Sept. 25, 1951 R. C. DEHMEL 2,569,292

WIRE WINDING MACHINE

Filed March 9, 1946 2 Sheets-Sheet 1

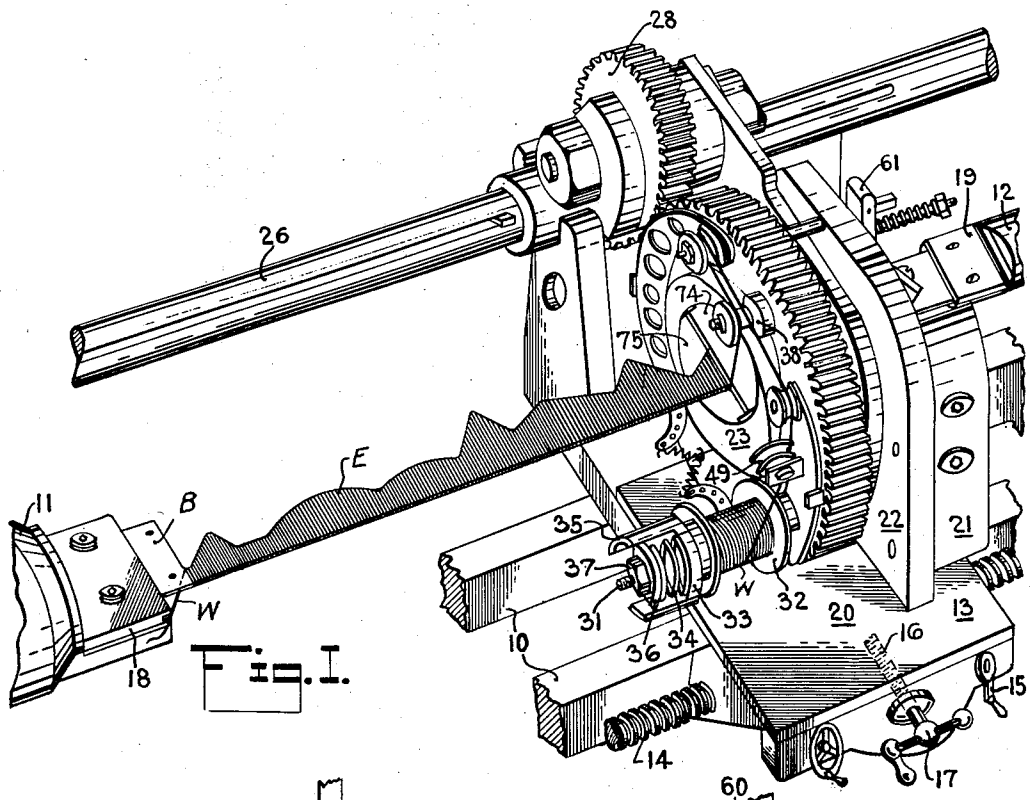



Fig. I.

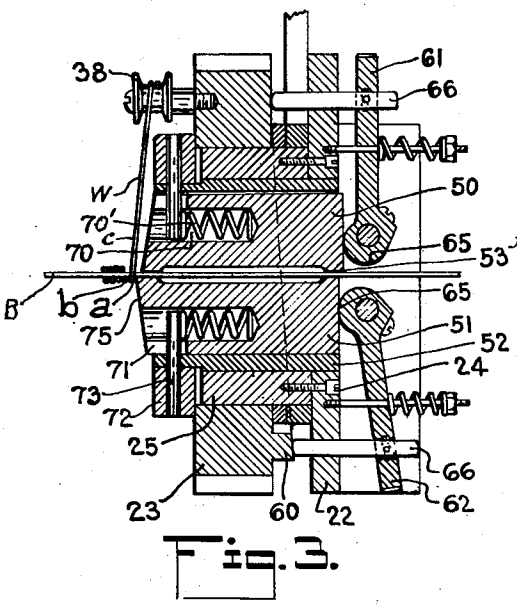



Fig. 3.

