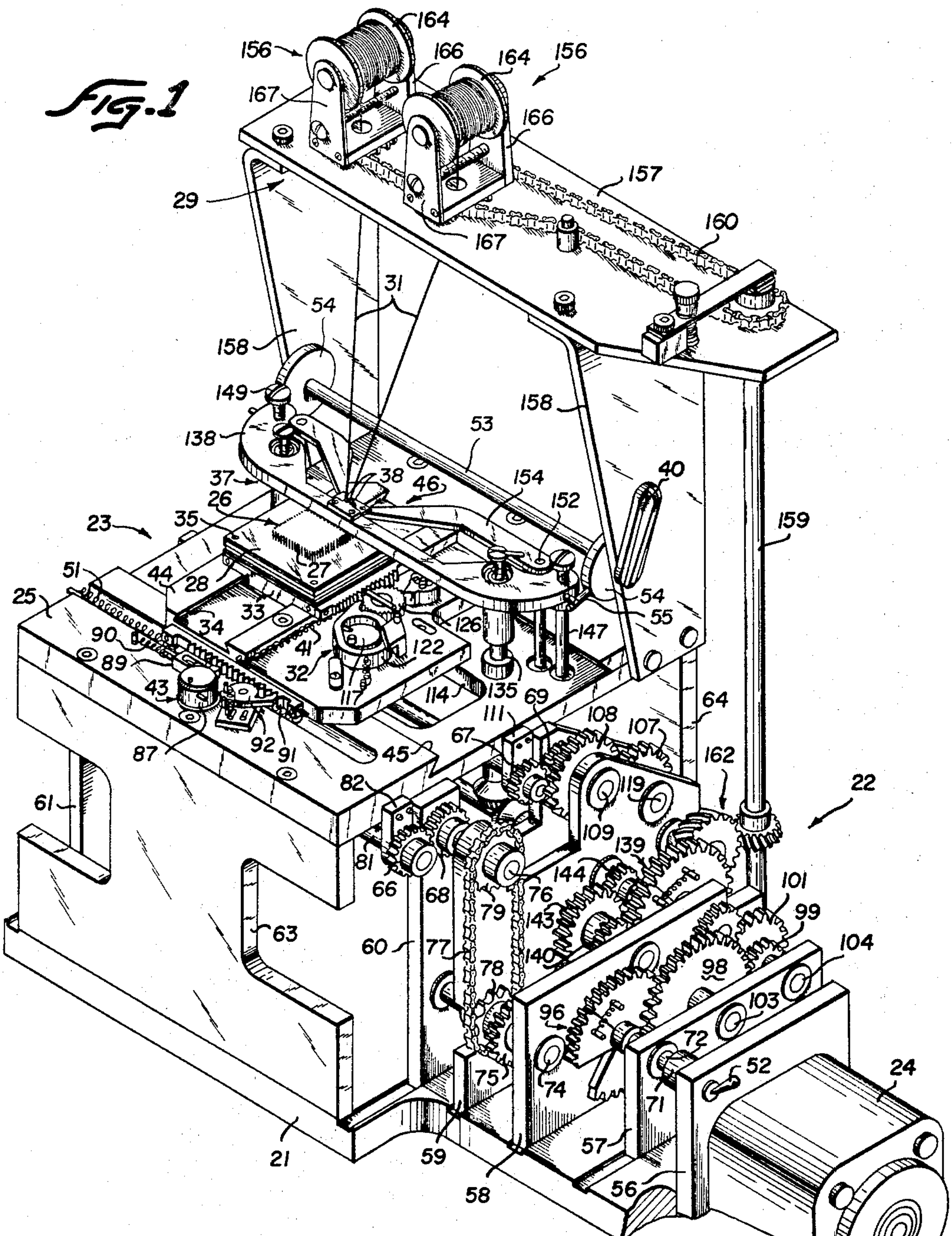
SOLENOID WINDING MACHINE

Filed Sept. 16, 1964 6 Sheets-Sheet 1

FIG. 1



INVENTOR
IVAN VIRGIL RONDAS

BY Louis A. Kline
John J. Matlago
Dominick Nardelli
HIS ATTORNEYS

Nov. 12, 1968 I. V. RONDAS 3,410,317

SOLENOID WINDING MACHINE

Filed Sept. 16, 1964 6 Sheets-Sheet 2

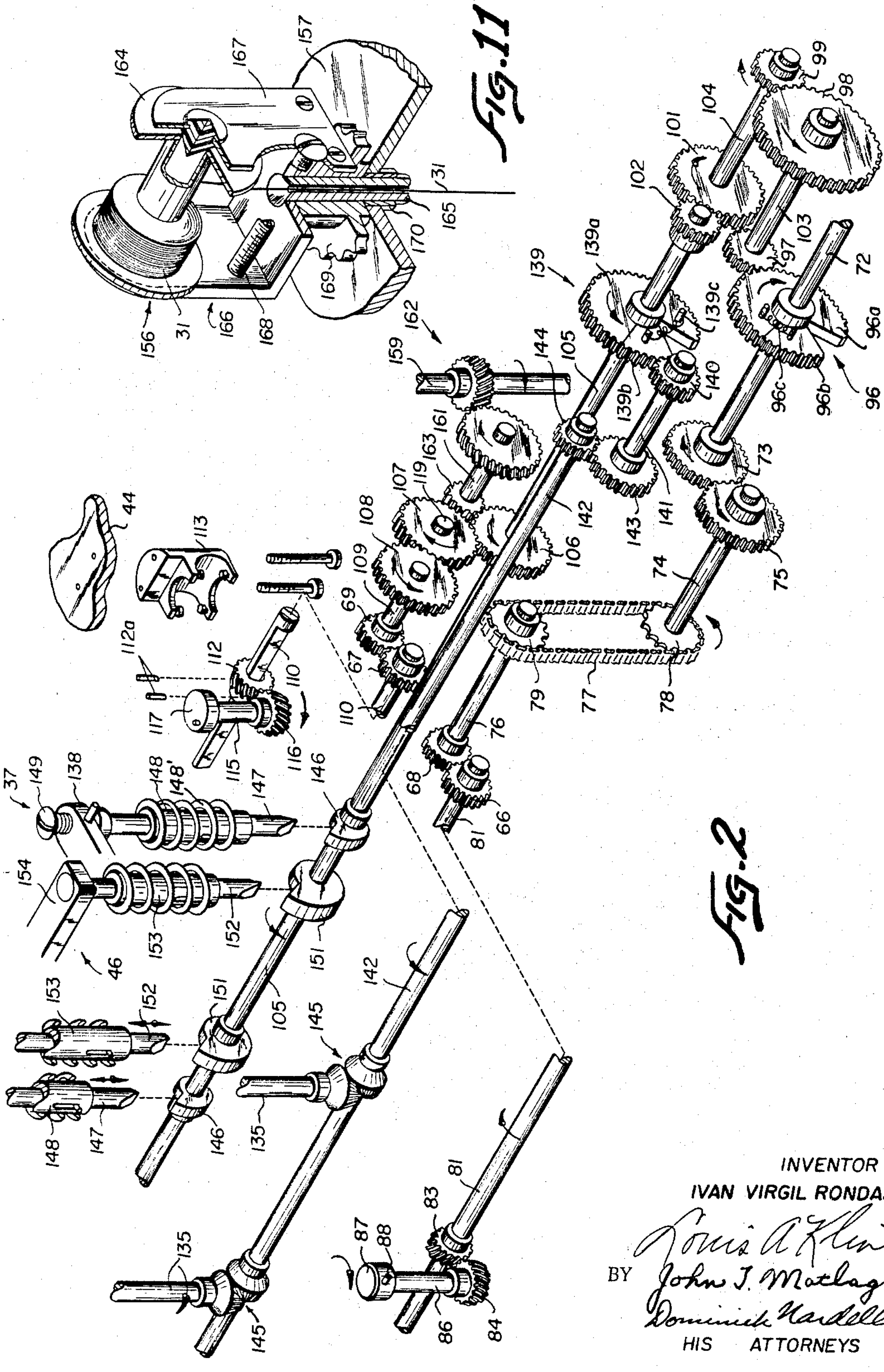


FIG. 11

FIG. 2

INVENTOR
IVAN VIRGIL RONDAS

BY Louis A. Kline
John J. Matlago
Dominick Nardelli
HIS ATTORNEYS

FIG. 3

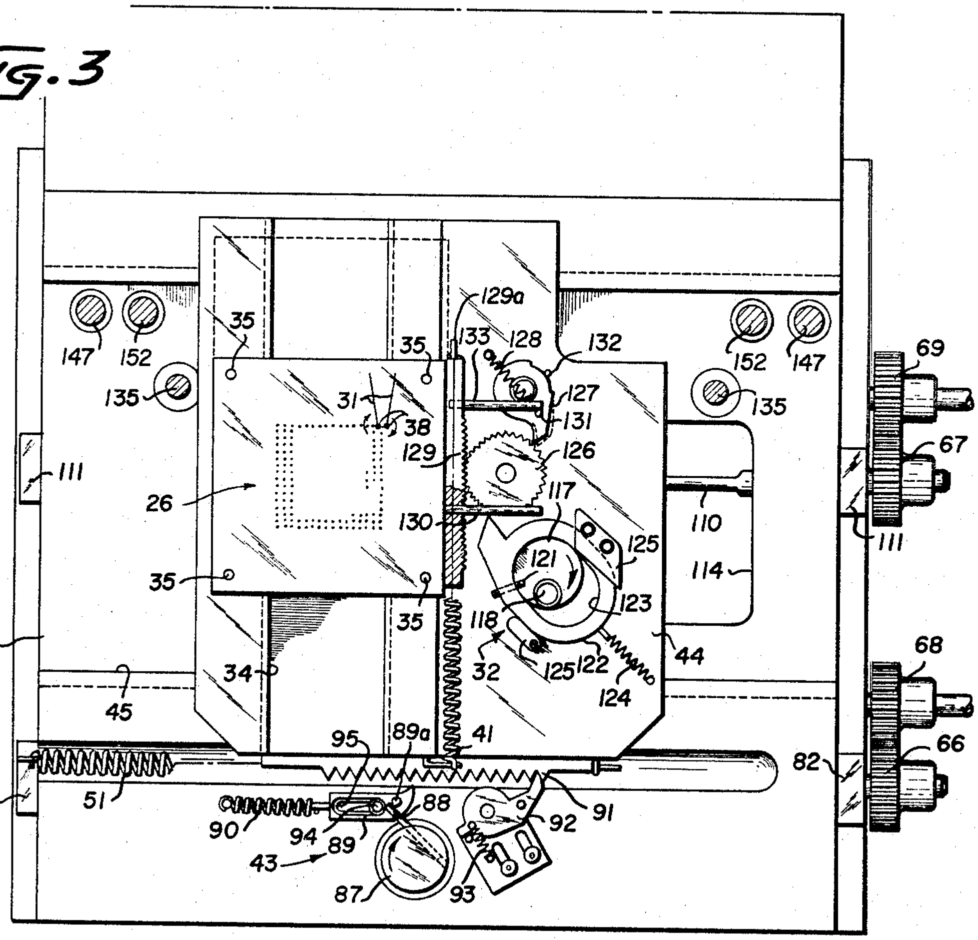


