holds the shaft 155 from axial movement in its bearings. Referring to Figs. 30 to 33, inclusive, the cam 160 is in the form of a block having its portion below the shaft 155 tapered and rounded at one side to adapt it to be engaged with a lever, to be described later, which rides against its rounded face to rock the shaft 155 to swing the yarn-retainer or hook 150 into position to catch and hold the yarn leading from the thread-guide to the bobbin being wound.

Journaled on a stud 164 is a toothed ratchet-wheel 165 secured rotatively with a cam-disk 166 which has a recess 167 with an arcuate boundary cut into its side as indicated in dotted lines in Figs. 27 and 28. A spring 170 coiled around the stud 164 has one end anchored to the upper end thereof with its opposite end fastened in a hole in the cam-disk 166, the tension of the spring tending to rotate the ratchet-wheel 165 and cam-disk 166 in a clockwise direction as viewed in Figs. 27 and 28. Normally, rotation of the ratchet-wheel 165 and cam 166 is prevented by means of a holding pawl 171 engaging with the teeth of the ratchet. The ratchet-teeth extend throughout only substantially half of the circumference of the ratchet-wheel 165 and a stop-finger 172 projects radially at one end of the series of teeth in position to be engaged by the end of the holding pawl 171 to limit the rotation of the ratchet-wheel under the action of the spring 170. The holding pawl 171 is pivoted on a stud 173 which also forms the pivot for an escapement lever 174. The escapement lever 174 is pivoted on the reduced lower portion 175 of the stud 173 which has its further reduced terminal portion inserted through a hole in the bottom of a casing 148 and secured in place by a nut 177, see Fig. 31. The upper reduced portion 178 of the stud 173 extends through an opening in the cover or closure 149 overlying the top of the casing 148 with a thumb-nut 180 screwed onto its end to hold the cover in place.

The escapement lever 174 is formed with a toe-portion 181 adapted to normally ride on the periphery of the cam-disk 166, see Fig. 31, the end of the toe being of arcuate shape to adapt it to slide through the recess 167 in the periphery of the cam 166 when the slot is turned into register therewith as indicated in Fig. 28 of the drawings. Projecting from one side of the escapement lever 174 is an arm 182, to which is pivoted by means of a screw 184 an actuating lever 185 for the ratchet-wheel 165. The actuating lever 185 carries a pawl 186 pivoted thereto at 187 and having a sharpened toe at its end adapted to engage the teeth of the ratchet-wheel 165, as indicated in Fig. 27. The pawls 171 and 186 are connected by a helical spring 188, shown in Fig. 28, which normally maintains them in position to engage the teeth of the ratchet-wheel 165. It will be noted that the end of the curved arm 182 is adapted to engage the offset end of the tail of the pawl 186 to release its toe from the teeth on the ratchet-wheel 165 in resetting the bunch-builder in the manner as explained later. The holding pawl 171 has a downwardly-projecting finger 169 adapted to be engaged by the side of the escapement lever 174 during resetting of the bunch-builder. A helical spring 189 anchored to a lug at the side of the casing 148 has its opposite end hooked into a hole in an arm 190 of the actuating lever 185, thus tending to rock the latter in a contraclockwise direction. The arm 190 of the actuating lever 185 projects outwardly through an opening in the side of the cover 149 and is offset downwardly and forwardly to locate its end in position to be engaged by an element, to be described later, which functions to reset the bunch-builder at the commencement of winding a bobbin.

The main arm 191 of the actuating lever 185 is of arcuate form extending through an opening at one side of the cover 149 in position to be engaged by means on the traverse-rod 90 to rock the lever to cause the pawl 186 to turn the ratchet-wheel 165 intermittently. At one side of the arm 191 of the actuating lever 185 is a downwardly-offset finger 192 having a stud riveted thereto which serves as a pivot for a contact-member 193, see Figs. 29 and 34. A helical spring 194 anchored at its upper end to the lever 185 has its opposite end connected to an offset ear 195 on the contact-member 193 tending to yieldingly maintain the latter in the position shown in Fig. 34. The contact-member 193 is adapted to be engaged by an upstanding abutment or bunter 196 formed as part of a collar 197 secured to the traverse-rod 90, see Figs. 27 and 29. As the traverse-rod 90 is reciprocated the actuating lever 185 is rocked by the bunter 196 to advance the ratchet-wheel 165 with a step-by-step motion. When the bunch-building device is set by moving the contact-member 193 into position to be engaged by the reciprocating bunter 196 the latter may be at its rearmost position, in which case the contact-member pivots against the action of the spring 194 until the bunter moves forwardly, the contact-member 193 thereafter being rocked by the spring to its normal position to be engaged by the bunter during its next rearward stroke. It will be noted by reference to Fig. 27 that the forward offset end 183 of the operating lever 185 projects through a slot 198 in the end of the casing 148 and engages the end thereof to limit its rocking movement under the action of the spring 189, see also Fig. 28.

After a predetermined number of reciprocations of the traverse-rod 90 the ratchet-wheel 165 is turned to a position in which the recess 167 in the cam 166 registers with the end of the toe 181 of the escapement lever 174 to release the latter. The spring 189 then acts to swing the escapement lever in a contraclockwise direction. Secured to the upper side of the escapement lever 174 is a member or plate 200, the narrowed end of which normally engages the side of the cam 160 in the manner shown in Figs. 29, 31 and 33, these views illustrating the cam 160 in position during the winding of the bunch at the start of the bobbin. The shaft 155 is then held in such angular relationship by the cam 160 that the yarn-retaining member 150 projects downwardly in position for its hook or prong 151 to engage the length of yarn between the thread-guide 125 and the bobbin to prevent it from being traversed by the guide, see also Fig. 27. The member 200 is pivoted on the upper reduced portion of the stud 173, see Fig. 31, to permit it to be adjusted in angular relationship with respect to the escapement lever 174. To secure the member 200 in adjusted position on the escapement lever 174, a screw 201 passes through a slot 202 extending laterally of the rearward end of said member and projects through a hub or spacer sleeve 203 with its end threaded into a hole in the tail-end of the escapement lever, see Fig. 31.

When the escapement lever 174 is released and rocked on its pivot stud 173 the member 200 will be moved with it to displace its narrowed end from under the side of the cam 160. A helical spring 205 coiled around the sleeve 163 with one end attached to the cam at 206 and its opposite leg 207 bearing against the under side of the cover 149 of the casing 148 acts to rock the cam 160 and rotate the shaft 155 to the position shown in Fig. 30. This partial rotation of the shaft 155 rocks the yarn-retaining member 150 upwardly to release its hook 151 from the yarn *y* after the completion of the bunch winding. The bunch-building device is reset after the completion of each bobbin by means to be described later.

Doffing control-means

The completed bobbin B is doffed by withdrawing the cup 95 from engagement with the head *h* of the yarn-carrier *b* under the control of means actuated by the winding yarn. Referring to Figs. 1, 2 and 3 of the drawings, the yarn *y* is usually supplied from a cone or other type of package arranged above the machine, but not shown herein; or it may deliver from any suitable source with the strand leading downwardly from above. Before entering the thread-guide 125 the strand leads across a fixed bail 210 consisting of a wire rod supported at a distance above the thread-guide. The rod 210 is bent into a loop 211 at one end with its bifurcations held in a recessed mounting 212 and clamped thereto to adapt it to be longitudinally adjusted by means of an overlying clamping plate 213 and screw 214. The mounting 212 for the bail 210 forms a part of a bracket to be described later as supported from the magazine of the donning mechanism. Inwardly beyond its mounting the rod or bail 210 is offset at an angle and then continued in the same plane in parallel relation to the axis of the winding-spindle 10. The angularly offset portion 215 of the bail 210 serves as a track or guide to permit displacement of the feeding yarn inwardly towards the bobbin *b* after the latter has been wound to a predetermined length whereby to cause the yarn to engage a movable thread-bail 220 connected to actuate a switch in the electrical circuit of the solenoid 115 which functions to retract the bobbin-driver or cup 95. By releasing the clamping plate 213, see Fig. 1, the fixed thread-bail 210 may be moved longitudinally to adjust the position of its offset portion 215 whereby to wind bobbins of different lengths.

The bail 220 is comprised of a length of wire extending in parallel relation to and beneath the fixed bail 210 with its ends bent at right-angles to form legs terminating in helical coils 221 and 222, see Fig. 1, which form bearings for pivotally mounting the bail. The bearings 221 and 222 are supported on pins 223 and 224 which project from portions of brackets to be described later as mounted on the bobbin magazine. The coil 222 at the inner end of the bail 220 is extended in an arm 225 which is bent laterally to engage in an eye or hook at the upper end of a depending link 226, see Fig. 3. The lower end of the link 226 is hooked to a rockable switch-actuating member 230 pivoted on a stud 231 projecting from a bracket 232 fastened to a casing 233, to be described later. The casing 233 encloses certain of the electrical connections for the machine. The switch-actuating member 230 may consist of a sheet-metal plate provided with fingers 234 projecting from its forward face and shaped to grip the glass tube or casing of a mercury-type switch 235. Wire conductors 236 and 237 form part of a circuit from the switch 235 to the bobbin-doffing solenoid 115 shown in Figs. 4 and 5 and previously described. The switch 235 is so arranged that when the bail 220 is tilted by engagement with the yarn strand *y* its arm 225 will be rocked to act through the link 226 to tilt the switch-holder 230 upwardly, whereby the mercury in the tube or casing will contact the terminals to close the circuit through the wires 236 and 237.

Thread-guide returning means

At the completion of winding a bobbin the thread-guide will have advanced outwardly along the section 130 of the traverse-rod 90 due to the feed of the nut 138 on the threads 137 of the rod-section. Before commencing to wind another bobbin it is therefore necessary to restore the thread-guide to its initial position at the rearward end of the rod-section 130 and this is accomplished electromagnetically through the means shown in detail in Figs. 6 to 10, inclusive. Secured to the under side of the bracket 37 is a casing 239 within which is mounted a solenoid 240. The solenoid 240 is wound on a tubular core 241 which, in turn, is mounted on a horizontally-extending tube or sleeve 242 secured in a hub 243 at one end of the casing 239. The opposite end of the tube 242 is supported in a bearing at the outer end of the casing 239, the opening being closed by a plug 244. A sheet-metal cover 238 encloses the solenoid 240, being fastened to the casing by screws 248, see Figs. 10 and 35. Slidable within the tube 242 is a plunger-rod 245 having its end bent upwardly in a right-angular arm 246, the upper part of the tube 242 being cut away throughout its length extending outwardly beyond the solenoid 240, see Fig. 9. Journaled on the reduced upper end of the arm 246 is a toothed pinion 247 having its teeth in mesh with a pair of rack-bars 249 and 250. A rectangular shoe 251 mounted on the reduced terminal portion of the arm 246 engages in a slot 252 cut into the under side of the bracket 37 and extending longitudinally thereof. The plunger-rod 245 constitutes an armature slidable longitudinally through the solenoid 240, being normally held projected axially therefrom by means of a helical spring 253 pocketed in the tube 242. One end of the spring 253 engages around a reduced projection 254 on the end of the plunger-rod 245 and its opposite end abuts a pin 255 driven through the sides of the tube 242.

The rack-bar 249 is fixed on the bracket 37, being located in a slot on the under side thereof and secured in position by screws 256 passing downwardly therethrough and threaded into an offset flange on the casing 239, see Fig. 9. The opposite rack-bar 250 is mounted to slide longitudinally in a slot 258 on the under side of the bracket 37, being held in place by a flange on the casing 239. The rack-bar 250 carries a pusher-plate 260 constructed in the form of an angular plate bent at right-angles to form a foot 261 underlying the bottom of the bracket 37 and attached to the rack-bar 250 by screws 262, see Fig. 9.

Secured to the upper end of the pusher-plate 260 is a block 263 which is adapted to make contact with means carried by the thread-guide 125 for releasing the nut 138 from the threads on the traverse-rod section 130 and to thereafter, by

its continuous contact with the side of the member **266**, slide the thread-guide rearwardly of the traverse-rod **90** while the rack **250** is slid in the same direction; it being understood that the withdrawal of the plunger-rod or armature **245** within the solenoid **240** causes the pinion **247** to travel on the fixed rack-bar **249** whereof its rotation will slide the movable rack-bar **250** toward the machine casing **4**.