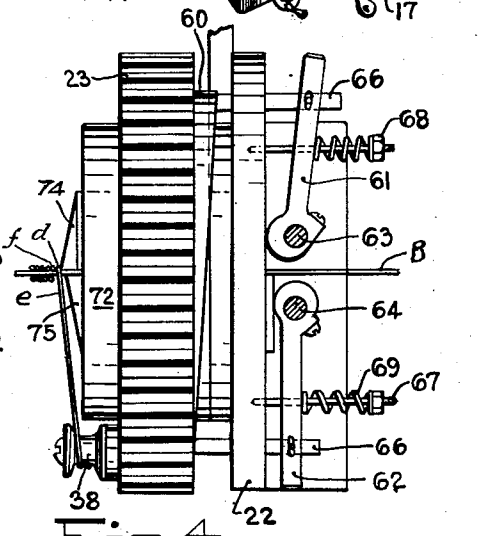



Fig. 4.

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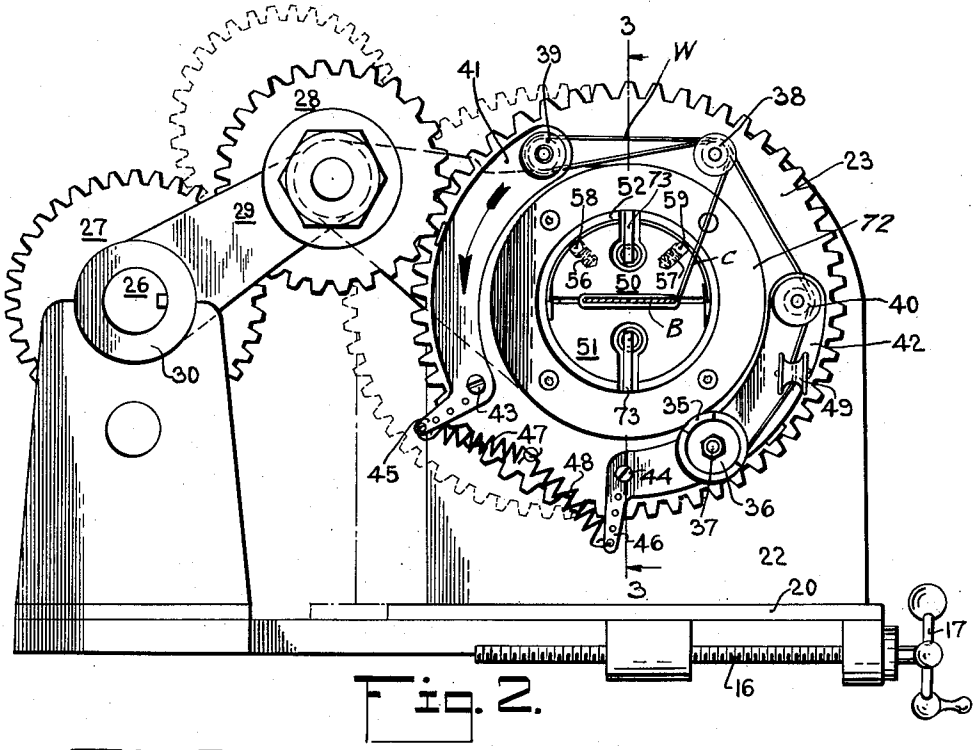
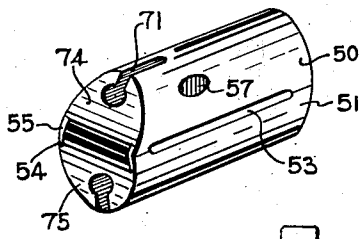



Fig. 2.

Fig. 5.