FIG. 3a

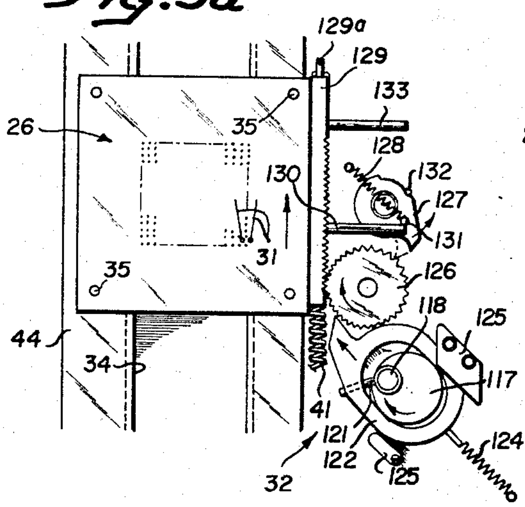
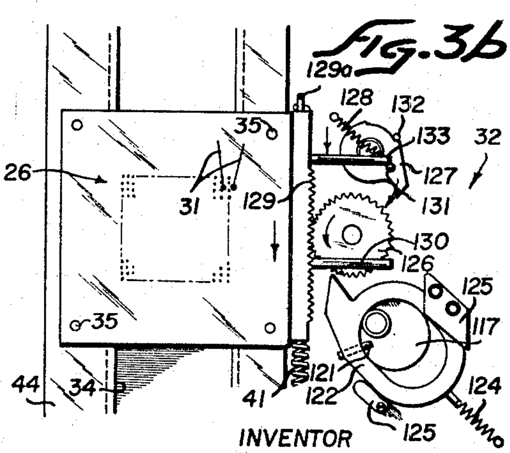


FIG. 3b



INVENTOR
IVAN VIRGIL RONDAS

BY Louis A. Kline
John J. Matlago
Dominick Nardelli

HIS ATTORNEYS

Nov. 12, 1968 I. V. RONDAS 3,410,317

SOLENOID WINDING MACHINE

Filed Sept. 16, 1964 6 Sheets-Sheet 4

FIG. 7a

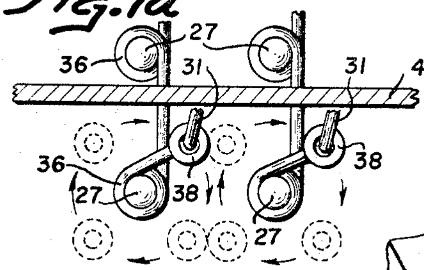


FIG. 7b

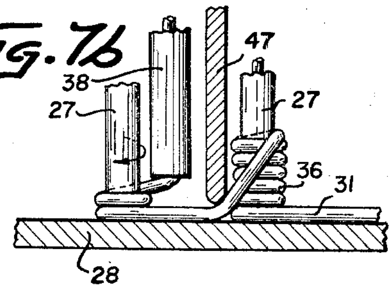


FIG. 7

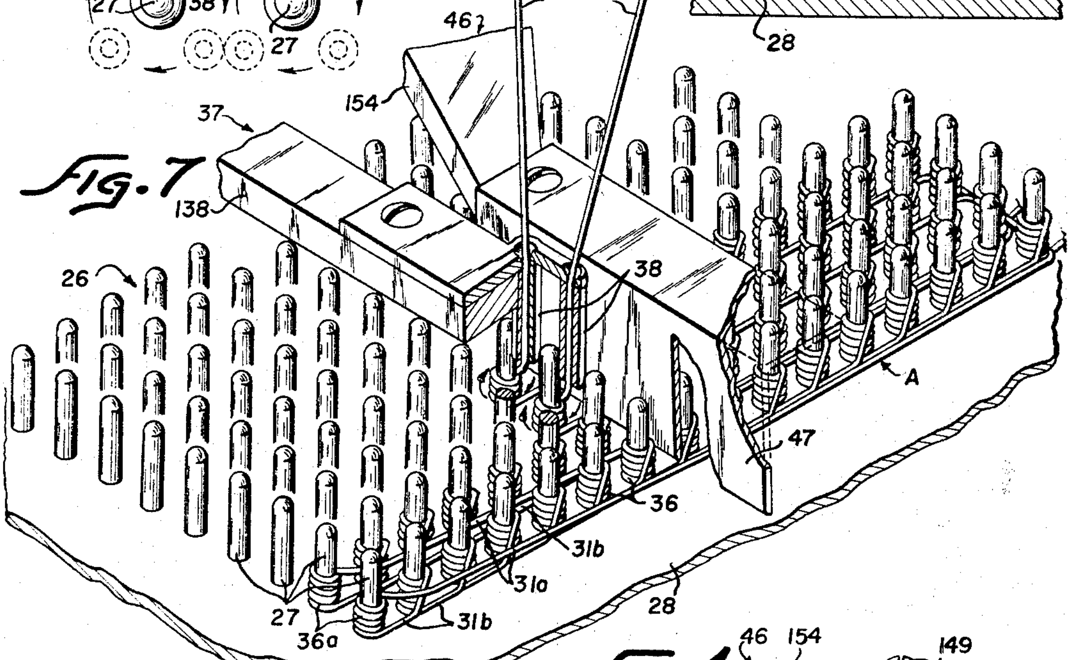
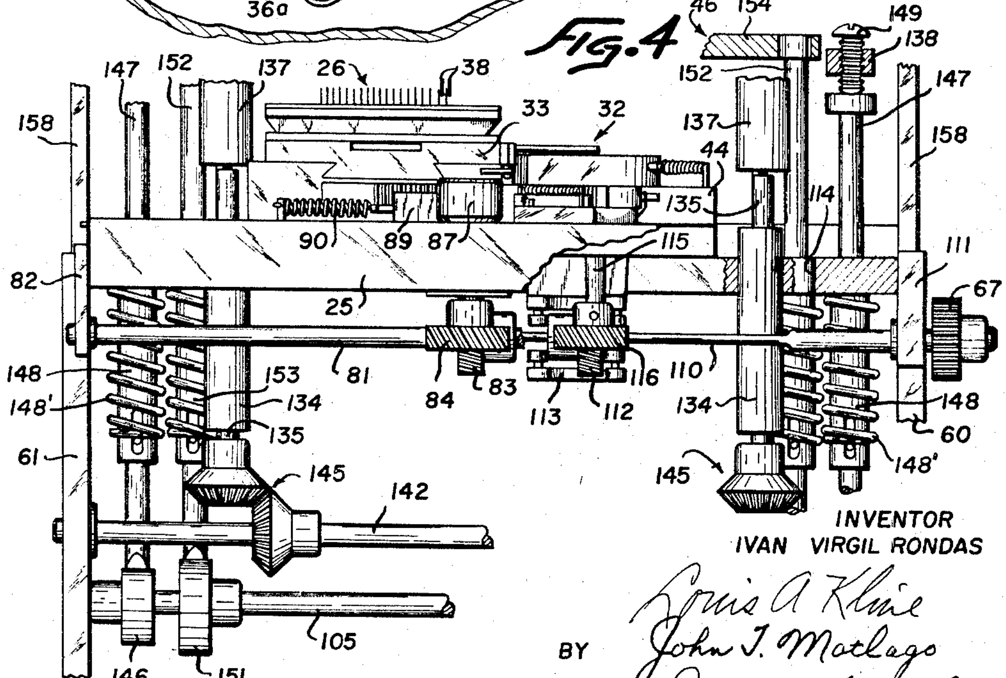