The means for releasing the nut **138** from the threads **137** of the rod-section **130** are shown most clearly in Figs. 8, 9, 27 and 29 as comprising a cam-lever **265** operable to press the nut **138** laterally against the action of its spring **141**. The cam-lever **265** is carried on a bearing member **266** slidable along the rod-section **130** with the thread-guide **125**. As shown most clearly in Fig. 29, the bearing member **266** comprises a portion encircling the rod-section **130** with an arm **267** extending downwardly therefrom and terminating in a loop straddling the sides of the push-rod **52** to adapt it to slide thereon. Extending laterally from the member **266** is a forked bearing **268**, see Fig. 27, between the sides of which is pivoted the cam-lever **265**. The cam-lever **265** has a main arm **269** formed with a hub **270** pivoted on a pin **271** extending between the sides of the forked bearing and offset laterally from this main arm is an arcuately-shaped flange **272** having an inclined edge adapted to engage against the side of the tubular nut **138**, see Fig. 27. At the lower end of the main arm of the lever **265** is a right-angular finger **273** rounded on one side and adapted to be engaged by the vertical edge of the block **263** carried by the pusher-plate **260**, while a lateral projection or abutment **274** of the block, see Figs. 9 and 19, engages the side of the member **266**, see Fig. 27, to return the thread-guide to initial position.

Energizing means for the guide-returning solenoid

The solenoid **240** for restoring the thread-guide **125** to initial position is energized through the operation of a mercury switch **275** mounted on a rockable member **276** pivoted on the bracket **232**, before mentioned, being similar in arrangement to the switch **235** described previously. The switch **275** is rocked through means actuated by a wound bobbin doffed from either of the winding units of the pair. Referring to Figs. 2, 7, 11 and 12, a bobbin-guiding guard or chute **277** is arranged below each winding-spindle, being fastened to a cover **278** attached to the forward open side of the casing **233**, previously mentioned. The casing **233**, in turn, is fastened to the drive-casing **4** of the machine by means of screws **279** shown in Fig. 2. Each guard or chute **277** is constructed in two parts, one side wall **280** being of substantially triangular form with its forward end supported from the bracket **37** by means of a screw **282** inserted through an ear on its side and screwed into a flange on the casing **239** as shown in Figs. 2, 11 and 12. The opposite wall of the chute is in the form of a relatively narrow plate **281** fastened in vertical forwardly-projecting position on the cover **278**. Pivoted on a stud **284** extending through one side of the chute **277** with its end screwed into a boss on the side of the casing **239**, see Fig. 7, is a sheet-metal gate **285** normally held in raised position by a spring **283**, shown in Figs. 7 and 12, but adapted to be swung downwardly towards the inclined bottom edge of the wall **280** of the chute **277**. When the gate **285** is engaged by a wound bobbin discharged or doffed from the winding-spindle it will fall against the free end of the gate to swing the latter downwardly to actuate a lever **286** which operates the switch **275**.

Referring particularly to Fig. 11, the lever **286** is in the form of a double bell-crank constructed of wire wound spirally to form opposite bearings **287** which are pivoted on pins **288** projecting from elbow-shaped brackets **289** screwed to the cover **278**. A pair of parallel arms **290** project from the bearings **287** of the lever **286** and are bent at right-angles to form extensions **291**, one of which projects through an arcuately-shaped slot **292** in the wall **280** of the right-hand chute **277** in position beneath its gate **285**, while the opposite arm projects past the wall **281** of the opposite chute. On the opposite sides of the bearings **287** is a loop-shaped arm **293** terminating in a right-angular portion positioned to engage with the bent end **294** of a wire-lever **295**. The lever **295** is pivoted on a stud **296** projecting from an angularly-shaped bracket **297** fastened to the under side of the casing **233**. As shown in Fig. 11, the lever **295** has a looped end curled around the bent end of a vertical wire-link **298** and held in place thereon by a collar **299**. The upper end of the link **298** is hooked through an opening in the switch-member **276**. It will thus be apparent that when a bobbin is discharged through either one of the chutes **280** it will engage one or the other of the gates **285** to depress the latter whereby to rock the bell-crank lever **286**, thereby causing the latter to act through the lever **295** to tilt the switch **275** to flow the mercury across its terminals. The mercury switch **275** is connected by wires **300** and **301** in circuit with the solenoid **240** shown in Fig. 8 in accordance with the diagram of the wiring to be explained later.

The bobbin chutes **277** are open at the bottom to allow the bobbins to drop off from the ends of the gates **285**, whence they are received in a trough or box **302** supported by brackets **303** fastened to the legs **3** of the machine. The springs **283** are coiled around each stud **284** with one end held in a hole in the side wall **280** of the chute **277** and the opposite end bearing on the under side of the gate **285**, see Figs. 2, 11 and 13, these springs acting to raise the gates to the initial position shown in Figs. 2 and 13. The ends of the gate **285** engage against the cover-plate **278** when raised by the springs **283** and the length of yarn extending between the thread-guide and the discharged bobbin is clamped and held for a purpose to be explained later. A spring **305** anchored to a pin **306** projecting forwardly from the side of the bed **2** has its opposite end connected to the lever **295**, the spring tending to hold the lever with its end **294** engaged with the loop-shaped arm **293** of the bell-crank lever **286**, see Fig. 11, thereby acting to return the lever to initial position as shown in Fig. 13 and also to tilt the switch **275** back to first position to break the contact at the terminals thereof.

Bobbin-donning means

A supply of empty yarn-carriers or bobbins *b* is contained in a hopper or magazine **400** located above each winding unit. Each magazine consists of a pair of vertical chutes **401** and **402** of channel shape, shown in Figs. 1, 2, 3 and in the enlarged views 14 to 18*a*, inclusive; the rearward chute **401** being fixedly secured to a bracket **403** mounted on the machine casing **4** and said bracket **403** being provided with an arm **404** overhanging the side of the casing. The bracket **403**

has a foot fastened to the flange 405 of a portion of the casing 233 which rests on the boss 13 on the side of the main casing 4, being secured in place by suitable screws 406. A lug 407 adjacent the top of the bracket 403 is bifurcated to straddle a square rod 408 which extends longitudinally throughout the length of the machine, being mounted in arched brackets 409 rising from the sides thereof, see Fig. 2. This upper connection of the arm 404 with the square rod 408 serves to reinforce its support on the casing 4.

The rearward chute 401 has a plate 414 fastened to its back and formed with an angular flange 415 overlying a boss 416 on the arm 404 with screws 417 screwed through the side of the arm and threaded through the plate and the wall of the chute, see Figs. 2 and 14. The forward chute 402 has a similar plate 418 with its offset flange 415 slidable on an elongated boss 419 on the top of the arm 404 to adapt this part of the magazine to be adjusted laterally with respect to the chute 401 to accommodate bobbins of different lengths; it being noted that the opening or trough in the rearward chute 401 is larger than that in the forward chute 402 to accommodate the enlarged heads *h* of the bobbins. The forward chute 402 is attached to the arm 404 by screws 420 inserted through parallel slots 421 at the end of the arm, and by releasing the screws the chute 402 may be slid along the arm to a position proportionate to the length of the bobbins being used. Referring to Figs. 14 to 16, each magazine 400 is located in laterally offset relationship with respect to the spindle which it serves and the rearward wall of the chute 402 is curved at the bottom, as shown at 422 in Fig. 14, to direct it towards the spindle, and the wall of the chute 401 has a laterally offset and similarly-curved extension, whereof to form part runways 423 and 424, see Figs. 18 and 18*a*, on which the bobbins roll or slide.

A bifurcated frame 425, shown most clearly in Fig. 18, has its arms 426 and 427 pivoted on a rod 428 held in bearings 429 and 430 at the ends of the pair of brackets 431 and 432. The rearward bracket 431, shown most clearly in Fig. 15, is fastened to a pad on the side of the arm 404 by means of screws 433 and the forward bracket 432 is fastened by screws 434 to a pad projecting from the under side of the arm 404 at its outer end. The rearward bracket 431 has an arcuate arm 435 extending outwardly and downwardly to support the rod 428 in the hub or bearing 429 at its end and is also provided with an inclined arm 436 which terminates in a hub or bearing 437 for supporting one end of a second rod 438. The forward end of the rod 438 is supported in a boss or hub 439 on the forward bracket 432, see Fig. 14. The bearing hub 430 is supported by an arcuate arm 440 and this arm is extended beyond the hub in a portion 441 which carries the mounting 212 for the fixed thread-bail 210 and also the mounting or pin 223 for the pivoted thread-bail 220, these parts having been referred to previously. The rearward pin or pivot 224 for the movable thread-bail 220 is supported in an arm 442 projecting laterally from the rearward bracket 431, see Fig. 17.

The bifurcated frame 425 carries a pair of prongs or fingers 445 and 446, see Figs. 14 to 18, inclusive, which are adapted to be swung into position to form continuations of the runways 423 and 424, see Fig. 18*a*, thereby serving as ramps for feeding the bobbins into position in axial alinement with the spindle-cups 95 and 105. The fingers or ramp-members 445 and 446 are offset slightly with respect to each other so that the rearward one which supports the larger end of the barrel of the bobbin *b* will be below the forward one which supports the smaller or tip end of the bobbin; each finger being inclined upwardly at its end to form a sort of cradle for the bobbin. The finger 445 has a lateral extension 445' forming a continuation of the runway 423 with its left-hand edge positioned to adapt it to abut the head *h* of the bobbin *b* to prevent longitudinal sliding movement of the latter on the fingers 445 and 446. The rearward finger 445 is secured fast to the side of the crossbar of the frame 425 while the forward finger 446 is adjustable longitudinally thereof, being slidable along the bar and secured in position by a screw 447 inserted through a longitudinal slot 448 in the bar. The purpose of this adjustment is to aline the forward finger 446 with the forward chute 402 when the latter is adjusted to accommodate bobbins of different lengths. Normally, the frame 425 assumes the position shown in Figs. 14 and 15 with its fingers 445 and 446 withdrawn out of the way of the winding bobbin and after a bobbin has been doffed the frame is carried up into the position shown in Figs. 16 and 17 to guide a fresh bobbin into place between the spindle-cups 95 and 105. Electromagnetic means are employed to rock the frame 425 to carry its fingers 445 and 446 into bobbin-delivering position, the connections for this part of the machine being described hereinafter.

The bobbins *b* are stacked one over another in each magazine 400 and normally held from delivering therefrom by means of a gate 455 in the form of a U-shaped frame having its arms 456 pivoted on the rod 438. The gate 455 has a lip 457 which closes down against the runways 423 and 424. A second gate or hold-back member 460, also of U-shaped construction with its arms pivoted on the rod 438, is normally held raised above the first-named gate 455 and provided with a pair of fingers 461 and 462 adapted to be carried down between the endmost and next adjacent bobbin in the magazine before the gate 455 is released, its function being to prevent the delivery of more than one bobbin at a time. The rearward finger 461 is fixed on the cross bar of the frame 460 in position to pass down through the curved lower extremity of the chute 401 which is cut away at 463 as shown in dotted lines in Fig. 18. The outer finger 462 is adjustable longitudinally of the gate 460 to conform to the lateral adjustment of the chute 402, being slidable on the crossbar of the gate and held in adjusted position by a screw 464 passing through a slot 465. A slot 466 in the lower curved portion of the chute 402 provides an opening through which the finger 462 is projected.

The frame 425 with the ramp-fingers 445 and 446, the bobbin-releasing gate 455 and the hold-back gate 460 are operated in timed sequence through the control of a solenoid 470 mounted below the winding-spindle 10 within the box or casing 233. Referring to Figs. 2 and 3, the solenoid 470 is wound on a tubular core 471 surrounding a sleeve 472. The upper end of the sleeve 472 is held in the bore of a boss 473 on the upper wall of the casing 233 and its lower end is supported in a hub or boss 474, also integral with the casing 233, with set-screws 475 for securing the sleeve 472 against longitudinal movement. A thimble or bushing 476 inserted in the upper end of the bore of the sleeve 472 with its

flange abutting the top of the boss 473 provides a bearing for a plunger-rod 477 constituting a slidable armature for the solenoid 470, see Fig. 3. The plunger-rod 477 carries a collar 478, held fast thereon by a set-screw 479, which acts as a stop to limit the downward sliding movement of the armature within the solenoid 470 in the manner illustrated in Fig. 17. Held in a transverse hole at the upper end of the plunger-rod 477 is a cross-pin 480 having its opposite ends projecting from either side of the rod. The pin 480 is held in place by a screw 481 threaded into the end of the rod 477 and secured against release by a check-nut 482, see Figs. 1 and 15.