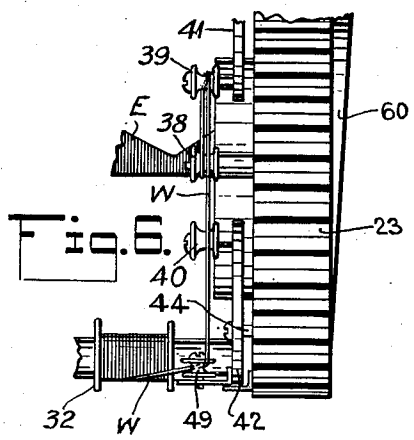




Fig. 6.

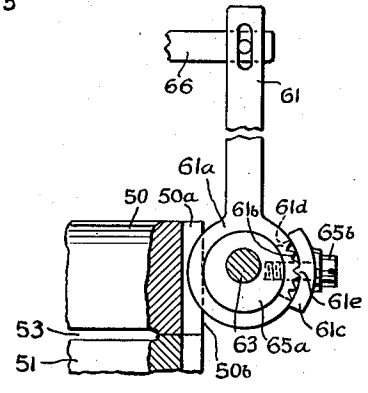



Fig. 7.

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# UNITED STATES PATENT OFFICE

2,569,292

## WIRE WINDING MACHINE

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Application March 9, 1946, Serial No. 653,319

10 Claims. (Cl. 242—9)

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This invention relates to wire-winding machines, and an object of the invention is to provide an improved winding machine for winding wire or similar flexible material efficiently and with great accuracy around a mandrel or blank of varying width.

More particularly, the invention relates to an improved machine for winding conductor wire around a flat core of varying width having an angular edge to be wrapped, to provide a variable potentiometer card.

The relatively steep slopes formed by the sinuous or angular edge contour of a variable potentiometer card have heretofore made the winding of such cards with conductor wire usually of fine gauge, extremely difficult due to the tendency of the individual lays of wire to slip out of position along the steeply sloping edge of the card. Efforts have been made to insure each lay of wire being retained in proper position by notching one or more edges of the potentiometer card. In other cases, the card blank itself has been formed of a relatively soft material, so that the lays of wire cut their own notches in the edges during the winding operation, and thus are held permanently in place. These and other expedients are either unsatisfactory mechanically, or result in too expensive a product.

A further object of this invention is to provide an improved winding machine for winding potentiometer cards, constructed and arranged to wind slopes of substantially any reasonable degree of steepness on blanks of any desired hardness, thus avoiding the necessity of employing special devices such as blanks formed of special composition.

These, and other objects, which will be apparent to those skilled in the art, are accomplished by the present invention, one embodiment of which is hereinafter described in specific detail.

In the accompanying drawing:

Fig. 1 is a view generally in perspective of a preferred embodiment of the invention with parts broken away and showing a step of the method towards the end of the winding operation;

Fig. 2 is a transverse sectional view looking from left to right of Fig. 1 showing the carriage and associated parts in end elevation;

Fig. 3 is a vertical sectional view of the winding head and associated parts taken on line 3—3 of Fig. 2 with parts of the thread tensioning means omitted;

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Fig. 4 is a view largely in side elevation of the parts shown in Fig. 3 looking at the same from the right side of Fig. 1 and with the winding head advanced 180° from its position in Fig. 3;

Fig. 5 is a detail view showing the "holding blocks" in perspective removed from their position shown in the preceding figures;

Fig. 6 is a plan view looking down on the right side of the winding head as viewed in Fig. 2; and

Fig. 7 is an enlarged detail view of means for adjusting the winding machine for wire of different gauge.

The machine considered as a whole resembles a lathe and is provided with the usual structural parts including a bed 10, head stock 11 and tail stock 12. Positioned between the head and tail stock is a carriage 13 mounted for longitudinal movement when operatively connected to the lead screw 14 by clutch 15. The carriage is also mounted for transverse movement by means of a transverse screw 16 shown in the present disclosure as manually manipulated by handle 17 following conventional practices in these respects.