FIG. 4



INVENTOR
IVAN VIRGIL RONDAS

BY Louis A. Kline
John T. Matlago
Dominick Nardelli
HIS ATTORNEYS

SOLENOID WINDING MACHINE

Filed Sept. 16, 1964

FIG. 5

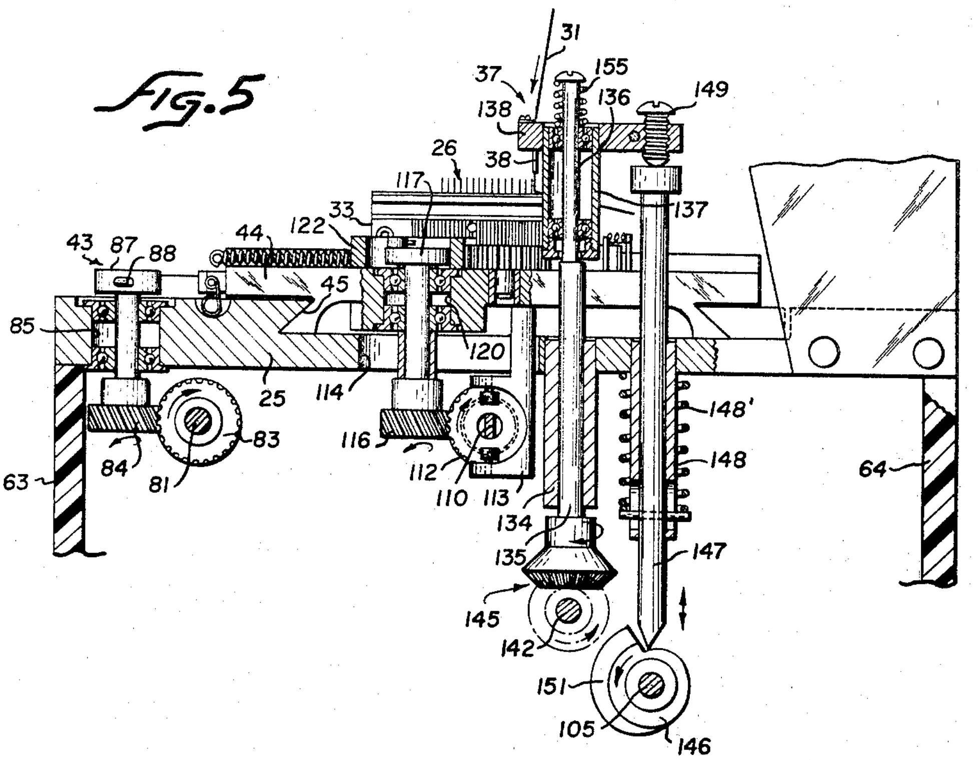
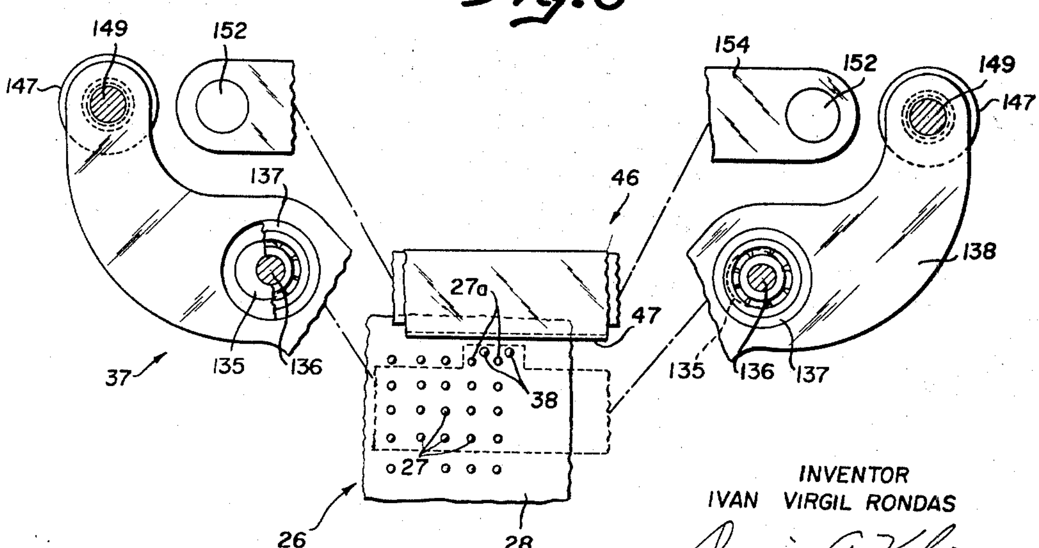


FIG. 6



INVENTOR
IVAN VIRGIL RONDAS

BY Louis A Kline
John J. Matlago
Dominick Nardelli
HIS ATTORNEYS

SOLENOID WINDING MACHINE

Filed Sept. 16, 1964 6 Sheets-Sheet 6

FIG. 8

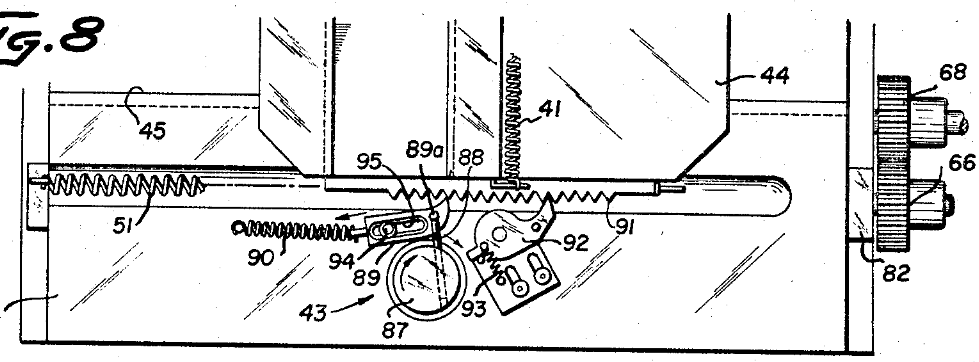


FIG. 9

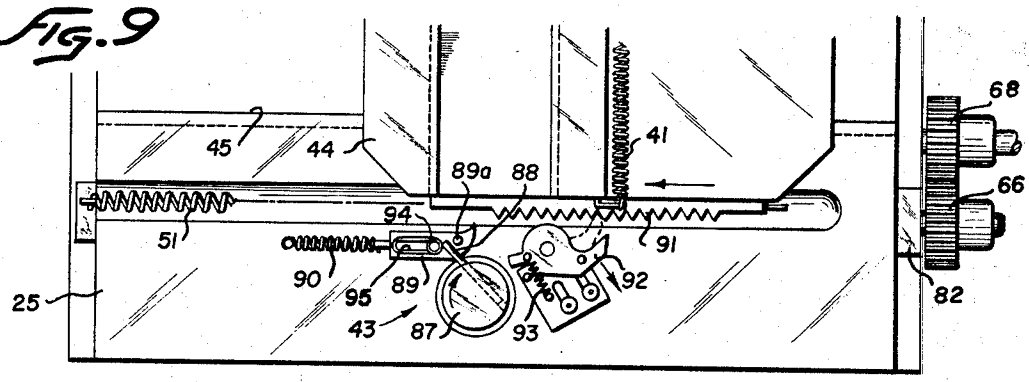
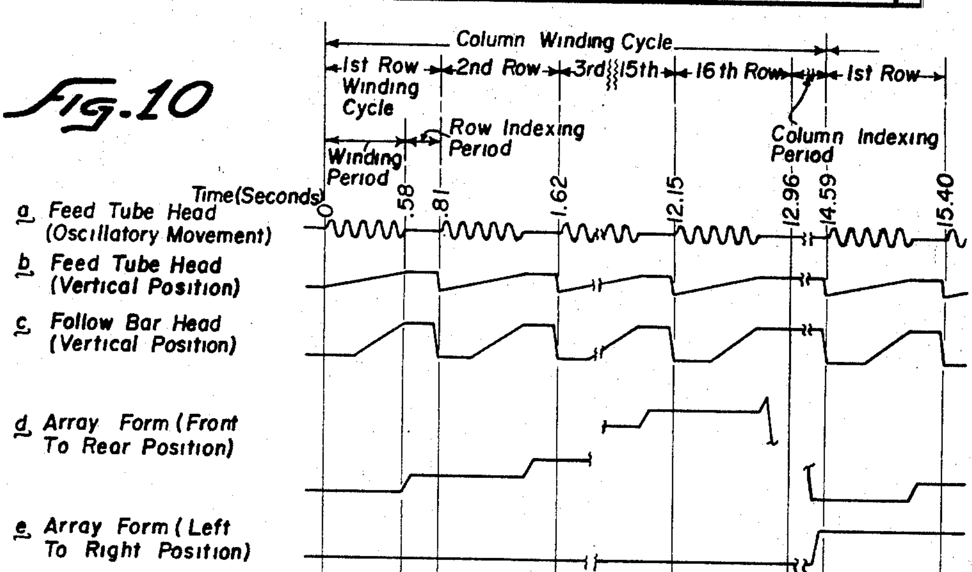


FIG. 10



INVENTOR
IVAN VIRGIL RONDAS

BY Louis A Kline
John J. Mathago
Dominick Nardelli
HIS ATTORNEYS

United States Patent Office

3,410,317
Patented Nov. 12, 1968

3,410,317
SOLENOID WINDING MACHINE

Ivan Virgil Rondas, Compton, Calif., assignor to The National Cash Register Company, Dayton, Ohio, a corporation of Maryland

Filed Sept. 16, 1964, Ser. No. 396,914
11 Claims. (Cl. 140—93)

The present invention is directed to an electrical solenoid winding machine and more particularly to a machine for winding solenoid arrays in a new and improved manner.

In my copending United States patent application Ser. No. 206,759, filed on July 2, 1962, now Patent No. 3,279,708, an electrical solenoid winding machine has been disclosed that simultaneously winds all the solenoids in one row on an array of solenoid forms or pins fixed to a nonrotatable support. After the machine winds a row of solenoids, the support for the solenoids is indexed relative to the solenoid winding elements, so that the next row of solenoids can be wound by the machine on the next row of pins. The machine inherently series-winds the solenoids in each column from an integral or continuous length of conductor. After all the solenoids are wound on the array of solenoid forms, the conductors, forming the solenoids in the respective columns, are cut from their respective feeding means; the support is removed from the machine; and the array of solenoids is potted with a suitable plastic compound forming a rigid panel having solenoids, arranged in rows and columns, with the axes of the solenoids disposed parallel to each other. Multiple panels, having the same spacing and pattern between solenoids, are placed in a congruent stack so that bistable magnetic rods can be readily inserted through the aligned solenoid openings to form a magnetic rod memory matrix, for example, as disclosed in a commonly assigned, copending U.S. patent application Ser. No. 347,184, filed on Feb. 25, 1964, now Patent No. 3,315,241, inventor Donal A. Meier. Each magnetic rod of that particular memory stores a multidigit word, and therefore, during a read operation, the solenoid coils in each panel are used as a digit sense winding. To convert the solenoid coils in the panel, as produced by my prior machine, into a digit sense winding, the series-connected solenoid coils in one column have been connected in series with the series-connected coils in another column. This operation has been performed by soldering the conductor extending from one end of one column to the conductor extending from one end of another column. This is a very costly and tedious operation especially when it is performed on a panel array of 256 solenoid coils arranged in rows and columns confined within an area of less than one square inch.