Pivoted on the rod 428 adjacent the side of the bracket 431 is an operating lever 485 for the frame 425 having its end bifurcated to straddle the rod 477 and its bifurcations slotted at 486, see Fig. 15, to engage the pin 480. The lever 485 has several functions, one of which is to reset the bunch-builder, its downwardly-projecting arcuate arm 487 being adapted to engage the arm 190 of the ratchet-actuating lever 185 as indicated by dash-lines in Fig. 27 and mentioned previously. Projecting from the side of the lever 485 is a rectangular lug 488 which engages through an elongated rectangular slot 489 in a cam-shaped extension 490 which is integral with the rearward arm 426 of the frame 425, see Figs. 1 and 15. It will be apparent that when the plunger-rod 477 is carried down by the attraction of the solenoid 470 it will rock the lever 485 downwardly and through the engagement of its lug 488 with the slot 489 will swing the frame 425 from the position shown in Fig. 15 to that illustrated in Fig. 17. This movement of the lever 485 carries its arm 487 into engagement with the arm 190 of the actuating lever 185 to swing the latter to reset the bunch-builder in the manner as explained more fully hereinafter.

The cam-shaped extension 490 has its edge 491 disposed eccentrically with respect to the pivot of the frame 425 and this edge is adapted to engage against the side of a stud or pin 492 projecting from the side of the rearward arm of the hold-back gate 460. The stud 492, shown in Figs. 1, 16 and 18, may be riveted or otherwise secured to the arm of the hold-back gate 460 and its engagement with the cam-edge 491 causes the gate to be actuated under the force of gravity to insert its fingers 461 and 462 into engagement with the next to the endmost bobbin in the magazine 400, see Fig. 16, before the lowermost bobbin is released by the gate 455. The bobbin-releasing gate 455 is actuated by means of a tapered finger 493 projecting downwardly from its rearward arm 456 with its rearwardly inclined edge, see Fig. 14, adapted to be engaged by the crossbar or bridge-piece of the frame 425 to rock the gate upwardly when the ramp-fingers 445 and 446 are carried up to the position shown in Fig. 16 to deliver the fresh bobbin to the spindle-cups 95 and 105.

It is necessary that the spindle-cup 95 be held retracted until the thread-guide 125 has been restored to first position and the fresh bobbin *b* has been placed in alinement therewith by the donning means. To provide for this cooperation between the various mechanisms the switch 235 which closes the circuit to the solenoid 115 for operating the spindle-cup 95 is maintained in tilted position by detent-means illustrated in detail in Fig. 14. This detent-means consists of a bell-crank lever 494 pivoted on a lug 495 rising from the top of the casing 233. The vertical arm of the lever 494 has a notch at its upper end adapted to receive the tail end of the arm 225 of the thread-bail 220 which is connected to the switch 235 by the link 226. The lever 494 has a short arm 496 carrying a weight 497 for swinging the lever into position to effect this engagement, this movement of the lever being limited by a stop-pin 498 projecting from the bearing lug 495. The horizontal arm 499 of the lever 494 extends across the plunger-rod 477 of the solenoid 470 and is adapted to be engaged by the end of the screw 479 which projects from the collar 478 fastened to the plunger-rod. Through this arrangement of the elements, when the plunger-rod 477 is drawn downwardly to actuate the bobbin-delivering means the lever 494 will be rocked from the screw 479 near the end of the rod's motion to release the notched end of its vertical arm from the bail 220, whereafter the switch 235 will be influenced by gravity to swing back into the position shown in Fig. 3 to open the circuit to the spindle-cup actuating solenoid.

Means for retrieving and attaching yarn to fresh bobbins

After the doffing of a wound bobbin the length of yarn leading from the thread-guide to the discharged bobbin must be retrieved and carried into position to be gripped by the fresh bobbin when the latter is delivered to the winding-spindle. This is accomplished by the action of a yarn-retriever which, after the thread-guide has been restored to initial position, picks up the yarn and carries it across the spindle-cup 95 in position to be gripped against the end of the bobbin *b* when the latter is engaged with the cup. The yarn-retriever may be of any preferred form of construction and, as shown in the present drawings, Figs. 35 to 41 inclusive, it consists in a wire finger 500 which is mounted to slide in a path parallel to the axis of the winding-spindle. The free end of the finger 500 is bent into a zigzag hook 501, see Fig. 35, for catching the yarn and its opposite end is attached to a bifurcated arm 502 having the ends of its bifurcations curled around the fixed horizontal rod 428, mentioned previously, and straddling the ends of a flat-sided sleeve 505 which is slidable on the rod. The end of the finger 500 is fastened to the arm 502 by screws 506, thus being mounted free to rock or swing about the axis of the rod 428. An ear 507 projecting upwardly from the side of the sleeve 505 carries a pin or stud 508 having a washer 509 on its reduced headed end and a second washer 510 held against a shoulder on the stud by a nut 511, see Fig. 41. The stud 508 passes through a slot 512 in a rockable lever 515 pivoted at its upper end on a screw or stud 516. The stud 516 is screwed into a bracket 517 fastened by screws 518 to the bracket 403, described previously.

The lever 515 is normally maintained in the position shown in Fig. 35 by means of a spring 520 attached to its upper arm at 521 and anchored to a lug 522 projecting upwardly from the bracket 517. The lever 515 is rocked to slide the yarn-retriever or finger 500 toward the spindle-cup 95 by means of a solenoid 525 having its tubular core 526 held between arms 527 and 528 projecting downwardly from the bracket 517. Slidable within the core 526 of the solenoid 525 is an armature 530 in the form of a plunger-rod having its outer end bent around to hook through a longitudinally-extending slot 531 in the lever

515. The bent end of the rod 530 projects through the slot 531 in the lever 515 and engages in a horizontal slot 532 in a framework 533 depending from the bracket 517, the slot 532 thus serving to guide the plunger-rod in its motion for operating the lever 515. A collar 534 secured fast on the rod 530 is adapted to engage the end of the core 526 of the solenoid 525 to limit the inward stroke of the rod while its outward stroke is limited by the engagement of the lever 515 against a finger 535 projecting from the framework 533 of the bracket 517.

The yarn-retriever or finger 500 normally assumes the position indicated in Fig. 37, extending downwardly under the action of gravity with its hooked end 501 withdrawn out of the way of the winding bobbin. In order for the yarn-retriever to catch the length of yarn *y* leading downwardly from the thread-guide 125 to the discharged bobbin it must be raised into the position indicated in Fig. 38 and this is accomplished by causing its supporting arm 502 to ride outwardly on an inclined portion 539 of a wire bail or guiding element 540, shown in detail in Figs. 39 and 40. The bail 540 is supported on the fixed rod 428 on which the yarn-retriever 500 slides, its ends being held in collars 541 and 542 fastened to the rod by set-screws 543 indicated by dotted lines in Fig. 35. The bail 540 extends parallel with the axis of the winding-spindle and at its forward end it is bowed outwardly in the inclined portion 539 along which the arm 502 rides to throw the finger 500 outwardly and upwardly into the position illustrated in Fig. 38.

The action of the yarn-retriever must be delayed until after the thread-guide 125 has been returned to first position adjacent the spindle-cup 95. The thread-guide 125, upon approaching its initial position adjacent the spindle-cup 95, is rocked upwardly about its pivot on the traverse-rod section 130 to provide clearance for the yarn-retriever which moves rearwardly in a path below the guiding member 136. The thread-guide 125 is rocked upwardly by means of an angular bracket or rest 537 which, as shown in Figs. 27 and 29, is carried by the traverse-rod section 130 and provided with an inclined arm 538. When the thread-guide 125 is shifted rearwardly its arm 135 is caused to ride up the inclined arm 538 to the position indicated in Fig. 29 to provide the clearance for the yarn-retriever. Means described as follows are provided for retaining the yarn-retriever 500 in its inoperative position after the solenoid 525 has been energized. It will be observed by reference to Fig. 35 that when the lever 515 is held in its initial position by the spring 520 the plunger-rod or armature 530 projects into the core 526 of the solenoid 525 only to a slight extent and therefore the magnetic force of the solenoid is insufficient to overcome the tension of the spring. To cause the solenoid 525 to slide the plunger-rod 530 it is necessary that it be advanced into the core 526 of the solenoid and this is effected by applying a mechanical force to the yarn-retriever to initiate its advance inwardly along the rod 428. The means for effecting this initial movement of the yarn-retriever consists in a pin 545 projecting forwardly from the crossbar of the bobbin-releasing gate 455, see Fig. 14. When the gate 455 is rocked upwardly to release a bobbin from the magazine 400 the pin 545 will wedge against the inclined edge 546 of the arm 502 to slide the latter along the rod 428 to the position indicated by dash lines in Fig. 35. This initial movement of the yarn-retriever 500 will rock the lever 515 to project the plunger-rod 530 into the core 526 of the solenoid 525 a sufficient distance for it to be influenced by the magnetic force of the latter to slide the plunger to rock the lever 515 to its extreme position shown in Fig. 36. In this manner the yarn-retriever is quickly shifted toward the spindle-cup 95 to draw out the length of yarn *y* leading from the thread-guide 125 and locate it across the open end of the cup. Then, as the spindle-cup 95 is released and forced outwardly to grip the end of the bobbin *b*, the yarn will be clamped thereagainst. The solenoid 525 is connected in parallel with the bobbin-doffing solenoids 115 by wires 547 and 548 as described hereinafter.

Timing device for doffing and donning means

In order that the spindle-cups 95 may be held retracted until fresh bobbins have been delivered into position to be engaged thereby, and to insure that the bobbins are held in place until engaged by the spindle-cups, a timing switch is employed in circuit with the solenoids 115 which retract the spindle-cups and the solenoids 470 which actuate the ramp-fingers 445 and 446 of the donning means. The timing switch 555 is shown in Fig. 3 as located within the casing 233 midway between the two winding units of each pair and is illustrated in detail in Figs. 19 to 26, inclusive. The switch 555 is of the rotary drum-type energized by a spring which is placed under tension by electromagnetic means.

Referring to Figs. 19 to 23, inclusive, the switch 555 comprises a rotary spindle or shaft 556 having its reduced ends 557 and 558 journaled in fixed bearings. As shown most clearly in Fig. 20, a dome-shaped bracket 560 is mounted on the upper wall of the casing 233 and fastened in place by screws 561 with its dome overlying an opening 562 in the wall. The upper reduced end of the spindle 556 is seated in a bearing in the crowned top wall of the bracket and its lower end is held in a bearing at the end of a bracket 563 attached to the rearward wall of the casing at 564. Enclosing the spindle 556 is a sleeve 565 of rectangular shape in cross-section, see Fig. 25, arranged with its lower end bearing against a nut 566 threaded onto the end of the spindle. Abutting the side of the nut 566 is a disk 567 of insulating material having a recess in its upper face within which is fitted a cylindrical boss 570 surrounding the sleeve 565. A second boss 571 of similar size and shape surrounds the sleeve 565 above the lower boss 570 and is separated therefrom by a disk 572 recessed on both sides to receive the bosses. Located above the boss 571 is a disk-like cam 575, shown in plan view in Fig. 23, which is also constructed of insulating material. The two bosses with their disks and the cam 575 are preferably constructed of plastic material such as sold under the trade-mark "Bakelite," being mounted on the rectangular sleeve 565 to key them together rotatively. The lower boss 570 is recessed circumferentially of its periphery to receive a metal contact-strip 576 with its edges held in the recesses in the disks 567 and 572. A similar contact-strip 577 is recessed into the periphery of the boss 571 and held in the same manner by the disk 572 and the cam 575. The contact-strip 577 extends throughout slightly more than 180° of the circumference of the boss 571, while the contact-strip 576 has a somewhat

greater extent around the periphery of the boss 570, the difference in length of the two strips being for a purpose as explained later.

As illustrated in Fig. 24, the contact-strip 577 on the upper boss 571 is adapted to be engaged by the ends of brushes 580 and 581 connected by wires 582 and 583 with the circuit for the spindle-cup retracting solenoids 115. The contact-strip 576 on the lower boss 570 is similarly engaged by the ends of brushes 584 and 585 connected by wires 586 and 587 with the circuit for the solenoids 470 which actuate the transfer mechanism of the donning means. Referring to Figs. 21 and 26, the brushes 580, 581, 584 and 585 are of rectangular shape arranged to slide in slots in the sides of metal plates 589 fastened to the inclined sides of a mounting 590 of insulating material, the plates 589 being spaced from each other on the mounting, see Fig. 26. The mounting 590 is of substantially triangular shape with its base fastened to the rearward wall of the casing 233 by screws 591. The brushes are held in the slots of the plates 589 by overlying metal covers 592 fastened in place by screws 593 passing through the covers and threaded into the mounting 590; it being noted that the mounting is constructed of suitable material to insulate the brushes from the metal casing 233. The covers 592 are folded downwardly against the rearward sides of the plates 589 and formed with apertures for receiving cylindrical extensions or pins 594 projecting from the rearward ends of the brushes. Helical springs 595 surround the pins 594 in the pockets at the rear of the brushes, being held under tension to maintain the forward ends of the brushes contacting with the metal strips 576 and 577 on the hubs 570 and 571. It will be understood from the foregoing that as the switch-bosses 570 and 571 are rotated their contact-strips 576 and 577 will close the electrical circuits through the several brushes 580, 581, 584 and 585 during a portion of the rotation of the bosses, whereas, when the brushes ride off from the contact-strips the circuits will be opened.