The machine is designed to wind a length of conductor wire W or the like on to an elongated flat core blank B of variable width and which in the form illustrated has one edge E to be wrapped of irregular or angular contour with steep slopes and is intended to form a variable potentiometer in which case the wire is of extremely fine gauge bare or insulated metallic wire. It is understood that the term "angular" is intended to comprehend any variation of the edge from parallel relation to the axis along which the blank is wound, for convenience called the "longitudinal" axis. The head and tail stocks are provided respectively with clamping means 18 and 19 for holding securely the opposite ends of the core blank. The carriage includes a table 20 to which is secured an upstanding frame 21 extending transversely of the length of the machine and including a plate 22 for supporting a winding head 23. Secured to the plate 22 around a central aperture therein by small bolts 24, Fig. 3, and projecting towards the head stock from one side thereof like a hub is a hollow bearing 25 of cylindrical form with its outer face machined to a smooth cylindrical contour. The winding head 23 is conveniently provided externally with teeth to form a large spur gear and is rotatably mounted on the hub-like bearing 25. The spur gear is driven from a power shaft 26 and forms the floating end element of a gear train, the first element of which

is a power gear 27, Fig. 2, spline-keyed to the power shaft so as to be free to move thereon with the longitudinal traverse of the carriage. An idler gear 28 is at all times in mesh with the power gear and the winding head gear 23 and is mounted at the outer end of a link 29, the other end of which terminates in a sleeve 30 rotatably mounted on the power shaft. By reference to Fig. 2 it will be seen that by means of this flexible gear train it is possible to move the carriage transversely to set the winding head relative to the longitudinal axis of the core blank being wound, and at all times the winding head is operatively connected to the power shaft in the several positions in which it may be adjusted by the carriage as indicated by the full and ghost lines in Fig. 2. The screw 14, Fig. 1, for advancing the carriage traverse and the power shaft 26 are operatively connected by means of gear sets (not shown) which can be changed and replaced by gears having different gear ratios to provide the required degree of carriage advance per rotation of head as is commonly practiced in machine tools.

The winding head 23 is provided with mechanism for feeding the wire W evenly under tension to the card blank B. For this purpose the head is provided with a spool shaft 31 supporting a supply spool 32 of the winding material. For the purpose of restraining what would otherwise be the normal freedom of rotation of the spool on its shaft, tensioning devices are provided, which in the illustrated instance, includes a barrel-like bearing head 33 pressed by spring 34 into frictional engagement with the outer end of the spool. The spring 34 is contained within a barrel-like extension 35 in which rides a flat cylindrical bearing disc 36 riding freely on the outer end of the spool shaft and disposed in adjusted position by means of a nut 37 engaging the outer end of the shaft. Also mounted on the front face of the winding head are a series of fan pulleys about which the wire is trained and properly tensioned and from which it is discharged by a final guide pulley 38. For the purpose of tensioning the wire as it is trained about the several pulleys, two of the pulleys 39 and 40 are mounted respectively on the free ends of arms 41 and 42 which are pivoted at 43 and 44, Figs. 2 and 6, to the front side of the winding head. The lower ends of these arms are provided with angled extensions 45 and 46 and are biased by tension springs 47 and 48 which act on the arms to pull their associated pulleys outwardly and thus tension the loop of wire which extends from the first pulley 40 over pulley 38 and around pulley 39 back to the feed guide pulley 38. The fourth pulley 49 is located between the spool 32 and the first pulley 40, and is disposed with respect to the other three pulleys as particularly shown in Fig. 6 so that its axis of turn is offset from and at right angles to the axis of rotation of the other spools. By this means the wire may be withdrawn from the supply spool at any point thereon and with a change of the direction as shown in Fig. 6 be directed onto the first pulley 40.