Accordingly, an object of the present invention is to provide a machine for producing a coordinate array of solenoids in which the solenoid coils in one column and the solenoid coils in another column are connected in series and are formed from the same integral or continous length of conductor.

Another object is to provide a machine for automatically winding a coordinate array of solenoid coils wherein the machine loops back the conductor, after winding the solenoid coils in one column, and returns the conductor along a path adjacent to the straight lengths of conductor between the various solenoid coils before winding the solenoid coils in another column to produce a panel of solenoid coils wherein the stray circular magnetic fields formed around the straight length of conductor between solenoid coils are substantially cancelled.

Another object is to provide a machine for winding a solenoid array on an array of solenoid pins fixed to a support wherein the support is held stationary, while a feed tube having a conductor passing therethrough orbits about one of the pins and a stationary follow bar folds the conductor extending from the top of the last wound solenoid coils thereagainst and holds it as the feed tube winds the next solenoid coil.

Other objects and features of the invention will become apparent to those skilled in the art as a disclosure is made in the following detailed description of a preferred embodiment of the invention as illustrated in the accompanying drawings in which:

FIG. 1 is a pictorial view of a solenoid winding machine showing a preferred illustrative embodiment of the present invention for winding solenoid arrays;

FIG. 2 is a schematic representation of the gear train shown in FIG. 1;

FIG. 3 is a plan view of the table assembly of the machine showing the machine winding the first two solenoid coils on the array form;

FIG. 3*a* is a plan view of the row indexing assembly ready to release and return the carrier plate to the forward position;

FIG. 3*b* is a plan view of the row indexing assembly ready to stop the carrier plate in the forward position;

FIG. 4 is a sectional front elevation of the table assembly of the machine;

FIG. 5 is a sectional side elevation of the table assembly of the machine;

FIG. 6 is a top view of a portion of the feed tube head and follow bar head showing a portion of the solenoid array form, feed tubes, and follow bar in a larger scale than the remaining structure;

FIG. 7 is an enlarged pictorial view of a portion of the solenoid array form being wound with solenoids;

FIG. 7*a* is an enlarged plan view of a portion of the solenoid array form showing the path of the two feed tubes, each orbiting around a respective pin;

FIG. 7*b* is an enlarged elevation of a portion of the solenoid array form showing the follow bar folding the conductor against the last wound solenoid and the feed tube winding another solenoid;

FIG. 8 is a plan view of the column indexing assembly moving the carrier plate to the right;

FIG. 9 is a plan view of the column indexing assembly which has been manually released allowing the array form to move to the left of the machine;

FIG. 10 is a graphical representation of the movements of the various parts of the machine; and

FIG. 11 is an enlarged pictoral view in partial section of one of the conductor reel units shown in FIG. 1.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, FIG. 1 illustrates a preferred embodiment of the present invention. The machine has a base plate **21** which supports a gear train **22**, an electric motor **24**, and a table assembly **23**. The table assembly **23** supports a solenoid array form **26** for movement in two orthogonal directions under a conductor supply means **29**. The movement of the array form **26** in one direction is produced by a sliding block **44** slidably mounted within a dovetail groove **45**, disposed parallel to the front of the machine and formed in a fixed plate **25** of the table assembly **23**. The movement of the array form **26** in the other dircetion is produced by a solenoid carrier plate **33** slidably mounted within a dovetail groove **34**, disposed front to rear of the machine and formed in the sliding block **44**. The solenoid carrier plate **33** supports the solenoid array form **26** under a conductor feed or guide tube head **37** and a follow bar head **46**. The machine provides for winding an array of individual solenoid coils **36** (as shown in FIG. 7) on respective pins **27** mounted in a die plate **28** of the array form **26**. For clarity, the portion of the array form **26** in FIG. 7 is shown greatly enlarged. For example, the pins **27** are arranged sixteen to a row and sixteen to a column wherein the rows are oriented parallel to the fornt of the machine and the columns front to rear of the machine. The two hundred fifty-six pins in the array form **26** occupy an area less than one square inch. Conductors **31** which are wound onto the pins **27** to form the solenoid coils **36** are supplied by the conductor supply means **29** (FIG. 1), supported above the feed tube head **37**, as shown.

After the machine winds the solenoid coils **36** on all the pins **27** of the array form **26**, an array of solenoid coils is produced and arranged in rows and columns corresponding to the location of individual solenoid pins **27** of the array form **26**. The machine winds the array of solenoid coils **36** by winding coils on two pins **27** at a time by moving the array form **26** below the feed tube head **37** in three distinct directions which are: (1) indexing the array form **26** in equal increments to successive pin positions from front to rear until all the coils in two columns are wound, (2) returning the array form **26** in one step to its prior position in front of the machine, and (3) indexing the array form in equal increments to successive positions from left to right so that two more columns of pins **27** may be wound with coils. Referring to FIGS. 7, 7*a* and 7*b*, each time two new pins are disposed under the feed tube head **37**, a follow bar head **46** is dropped to hold the conductors **31** against the die plate **28**, and the feed tube head **37** is set into circular oscillatory motion by the gear train **22**, so that each of the two feed tubes **38** in the feed tube head **37** orbits around a respective pin disposed under the head. (The orbiting paths of the feed tubes **38** are shown in FIG. 7*a*.) The pitch of the turns of the solenoid coils **36** is controlled by two cams **146** (FIG. 2) which gradually lift cam followers **147** and, in turn, the feed tube head **37** upwardly while the two coils are being wound. The follow bar head **46** includes a follow bar **47** (see FIG. 7*b*) which folds and holds each conductor **31** against each of the previously wound coils and against the die plate **28**. After two coils are wound, two other cams **151** (FIG. 2) lift cam followers **152** and, in turn, the follow bar head **46** sufficiently so that the follow bar **47** clears the pins **27** before the next row of pins on array form **26** is indexed under the feed tube head **37**. A row indexing assembly **32** (FIG. 1), mounted on the sliding block **44**, performs the row indexing operation. Since the feed tubes **38** stop and start from an oblique position with respect to the columns and rows of pins **27** (as shown in FIG. 7*a*), the feed tubes **38** are able to pass between the pins **27** whenever the array form **26** is indexed in either direction. After all the coils in the first two columns are wound, the row indexing assembly **32** releases the array form in a manner to be later described and, in turn, the array form **26** is pulled to the front of the machine by a spring **41** (FIG. 1). Since the array form **26** is pulled to the front of the machine, the conductor lengths **31***a* (FIG. 7) from the last wound solenoids **36***a* in one column are respectively laid down near the conductor lengths **31***b* connecting solenoids **36** in the same column. This procedure substantially cancels the stray magnetic field formed around the lengths **31***b* when current flows through the conductors. After the array form **26** is returned to the front of the machine, a column indexing assembly **43** (FIG. 1), mounted on the fixed plate **25**, indexes the array form two columns to the right. The pins in the third and fourth columns are wound next.

As shown in FIG. 7, the same continuous conductor that wound the coils in the first column is used to wind the coils in the third column, and the same continuous conductor that wound the coils in the second column is used to wind the coils in the fourth column. After the solenoid coils **36** are wound on all the pins **27** on the solenoid array form **26**, the form is ready to be removed from the machine. The form **26** is removed manually after lifting the feed tube head **37** out of the way by rotating a suitable lever **40** (FIG. 1). The lever **40** rotates a shaft **53** and disks **54**, fixed to the shaft **53**. Suitable pins **55** on the disks **54** raise the head **37**. After the array form **26** is removed, the two conductors **31** are cut. The array of solenoid coils **36** is now ready to be potted with a dielectric plastic material. A suitable mold (not shown) is placed around the array of solenoid coils with the die plate **28** of the array form **26** forming one surface of the mold. The suitable dielectric material is invested around the solenoid coils in a standard manner. After curing, the invested array of solenoid coils and solid dielectric material are removed from the mold. Also, the die plate and the pins **27** are removed from the coils to provide a solenoid panel (not shown) wherein the axes of the coils are disposed parallel to each other and the spacing between the coils' axes is accurately maintained. Multiple solenoid panels, produced in this manner, can be stacked with magnetic rods inserted through corresponding solenoid coils in each panel to form the memory, for example, as disclosed in the abovementioned Donal A. Meier application.

The solenoid winding machine, shown in FIG. 1, includes the conductor supply means **29** for supplying two continuous length conductors **31** to respective feed tubes **38** in the head **37**. The two feed tubes **38** feed succeeding portions of the conductors **31** to the respective pins **27** to wind two solenoid coils **36** at a time in the same row. Indexing of successive rows of pins **27** below the feed tube head **37** provides for sequentially winding the coils in two columns, wherein the coils in each column are connected in series and formed from the same continuous length conductor **31**. Indexing of successive columns, two at a time, below the feed tube head **37** provides for winding the next two columns of pins **27** with solenoid coils so that the coils in alternate columns throughout the array are connected in series and are formed from the same continuous length conductor **31**.