The rotary action of the switch 555 is controlled by means explained as follows: Mounted above the cam-disk 575 is a toothed pinion 600 having its hub fitted to the rectangular sleeve 565 with the end of the hub abutting the upper face of the cam-disk. Mounted on the spindle 556 above the pinion 600 is a ratchet-wheel 601, free to turn on the spindle but held rotatively with respect to the pinion by means of pointed teeth on its under face engaging similar teeth on the upper face of the pinion. Through this means the ratchet-wheel 601 may be adjusted rotatively with respect to the pinion 600 by releasing the nut 566, this adjustment being for the purpose of timing the action of the switch. It will be understood that the ratchet 601 and sleeve 565 are clamped between a head or flange at the upper end of the spindle 556 and the nut 566 at the lower end of the spindle to cause them to rotate with the spindle as a unit, see Fig. 22. The ratchet-wheel 601 constitutes a part of an escapement mechanism which regulates the turning motion of the switch-hubs to maintain the two circuits closed for a definite period. Above the bracket 560 is a U-shaped bracket 605 fastened by screws 606 to an angular lug 607 on the side of the casing 233, see Figs. 19 and 20. Held in lugs 608 and 609 at the top of the bracket 605 is a cross-pin 610 forming the pivot for a pair of pawls 611 and 612. The lower ends of the pawls 611 and 612 are shaped to engage with the teeth of the ratchet-wheel 601, first one pawl and then the other being released from the teeth to permit the ratchet-wheel to rotate intermittently in the manner of a clock escapement. The pawls 611 and 612 have sleeve-like hubs 613 and 614 rotatable on the pin 610 and held in abutting relationship between the lugs 608 and 609. Wire springs 615 and 616 coiled around the hubs 613 and 614 of the pawls 611 and 612 act to urge the pawls into engagement with the teeth of the ratchet-wheel 601, one end of each spring bearing against the side of the bracket 605 with its opposite end bent to engage under the edge of its respective pawl.

The pawls 611 and 612 are intermittently released from the teeth of the ratchet through the means of a rockable cam-member 620 secured fast to the end of a rock-shaft 621 mounted in a bearing 622 on the bracket 605. The cam 620 is formed with two laterally-offset rounded protuberances 623 and 624 adapted to strike against ears 625 and 626 projecting laterally from the sides of the pawls 611 and 612, see Figs. 20 and 22. The rock-shaft 621 is oscillated from the movement of the traverse-rod 90, shown fragmentarily in Figs. 20 and 21. For this purpose the bunter-collar 197, previously referred to as being secured to the rod 90, has a downwardly-projecting finger or lug 199 adapted to engage the side of a finger 630 pivoted to the end of the rock-shaft 621. As shown in Figs. 20 and 21, the finger 630 has a bifurcated bearing at its lower end formed by ears 631 pivoted on a cross-pin 632 extending through the sides of a forked head 633 which is fast on the end of the rock-shaft 621. The finger 630 is offset from its pivotal axis and formed at its end with a right-angular projection 634 adapted to be engaged by the side of the lug 199 on the bunter-collar 197. Normally, the finger 630 is rocked toward the right, as viewed in Fig. 20, to maintain its bent end out of the range of the lug 199. The finger 630 is swung toward the left into position to be engaged by the lug 199 on the collar 197 by the action of a lever 635 actuated by the rotary switch-cam 575 shown in plan view in Fig. 23. The cam-lever 635 is of bifurcated form with its opposite sides pivoted on the ends of a pin 636 held in a boss 637 on the side of the bearing 622 of the bracket 605. The end of its upper arm 638 is connected by a helical spring 639 to an ear 640 on the side of the finger 630, this connection being yieldable for a purpose as explained later. The lower arm 641 of the lever 635 has an arcuate right-angular portion or shoe 642 which bears against the periphery of the cam 575, a spring 643 serving to maintain this engagement. The spring 643 is coiled around the bearing pin 636 with one leg bent around to engage across the edge of the upper arm 638 of the lever 635 and the end of its opposite leg bearing against the top of the dome of the bracket 560. The spring 643 is held on the end of the pin 636 by a collar 644, shown in Fig. 21, but omitted from Fig. 20 for the sake of clarity.

The cam 575 is of generally circular shape in plan view as shown in Fig. 23 with its circumference reduced in diameter at the low point 574 on which the shoe 642 normally rides. When the cam 575 is rotated in a contraclockwise direction as viewed in Fig. 23, its circular edge of greatest radius will ride against the shoe 642 to rock the lever 635 in a contraclockwise direction as viewed in Fig. 20. This rocking motion of the lever 635 acts through the spring 639

to swing the finger 630 to the left into position to be engaged by the lug 199 on the bunter-collar 197. The reason for the resilient connection between the lever 635 and the finger 630 will now be apparent, the spring 639 being adapted to yield should the finger 630 be swung to the left to cause it to strike the side of the lug 199 when the latter is in alinement with the projection 634 on the finger.

It has been stated that the cam 620 is rocked to oscillate the pawls 611 and 612 by the engagement of the lug 199 with the finger 630 at the end of the rock-shaft 621, and means are provided for resiliently resisting this rocking action of the shaft and cam in the form of a spring-arm 645 which bears against the flat side of the head 633 on the rock-shaft 621. The spring-arm 645 is formed of wire coiled helically about a supporting rod 646 which projects from the side of the dome of the bracket 560, being held in place thereon by collars 647. The end of the wire projecting from its coil bears against the top of the casing 233 to maintain the spring-arm 645 under tension so that as it presses against the side of the head 633 it tends to maintain the cam 620 in neutral position.

Resetting means for rotary switch

As previously stated the switch 555 is actuated by a spring and, as shown in Figs. 19 and 20, the spring 654 operates a longitudinally-slidable rack 655 arranged with its teeth in mesh with the pinion 600. The rack 655 is slidable in a channel-shaped guideway 656 which projects from the forward side of the dome-shaped bracket 560, the forward end of the guideway being supported upon a flat shelf 657 extending from the casing 239, see Figs. 35 and 36. Joined to the forward end of the rack 655 by a screw-threaded connection 658, or other suitable means, is a rod 660 forming an extension of the rack. The spring 654 is coiled around the rod 660 and held at its outer end by a collar 661 fastened to the rod by a set-screw shown in Fig. 35. The inner end of the spring 654 bears against the end of a sleeve 662 held in a bearing at the end of an arm 663 which is formed as a part of a sheet-metal bracket 664 fastened to the side of the cover 238 on the casing 239, which latter is fastened to the under side of the bracket 37. Thus, it will be apparent that when the rack 655 on the rod 660 is slid to the left, as viewed in Fig. 35, it will compress the spring 654 to energize it.

The rod 660 is moved to compress the spring 654 under the action of a solenoid 665 mounted on the bracket 664, referred to previously. The bracket 664 is fastened to the cover 238 by the screws 248, previously described, and a screw 666 and is provided with laterally-extending arms 667. Held in bearings at the ends of the arms 667 is a sleeve 668 which forms the tubular core of the solenoid 665. At its forward end the upper half-section of the sleeve 668 is cut away leaving a semicircular bearing at the bottom for supporting a plunger-rod 670 constituting the armature of the solenoid 665. The outer end of the plunger-rod 670 is bent upwardly at right-angles and formed with a forked end 671 straddling the sides of the rod 660, see Fig. 37. A collar 673 secured fast on the rod 660 abuts the side of the forked end 671 of the plunger-rod 670 whereby, when the latter is drawn into the solenoid 665, it will slide the rod to the left as viewed in Fig. 35 to compress and energize the spring 654 in the manner as indicated in Fig. 36. The opposite sliding movement of the rod 660 under the action of the spring 654 is limited by contact of the bent end of the plunger-rod with the arm 663. The solenoid 665 is connected in an electrical circuit to be explained later by means of wires 674 and 675. It will be observed from the foregoing that when the solenoid 665 is energized to slide the rod 660 to tension the spring 654 it will move the rack 655 which acts through the pinion 600 to rotate the spindle 556 to restore the switch bosses 570 and 571 to the position shown in Figs. 24 and 25.

Electrical circuits for doffing and donning means

Fig. 42 is a simplified diagram of the various circuits for the several solenoids which operate diffierent elements of the machine and the circuit-breakers for controlling the same. It will be understood, however, that the present diagram is for the purpose of illustrating a preferred arrangement of circuits and that any other suitable arrangement may be employed for energizing the solenoids, and that the solenoids may be constructed to adapt them for use with alternating current or with direct current at any desired voltage. With the arrangement of circuits illustrated in the present diagram, alternating current is supplied from a source through the line conductors 680 and 681. The line conductors 680 and 681 conveniently may extend through the casings 233 for the several pairs of units mounted along the machine bed and as all the units are the same the circuits for one pair of units only are explained herein. Branch line conductors 682 and 683 lead from the main line conductors 680 and 681 to a main switch 685 for a pair of units, the switch having manual operating means 686 indicated in Figs. 3 and 11. Beyond the switch the branch line conductors are indicated by the reference characters 687 and 688.

The lead wire 236 of the switch 235, which, as explained above, is operated by the thread-bail for controlling the doffing means, is connected to one of the branch line conductors 687. The opposite lead wire 237 of the switch 235 is connected to a junction 690, from which junction a wire 122 leads to the spindle-cup controlling solenoid 115 for one winding unit of the pair. This circuit is completed through the wire 123, solenoid 115 for the other winding unit of the pair, and thence through wire 123' to the opposite branch line conductor 688. The second mercury switch 235, shown at the right in Fig. 42, is connected in parallel with the first-mentioned switch 235 through a wire 236' between the branch line conductor 687 and the switch and a wire 237' between the switch and junction 690.

The timing device 555 is connected in the above described circuit in parallel with the switches 235 through wiring explained as follows: The brushes 580 and 581 of the timing device or switch 555 are connected to wires 582 and 583, as described previously, the wire 582 being connected to the branch line conductor 687 while the wire 583 is connected to the junction 690 of the circuit including the mercury switches 235 and solenoids 115. Thus, when the switch 555 is closed its upper contact-element 577 bridges the brushes 580 and 581 to close the circuit including the solenoids 115 to retain the spindle-cups in retracted relationship.

Connected in parallel with the bobbin-doffing solenoids 115 in the circuit described above are the two solenoids 525 for the yarn-retrievers of

the pair of winding units. The circuit for the solenoids 525 comprises a wire 547 leading from the junction 690 to one solenoid 525 of the winding unit of the pair, a wire 548 connecting this solenoid with the similar solenoid for the other winding unit of the pair and a wire 548' connected to the wire 123' which, as explained previously, is connected to the branch line conductor 688.

The circuit for energizing the solenoids 240 which operate to return the thread-guides 125 to initial position includes the mercury switch 275 arranged in series therewith. One terminal of the switch 275 is connected to the branch line conductor 687 by means of the lead wire 300 while the opposite terminal is connected to one of the solenoids 240 through the lead wire 301 and wire 691. The two solenoids 240 are connected in series by means of the wire 692 and the circuit is completed through the wire 693 connecting the second solenoid and branch line conductor 688. The timing device resetting solenoid 665 is connected in parallel with the solenoids 240 by means of its lead wires 674 and 675, the former being connected to the lead wire 301 of the switch 275 and the latter to the wire 693 connected to the branch line conductor 688.