Mounted within the hub-like bearing 25 for reciprocal movement with respect to the core blank is means for precisely and firmly holding each newly laid turn in proper position comprising in the present instance two separately movable holding blocks 50 and 51 each of which is substantially a half cylinder. When brought together as shown in Fig. 5 the blocks form a generally cylindrical assembly, each half of which



is longitudinally slidable in the bearing 25 at opposite sides of the blank. The bearing may be lined with a steel bushing 52 the inner surface of which is machine smooth to facilitate the reciprocatory action of the holding blocks. The forward end of the bushing 52 is provided with an annular shoulder 72 which acts as an end bearing for the winding head. The blocks as shown in Figs. 3 and 5 each have their adjacent flat surfaces cut back or recessed to provide a clearance 53 arranged to reduce the area of contact and hence the friction, with the core blank which is positioned between the blocks, Fig. 3.

Considered in front elevation as shown in Figs. 2 and 5 a projection 54 from the outer edge of each block extends radially, in relatively opposite directions, into a recess 55 designed to receive the same on the companion block. These projections not only preclude any relative sidewise movement between the two blocks, but also keep the wire from getting snagged in the space between the blocks. The upper block 50 is provided on opposite sides of its crown with a pair of recesses 56 and 57 in which are located respectively spring pressed balls 58 and 59, Fig. 2, designed to react against the steel bushing 52 to force the upper block downwardly into light bearing engagement with the blank B and thus acts in effect to clamp the blank between the two blocks, but this clamping action is not of sufficient intensity to in any way interfere with the longitudinal traverse of the carriage along the blank during the winding operation.

The rear face of the winding head 23 is machined to form a curved ridge constituting a cam 60, Fig. 4, having a single high point spaced 180° from the low point. Mounted on the frame 21 in rear of the winding head are two rockers 61 and 62, one for each block. These rockers are of similar construction and extend radially outwardly from their pivot pins 63 and 64 respectively. The hub portion of each of the rockers is of eccentric cam design, each provided with a high point 65 in bearing engagement with the rear face of its respective block as best shown in Fig. 3. Each of the rockers is designed to be oscillated by means of the winding head cam 60 and for this purpose each rocker is provided with a cam follower or finger 66 pivoted to and extending through a slot in its associated rocker. The follower end of the finger rides on the inclined working face of the cam 60, and is resiliently biased toward following engagement by a coiled spring 69 fitted between the arm of the rocker and nut 68 adjustable on a spring centering rod 67 secured to the frame.

Each block is provided with means for maintaining it in resilient engagement with the eccentric hub of the respective rocker and for this purpose each block is provided with a pocket 70, Fig. 3, the outer end of which opens through the outer side of the block to form a slot 71. A pair of pins 73 extend from the shoulder 72 through the bushing 52 and extend into the slot 71. A compressed spring 70' housed within each pocket 70 bears at one end against its associated pin and at the other end against the related block.

The advance or working end of each of the blocks projects beyond the shoulder 72 and is provided with a bevelled guide face for guiding the length of wire discharged from pulley 38 onto the card blank B and for temporarily holding the wire so laid in its exact proper position. The beveled faces of the blocks in complementary alined relation form a generally convex contour

as seen from Fig. 5. As viewed in Figs. 1, 3 and 5, the block **50** is provided with guide face **74** which is inclined downwardly and forwardly and block **51** is provided with guide face **75** which is inclined upwardly and forwardly. The faces terminate at opposite sides of the blank and are so arranged relative to the points at which the wire is discharged from the last spool or the last pulley to cause the length of material about to be laid on the blank to slide down the inclined faces, first on one and then the other and be guided into position as indicated in Figs. 3 and 4.