The gear train **22** of the solenoid winding machine produces, when it is powered by the electric motor **24**, the various movements required to wind the array of solenoid coils **36**. Briefly, these movements comprise: (1) an intermittent horizontal front-to-rear movement of the solenoid carrier plate **33** for indexing each row of pins **27** successively under the feed tube head **27**; (2) a downward movement of the follow bar **47** to fold and tuck each conductor against a respective previously wound coil and to hold the conductors **31** against the die plate **28**; (3) a downward movement of the feed tube head **37** so that the first turn of the coil is formed against the die plate **28**; (4) a circular oscillatory movement of the feed tube head **37** in a horizontal plane for orbiting the feed tubes **38** around respective pins **27**; (5) an upward vertical movement of the feed tube head **37** during the winding of the coils to provide for the pitch in the turns thereof; (6) an upward movement of the follow bar **47** after the coils are wound; and (7) a horizontal left-to-right movement of the sliding block **44** for indexing the next two columns of pins under the feed tube head **37**. The combination of these seven movements provides for the winding of a complete array of solenoid coils wherein one column of solenoid coils is connected in series with another column of solenoid coils and the solenoids in both columns are formed from a continuous length conductor.

In general, in order to wind an array of solenoid coils **36** on an array form **26** with the machine described herein, the array form **26** is placed on the carrier plate **33**, after the feed tube head **37** is lifted out of the way by lever **40**. The follow bar head **46** is being held up above the carrier plate **33** because the motor **24** has been stopped after the gear train lifted the follow bar head **46** above the pins **27**. The array form **26** is aligned with the carrier plate **33** by dowels **35** (see FIG. 3) fitting into alignment holes in the die plate **28**. The carrier plate **33** is in the extreme forward position of the machine as determined by the row-indexing assembly **32** and the sliding block **44** is in the extreme left position as determined by the column indexing assembly **43** (see FIG. 3). After the feed tube head **37** is released by the lever **40**, the two feed tubes **38** are positioned to the rear and right of the first two pins **27a** to be wound, more clearly shown in FIG. 6. (Only one corner of the pins on the array form **26** is shown in FIG. 6 for clarity, and the portion of the feed tube head **37** over the array form is shown by dash lines.) The machine starts to wind coils when a switch **52** (FIG. 1) for the motor **24** is closed.

After the switch **52** for the motor **24** is closed, the motor **24** actuates the gear train **22** to cause the feed tube head **37** and the follow bar head **46** to drop toward the die plate **28** of the array form **26**. Thus, the follow bar **47** is able to hold the loose ends of the conductors against the die plate **28** and the feed tubes **38** are able to place the first turn of the coils **36** near the die plate. The winding of the coils **36** on any two pins adjacent the respective feed tubes **38** is accomplished by the combination of two synchronized movements. Referring to FIG. 10, these two synchronized movements and the other movements mentioned above are shown in graph form wherein the abscissa denotes time and the ordinate denotes distance. The two synchronized movements that cause the coils **36** to be wound are the circular, oscillatory movement (FIG. 10*a*) and the upward, vertical movement (FIG. 10*b*) of the feed tube head **37**. The circular oscillatory motion of the feed tube head **37** causes the two feed tubes **38** to orbit in a circular path, for example, five times about respective pins **27**, which are indexed under the head **37**, thus winding the conductors **31** around the pins. The upward, vertical movement of the head **37**, during the oscillatory motion, positions the conductors **31** vertically on respective pins **27** to produce a single layer of turns of a predetermined pitch on each of the pins. The upward movement of the feed tube head **37** during the winding period of a row winding cycle is in a direction parallel to the axes of the coils **36**, as illustrated in FIG. 10*b*. After the first two turns are formed on the coils, the follow bar **47** is no longer needed to hold the loose ends of the conductors **31** against the die plate **28**, and the follow bar head **46** starts to rise (FIG. 10*c*). As mentioned before, the follow bar head **46** rises a greater vertical distance than the feed tube head **37** in order to clear the pins **27** while the feed tubes **38** are able to pass between the pins **27** whenever the solenoid carrier plate **33** is indexed. After the winding period which is, for example, .58 of a second, a row indexing period follows in which the solenoid carrier plate **33** is indexed by the row indexing assembly **32** one incremental step to the rear of the machine, as illustrated in FIG. 10*d*. Afterwards the feed tube head **37** and the follow bar head **46** are both lowered (FIGS. 10*b* and 10*c*) to start the second row winding cycle. During the row indexing period, a dwell period is provided for the feed tube head **37**. The dwell period or row indexing period is, for example, .23 of a second, or two-sevenths of a row winding cycle which is .81 of a second.

The row winding period and the dwell period are repeated for each row winding cycle. As mentioned before, after the last or sixteenth row is wound, the solenoid carrier plate **33** is again indexed to the rear by the row indexing assembly **32**. However, referring to FIG. 3*a*, the row indexing assembly **32** is tripped, in a manner to be described hereinafter, by a rod **130** attached to and extending horizontally from the carrier plate **33**. After the row indexing asembly **32** is in the tripped position as shown in FIG. 3*b*, spring **41** is able to pull the carrier plate **33** to the front of the machine as illustrated by the timing diagram of FIG. 10*d*. Immediately after the sixteenth row winding cycle follows the column indexing period. The column indexing operation is performed after the carrier plate **33** reaches its forward position, by the column indexing assembly **43**, stepping the carrier plate **33** left-to-right, as shown by FIG. 10*e*. This procedure positions the next two columns of pins in line with the feed tube head **37**. A dwell period is provided for the row indexing assembly **32**, feed tube head **37**, and follow bar head **46** during the end portion of each column winding cycle. This dwell period is, for example, 1.63 seconds long or one-ninth of a column winding cycle which is 14.59 seconds.

When the next two columns of pins are positioned under the head **37**, another column winding cycle starts. The column winding cycle is repeated eight times, since, as mentioned before, there are sixteen columns of pins **27**, or until all the solenoid coils in the array are wound. Then, when the array form **26** reaches its position at the front of the machine, the motor **24** is turned off by opening the switch **52** (FIG. 1) and the array form **26**, with the solenoid coils **36** wound on the pins **27**, is removed from the machine. Before an array of solenoid coils is wound on another array form **26**, the column indexing assembly **43** is released manually (FIG. 9) so that another spring **51** is able to pull the block **44** to the starting position at the left of the machine. An array of solenoids on another array form **26** is wound by starting the motor **24** after the other array form **26** has been placed on the carrier plate **33**.

Referring again to FIG. 1 for a more detailed description of the solenoid winding machine, the main support and housing structure for the winding machine are shown to include the base plate **21** to which are fixed a vertical motor support plate **56**, and five vertical bearing support plates **57** to **61** for supporting the motor **24** and gear train **22**. The table assembly **23** is supported above the base plate **21**, as shown, with the fixed plate **25** of the table assembly **23** suitably bolted to two upright plates **63** and **64**, made of, for example, plastic and disposed at the front and at the rear of the machine, respectively. Plastic plates **63** and **64** provide sufficient flexibility to allow the table assembly **23** to move forward in case of a mechanical jam-up to cause the disengagement of spur gears **66** and **67** from spur gears **68** and **69** respectively. Gear **66** supplies power to actuate the column indexing asembly **43**, and gear **67** supplies power to actuate the row indexing assembly **32**.

As mentioned before, the column indexing assembly **43** indexes the solenoid array form **26** two columns to the right after the coils **36** in the first two columns are wound. Referring to FIGS. 1 and 2, a column indexing operation is performed every time the motor **24** makes one revolution in the following manner: A flexible coupler **71** couples the motor **24** to a shaft **72** that is bearing mounted to bearing support plates **57** and **58**. A spur gear **73** (FIG. 2) keyed to the left end of shaft **72** engages and rotates another spur gear **75** on shaft **74** at a one-to-one ratio (1:1). Shaft **74** is bearing mounted to bearing plates **58** and **60** and rotates (1:1) a shaft **76** through a chain **77** engaging sprockets **78** and **79** on shafts **74** and **76**, respectively. The gear **68**, that rotates (1:1) gear **66**, is keyed to the shaft **76**. Gear **66** is, in turn, keyed at one end to a shaft **81** that is bearing mounted to two bearing tabs **82** (see FIGS. 1 and 4) depending from and bolted to opposite ends of the fixed plate **25**, thereby positioning shaft **81** under the fixed plate **25**. Approximately, at the center of the shaft **81** is keyed a helical gear **83** (FIG. 2) that rotates (1:1) another helical gear **84** for transmitting rotational motion upward 90 degrees to a shaft **86** and to the column indexing assembly **43**. The shaft **86** extends through a bore **85** (FIG. 5) in the fixed plate **25** and is suitably bearing mounted therein. The shaft **86** has formed at the upper end thereof a flat head **87** with a tripping pin **88** extending horizontally therefrom.

Referring to FIG. 8, the sliding block **44** is moved by a dog **89** which is mounted to the fixed plate **25** by a pin **94**. Since the pin **94** extends through an elongated slot **95** formed in the dog, the dog can be moved to the right and against a rack **91**, fixed to the block **44**. The dog **89** is moved by the tripping pin **88** once during a revolution of the shaft **86**. As the tripping pin **88** revolves, it engages a lug **89a** extending upward from the dog **89** urging it to the right against the action of the tension spring **90**. At the same time, the point of the dog **89** is urged by the tripping pin **88** toward a toothed rack **91**, to cause the sliding block **44** to slide to the right along the dovetail groove **45** in the fixed plate **25**. As the rack **91** moves to the right, a pawl **92** rides over one of the teeth in the rack **91** to engage the next tooth. Pawl **92** is held in place against the rack **91** by a suitable tension spring **93**.