The electrical circuit for energizing the bobbin-donning means includes the timing switch 555 and the solenoids 470. This circuit comprises a lead wire 586 from the wire 582 connected to the branch line conductor 687, the lead wire 586 being connected to the brush 584 of the timing switch 555. The opposite brush 585 is directly connected by means of a wire 587 to the solenoid 470 of one winding unit of the pair which, in turn, is connected by means of wire 696 to the solenoid 470 of the other winding unit of the pair. The circuit is completed through the solenoids 470 by means of a wire 697 connecting the second-mentioned solenoid to the branch line conductor 688. When the contact-element 576 of the timing switch 555 bridges the brushes 584 and 585, after the switch has been reset, the solenoids 470 are energized in the circuit including the connecting wires 582, 586, 587, 696 and 697. Both solenoids 470 are thus energized to actuate the donning mechanism in the manner as explained later.

Method of operation of the complete machine

Assuming that the yarn-carriers or bobbins *b* are in winding position with their tip ends held in the cups 105 and their butt ends in the spindle-cups 95 of one pair of the winding units, and that the spindles 9 and 10 are connected to the drive, the winding proceeds in the manner explained as follows: The drive-shafts 5 and 6 are rotated continuously from a suitable source of power and through the means of the gears 20 and 21 the spindles 9 and 10 are driven to rotate the bobbins *b*. The gears 63 and 64 connect the shaft 5 to drive the cams 70 and the rocker-levers 82 are oscillated thereby to reciprocate the traverse-rods 90 in paths parallel to the axes of the bobbins. At the commencement of the winding the thread-guides 125 are positioned at the rearward ends of the traverse-rod sections 130 which are swung inwardly toward the bobbins by the engagement of their fingers 147 bearing against the inclined edges of the formers 145, see Fig. 27. It will be sufficient for an understanding of the method of winding to explain the operation of one unit only.

Bunch building.—It is assumed that the bunch-builder has been set by the engagement of the arm 487, see Fig. 17, with the arm 190, shown in Fig. 27, to position the yarn-retainer 150 with its hook 151 projecting downwardly as illustrated in Figs. 27 and 29 to effect its engagement with the yarn *y* as it leads from the grooved guide-element 136 to the bobbin *b* with its end attached to the latter; it having been explained previously that the yarn *y* leads down from above to feed through the groove of the guide-element 136. The traverse-rod 90 is reciprocated with a uniform extent of traverse in accordance with the adjustment of the link 87 along the rocker-lever 82 and the length of traverse of the thread-guide 125 remains constant throughout the winding. However, since at the commencement of the winding operation the yarn *y* leading between the guide and the bobbin *b* is held in the hook 151 of the yarn-retainer 150 it will have its traverse restricted so that the coils of winding will be deposited to form a relatively short layer or bunch indicated at *x* in Fig. 27.

The bunch-builder operates in a manner common to devices of this type, being actuated to release the holding means for the yarn-retainer 150 to cause the latter to be thrown out of engagement with the yarn after the bunch winding has been completed. The yarn-retainer 150 is held in active position, as shown in Fig. 29, by the engagement of the plate 200 with the side of the cam 160 on the shaft 155, see Fig. 31. This relationship of the parts is maintained by the escapement device including the ratchet-wheel 165 which carries the cam-disk 166. During the winding of the bunch the ratchet-wheel 165 is rotated intermittently under the action of the pawl 186 on the actuating lever 185. The lever 185 is oscillated against the tension of its spring 189 by the reciprocatory movement of the bunter 196 on the collar 197 carried by the traverse-rod 90, this action having been explained previously. Eventually, as the cam-disk 166 is turned into the position illustrated in Fig. 28, the toe 181 of the escapement-lever 174 will slide through the recess 167 in the cam-disk to permit the lever to be moved under the impulse of the spring 189. This release of the escapement-lever 174 frees the plate 200 from engagement with the side of the cam 160, whereupon the spring 205 will rock the shaft 155 to swing the yarn-retainer 150 into the position shown in Fig. 30. The yarn *y* is thereby released from the hook 151 on the yarn-retainer 150 and allowed to feed directly from the guide-element 136 to the bobbin *b* to cause it to be traversed to the full extent to start the service winding.

The winding proceeds with the thread-guide 125 traversing the yarn to lay it in helical turns ont he barrel of the bobbin *b* with the courses advanced toward the tip end of the bobbin. The traverse of the yarn is advanced by the engagement of the contact-wheel 140 with the layers of winding deposited on the bobbin *b* and the yarn forms a conical mass as the contact-wheel is guided outwardly from the axis of the bobbin with its finger 147 sliding along the inclined edge of the former 145. It will be understood that as the contact-wheel 140 is moved laterally away from the bobbin the traverse-rod section 130 gradually swings outwardly with it until it is in alinement with the main portion of the traverse-rod 90. Usually, a spring, not herein shown, is employed for urging the inner end of the traverse-rod section 130 laterally outward away from the bobbin to initially hold the finger 147 in engagement with the guiding edge 146 of

the former 145. This adjustment between the parts of the traverse-rod is permitted by the pin-and-slot connection at their ends, referred to previously and indicated at 134 in Fig. 27. It will be understood that at each rearward stroke of the traverse-rod 90 the periphery of the contact-wheel 140 will engage with the yarn on the bobbin to turn the nut 138 in a contraclockwise direction as viewed in Fig. 30. This turning of the nut 138 acts to feed the thread-guide 125 outwardly along the traverse-rod section 130 with the bobbin B, indicated by dot and dash lines in Fig. 27, growing by longitudinal extension.

Bobbin doffing operation.—As has been stated, two bobbins are wound simultaneously on each pair of units and are usually completed at the same instant. In some cases where a break in the yarn occurs the winding of one bobbin may lag behind that of the other, but such occurrences are infrequent and both bobbins of the pair are doffed at the same time even though only one is completed.

The operation of the doffing mechanism is initiated by the action of the yarns feeding to the bobbins. As one or both of the bobbins reach their predetermined length the yarn *y* drawing across the thread-bail 210 will ride along the inclined portion 215 thereof, see Figs. 1, 4 and 37, to cause it to engage against the movable bail 220 to rock the latter on its pivots 223 and 224. This rocking motion of the bail 220 causes its arm 225 to act through the link 226 to tilt the switch 235 to flow the mercury across its terminals, see Fig. 3. As the switch 235 is thus actuated it closes the circuit through the wires 236, 237 and other connections, explained previously and shown in Fig. 42, to energize the spindle-cup retracting solenoids 115. As the solenoids 115 are energized they act to slide the sleeves 96 to withdraw the cups 95 on the spindles 9 and 10 away from the butt ends *h* of the bobbins *b* to release the latter in the manner indicated in Fig. 5 of the drawings. The two bobbins are thus released from the winding-spindles simultaneously and discharged down through the chutes 277 arranged therebelow. As the bobbins *b* drop into the chutes 277 they strike against the free ends of the gates 285, causing the latter to be depressed in the manner indicated in Fig. 12 of the drawings, whereof to allow the bobbins to drop out of the chutes into the trough or box 302. As each bobbin drops through its respective chute the end of the yarn trailing therefrom is caught between the end of the gate 285 and the covers 278 at the rear of the chute in the manner indicated in Fig. 13, the gates 285 when released being carried upwardly into initial position by the action of their springs 283, see Fig. 11.

Referring to Fig. 14 of the drawings, it is noted that when the thread-bail 220 is rocked by the engagement of the yarn therewith the end of its arm 225 is slid upwardly along the edge of the lever 494 to cause it to be engaged in the notch at the upper end of the vertical arm of the lever, the purpose of this arrangement being to retain the switch 235 in position with the circuit to the solenoids 115 closed. The solenoids 115 will thus remain energized to hold the spindle-cups retracted until the detent-lever 494 is released from the arm 225 of the bail 220 to permit the switch 235 to tilt under the action of gravity to open the circuit. It may be mentioned here that the shifting of the switch to first position restores the thread-bail 220 to operative relationship with the fixed bail 210, the rocking motion of the bail 220 back to first position being limited by the engagement of its arm with a pin 219 shown in Fig. 3 as projecting from the side of the mounting for the thread-bails. The detent-lever is released from the bail 220 in the manner as explained later.

Restoring thread-guides to first position.—After the wound bobbins have been doffed from the spindles 9 and 10 of the two winding units of the pair the thread-guides 125 are returned to first position by releasing their nuts 138 from the threads 137 on the traverse-rod sections 130 and sliding the guides rearwardly on the latter.

The action of the guide-returning means is initiated by the passage of the doffed bobbins B through the chutes 277. As the gates 285 in the chutes are depressed by the bobbins B striking thereagainst they rock the bell-crank lever 286, see Figs. 11 and 12, and the latter, in turn, acts through the lever 295 and link 298 to tilt the switch 275 to flow the mercury across its contacts. This actuation of the switch 275 closes the circuit through wires 300, 301, 691, 692 and 693, see Fig. 42, to energize the two solenoids 240. The solenoids 240 then act to slide the plunger-rods 245 to travel the pinions 247 on the fixed racks 249. The rotation of the pinions 247 causes the movable racks 250 to slide towards the right, as viewed in Figs. 6 to 8, to cause the blocks 263 on the pusher-plates 260 to engage with the nut-releasing levers 265. Immediately this engagement occurs the levers 265 are rocked to cause the cam edges on their flanges 272 to displace the nuts 138 laterally to release them from the threads 137 on the traverse-rod sections 130, see Fig. 27. Thereafter, the further sliding movement of the pusher-plates 260 fixed on the rack-bars 250 acts to slide the thread-guides 125 rearwardly, as indicated by dash lines in Fig. 8, to restore them to first position as shown in Fig. 1.

The solenoids 240 are energized only for an instant while the bobbins are being discharged through the chutes 277 and as soon as the gates 285 are released and elevated by their springs 283 the bell-crank lever 286 is permitted to rock back to its first position shown in Fig. 2. The bell-crank lever 286 thus releases the lever 295 which is swung back to the position shown in Fig. 11 under the action of its spring 305, thereby restoring the switch 275 to first position to open the circuit to the solenoids 240. While, as stated before, the circuit remains closed only for a brief interval, the solenoids 240 actuate their plunger-rods 245 with a rapid motion so that the pusher-plates 260 return the guides to the inner ends of the traverse-rod sections 130 before the solenoids are deenergized. Immediately the circuit is opened and the solenoids 240 deenergized the springs 253, shown most clearly in Fig. 8, act to slide the plungers 245 back to first position to move the pusher-plates 260 into inoperative position so that they will not interfere with the advance of the thread-guides 125 during the winding of the next bobbins.

Yarn retrieving.—After the thread-guides have been restored to first position the lengths of yarn leading therefrom to the doffed bobbins are retrieved and carried into position to be clamped to the ends of the fresh bobbins as the latter are connected to the winding-spindles 9 and 10. The yarn-retrievers 500, see Figs. 35 to 41 inclusive, are actuated by the solenoids 525 which, as indicated in the diagram of Fig. 42, are connected in par-

allel with the circuit for the solenoids 115 for the bobbin-doffing means. This circuit, as has been stated, is closed by the switches 235 actuated from the movable thread-bails 220. It has been explained that the plunger-rods 530 are initially maintained with only a small portion of their length within the cores 526 of the solenoids 525, being held under the tension of the springs 520 acting on the levers 515. Therefore, the magnetic force of the solenoids 525 is insufficient to slide the plunger-rods 530 until they have entered farther into the cores 526 of the solenoids. To effect this the yarn-retrievers 500 are advanced mechanically to a slight extent along their supporting rods 428 from the position shown by full lines in Fig. 35 to that indicated by dash lines. The impulse thus given to advance the yarn-retrievers 500 is applied by the action of the pins 545 on the bobbin-releasing gates 455 as the latter are raised in the manner explained later, the pins sliding along the inclined edges 546 of the arms 502 of the yarn-retrievers. The plunger-rods 530 are thus carried into range of the magnetic force of the solenoids 525 to be influenced thereby to rock the levers 515 to slide the yarn-retrievers 500 from the position shown in Fig. 35 to that illustrated in Fig. 36.

Meanwhile, the thread-guides 125 have been returned to first position as indicated in Figs. 1 and 27, and in approaching the end of the traverse-rod sections 130 their arms 135 have encountered the inclined arms 538 of the rests 537 to rock the guides upwardly into the relationship illustrated in Fig. 29, this displacement of the guides being for the purpose of clearing a path for the yarn-retrievers 500 and also to position the guides in proper relation to the yarn-retainers 150 to insure that the latter will catch the yarns leading from the guides to the bobbins when the winding is again started. As the plungers 530 actuate the levers 515 to slide the yarn-retrievers 500 inwardly toward the spindle-cups 95 their hooks 501 catch the yarns *y* leading down from the guides to the discharged bobbins and held by the gates 285 as indicated in Fig. 36. The yarns *y* are thus positioned and held extending across the recessed ends of the spindle-cups 95, as shown in Fig. 38, it having been explained that as the yarn-retrievers slide along the bails 540 they are rocked upwardly into operative position by the inclined portions 539 of the bails as indicated in Figs. 39 and 40.

Timing switch setting.—The timing switch 555 is reset after each operation of the doffing means under the control of the solenoid 665, see Figs. 19 to 25, inclusive, and Figs. 35 and 36. The solenoid 665 is connected in parallel with the solenoids 240 by means of wires 674 and 675, and thus is energized by the closing of the switch 275. When the solenoid 665 is energized during the return of the thread-guides it slides the plunger-rod 670 to move the rod 660 and rack 655 in the same direction to rotate the pinion 600 in a contraclockwise direction as viewed in Fig. 19. The rotation of the pinion 600 turns the sleeve 565 and spindle 556 in the same direction and also rotates the ratchet-wheel 601 which is engaged with the pinion. The bosses 570 and 571 on the sleeve 565 are thus rotated in a contraclockwise direction to locate their contact-strips 576 and 577 in the position shown in Figs. 24 and 25. In other words, the contact-strips are adjusted to bridge their associated pairs of brushes and to maintain the circuits closed for a definite period as the switch-bosses 570 and 571 are rotated in the opposite direction, or clockwise, under the action of the spring 654 on the rod 660, see Fig. 19. It will be understood that the solenoid 665 is deenergized after a brief interval by the return of the switch 275 to open position after the doffed bobbins have passed through the chutes 277. At this juncture, however, the switch 555 will have been reset so that the circuit to the solenoids 115 for the spindle-cups 95 will remain closed through the upper brushes 580 and 581 and wires 582, 583, 122, 123 and 123'. The switch 555 functions to close this latter circuit for the purpose of retaining the spindle-cups 95 in retracted position after the switch 235 has been actuated to open the first-described circuit to the solenoids 115. It has been explained that the switch 235 is maintained closed for an interval by the operation of the detent-lever 494 shown in Fig. 14 which is eventually released by the action of the bobbin-transfer means. However, it is necessary to retain the spindle-cups retracted until the fresh bobbins have had time to move into position to be engaged by the cups and therefore the release of the spindle-cups to effect their engagement with the bobbins is delayed by the functioning of the switch 555. When the switch 555 is reset it also bridges the brushes 584 and 585 to close the circuit through wires 586, 582, 587, 696 and 697 to supply current to the solenoids 470 for operating the donning mechanism.

The switch-bosses 570 and 571 are rotated to maintain these two last-mentioned circuits closed for a definite period through the action of the escapement means which controls the rotation of the ratchet-wheel 601. It has been stated that the traverse-rod 90 is reciprocated continuously and the finger 630 is carried into position to be engaged by the lug 199 on the collar 197 carried by the rod to cause it to actuate the escapement mechanism. During the setting of the switch 555 the cam 575 is turned with the spindle 556 to cause its periphery of greatest radius to ride against the shoe 642 on the lever 635 to rock the latter and maintain it in position for a definite interval, thereby causing it to rock the finger 630 into operative position with respect to the lug 199. Thereafter, each reciprocation of the traverse-rod 90 will cause the lug 199 to engage the projection 634 on the finger 630 to oscillate the shaft 621. The oscillation of the shaft 621 causes the protuberances or lobes 623 and 624 of the cam 620 to strike against the ears 625 and 626 on the pawls 611 and 612 to alternately rock the latter against the tension of their springs 615 and 616. The pawls 611 and 612 are thus alternately released from the teeth on the ratchet-wheel 601 to permit the latter to turn intermittently, thus effecting a somewhat retarded rotation of the switch-bosses 570 and 571 in a clockwise direction as viewed in Figs. 24 and 25 when the spring 654 slides the rod 660 and rack 655 to rotate the pinion 600. Rotation of the switch-bosses in this direction is arrested by the engagement of the arm 671 with the arm 663 of the bracket 664, see Fig. 35. At this juncture the cam 575 will have been turned to the position shown in Fig. 23 to allow the lever 635 to return to the position shown in Fig. 20. As the lever 635 is rocked to this latter position by its spring 643 its upper arm 638 acts through the spring 639, the coils of which are closed, to swing the finger 630 out of the range of the lug 199 on the collar 197 carried by the traverse-rod 90.

It will be noted by reference to Figs. 24 and 25

that the contact-strip 576 on the lower boss 570 is of slightly greater extent than that of the strip 577. Consequently, the circuit including the brushes 584 and 585 which supplies current to the donning mechanism will remain closed an instant longer than the circuit including the brushes 580 and 581 which supplies current to the spindle-cup retracting solenoids 115. The purpose of this arrangement is to effect the release of the spindle-cups before the ramp-fingers 445 and 446, which hold the fresh bobbins in place, have been withdrawn or, stated otherwise, to delay the release of the bobbins until the spindle-cups have engaged their ends.

Bobbin donning.—Immediately the thread-guides have been returned to first position and the yarns *y* leading therefrom retrieved and positioned across the ends of the spindle-cups 95, the bobbin-donning means comes into operation; it being understood that the several operations of the doffing and donning means follow each other rapidly so that their various functions are performed almost simultaneously. The closing of the circuit to the solenoids 470 as effected by the resetting of the switch 555 energizes these solenoids to cause them to draw the plunger-rods 477 downwardly, see Figs. 3 and 14 to 17, inclusive. As the donning means for both winding units of the pair are operated in the same manner it will be sufficient to explain the functioning of only one of them. The downward movement of the plunger-rod 477 acts first to rock the hold-back gate 460 downwardly to cause its fingers 461 and 462 to enter between the lowermost and next adjacent bobbin in the magazine or hopper 400. As described previously, the plunger 477 is connected to the lever 485 by the pin 480 engaging in the slot 486 at its bifurcated end. The operating lever 485 is connected by the lug 488 engaged in the slot 489 to rock the frame 425 to carry its ramp-fingers 445 and 446 upwardly from the position shown in Fig. 15 to that illustrated in Fig. 16. During this rocking motion of the frame 425 the edge 491 of its cam 490 rides across the pin 492 on the side of the gate 460, thereby releasing the gate to permit it to be lowered by gravity into its operative position shown in Fig. 16 to hold back all but the endmost bobbin *b* in the magazine 400.

As the frame 425 is rocked forwardly by the movement of the plunger 477 the ramp-fingers 445 and 446 are carried into alinement with the runways 423 and 424 at the bottom of the chutes 401 and 402 and at this juncture the bobbin-releasing gate 455 is lifted. The gate 455 is actuated by the crossbar of the frame 425 as it rides across the inclined lower end of the finger 493, thus causing the gate to be lifted as shown in Fig. 16 while the ramp-fingers 445 and 446 are being brought into place to receive the bobbin which rolls or slides therealong after its release by the gate.

As before stated, the ramp-fingers 445 and 446 are maintained in operative position with their cradle-like ends supporting the bobbin *b* in alinement with the winding-spindle until the circuit to the spindle-cup solenoid 115 is opened at the switch 555. Upon the opening of this circuit the solenoid 115 is deenergized and the spring 101 projects the spindle-cup 95 into engagement with the butt end of the bobbin to firmly grip the latter as its tip end is forced into the cup 105; it being understood that the bobbin is positioned while being donned so that its tip end will clear the cup 105 until forced thereinto by the projection of the spindle-cup 95.

It will be understood that when the boss 570 of the switch 555 has been turned to carry the contact-strip 576 out of range of the brushes 584 and 585 the circuit to the solenoid 470 will be opened to deenergize the latter, whereupon a spring 700 in the sleeve 472 of the solenoid 470 presses against the end of the plunger 477 to raise the latter and restore the other parts of the donning mechanism to inactive position. It has been explained that the downward movement of the plunger-rod 477 causes the end of the screw 479 in the collar 478 to engage the horizontal arm 499 of the detent-lever 494, thus releasing it from the thread-bail 220 to allow the latter to swing back into first position under the effect of gravity acting on the switch 235.

Resetting bunch-builders.—As soon as the bobbins *b* are gripped to the winding-spindles the yarns *y* leading through the thread-guides and clamped to the bobbins will be wound thereon, causing the lengths trailing to the discharged bobbins to be broken as they are held clamped by the ends of the gates 285, see Fig. 15. In the meantime the bunch-builders have been reset by the action of the arms 487 of the levers 485 as the latter are rocked by the sliding movement of the plungers 477. It will be sufficient to explain the resetting of one bunch-builder. As the end of the arm 487 rides against the arm 190 of the actuating lever 185 it will move the latter bodily to rock the escapement-lever 174, connected therewith, on the stud 173. This movement of the lever 174 will cause the end of its arm 182 to move in a clockwise direction from the position shown in Fig. 28 to engage the tail end of the pawl 186 as shown in Fig. 27 to release its toe from the teeth of the ratchet-wheel 165 and hold the pawl disengaged therefrom. At the same time the lug 169 on the holding pawl 171 is engaged by the edge of the escapement-lever 174 to release said pawl from the teeth on the ratchet-wheel 165. Upon release of the ratchet-wheel 165 the spring 170 acts to rotate the cam 166 in a clockwise direction to restore the cam to its first position shown in Fig. 27, the stop-finger 172 bringing up against the end of the pawl 171 to arrest the rotation of the ratchet-wheel 165 in this direction. The translation of the actuating lever 185 also has the effect to cause the escapement-lever 174 to be carried back into first position, thereby causing the plate 200 to slide across the curved side of the cam 160, see Figs. 32 and 33, to restore said cam to its original position illustrated in Figs. 27, 29 and 31. As the cam 160 is restored to first position the shaft 155 is turned against the action of its spring 205 to carry the yarn-retainer hook 151 down into position to engage the yarn *y* in the manner indicated in Figs. 27 and 29. As soon as the cam 160 has been restored to position to be held by the plate 200 the arm 487 is withdrawn to release the lever 185, whereupon it will be returned by the spring 189 to the position shown in Fig. 27 to permit the pawls 186 and 171 to again engage the teeth on the ratchet-wheel 165. After this resetting of the bunch-builder the winding units are prepared to operate in the manner as explained previously to first wind bunches on the bobbins *b* and then build the service winding which forms the cylindrical bodies of the bobbins B.

All of the several units of the gang winding machine operate in the same manner, the wind-

ing operation being practically continuous except at such times as it may be necessary to arrest the winding at a single unit for piecing-up a broken end or replenishing the supply of yarn. The yarn is preferably supplied from large cones or packages containing sufficient yarn to wind a large number of bobbins before the supply is exhausted so that the machine has an extremely high rate of production as its spindles are driven at high speed.

If it becomes necessary to arrest the winding at one of the units the drive is disconnected by sliding the push-rod **52** rearwardly, see Figs. 8 and 10, to release the detent-means which maintain the clutches engaged. The sliding movement of the push-rod **52** causes its arm **54** to rock the latch **55** to disengage its shoulder **51** from the block **50** on the arm **49** which is fast on the rod **34**. When the arm **49** is released the helical spring **58**, shown in Figs. 1 and 7 and previously described as being fastened to the arm **59** on the member **32** with its opposite end anchored to a fixed part of the casing **4**, will rock the last-named member. The rocking of the member **32** causes its fingers **30** and **76** to engage the beveled sides of the grooves in the clutch-members **26** and **68** to move the latter toward the right, as viewed in Figs. 1 and 2, whereby to release them, respectively, from the driving gears **21** and **63**. In this manner the drive for the spindle **9** or **10** and for the cam **70** is disconnected to arrest the rotation of the spindle and the reciprocation of the thread-guide **125**. When the piecing-up of the yarn or the replenishment of the supply is completed the operation of the winding unit is started again by moving the handle **38** to rock the rod **34**, whereby to reengage the latch **55** with the detent-lever **43**.

It will be observed from the foregoing that the present invention provides an entirely automatic winding machine adapted for continuous operation to wind cops, bobbins, pirns and other forms of packages at a high rate of production. It will be observed further that by the use of electromagnetic means for operating the various instrumentalities of the doffing and donning mechanisms the construction of the machine is simplified and extra loading of the drive is avoided.

The improved construction of the present machine also avoids the use of complicated cams and gearing connected with the drive to transmit motion to parts of the doffing and donning mechanisms.

While the invention is herein shown and described, by way of example, as embodied in a preferred form of construction, it is to be understood that various modifications may be made in the structure and arrangement of its parts without departing from the spirit or scope of the invention. Therefore, without limiting ourselves in this respect, we claim:

1. In a winding machine of the type in which yarn is wound by a rotating spindle and guided by traversing means, the combination with said spindle and traversing means of means for automatically doffing a wound mass of the yarn from the spindle, and an electric solenoid for supplying power to operate the last-named means.

2. In a winding machine of the type indicated, the combination of means for rotating a yarn-carrier, means for traversing the yarn on the carrier, means for automatically doffing a full carrier and donning an empty carrier, and electric solenoid power means for operating the last-named means.

3. In a winding machine of the type indicated, the combination of means for rotating a yarn-carrier, means for automatically doffing a full carrier and donning an empty carrier, electromagnet power means for operating the last-named means, and means actuated during the winding operation for controlling the electromagnet power means for operating the doffing and donning means.

4. In a winding machine of the type indicated, the combination of a winding-spindle, means for traversing yarn longitudinally thereof, and magnet means for retracting the spindle to doff a wound mass of the yarn therefrom.

5. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier connected therewith, and magnet means for relatively moving the spindle and carrier to doff the carrier from the spindle.

6. In a winding machine of the type indicated, the combination of spindles for supporting a yarn-carrier therebetween and rotating the carrier to wind yarn thereon, and electromagnet power means for moving the spindles relatively of each other to doff the carrier therefrom.

7. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, electromagnet power means for disconnecting the carrier and spindle to doff the carrier, and control means for the electromagnet power means automatically operated during the winding operation.

8. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, electromagnetic means for disconnecting the carrier from the spindle, and means actuated by the strand of yarn feeding to the package being wound for initiating the operation of the electromagnetic means to doff the wound carrier.

9. In a winding machine of the type indicated, the combination of a rotating spindle having separate parts relatively movable axially of each other to support a yarn-carrier to wind yarn thereon, electromagnetic power means for relatively moving the separate parts of the spindle to release the carrier, and control means for the electromagnetic power means automatically operated during the winding to doff a wound carrier.

10. In a winding machine of the type indicated, the combination of opposite spindles for supporting a yarn-carrier therebetween and rotating it to wind yarn thereon, an axially-movable coupling on one of the spindles engageable with the yarn-carrier, an electromagnetic coil for retracting the coupling to release the carrier, an electric circuit for energizing the electromagnetic coil, and control means in the circuit actuated during the winding to energize the coil to cause the wound carrier to be doffed.

11. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a magazine for holding a supply of empty carriers, means for doffing a wound carrier and transferring an empty carrier from the magazine to the spindle, and electromagnet power means for operating the last-named means.

12. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, means for continuously rotating the spindle, a magazine for

holding a supply of empty carriers, means for doffing a wound carrier and transferring an empty carrier from the magazine to the spindle while the latter is rotating, and electromagnet power means for operating the last-named means.

13. In a winding machine of the type indicated, the combination of opposite spindles for supporting a yarn-carrier therebetween and rotating it to wind yarn thereon, a magazine for holding a supply of empty carriers, electromagnet power means for moving the spindles axially relatively of each other to doff a wound carrier, means for transferring an empty carrier from the magazine to position it between the spindles, and electromagnet power means connected to operate the last-named means.

14. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, electromagnetically-operated means for doffing a wound carrier, a magazine for holding a supply of empty carriers, electromagnetically-operated means for transferring an empty carrier from the magazine to the spindle, and control means for initiating the operation of the separate electromagnetically-operated means for doffing a wound carrier and transferring an empty carrier to the spindle in timed sequence.

15. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, electromagnetically-operated means for doffing a wound carrier, means actuated during the winding for initiating the operation of said electromagnetically-operated means, a magazine for holding a supply of empty carriers, electromagnetically-operated means for transferring an empty carrier from the magazine to the spindle, and means actuated by the doffed carrier for initiating the operation of the last-mentioned electromagnetically-operated means to transfer an empty carrier to the spindle.

16. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, means for doffing a wound carrier, a magazine for holding a supply of empty carriers, means for transferring an empty carrier from the magazine to the spindle, electromagnetic means for operating the doffing and transferring means, and control means for energizing the electromagnetic means to doff a wound carrier and transfer an empty carrier in timed sequence, said control means acting to retard the deenergization of the electromagnetic means for operating the doffing means until an empty carrier has been transferred.

17. In a machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, means for doffing a wound carrier, a magazine for holding a supply of empty carriers, means for transferring an empty carrier from the magazine to the spindle, electromagnetic means for operating the doffing means and transferring means in timed sequence, a bail actuated by the yarn being wound for initiating the operation of the electromagnetic means, detent-means for holding the bail, means operated by the transferring means for actuating the detent-means to release the bail, and means for returning the bail to its initial position.

18. In a machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, means for doffing a wound carrier, a magazine for holding a supply of empty carriers, means for transferring an empty carrier from the magazine to the spindle, an electric circuit including separate electromagnetic means for operating the doffing means and transferring means, a switch in the circuit for controlling the energization of the electromagnetic means for operating the doffing means, a bail actuated by the yarn being wound and connected to operate the switch, detent-means engageable with the bail to retain the switch closed, a second switch in the circuit actuated by a doffed carrier for energizing the electromagnetic means for operating the transferring means, means operated by the transferring means for actuating the detent-means to release the bail, and means for returning the bail to its initial position.

19. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a magazine for holding a supply of empty carriers, means for retracting the spindle to doff a wound package, means for transferring an empty carrier from the magazine to the spindle, an electric circuit including separate electromagnetic means for operating the doffing means and transferring means, switches in the circuit for controlling the energization of the separate electromagnetic means in timed relation, and an additional switch in the circuit for delaying the deenergization of the electromagnetic means for withdrawing the spindle until after an empty carrier has been transferred to a position to be engaged by the spindle.

20. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a magazine for holding a supply of empty carriers, means for retracting the spindle to doff a wound carrier, means for transferring an empty carrier from the magazine to the spindle, an electric circuit including separate electromagnetic means for operating the doffing means and transferring means, switches in the circuit for controlling the energization and deenergization of the separate electromagnetic means in timed relation, and means actuated by the doffed carrier for initiating the operation of the switches for controlling the deenergization of the separate electromagnet means.

21. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a magazine for holding a supply of empty carriers, means for retracting the spindle to doff a wound carrier, means for transferring an empty carrier from the magazine into position to be engaged by the spindle, an electric circuit including separate electromagnetic means for operating the doffing and transferring means, switches in the circuit for controlling the energization of the separate electromagnetic means in timed relation, said switches comprising a rotary switch having contacts in the circuit for controlling the deenergization of the separate electromagnetic means in timed relation, and escapement means for retarding the operation of the rotary switch.

22. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a magazine for holding a supply of empty carriers, means for doffing a wound carrier, means for transferring an empty carrier from the magazine to the spindle, an electric circuit including separate electromagnetic means for operating the doffing means and transferring means, switches in the circuit for controlling the energization of the

separate electromagnetic means in timed relation, said switches comprising a rotary switch having contacts in the circuit for controlling the deenergization of the separate electromagnetic means in timed relation, a spring for rotating the rotary switch, escapement means for retarding the rotation of the switch by the spring, and electromagnetic means in the circuit for setting the rotary switch to be actuated by the spring.

23. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, means for automatically doffing a wound carrier and donning an empty carrier, electromagnet power means for operating the last-named means, and means operative after a wound carrier has been doffed for engaging the yarn strand to position it between the spindle and the empty carrier.

24. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, traversing means, said spindle and traversing means being relatively reciprocated to wind the yarn in overlying layers on the carrier, means for doffing a wound carrier and donning an empty carrier, electromagnet power means for operating the last-named means, and yarn-retrieving means operated after a wound carrier has been doffed to engage the yarn strand between the traversing means and the doffed carrier and position it between the spindle and the empty carrier being donned.

25. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, traversing means, said spindle and traversing means being relatively reciprocated to wind the yarn in overlying layers on the carrier, a magazine for holding a supply of empty carriers, yarn-retrieving means for postioning the yarn strand adjacent the end of the spindle, and electromagnetically-operated means for automatically doffing a wound carrier, actuating the yarn-retrieving means to position the yarn strand and transferring an empty carrier from the magazine to the spindle, said last-named means operating to transfer an empty carrier in timed sequence to the doffing and yarn-retrieving operations.

26. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, electromagnetically-operated means for automatically doffing a wound carrier and donning an empty carrier, means for positioning the yarn strand to be gripped between the spindle and empty carrier when the latter is donned, and means engaging the yarn strand to cause it to break between the spindle and the doffed carrier when the empty carrier is rotated.

27. In a winding machine of the type indicated, the combination of a winding-spindle for rotating a bobbin, means for traversing yarn to wind it on the bobbin, means for progressively advancing the traversing means, means for doffing a wound bobbin, electromagnet power means for operating the doffing means, and means operated by the strand of yarn being wound as it is advanced by the traversing means for initiating the operation of the electromagnet power means to doff the wound bobbin.

28. In a winding machine of the type indicated, the combination of a spindle for rotating a bobbin to wind yarn thereon, traversing means adapted to progressively advance along the bobbin, said spindle and traversing means being relatively reciprocated to wind the yarn in overlapping layers, means for doffing a wound bobbin, electromagnet power means for operating the doffing means, and means operated by the strand of yarn being wound to initiate the operation of the electromagnet power means to doff the wound bobbin.

29. In a winding machine of the type indicated, the combination of a spindle for rotating a bobbin to wind yarn thereon, traversing means adapted to progressively advance along the bobbin, said spindle and traversing means being relatively reciprocated to wind the yarn in overlying layers on the bobbin, means for doffing a wound bobbin, an electric circuit including electromagnetic means for operating the doffing means, a switch for controlling the electromagnetic means, and a bail actuated by the strand of yarn being wound to operate the switch to initiate the operation of the means for doffing the wound bobbin.

30. In a winding machine of the type indicated, the combination of a spindle for rotating a bobbin to wind yarn thereon, a reciprocating thread-guide adapted to progressively advance to wind the yarn in overlapping layers on the bobbin, means for doffing a wound bobbin, an electric circuit including electromagnetic means for operating the doffing means, a switch for controlling the electromagnetic means, a fixed bail over which the yarn is drawn and along which it advances as it is wound on the bobbin, a movable bail having a portion engageable by the yarn at the end of its advance along the fixed bail by the thread-guide, said movable bail being actuated by the yarn, and means actuated by the movable bail to operate the switch to initiate the operation of the doffing means.

31. In a winding machine of the type indicated, the combination of a winding-spindle, traversing means adapted to progressively advance with respect to the spindle, said spindle and traversing means being relatively reciprocated to wind the yarn in overlapping layers on a bobbin, means for doffing the wound bobbin and reestablishing the initial relationship of the traversing means and spindle, and electromagnet power means for operating the last-named means.

32. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, traversing means adapted to progressively advance along the carrier, said spindle and traversing means being relatively reciprocated to wind the yarn in overlapping layers on the carrier, means for doffing the wound carrier and reestablishing the initial relationship of the traversing means and spindle, electromagnet power means for operating the last-named means, and means operated by the yarn as it is advanced by the traversing means for initiating the operation of the electromagnet power means.

33. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind the yarn thereon, a thread-guide, means for reciprocating the thread-guide and progressively advancing it to wind the yarn in overlapping layers on the carrier, means for doffing a wound carrier, means for restoring the thread-guide to initial position, an electric circuit including separate electromagnetic means for operating the doffing means and restoring means, and means in the circuit

for controlling the operation of the separate electromagnetic means in timed sequence.

34. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind the yarn thereon, a thread-guide, means for reciprocating the thread-guide and progressively advancing it to cause the yarn to be wound in overlapping layers on the carrier, electromagnetically-operated means for doffing a wound carrier, means operated by the yarn being wound as it is advanced by the thread-guide to initiate the operation of said electromagnetically-operated means, electromagnetically-operated means for restoring the thread-guide to initial position, and means actuated by the doffed carrier for initiating the operation of the second-mentioned electromagnetically-operated means.

35. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, traversing means adapted to progressively advance along the carrier during the winding, means for relatively reciprocating the carrier and traversing means to wind the yarn in overlapping layers on the carrier, means for doffing a wound carrier, means for restoring the traversing means to initial position, electromagnetic means for operating the doffing means and traversing means-restoring means in timed sequence, yarn-retrieving means for engaging the yarn to position it adjacent the spindle, and electromagnetic means for operating the yarn-retrieving means.

36. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, traversing means adapted to progressively advance along the carrier during the winding, means for relatively reciprocating the carrier and traversing means to wind the yarn in overlapping layers on the carrier, electromagnetically-operated means for automatically doffing a wound carrier and donning an empty carrier, means actuated by the yarn being wound as it is advanced by the traversing means for initiating the operation of the doffing means, a chute through which the doffed carrier descends, means for positioning the yarn strand to be gripped between the spindle and carrier when the empty carrier is donned, electromagnetically-operated means for restoring the traversing means to initial position, and a pivoted gate in the chute actuated by the doffed carrier to initiate the operation of the last-named means, said gate acting to grip the yarn strand trailing from the doffed carrrier against the chute to cause the strand to break when the empty carrier is rotated.

37. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, traversing means progressively advanced along the carrier during the winding, said traversing means and carrier being relatively reciprocated to wind the yarn in overlapping layers, a magazine for holding a supply of empty carriers, and electromagnet-operated means for successively doffing a wound carrier, restoring the thread-guide to initial position and transferring an empty carrier from the magazine to the spindle.

38. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a reciprocating thread-guide, means for progressively advancing the thread-guide along the carrier to wind the yarn in overlapping layers thereon, a magazine for holding a supply of empty carriers, separate electromagnetically-operated means for doffing a wound carrier, restoring the thread-guide to initial position and transferring an empty carrier from the magazine to the spindle, and means for controlling the operation of the separate electromagnetically-operated means in timed sequence.

39. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a reciprocating thread-guide, means for progressively advancing the thread-guide along the carrier to wind the yarn in overlapping layers thereon, a magazine for holding empty carriers, means for doffing a wound carrier, means for returning the thread-guide to initial position, means for transferring an empty carrier from the magazine to the spindle, an electric circuit including separate electromagnetic means for operating the doffing means, thread-guide returning means and transferring means, and means in the circuit for controlling the operation of the separate electromagnetic means in timed sequence.

40. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a reciprocating thread-guide, means for progressively advancing the thread-guide along the carrier to wind the yarn in overlapping layers thereon, a magazine for holding empty carriers, means for doffing a wound carrier, means for restoring the thread-guide to initial position, means for transferring an empty carrier from the magazine to the spindle, an electric circuit including separate electromagnetic means for operating the doffing means, thread-guide restoring means, and carrier-transferring means, means actuated by the yarn being wound as it is advanced by the thread-guide to energize the electromagnetic means for operating the doffing means, and means actuated by the doffed carrier to energize the electromagnetic means for operating the thread-guide restoring means and for transferring an empty carrier to the spindle.

41. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a reciprocating thread-guide, means for progressively advancing the thread-guide along the carrier to wind the yarn in overlapping layers thereon, a magazine for holding empty carriers, means for doffing a wound carrier, means for returning the thread-guide to initial position, means for transferring an empty carrier from the magazine to the spindle, an electric circuit including separate electromagnetic means for operating the doffing means, thread-guide returning means and transfer means, switches in the circuit for separately energizing the electromagnetic means in timed sequence and deenergizing the electromagnetic means in timed sequence.

42. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a reciprocating thread-guide, means for progressively advancing the thread-guide along the carrier to wind the yarn in overlapping layers thereon, a magazine for holding empty carriers, means for doffing a wound carrier, means for returning the thread-guide to initial position, means for transferring an empty carrier from the magazine to the spindle, an electric circuit including separate electromagnetic means for operating the doffing

means, thread-guide returning means and transferring means, switches in the circuit for initiating the operation of the separate electromagnetic means independently of each other, control means for operating the switches in timed sequence, and means in the circuit for retarding the deenergization of the electromagnetic means for operating the doffing means until after an empty carrier has been transferred.

43. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a reciprocating thread-guide, means for progressively advancing the thread-guide along the carrier during the winding, a magazine for holding empty carriers, means for doffing a wound carrier, means for returning the thread-guide to initial position, a yarn-retriever for positioning the yarn adjacent the end of the spindle, means for transferring an empty carrier from the magazine to the spindle, an electric circuit including separate electromagnetic means for operating the doffing means, thread-guide returning means, yarn-retriever and carrier-transferring means, and means in the circuit for controlling the energization and deenergization of the separate electromagnetic means in timed sequence.

44. In a winding machine of the type indicated, the combination of a rotating spindle for winding a bobbin, means for traversing the yarn on the bobbin, a yarn-retainer operative to restrain the traverse of the yarn to wind a bunch at the beginning of the winding, and electromagnet power means for actuating the yarn-retainer to engage the yarn strand to start a new bunch.

45. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a reciprocating traversing means, means for progressively advancing the traversing means along the carrier during the winding operation, a yarn-retainer engageable with the yarn strand being wound to restrain its traverse at the beginning of the winding to wind a bunch on the carrier, and electromagnetically-operated means for doffing a wound carrier, restoring the traversing means to initial position, donning an empty carrier, and operating the yarn-retainer to engage the yarn strand in timed sequence.

46. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, reciprocating traversing means, means for progressively advancing the traversing means along the carrier during the winding operation, a magazine for holding empty carriers, means for automatically doffing a wound carrier, means for restoring the traversing means to initial position, means for transferring an empty carrier from the magazine to the spindle, a yarn-retainer engageable with the yarn strand being wound to restrain its traverse to wind a bunch at the beginning of the winding, and electromagnetic means for operating the doffing means, thread-guide restoring means, carrier-transferring means and yarn-retainer in timed sequence.

47. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, reciprocating traversing means, means for progressively advancing the traversing means along the carrier during the winding operation, a magazine for holding empty carriers, means for doffing a wound carrier, means for returning the traversing means to initial position, means for transferring an empty carrier from the magazine to the spindle, a yarn-retainer engageable with the yarn strand being wound to restrain its traverse to wind a bunch at the beginning of the winding, said yarn-retainer being normally held in an inoperative position, a trip-lever for operating the yarn-retainer to engage the yarn, and electromagnetic means for operating the doffing means, traverse return means, carrier-transferring means and the trip-lever for the yarn-retainer in timed sequence.

48. In a winding machine of the type indicated, the combination of a plurality of rotatable winding-spindles, electromagnet-operated means for doffing the wound masses from the spindles, and means adapted to be actuated during the winding on any of the several spindles to initiate the operation of the electromagnet-operated means to simultaneously doff the wound masses from the plurality of spindles.

49. In a winding machine of the type indicated, the combination of means for simultaneously winding bobbins on a plurality of yarn-carriers, electromagnet-operated means for doffing the wound bobbins and donning empty carriers, and means actuated when one of the bobbins is fully wound to initiate the operation of the electromagnet-operated means to simultaneously doff the plurality of wound bobbins and don empty carriers.

50. In a winding machine of the type indicated, the combination of means for simultaneously rotating a plurality of yarn-carriers to wind bobbins thereon, electromagnet-operated means for simultaneously doffing the plurality of wound bobbins and donning empty carriers, and control means for the electromagnet-operated means actuated by the winding on any one of the bobbins whereby to simultaneously doff all the wound bobbins and don empty carriers.

51. In a winding machine of the type indicated, the combination of means for simultaneously winding bobbins on yarn-carriers at a plurality of stations, electromagnet-operated means at each of the stations for automatically doffing a wound bobbin and donning an empty carrier, means connecting the electromagnet-operated doffing and donning means of the several stations to cause them to be operated simultaneously, and means at each station adapted to be actuated during the winding for controlling the last-named means to operate the doffing and donning means at all the stations simultaneously.

52. In a winding machine of the type indicated, the combination of a plurality of spindles for simultaneously rotating yarn-carriers to wind bobbins thereon, means at each spindle for automatically doffing wound bobbins and donning empty carriers, electromagnetic means for operating the doffing and donning means, an electric circuit connecting the electromagnetic means of the several spindles for simultaneous operation, a switch for each spindle adapted to control the circuit, and means at each spindle actuated during the winding to operate its respective switch to initiate the operation of the plurality of doffing and donning means simultaneously.

53. In a winding machine of the type indicated, the combination of a plurality of spindles for simultaneously rotating yarn-carriers to wind bobbins thereon, reciprocating traversing means for each spindle, means for progressively advancing the traversing means along the carriers to

wind the yarn in overlapping layers on the carriers, means cooperating with each spindle for automatically doffing a wound bobbin and donning an empty carrier, electromagnetic means at each spindle for operating the doffing and donning means, an electric circuit connecting the electromagnetic means of the several spindles, switches for controlling the circuit, and means at each spindle actuated by the yarn being wound as it is advanced by the traversing means to operate one of the switches to energize the circuit.

54. In a winding machine of the type indicated, the combination of a plurality of spindles for simultaneously rotating yarn-carriers to wind bobbins thereon, means at each spindle for automatically doffing a wound bobbin and donning an empty carrier, electromagnetic means at each spindle for operating the doffing and donning means, an electric circuit connecting the electromagnetic means of the several spindles, switches in the circuit controlled by the winding at each spindle for energizing the electromagnetic means to initiate the operation of the plurality of doffing and donning means, and means in the circuit for controlling the deenergization of the electromagnetic means to doff the wound bobbins and don empty carriers in timed sequence.

55. In a winding machine of the type indicated, the combination of a plurality of spindles for simultaneously rotating yarn-carriers to wind bobbins thereon, traversing means at each spindle, means for progressively advancing the traversing means along the spindles, a magazine at each spindle for holding empty carriers, means at each spindle for doffing a wound bobbin, restoring the traversing means to initial winding position and transferring an empty carrier from the magazine to the spindle, a plurality of electromagnetic means at each spindle for operating the last-named means, a circuit connecting the electromagnetic means of the several spindles, switches in the circuit for controlling the energization of the several electromagnetic means of each spindle, and means in the circuit for controlling the deenergization of the several electromagnetic means at each spindle in timed sequence.

56. In a winding machine of the type indicated, the combination of a plurality of spindles for simultaneously rotating yarn-carriers to wind bobbins thereon, traversing means at each spindle, means for progressively advancing the traversing means along the spindles, a magazine at each spindle for holding empty carriers, means for disconnecting the spindles and carriers to doff the wound bobbins, an electric circuit having electromagnetic means for operating the doffing means, a switch operated during the winding on one of the carriers for energizing the circuit, means for restoring the traversing means to initial position, a second circuit having electromagnetic means for operating the restoring means, a switch actuated by a doffed bobbin to energize the second circuit, means for transferring empty carriers from the magazines to the spindles, a third circuit having electromagnetic means for operating the transferring means, said third circuit being energized by the last-named switch, and a switch for controlling the deenergization of the first and third circuits to maintain the spindles in disconnected relationship until the empty carriers have been transferred.

57. In a winding machine of the type indicated, a plurality of spindles for simultaneously rotating the yarn-carriers to wind bobbins thereon, means at each spindle for automatically doffing wound bobbins and donning empty carriers, electromagnetic means at each spindle for operating the donning and doffing means, a plurality of electric circuits connecting the electromagnetic means of the several spindles in pairs, and means at each spindle operated during a winding operation for controlling its respective circuit whereby the wound bobbins are automatically doffed and empty carriers donned in pairs.

58. In a winding machine of the type indicated, a plurality of spindles for simultaneously rotating yarn-carriers to wind bobbins thereon, a common means for continuously rotating the plurality of spindles, means at each spindle for automatically doffing wound bobbins and donning empty carriers, electromagnetic means at each spindle for operating the doffing and donning means, a plurality of electric circuits connecting pairs of the electromagnetic means at adjacent spindles, and means at each spindle actuated when the bobbin thereon has been fully wound for controlling its respective circuit to initiate the doffing and donning means whereby the wound bobbins are automatically doffed and empty carriers donned in pairs when either one or the other of the carriers of each pair has been fully wound.

59. In a winding machine of the type indicated, the combination of a plurality of alined spindles for supporting yarn-carriers therebetween and simultaneously rotating them to wind bobbins thereon, a common means for continuously rotating the plurality of spindles, electromagnetic means for moving one of the spindles of each pair axially with respect to the other to doff wound bobbins therefrom, electromagnetic means for donning empty carriers, a plurality of electric circuits connecting pairs of electromagnetic doffing and donning means, means at each spindle actuated by the strand of yarn being wound for energizing its respective circuit, and means in each circuit for controlling the electromagnetic means for doffing pairs of the wound bobbins and donning pairs of empty carriers in timed sequence.

60. In a winding machine of the type indicated, the combination of a spindle for rotating a yarn-carrier to wind yarn thereon, a magazine for holding a supply of carriers, means for doffing a wound carrier, means for transferring an empty carrier from the magazine into position to be donned on the spindle, electric solenoid power means for operating the doffing means and carrier-transferring means in timed sequence, and means operative during the winding to initiate the operation of the electric solenoid power means.

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