In operation, the core blank is placed in position by feeding it through the bearing **25** and between the holding blocks and clamping its opposite ends to the head and tail stocks with the blank stretched therebetween under tension. The feed end of the conductor wire W is first threaded around the direction and tension pulleys and is then secured between the jaws of the clutch **18**, Fig. 1. The machine is then started in operation so that the winding head turns in a counterclockwise direction as indicated by the arrow in Fig. 2. This causes the wire to be wrapped about the core blank along its longitudinal axis as the carriage is moved from left to right of the showing in Fig. 1. The carriage speed is so regulated relative to each cycle of movement of the winding head that the turns are laid relatively close to each other during the winding operation and the design of cams **65** is so related to the carriage travel per rotation of winding head that the forward movement of each holding block compensates the receding movement of the carriage. In other words, even though the carriage is receding while the wire is being laid, the newly laid turn is held stationary in fixed predetermined position for a sufficient time to prevent any slipping of the turn on the blank. As the winding head turns, the wire is laid against the guide faces first against the upper face and then against the lower face and these guide faces act to lay the wire without slipping in relatively straight lines onto the opposite flat sides of the blank where the turns remain in fixed position.

In the preferred embodiment of this invention each lay as it is positioned first on one side and then on the other side of the blank is held by one or the other associated blocks **50** and **51** under influence of rocker cams **65** into precise predetermined position either in engagement with the adjacent preceding lay or spaced thereupon a determinate distance to provide an air space between successive lays. As shown in Fig. 3, the lower holding edge **75** is holding the last lay marked *a* in parallel engagement with the underlap *b* of the previously laid loop and in this position the upper holding edge **74** is in its retreated position so that the blank is free to receive the length *c* of wire passing from the guide roller **38**, in this instant position shown to be at twelve o'clock position. As this pulley passes the nine o'clock position (as viewed in Fig. 2) the lay *d* is placed on top of the blank after which as the pulley passes into the six o'clock position shown in Fig. 4 the next lower lay is about to be paid from the length *e*. In the meantime the upper block has been gradually advanced by cam **60** from the retreated position shown in Fig. 3 into the advanced position shown in Fig. 4, for holding the lay *d* in the fixed predetermined position until guide roller **38** is again in the twelve o'clock position. Upper edge **74** then retreats so as to be out of the way for the next lay and lower edge **75** moves forward to hold the lower turn just laid. This action continues with first one and then the other of the holding blocks acting lengthwise of the blank and transversely of the lays to position each succeeding lay of wire on the card blank. At the termination of the operation, the wire ends are secured to the blank in conventional manner after which the potentiometer card thus formed is removed from the machine, and mounted on any suitable supporting form.



During the winding operation the lateral position of the winding head with relation to the card blank is of importance. By adjusting the winding head traverse carriage through the medium of the screw **16** so as to keep the winding head centered during winding with respect to the varying longitudinal contour of the card blank, the rate of payoff of wire from the supply spool **32** can be maintained relatively constant, thereby preventing large acceleration and deceleration of the wire and spool which would otherwise occur. If desired, automatic means such as any suitable follow-up system such as that shown in Riggs Patent No. 2,115,086, granted April 26, 1938, for controlling the traverse screw **16** to keep the winding head centered with respect to the card blank can be provided, the controlling element of course following the contoured edge E.

Where the winding machine is to be used for winding wire of different gauge it is necessary that the extent of movement of the holding blocks be accurately related to the gauge of wire used so that the turns are held in the desired position during the winding operation. In Fig. 7, there is shown an arrangement for adjusting the "throw" of the rocker cams, and hence the block movement, so that several different gauges of wire can be used in the present machine. Specifically, the rocker arm **61**, for example, is provided with a hub or collar **61***a* freely fitted on a cylindrical rod member **65***a* which is eccentrically pivoted at **63** so as to constitute the operating cam. The corresponding holding block **50** is provided with a vertical slot **50***a* for receiving the collar **61***a* so that the working face of the cam **65***a* can engage the coacting face **50***b* of the block at opposite sides of the slot. The working stroke or throw of the cam for a given angular movement of the arm **61** can be varied by an adjustable connection therebetween comprising a clamping plate **61***c* that normally holds the collar **61***a* in fixed relation to the cam **65***a* by a screw **65***b*. A detent or the like **61***e* can be conveniently formed on the under side of the plate **61***c* for selective engagement with one of a series of spaced notches **61***b* formed along the outer periphery of the collar **61***a*, the spacing of the notches determining the difference in gauge of wire used. The clamping plate screw **65***b* extends through a slot **61***d* in the collar **61***a* into a drilled tap in the cam **65***a* so that when the screw is loosened and the detent **61***e* lifted from its notch the rocker arm can be rotated within the limits of slot **61***d* with respect to the cam thereby providing quick and easy adjustment of the cam throw corresponding to the gauge of wire used.

It should be understood that this invention is not limited to specific details of construction and arrangement thereof herein illustrated, and that changes and modifications may occur to one

skilled in the art without departing from the spirit of my invention.

What is claimed is:

1. In a machine for winding conductor wire or the like around a flat core blank of varying width, the combination of blank securing means and winding means mounted for relative movement for winding the wire under tension about the blank along an axis thereof, movable means disposed at opposite sides of said blank for holding as it is laid each lay of wire in determinate position with respect to the previously laid adjacent lay first on one side of the blank and then on the other side, and means for moving alternately said holding means in timed relation to said winding means so as to hold said first named lay until the succeeding lay is laid at the opposite side of said blank, said holding means for said first named lay then moving to an unobstructing position so that the blank can receive the next lay following the aforesaid succeeding lay.

2. In a machine for winding conductor wire or the like around a flat core blank of varying width to form a potentiometer card, the combination of means for securing said blank in position, means for progressively winding the wire under tension about the blank, movable means disposed at opposite sides of said blank for guiding as it is laid each lay of wire toward the previously laid adjacent lay and for holding said lay of wire in determinate position with respect to said adjacent lay, and means for moving alternately said guiding and holding means in timed relation to said winding means for guiding and holding said lays of wire, first on one side of the blank and then on the other side, so that each lay is held until the succeeding lay is laid at the opposite side of said blank.

3. In a machine for winding conductor wire or the like around a flat core blank of varying width along the longitudinal axis of said blank, the combination of means for securing said blank in position, means for progressively winding the wire under tension about the blank along said axis, a pair of movable members for holding, first on one side of the blank and then on the other side each lay of wire as it is laid in determinate position with respect to the previously laid adjacent turn, and means for moving alternately said holding members in timed relation to said winding means so that said first named lay is held until the succeeding lay is laid at the opposite side of said blank.

4. In a machine for winding conductor wire or the like around an elongated flat core blank of varying width in a substantially smooth layer extending along the longitudinal axis of said blank, the combination of means for winding the wire about the longitudinal axis of the blank so that said wire is guided into position first on the one side and then onto the opposite side of the blank along parallel lines substantially at right angles to said longitudinal axis, a periodically operated member disposed at each side of said blank for temporarily holding the entire width of each lay alongside the adjacent lay of the previous turn, and means for coordinating the operation of said winding means and periodically operated members for alternating said holding operations so that a lay is finally positioned before the next succeeding lay is paid into position.

5. A machine for winding a small gauge wire about a flat core blank to form a variable potentiometer or the like, comprising spaced supporting means for engaging opposite ends of the blank to hold the same in fixed position, a carriage movable between said supporting means along the longitudinal axis of said blank, said carriage including a winding head through which the blank extends mounted for rotation about the blank for wrapping the wire about the blank as the carriage is advanced, and wire positioning and holding structure mounted on the carriage and engaging the blank at the opposite flat sides thereof, and means for coordinating the operation of said winding head and said structure so that said structure is arranged for alternate reciprocation at opposite sides of the blank in a direction transverse to the lays of wire on said blank in timed relation to rotation of the winding head whereby each turn of the wire as it is laid on the blank is guided and held alongside the adjacent previously laid turn until the next turn is laid.



6. In a wire winding machine, the combination of means for detachably holding an elongated flat core blank firmly in place, a movable carriage provided with a bearing having an opening through which the core blank extends as the carriage is fed in its traverse along the length of the blank, a pair of holding members on said carriage located on opposite sides of and lightly engaging the blank, said members each mounted for reciprocatory movement in the direction in which the carriage moves, a winding head journalled for rotary movement on the bearing and rotatable about the blank to wrap a wire closely about the blank as the carriage advances, and cam operating means controlled by the rotating winding head and operatively connected to said holding members to cause them alternately to hold as it is laid the wire alongside the adjacent previously laid wire first on one side and then on the opposite side of the blank.

7. In a winding machine, the combination of means for holding an elongated core blank in position to be wound with fine gauge wire, a carriage mounted for movement along the longitudinal axis of the core blank, a cylindrical bearing mounted on and movable with the carriage through which the blank extends, a winding head of annular form rotatably mounted on the exterior surface of said bearing, power means operatively connected to said winding head for causing rotation thereof, means carried by the winding head for guiding said wire onto the blank as the winding head rotates about the blank, a pair of holding members operating respectively on opposite sides of the blank for holding the last laid wire on the blank alongside the previously laid wire, each holding member being slidably mounted for reciprocatory movement in direction opposite to that of the other within the inner surface of said bearing, said winding head provided on its rear side with a cam forming surface, and a pair of cam followers, one for each holding member for moving the corresponding member in a direction to hold each lay of wire alongside the adjacent previously positioned lay as the carriage recedes from said lay and to cause the holding members to reciprocate once for each rotation of the winding head for alternate positioning lays at opposite sides of the blank.

8. In a winding machine, the combination of means for holding an elongated core blank in position to be wound with wire, a carriage mounted for movement along the longitudinal

axis of the blank, a cylindrical bearing mounted on and movable with the carriage through which the blank extends, a spur gear wheel forming a winding head rotatably mounted on the exterior surface of said bearing, power means having a geared connection with said spur gear for rotating the winding head, means carried by the winding head for guiding said wire onto the blank as the winding head rotates about the blank, a pair of holding members each in the general form of a half cylinder operating on opposite sides of the blank for holding the last lay of wire alongside the adjacent previously laid wire at both sides of the blank as the carriage recedes from said lay, said holding members each being mounted within the inner cylindrical surface of said bearing for slidable movement with respect to each other along said blank axis, resilient means reacting radially between one of said members and said bearing tending to maintain the blank lightly squeezed between the holding members, and cam operating means interconnecting said winding head and members to cause said members to reciprocate in relatively opposite directions, once for each rotation of the winding head for holding in final position each new lay of wire, first on one side of the blank and then on the other.

9. In a machine for winding wire or the like around a flat core blank having an edge of angular contour to be wrapped, the combination of means for securing said blank in position to be wound, a carriage movable along the longitudinal axis of said blank having means for progressively winding the wire about the blank along said edge, movable means disposed at the opposite flat sides of said core blank for holding as it is laid each turn of wire in determinate position with respect to the previously laid adjacent turn for preventing slipping of turns on steep slopes of said angular edge, and means for alternately moving said



holding means at opposite sides of said core blank in timed relation to each winding cycle and in relation to the travel of said carriage first on one side of said blank and then at the other so that said first-named turn is held in fixed position alongside said previously laid turn during receding movement of said carriage until the succeeding lay at each opposite side of the blank is laid.

10. In a machine for winding wire of predetermined gauge around a flat core blank having an edge of angular contour to be wrapped, the combination of means for securing said blank in position to be wound, a carriage movable along the longitudinal axis of said blank having means for progressively winding the wire about the blank along said edge, means movable into position at opposite sides of said blank for temporarily holding as it is laid each turn of wire in determinate position with respect to the previously laid adjacent turn for preventing slipping of turns during the winding operation, means for operating said holding means in timed relation to each winding cycle and in relation to the travel of said carriage so that said first named turn is held in fixed position alongside said previously laid turn during receding movement of said carriage until the succeeding lay at the opposite side of the blank is laid, and means associated with said operating means for varying the extent of movement of said holding means at both sides of said blank so as to compensate for variations in gauge of the wire used.

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