The block **44** is required to slide a sufficient distance to the right to position two new columns of solenoid pins **27** under the feed tube head **37** whenever shaft **86** makes one revolution. This result is achieved by making the pitch of the teeth (i.e., the distance between corresponding points on adjacent teeth) on the rack **91** equivalent to the center-to-center distance between the solenoid pins in every other column. Then, the length of pin **88** and the angle, that the tripping pin **88** makes with a radial line extending from the axis of the shaft **86**, are chosen to cause the dog **89** to move against the toothed rack **91** and to the right the equivalent of one tooth width before the tripping pin **88** disengages the lug **89a** on the dog **89**. The dog **89** is returned to its original position by the spring **90**, while the pawl **92** holds the sliding block **44** in its new position.

Having described in detail how the column indexing assembly **43** operates, the following is a detailed description of the operation of the row indexing assembly **32**, indexing the next row of pins under the feed tube head **37**. Referring again to FIGS. 1 and 2, gear **67** actuates the row indexing assembly **32**, and a new row is indexed under the feed tube head every time gear **67** makes one revolution. Because sixteen rows are to be indexed before the column indexing assembly **43** is to index the next two columns of pins, the gear **67** should make sixteen revolutions while the motor **24** makes one revolution. Also, the gear **67** should be provided with a dwell period or stop for a period of time while motor **24** makes one revolution to allow the column indexing assembly **43** to perform a column indexing operation. As mentioned before, the dwell period is one-ninth of one motor revolution. Therefore, while the motor **24** makes one revolution the gear **67** must make sixteen revolutions and also must stop rotating for a period of time. The dwell period provides sufficient time for the solenoid array form **26** to be returned to its position in front of the machine by the spring **41** and then be moved two columns to the right by the column indexing assembly **43**. The rotational speed of the motor **24** is increased in three steps. The first step increases the rotational speed 3:1 and is obtained by a segment gear **96** and a gear **97** on shafts **72** and **103**, respectively. The second step increases the rotational speed, also 3:1, and is obtained by gears **98** and **99** on shafts **103** and **104**, respectively. The third step increases the rotational speed 2:1 and is obtained by gears **101** and **102** on shafts **104** and **105**, respectively. This gives a speed increase of 18:1, while only sixteen revolutions of gear **67** are required for each motor revolution. Therefore, gear **102** and in turn, gear **67** are stopped by the gear train for a dwell period equal to two revolutions of gear **67**. This feature is performed by the segment gear **96** in the same manner as described in my above-mentioned patent application. However, a brief description of the operation of the segment gear **96** follows. Segment gear **96** is made of two gear segments **96a** and **96b** with a circumferential space between the two segments equal to one-ninth of the circumference. The larger gear segment **96a** is keyed to shaft **72** while the smaller segment **96b** is rotatable relative to the shaft **72**. Then, when the smaller segment **96b** engages gear **97**, there is sufficient friction in the gear train to cause the gear train to stop, and the rotating shaft **72** causes a spring **96c** on the gear **96** to stretch.

When the larger segment **96a** rotates sufficiently to contact the stationary smaller segment **96b**, it pushes the smaller segment **96b** causing it and gear **97** to rotate. When the smaller segment **96b** is free of the gear **97**, the spring **96c** returns the smaller segment to its position next to the larger segment as shown in FIG. 2. Since gear **97** stops for a period equal to one-ninth of the time it takes the motor to make one revolution, gear **102** and shaft **105** also stop for the same period. Therefore, gear **102** only makes sixteen revolutions every time the motor **24** makes one revolution. Thus, in summary, every time shaft **72** makes one revolution, shaft **103** makes two and two-thirds revolutions, shaft **104** makes eight revolutions, shaft **105** makes sixteen revolutions. Also, shafts **103**, **104** and **105** are provided with a dwell period. Having obtained the desired number of revolutions and the desired dwell period on shaft **105**, shaft **105** drives (1:1) gear **67** through three gears **106**, **107** and **108**. Gear **106** is keyed to shaft **105**, gear **107**, being an idler gear, is keyed to shaft **119**, and gear **108** is keyed to shaft **109**, which also has the gear **69** keyed thereto.

Since gear **69** drives (1:1) gear **67**, gear **67** also makes sixteen revolutions and stops for a period of time during the time motor **24** makes one revolution. Referring also to FIG. 4, gear **67** actuates the row indexing assembly **32** in the following manner: Gear **67** is keyed to one end of a spline shaft **110** that is bearing mounted to two bearing tabs **111** (see also FIG. 3) depending from and bolted to opposite ends of the fixed plate **25**. Spline shaft **110** slidably engages a helical gear **112** whereby gear **112** rotates with the shaft **110** but can also slide axially along the shaft. The gear **112** is restrained from rotating about the spline shaft **110** by two dowel pins **112a** (FIG. 2) suitably placed within gear **112**. Also, gear **112** is restrained from sliding with respect to the block **44** by a retaining member **113** depending from the sliding block **44** and extending through a large opening **114** (FIG. 4), formed in the fixed plate **25**. The gear **112** engages and rotates (1:1) another helical gear **116** that is keyed to a vertically disposed shaft **115** that is suitably bearing mounted within a bore **120** (FIG. 5) in the sliding block **44**.

Referring to FIG. 3, every time shaft **115** rotates one revolution, a ratchet dog **122** in the row indexing assembly **32** is actuated by an axially extending lug **118** eccentrically disposed on a flat head **117** formed at the upper end of the shaft **115**. The lug **118** contacts a pin **121** on the dog **122** to move the dog rearward against the force of a tension spring **124**. The pin **121** extends inwardly into an elongated opening **123** formed in the dog **122** as shown, and the head **117** is also disposed within the opening. The motion of the dog **122** is directed by guides **125** so that, as the dog is moved rearwardly by the lug **118**, the point of the dog contacts and rotates a ratchet wheel **126** to rotate the wheel clockwise as viewed in FIG. 3. When the lug **118** releases the pin **121**, the spring **124** returns the dog **122** to its original position. The ratchet wheel **126** is held in its new position by a pawl **127** urged against the wheel **126** by a tension spring **128**.

The ratchet wheel **126** meshes with a toothed rack **129** on the solenoid carrier plate **33** whereby the rack **129** is moved rearwardly whenever the wheel **126** rotates clockwise. In this embodiment the circular pitch of the teeth on the wheel **126** is made equal to center-to-center distance between the two adjacent rows of pins **27**. Therefore, the lug **118** and the pin **121** on the dog are so positioned that the lug **118** moves the dog **122** a distance sufficient to rotate the ratchet wheel **126** one tooth, and then the lug **118** releases the dog. The pawl **127** with the help of a toggle spring **128** holds the ratchet wheel **126** in the new position thereby placing another row of pins **27** under the feed tube head **37**.

Referring to FIG. 3*a*, as mentioned before, the shaft **115** makes sixteen revolutions and then stops or dwells for a period of time. However, when the lug **118** on the head **117** actuates the dog **122** the sixteenth time, the limit rod **130**, protruding horizontally from the rack **129**, engages an upwardly protruding lug **131** on the pawl **127** causing the pawl **127** to rotate counter clockwise so that the toggle spring **128** now holds the pawl away from the ratchet wheel **126** and against a pin **132**. Since the ratchet wheel **126** is free to rotate, the spring **41** extending under the rack **129** to a pin **129***a*, pulls the carrier plate **33** forward. When the carrier plate **33** reaches the front of the machine, another limit rod **133** on the rack **129** engages the lug **131** to rotate the pawl **127** clockwise against the ratchet wheel. The pawl **127** again engages and stops the ratchet wheel **126** so that the carrier plate **33** is stopped in the forward position. In the meantime, the shaft **115** has stopped rotating because, as mentioned above, by this time the smaller gear segment **96***b* has meshed with gear **97**. The segment gear **96** provides a sufficiently long dwell period so that the carrier plate **33** can return to its forward position and then can be indexed to the right by the column indexing assembly **43** in the manner previously described. After the carrier plate **33** is indexed to the right, the larger segment **96***a* of the segment gear **96** contacts the smaller segment **96***b* causing gear **97** to rotate.

Having described in detail how the row indexing assembly **32** operates, the following is a detailed description of the operation of the feed tube head **37** winding five evenly spaced turns on the pins **27**. Referring to FIGS. 4 and 5, the oscillating motion of the feed tube head **37** is produced by vertical shafts **135** having eccentric portions **136** (FIG. 5) projecting from the upper end. The shafts **135** are suitably bearing mounted to the fixed plate **25** by bushing **134**. The eccentric portions **136** are suitably bearing mounted within vertically disposed tubes **137** fixed to the under side of a horizontal bracket **138** of the feed tube head **37**. Since five turns are required on each coil **36**, the shafts **135** are rotated five times by the gear drive **22** for each revolution of gear **102** on shaft **105** (FIG. 2), which, as mentioned above, actuates the row indexing assembly **32** and rotates sixteen times each time the motor **24** rotates once. The shafts **135** should also be provided with a dwell period during the same period that shaft **105** makes one revolution so that a row indexing operation may be performed. Therefore, this dwell period for shafts **135** is referred to as the row indexing period (FIG. 10) and is equal to two-sevenths of the time that shaft **105** makes one revolution. Both shafts **135** make five revolutions and then stop or dwell for a period of time while the shaft **105** makes one revolution. First, the increase in rotation speed between shafts **105** and **135** is obtained in two steps. Referring to FIG. 2, the first step increases the rotation speed 3½:1 and is obtained by a segment gear **139** and a gear **140** on shafts **105** and **141**, respectively. The second step increases the rotational speed 2:1 and is produced by gears **143** and **144** on shafts **141** and **142**, respectively. This gives a speed increase of 7 to 1, while only five revolutions of shaft **135** are required for each revolution of shaft **105**. However, like segment gear **96**, segment gear **139** is made of two gear segments **139***a* and **139***b* but with a circumferential space between the two segments equal to two-sevenths of the circumference. Then, when the smaller segment **139***b*, which rotates freely on shaft **105**, engages gear **140**, shaft **141** stops and a spring **139***c* on the gear stretches. When the larger segment **139***a* contacts the smaller segment, gear **140** again starts to rotate. Since the gear **140** stops for two-sevenths of the time it takes shaft **105** to make one revolution, shaft **142** makes five revolutions every time shaft **105** makes one revolution. Referring again to FIGS. 4 and 5, the shaft **142** rotates (1:1) both vertical shafts **135** through bevel gears **145**. Thus, whenever shafts **135** rotate and because the eccentric portions **136** engage the bracket **138**, the bracket **138** oscillates in a horizontal plane causing the feed tubes **38** fixed to the bracket **138** to orbit about respective pins. Since the conductors **31** are threaded through the tubes **38** and held by the follow bar **47**, the conductors **31** are wound about the pins by the orbiting feed tubes as shown in FIG. 7*a*.

In order to wind solenoid coils with a single layer of turns, the bracket **138** holding the feed tubes **38** is raised, as it oscillates, by two cams **146** (FIG. 2) disposed on shaft **105**. Each cam **146** is engaged by a respective cam follower **147**, extending through a vertically disposed guide **148**, fixed to the plate **25**. Each cam **147** is spring biased toward cam **146** by compression spring **148'**. On top of both cam followers **147** rests the bracket **138**. Vertical adjustment for the feed tube head **37** is provided by screws **149** (FIG. 5). Since shaft **105** has rotated once while the feed tube head has made five oscillations, the cams **146** gradually lift the feed tube head **37** as the head oscillates and then the cams allow the head to drop abruptly as shown in FIG. 10*b* after the next row of pins is indexed under the feed tube head **37**. Suitably disposed compression springs **155** (FIG. 5) around the eccentric portions **136** help urge the feed tube head **37** downwardly.

While the feed tube head **37** is winding the solenoid coils **36**, the follow bar head **46** (FIG. 4) is also being raised so that the follow bar **47** clears the pins when the carrier plate **33** is being indexed. Then the follow bar head **46** is dropped (see FIG. 10*c*) in order to fold the conductors **31** against the last wound coils. Referring to FIG. 2, and as mentioned before, this operation of the follow bar head **46** is performed by two cams **151** also keyed to shaft **105**. As the cams **151** rotate, cam followers **152** follow the cams **151**. Cam followers **152** are disposed within vertical guides **153** fixed to the plate **25** (see FIG. 4). The upper end of the cam followers **152** are press fitted into openings disposed on opposite ends of a follow bar bracket **154** of the follow bar head **46**. Referring to FIG. 6, wherein is shown a plan view of the follow bar head **46**, the follow bar **47** is shown fixed to the center of the bracket **154**. The cams **151** for the follow bar are shaped so that the follow bar **47** is held against the die plate **28** while the feed tube head **37** performs the first two oscillations, and then the cams **151** raise the follow bar **47** above the pins before the row indexing operation is performed. The cams **151** allow the follow bar **47** to drop abruptly in front of the last wound coils **36** after the array form **26** is stepped rearwardly, bending the conductors downward in order to fold the conductors against the last two wound coils (see FIG. 7*b*). The follow bar **47** also forces the return portion **31***a* (FIG. 7) of the conductors **31** for the two previously wound columns against the straight lengths **31***b* of conductors between the solenoid coils **36** as indicated at region A in FIG. 7.

Referring again to FIG. 1, the conductor supply means **29**, including two rotatable supply bobbin units **156**, is shown for supplying two conductors **31** to the respective feed tubes **38** on the head **37**. Each bobbin unit **156** rotates on a vertical axis to produce axial rotation for each of the conductors **31** to prevent twisting of these conductors during the winding of the solenoid coils **36**. The rotatable bobbin units **156** are rotatably mounted on a bobbin platform **157** that is supported over the table assembly **23** by two brackets **158**. The bobbin units **156** are coupled to and are driven (1:1) by a vertical drive shaft **159** and chain **160**, as shown. The vertical drive shaft **159** is driven (2:1) by helical gears **162** (FIG. 2) mounted on shafts **159** and **161**, respectively. In turn, shaft **161** is driven (2½:1) by spur gear **106**, mounted on shaft **105**, driving a spur gear **163**, mounted on shaft **161**. Thus, the vertical drive shaft **159** makes five revolutions every time the feed tube head **37** makes five oscillations.

The two conductors **31** that are supplied from respective bobbin units **156** are drawn therefrom under tension through the respective feed tubes **38** to the solenoid array form **26**. Referring to FIG. 11 wherein the details of one of the bobbin units **156** are shown, one of the conductors **31** is pulled from a bobbin **164** through a hollow shaft **165** by one of the feed tubes **38** whenever the solenoid coils **36** are wound and the array form **26** is indexed. Each bobbin unit **156** includes a yoke **166** that rotatably supports the bobbin **164**. The yoke **166** is fixed to the upper end of the hollow shaft **165**. In turn, the shaft **165** is mounted in a bushing **170** fixed to the platform **157** so that the bobbin unit **156** rotates about a vertical axis. One arm **167** of the yoke **166** is made thin and flexible and of a spring-like material, for example, beryllium-copper, and the arm **167** is biased against the bobbin **164** by a bolt **168** to provide a drag brake for the bobbin. The drag on the bobbins **164** is uniform (e.g., one-quarter oz.) and is adjustable by rotating bolt **168** whereby the conductors can be held taut without interfering with the winding of the coils **36** and indexing of the array form **26**. Keyed to each shaft **165** is a sprocket **169** which is engaged by the chain **160** (FIG. 1) so that the bobbin units **156** are rotated within the bushing **170** by the chain **160**.

In the embodiment of the invention described, the machine winds two coils at a time so that the end product, a solenoid panel, has an array of solenoid coils wound in two separate series circuits. Solenoid panels of this type are required in the memory disclosed in the above mentioned Donal A. Meier copending application. The teachings of this invention are also useful to provide a machine which is able to wind all the solenoid coils in a panel one series circuit or more than two series circuits.

Therefore, in the light of the above teachings, various modifications and variations of the present invention are contemplated and will be apparent to those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An electrical solenoid array winding machine comprising: a support and a plurality of individual solenoid pins disposed in rows and columns on said support for receiving individual solenoid coils; conductor supply means for supplying at least one conductor; guiding means for guiding said conductor to a respective solenoid pin for winding said conductor thereon; means for providing relative movement between said support and said guiding means to wind a plurality of turns of said conductor about one of said solenoid pins and thereby form a solenoid coil; row indexing means for positioning the support relative to the guiding means to successively align said guiding means to the next solenoid pin in the same column of solenoid pins after a solenoid coil has been wound on said one solenoid pin; and column indexing means for relatively positioning the support and guiding means to align another column of solenoid pins with the guiding means so that a solenoid coil can be wound by said guiding means on each solenoid pin in said other column with the same integral length of conductor used to wind solenoid coils to the previous column.

2. An electrical solenoid array winding machine comprising: a support and a plurality of individual solenoid pins disposed in rows and columns on said support for receiving individual solenoid coils; conductor supply means for supplying at least one conductor; guiding means for guiding said conductor to a respective solenoid pin for winding said conductor thereon; means for providing relative movement between said support and said guiding means to wind a plurality of turns of said conductor about one of said solenoid pins and thereby form a solenoid coil; row indexing means for positioning the support relative to the guiding means to successively align said guiding means to the next solenoid pin the same column of solenoid pins after a solenoid coil has been wound on said one solenoid pin; means for relatively positioning the support and guiding means for realigning said guiding means with the pin in the first row on said support after all the solenoid coils are wound on pins in one column so that the conductor loops back along a path adjacent the straight lengths of conductor, the coils in the respective column being series connected so as to be capable of substantially cancelling out any stray circular magnetic fields formed around the straight lengths of conductor; and column indexing means for relatively positioning the support and guiding means to align another column of solenoid pins with the guiding means so that a solenoid coil is successively wound on each solenoid pin in said other column with the same integral length of conductor used to wind solenoid coils in the previous column.

3. An electrical solenoid array winding machine comprising: a support and a plurality of individual solenoid pins disposed on said support for receiving individual solenoid coils; conductor supply means for supplying at least one conductor; guiding means for guiding said conductor to a respective solenoid pin for winding said conductor thereon; means coupled to said guiding means for moving said guiding means about one of said solenoid pins to wind the conductor about said one solenoid pin and thereby form a solenoid coil; a follow bar and a follow bar control means for positioning the follow bar in stationary relationship with respect to said support as said solenoid coil is being formed for holding the conductor against the said support with the conductor folded from the top of a previously wound solenoid.

4. An electrical solenoid array winding machine comprising: a support and a plurality of individual solenoid pins disposed on said support for receiving individual solenoid coils; conductor supply means for supplying at least one conductor; guiding means for guiding said conductor to a respective solenoid pin for winding said conductor thereon; means for orbiting said guiding means about one of said solenoid pins to wind a plurality of turns of said conductor about said one of said solenoid pins and thereby form a solenoid coil; means for relatively positioning the support and guiding means to align another solenoid pin with said guiding means after a solenoid coil has been wound on said one solenoid pin; and a follow bar and follow bar control means to drop said follow bar down against said support after said other pin has been positioned adjacent said guiding means to fold the conductor from the top of the previously wound coil thereagainst and to remain in stationary relationship with respect to said support while another solenoid coil is being wound on said other pin.

5. An electrical solenoid array winding machine comprising: a support and a plurality of individual solenoid pins disposed in rows and columns on said support for receiving individual solenoid coils; conductor supply means for supplying at least one conductor to be wound into an array of series-connected solenoid coils; guiding means for guiding said conductor to a respective solenoid pin for winding said conductor thereon; means for orbiting said guiding means about one of said solenoid pins to wind a plurality of turns of said conductor about one of said solenoid pins and thereby form a solenoid coil; row indexing means for positioning the support relative to the guiding means to successively align said guiding means to the next solenoid pin in the same column of solenoid pins after a solenoid coil has been wound on said one solenoid pin; first dwell means for providing a dwell period for said means for orbiting said guiding means when said row indexing means is aligning said next pin with the guiding means; column indexing means for aligning another column of solenoid pins with said guiding means so that a solenoid coil is wound on each solenoid pin in said other column with the same length of conductor, used to wind solenoid coils in the previous column; and second dwell means for providing a dwell period for said means for orbiting said guiding means and for said row indexing means when said column indexing means is aligning another column of pins with the guiding means.

6. An electrical solenoid array winding machine comprising: a support and a plurality of individual solenoid pins disposed on said support for receiving individual solenoid coils; conductor supply means for supplying at least one conductor; guiding means for guiding said con-

ductor to a respective solenoid pin for winding said conductor thereon; means coupled to said guiding means for moving said guiding means about one of said solenoid pins to wind the conductor about said one solenoid pin and thereby form a solenoid coil; means for successively positioning said support to move another solenoid pin adjacent said guiding means after a solenoid coil has been wound on said one solenoid pin to form an array of series-connected solenoid coils; a follow bar and follow bar control means for positioning the follow bar in stationary relationship with respect to said support as said solenoid coil is being formed for holding the conductor against the support with the conductor folded from the top of the previously wound solenoid coil; said follow bar control means raising said follow bar above said pins before said means for positioning said support moves another pin adjacent said guiding means.

7. An electrical solenoid array winding machine comprising: a support and a plurality of individual solenoid pins disposed in rows and columns on said support for receiving individual solenoid coils; conductor supply means for supplying at least one conductor to be wound into a series of solenoid coils; guiding means for guiding said conductor to a respective solenoid pin for winding said conductor thereon; means for orbiting said guiding means about one of said solenoid pins to wind a plurality of turns of said conductor about said one solenoid pin and thereby form a solenoid coil; row indexing means for aligning another solenoid pin in the same column of solenoid pins with said guiding means after a solenoid coil has been wound on said one solenoid pin; first dwell means for providing a dwell period for said means for orbiting said guiding means when said row indexing means is aligning said other pin with said guiding means; column indexing means for aligning another column of solenoid pins with said guiding means so that a solenoid coil is wound on each solenoid pin in said other column with the same integral length of conductor, used to wind solenoid coils in the previous column; second dwell means for providing a dwell period for said means for orbiting said guiding means and a dwell period for said row indexing means when said column indexing means is aligning another column of solenoid pins with the guiding means; a follow bar and follow bar control means to drop said follow bar down against said support after said other pin has been positioned adjacent said guiding means to fold the conductor from the top of the previously wound coil thereagainst and to remain in stationary relationship with respect to said support while another solenoid coil is being wound on said other pin; and said follow bar control means raising said follow bar above said pins after a solenoid coil is wound on one pin and before another pin is positioned adjacent said guiding means.

8. An electrical solenoid array winding machine comprising: a support and a plurality of solenoid pins disposed in rows and columns on said support for receiving individual solenoid coils; conductor supply means for supplying at least one conductor; guiding means for guiding said conductor to a respective solenoid pin for winding said conductor thereon; means for providing relative movement between said support and said guiding means to wind a plurality of turns of said conductor about one of said solenoid pins and thereby form a solenoid coil; row indexing means for positioning the support relative to the guiding means to successively align said guiding means to the next solenoid pin in the same column of solenoid pins after a solenoid coil has been wound on said one solenoid pin; first dwell means for providing a dwell period for said means for providing relative movement between said support and said guiding means when said row indexing means is aligning the next pin with said guiding means; means for positioning the support for realigning said guiding means to the first solenoid pin in the column after a solenoid coil has been wound on the last solenoid pin in the respective column so that the conductor from the last wound solenoid in the column lies next to the interconnecting conductor lengths between solenoid coils in the column; column indexing means for aligning another column of solenoid pins with said guiding means so that a solenoid coil can be wound by said guiding means on each solenoid pin in said other column with the same integral length of conductor used to wind solenoid coils in the previous column; and second dwell means for providing a dwell period for said means for providing relative movement between said support and said guiding means and a dwell period for said row indexing means when the support is positioned for re-aligning said guiding means to the first solenoid pin in the column and when said column indexing means is positioning the support for aligning another column of solenoid pins with said guiding means.

9. An electrical solenoid array winding machine comprising: a frame for said machine; a table assembly mounted on said frame; a support having a plurality of solenoid pins arranged in rows and columns, and means mounting said support on said table assembly for movement thereon in two directions; a motor mounted on said frame; a gear train mounted on said frame to couple power from said motor to move said support in two directions relative to sai dtable; conductor supply means for sup-relative to said table; conductor; guiding means having at least one guide tube and said conductor passing therethrough for guiding said conductor to a respective solenoid pin for winding said conductor thereon; said gear train including means to power said guiding means so that said guide tube orbits around one of said pins and thereby forms a solenoid coil; said gear train including cam means for moving said guiding means and said guide tube in a direction axial to said pins so that the pitch of the solenoid coil is controlled; row indexing means disposed on said table assembly and powered by said gear train for successively positioning said support in one of said directions so that another solenoid coil may be wound on the next pin in the same column by said guiding means; and column indexing means disposed on said table assembly and powered by said gear train for successively positioning said support in the other of said directions so that another column of pins is positioned in line with said guide tube to wind solenoid coils on respective pins in said other column.

10. An electrical solenoid array winding machine comprising: a frame for said machine; a table assembly including a fixed plate having a groove formed in one surface thereof and mounted to said frame; a sliding block having a groove formed in one surface thereof and mounted in sliding relationship within said groove formed in said fixed plate, and said groove in said sliding block being disposed at right angles to said groove in said fixed plate; a solenoid carrier plate mounted in sliding relationship within said groove formed in said sliding block so that said solenoid carrier plate is movable in two directions; a support having a plurality of solenoid pins disposed in rows and columns for receiving individual solenoid coils, said support being mounted on said solenoid carrier plate; conductor supply means for supplying at least one conductor to be wound into solenoid coils; guiding means having at least one guide tube and said conductor passing therethrough for guiding said conductor to a respective solenoid pin for winding said conductor thereon; a motor and a gear train mounted on said frame and being coupled to said guiding means so that said guide tube orbits around one of said pins and thereby form a solenoid coil; row indexing means disposed on said sliding block for successively positioning said solenoid carrier plate along said groove, formed in said sliding block, so that another solenoid coil may be wound on the next pin in the same column by said guide tube; and column indexing means disposed on said fixed plate for successively positioning said sliding block along said groove, formed in said fixed plate, so that another

column of pins is positioned in line with said guide tube to have solenoid coils wound on respective pins in said other column; said gear train being also coupled to said row indexing means and to said column indexing means; and said gear train including a first dwell means for providing a dwell period for said guiding means while said row indexing means places said next pin in position to have a solenoid coil wound thereon, and a second dwell means for providing a dwell period for said row indexing means and for said guiding means while said column indexing means places said other column in position to have solenoid coils wound on the pins in said other column.

11. An electrical solenoid array winding machine comprising: a frame for said machine; a table assembly including a fixed plate having a groove formed in one surface thereof and mounted to said frame; a sliding block having a groove formed in one surface thereof and mounted in sliding relationship within said groove formed in said fixed plate and with said groove in said sliding block oriented at right angles to the said groove in said fixed plate; a solenoid carrier plate mounted in sliding relationship within said groove formed in said sliding block so that said solenoid carrier plate is movable in two directions; a support having a plurality of solenoid pins disposed in rows and columns for receiving individual solenoid coils; said support being mounted on said solenoid carrier plate; conductor supply means for supplying at least one conductor to be wound into solenoid coils; guiding means having at least one guide tube and said conductor passing therethrough for guiding said conductor to a respective solenoid pin for winding said conductor thereon; a motor and a grear train mounted on said frame and being coupled to said guiding means so that said guide tube orbits around one of said pins and thereby forms a solenoid coil; row indexing means disposed on said sliding block for successively positioning said solenoid carrier plate along said groove formed in

said sliding block so that another solenoid coil may be wound on the next pin in the same column by said guiding means; means disposed on said solenoid carrier plate for tripping said row indexing means, after the last pin in a respective column has been wound, for returning the first pin in said respective column adjacent said guide tube so that the conductor loops back and lies adjacent the lengths of conductor interconnecting the solenoid coils in said respective column; and column indexing means disposed on said fixed plate for successively positioning said sliding block along said groove formed in said fixed plate so that another column of pins is positioned in line with said guide tube to have solenoid coils wound on respective pins in said other column; said gear train being coupled to said row indexing means and to said column indexing means; said gear train including a first dwell means for providing a dwell period for said guiding means while said row indexing means places said next pin in position to have a solenoid coil wound thereon; and a second dwell means for providing a dwell period for said row indexing means and for said guiding means while said column indexing means places said other column in position to have solenoid coils wound on the pins in said other column.

References Cited

UNITED STATES PATENTS

2,862,671	12/1958	Dimond	242—7
2,855,159	10/1958	Mallina	242—7
2,963,051	12/1960	Shaw et al.	242—7 X
2,939,367	6/1960	Thomas	269—58 X
3,019,822	2/1962	Jacobson	242—7 X
3,106,351	10/1963	Fulton	242—9
3,185,184	5/1965	Loy et al.	140—93 X
3,186,077	6/1965	Vickery	140—93 X

BILLY S. TAYLOR, *Primary Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,410,317

November 12, 1968

Ivan Virgil Rondas

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 45, "27" should read -- 37 --. Column 14, lines 25 and 26, cancel "relative to sai dtable; conductor supply means for suprelative to said table; conductor; guiding means having at" and insert -- relative to said table; conductor supply means for supplying at least one conductor; guiding means having at --.

Signed and sealed this 10th day of March 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents