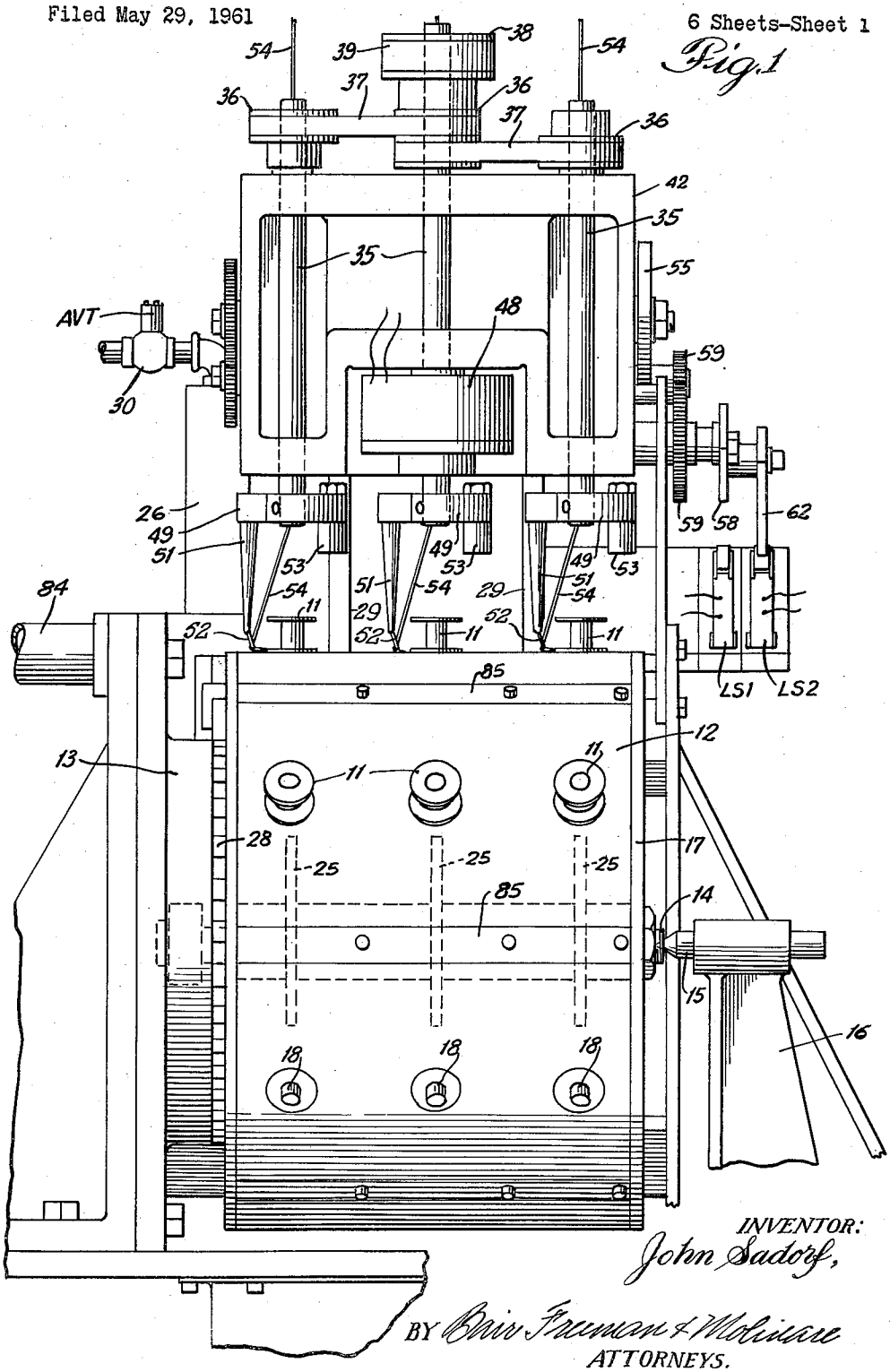
Aug. 20, 1963 J. SADORF 3,101,180

COIL WINDING APPARATUS

Filed May 29, 1961 6 Sheets-Sheet 1

Fig. 1



INVENTOR:
John Sadorf,

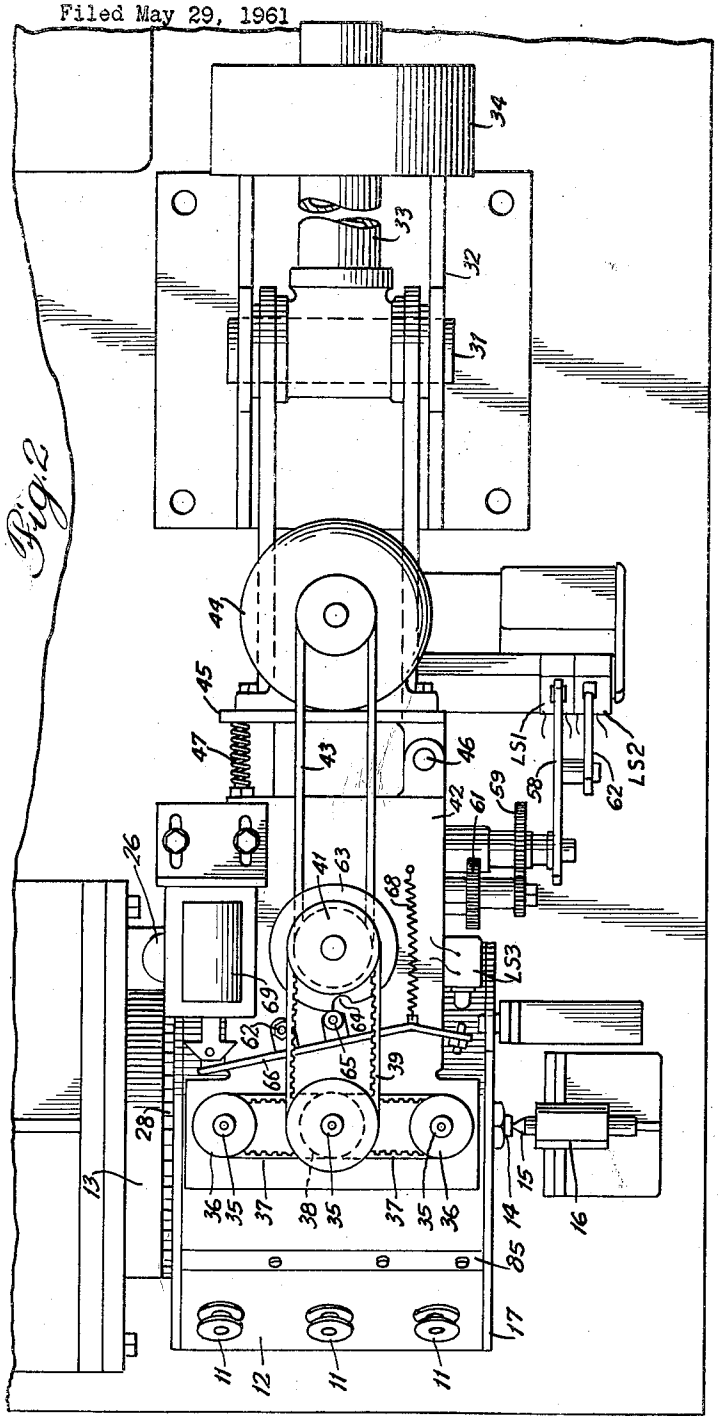
BY Brisebois Freeman & McKinnon
ATTORNEYS.

Aug. 20, 1963 J. SADORF 3,101,180

COIL WINDING APPARATUS

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Fig. 2



INVENTOR:
John Sadorf,

BY Blair Freeman & Molinare
ATTORNEYS.

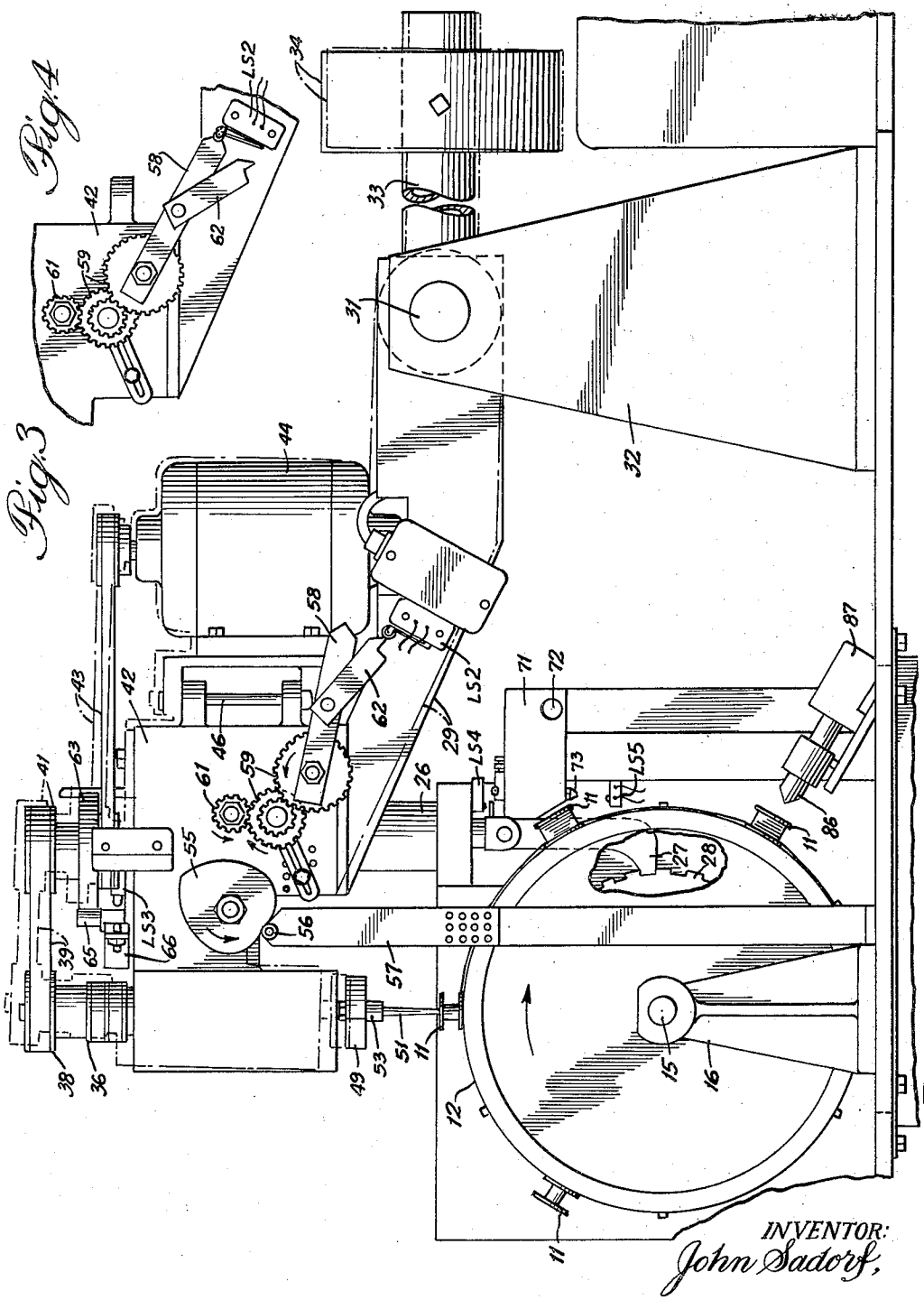
Aug. 20, 1963 J. SADORF 3,101,180

COIL WINDING APPARATUS

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Fig. 4

Fig. 3



INVENTOR:
John Sadorf,

BY Blair Freeman & Molinare
ATTORNEYS.

Aug. 20, 1963 J. SADORF 3,101,180

COIL WINDING APPARATUS

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Fig. 5

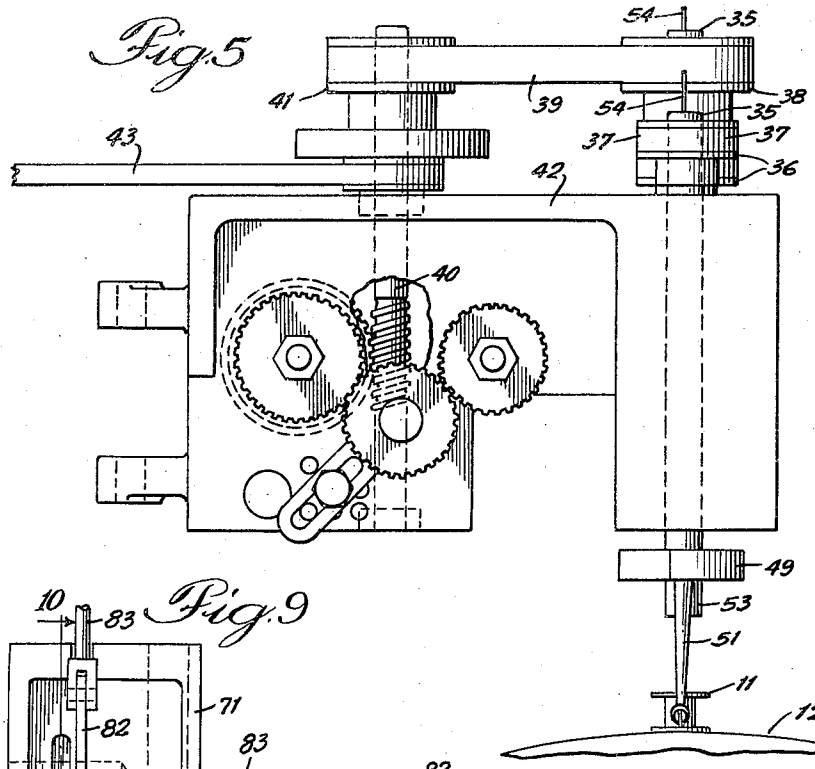


Fig. 9

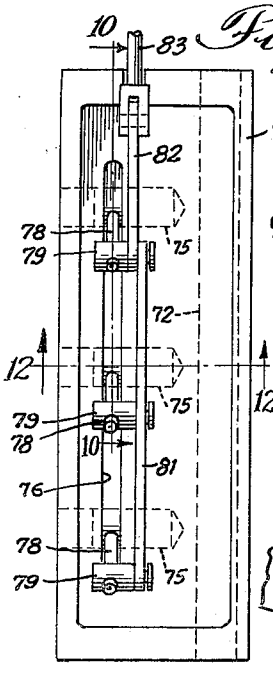


Fig. 10

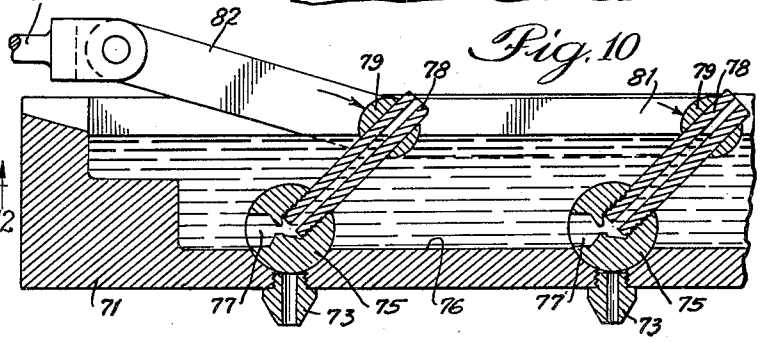


Fig. 11

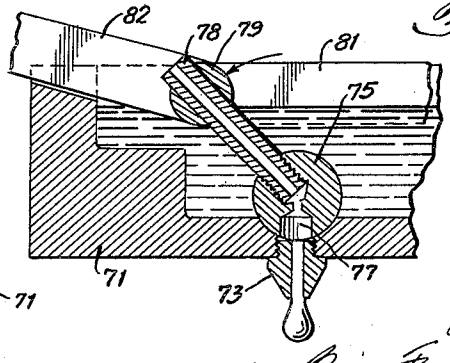
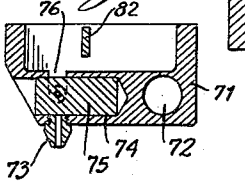


Fig. 12



INVENTOR:
John Sadorf,

BY Bair Freeman & Molinare
ATTORNEYS.

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COIL WINDING APPARATUS

Filed May 29, 1961 6 Sheets-Sheet 5

Fig. 8

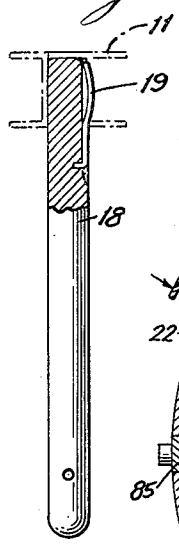


Fig. 6

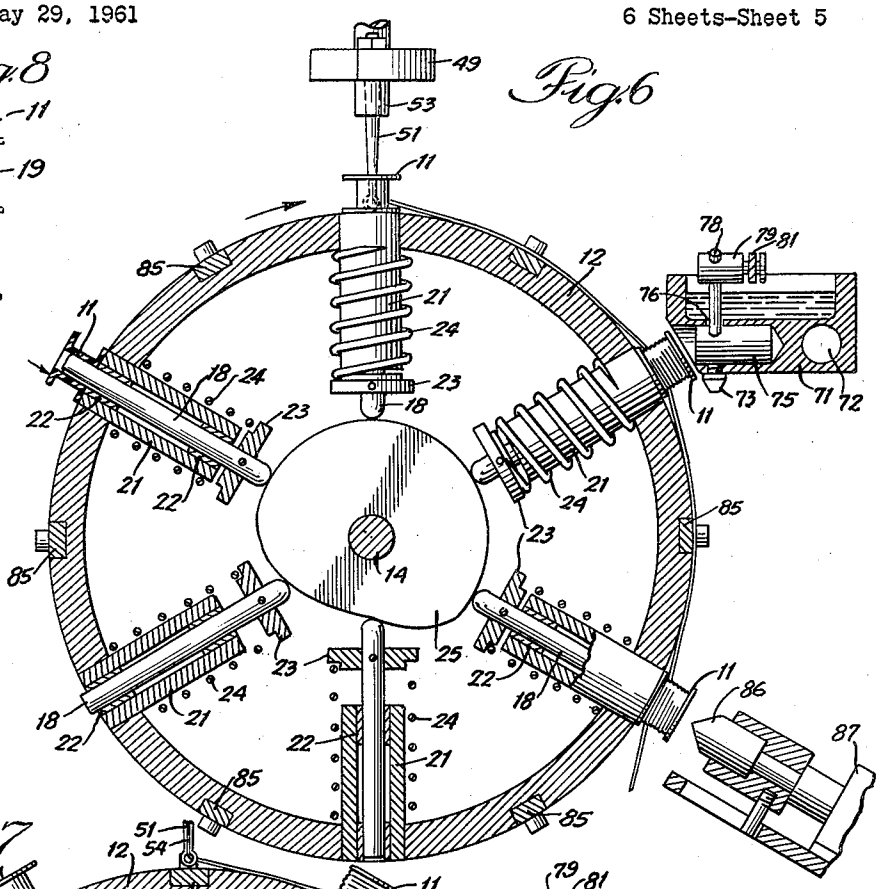
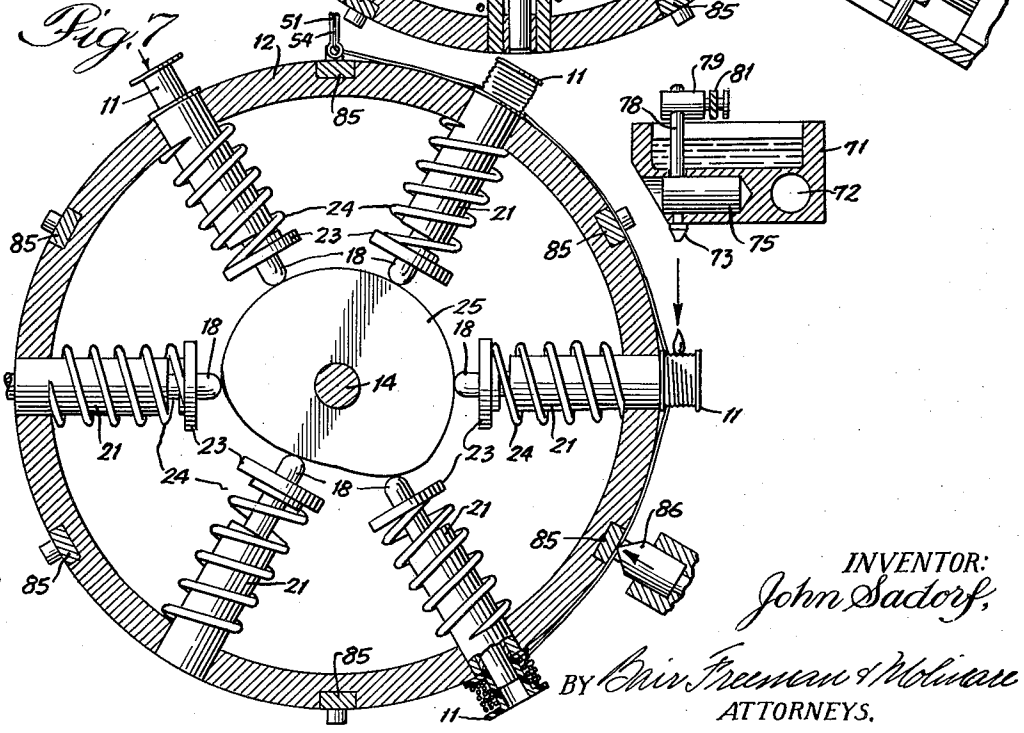


Fig. 7



INVENTOR:
John Sadorf,

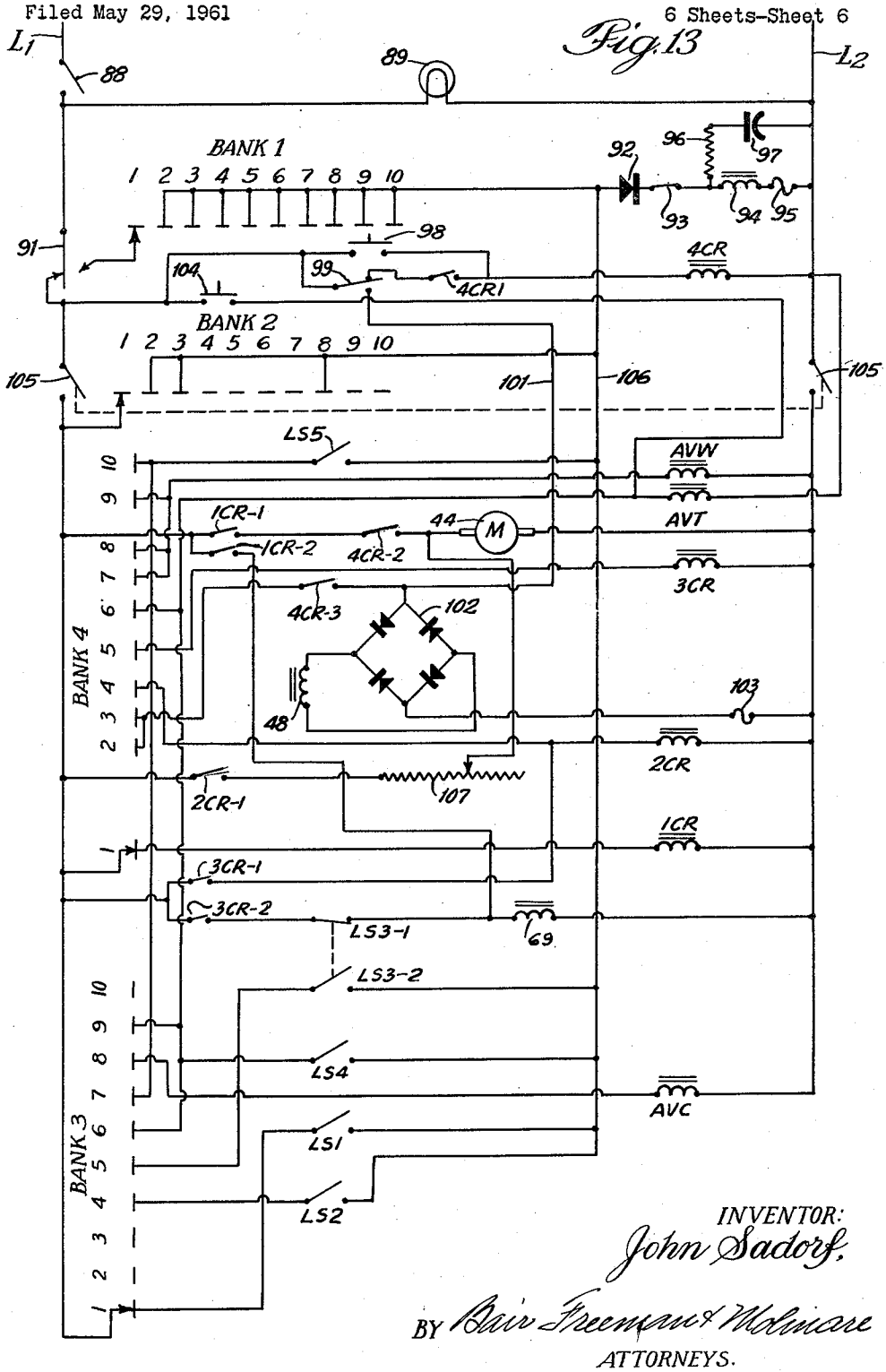
BY Brisebois, Freeman & Wolinsky
ATTORNEYS.

Aug. 20, 1963 J. SADORF 3,101,180

COIL WINDING APPARATUS

Filed May 29, 1961 6 Sheets-Sheet 6

Fig. 13



INVENTOR:
John Sadorf.

BY Blair Freeman & Molinare
ATTORNEYS.

United States Patent Office 3,101,180 Patented Aug. 20, 1963

3,101,180

COIL WINDING APPARATUS

John Sadorf, Fox Lake, Ill., assignor to George Stevens Manufacturing, Inc., Chicago, Ill., a corporation of Illinois

Filed May 29, 1961, Ser. No. 113,337
17 Claims. (Cl. 242—9)

This invention relates to coil winding apparatus and more particularly to apparatus for winding wire on bobbins rapidly and automatically or semi-automatically to form coils for electrical use.

In the art of coil winding and particularly of winding relatively small bobbin supported coils which are used in large numbers, there is an ever increasing desire for greater speed of production. The principal limiting factors in apparatus as heretofore known have been the loading of blank bobbins onto the apparatus and the unloading of finished coils. Heretofore, this loading and unloading has generally been done manually, or at least under manual control, after the end of each winding operation. Another limiting factor has been the tying or sealing of the end of the wire on the wound bobbins to prevent unwinding when the coil is removed from the machine.

It is a principal object of the present invention to provide coil winding apparatus in which a plurality of coils are simultaneously wound rapidly and automatically, or semi-automatically, with no loss of time for loading the bobbins and unloading the wound coils.

Another object is to provide coil winding apparatus in which the bobbins are mounted on a support movable step by step past winding heads so that blank bobbins can be loaded on the support during the winding of another group of bobbins.

According to a feature of the invention, the support is in the form of a rotatable tubular frame carrying the bobbins at its periphery and rotatable to bring different groups of bobbins thereon into registration with the winding heads. The winding heads are carried by a frame mounted for movement toward and away from the tubular frame under the control of a cam to provide a level winding action to lay the wire uniformly on the bobbins.

Another object is to provide coil winding apparatus in which the bobbins are easily mounted during a winding operation and are automatically stripped from the support to drop into a suitable receptacle.

According to a feature of the invention, the bobbins are mounted on pins retractable into the tubular frame and controlled by cams to be retracted during movement around the bottom portion of the tubular frame so that the wound coils may drop freely therefrom.

Another object of the invention is to provide a coil winding apparatus in which the winding heads are so controlled as to be stopped at the end of each winding operation in a position at the side of the mounting pins and bobbins so that they will not interfere with movement of the support.

According to a feature of the invention, the winding heads are driven at high speed for a predetermined number of revolutions and then at low speeds for a further and preferably relatively few revolutions and are finally stopped in predetermined angular positions by a mechanical latch.

A further object of the invention is to provide coil winding apparatus in which the wire after being wound is held against unwinding by applying a sealing material such as wax thereto.

Preferably the sealing material in molten form is dripped onto the sides of the wound bobbins from a container of molten wax. Features of the invention relate

to the valve construction utilized to control the quantity of wax dispensed at each operation of the valves so that an accurately measured quantity will be provided.

A further object is to provide coil winding apparatus in which the wire extends continuously from one bobbin to another in a series and is cut between bobbins on the support after sealing material has been applied thereto.

A still further object is to provide coil winding apparatus in which the operation is continuous in an automatically controlled cycle to wind the wire on the bobbins with the only manual operation required being loading of the bobbins.

The above and other objects and features of the invention will be more readily apparent from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a front elevational view of wire winding apparatus embodying the invention;

FIGURE 2 is a partial top plan view;

FIGURE 3 is a side elevation;

FIGURE 4 is a partial side elevation showing the parts in a different position than FIGURE 3;

FIGURE 5 is a partial side view of the winding head and gear box;

FIGURE 6 is a sectional view through the mounting sleeve illustrating the wax pot and certain of the mounting pin structures in section;

FIGURE 7 is a view similar to FIGURE 6 showing a different position of the parts;

FIGURE 8 is a detail view with parts in section of one of the mounting pins;

FIGURE 9 is a top plan view of the wax pot;

FIGURES 10 and 11 are partial sectional views of the wax pot;

FIGURE 12 is a section on the line 12—12 of FIGURE 9; and

FIGURE 13 is a wiring diagram of the control circuit.

The apparatus, as shown, is adapted to wind wire on conventional bobbins which may be of any desired size and shape and may be formed of paper, plastic, or the like. A typical bobbin with which the apparatus of the invention may be used is illustrated at 11 in FIGURES 1 and 2 as including a cylindrical sleeve portion with outwardly extending flanges at the ends thereof. It will be understood, of course, that the sizes and shapes of the bobbins may be varied as desired by making obvious modifications in the size and shape of the mounting elements therefor. According to an important feature of the invention, a plurality of bobbins are wound simultaneously and while only three bobbins are simultaneously wound in the apparatus, as shown, it will be apparent that the apparatus can be extended to wind any desired number of bobbins.

The Bobbin Supporting Means

The bobbins are supported on a movable support which is shown in the preferred construction as a cylindrical sleeve 12 mounted for rotation about a horizontal axis. In the form shown, the sleeve is supported at one end on an indexing head, indicated generally at 13, and which carries a non-rotatable shaft 14 extending through the sleeve. At its outer end, the shaft may be supported by a center 15 carried by a stand 16 with the outer end of the shaft in turn carrying an end plate 17 having a reduced flange fitting into the end of the sleeve to support it for rotation.

The bobbins 11 are mounted on mounting pins 18, as best seen in FIGURES 6 to 8, which extend radially through openings in the sleeve and are adapted to project beyond the sleeve to receive the bobbins. As best shown in FIGURE 8, the outer ends of the pins 18 carry spring members 19 which are biased outward from the pins yield-

ingly to engage the inner surface of a bobbin sleeve thereby to hold the bobbin securely on the pin against rotation and against accidental removal.

Each of the pins is slidably supported in a mounting sleeve 21 which is fixed in an opening in the sleeve 12 and which has short bearings 22 at its opposite ends through which the pin 18 is slidable. At its inner end each pin 18 carries a stop plate 23 which is engaged by a coil spring 24 to urge the pin radially inward of the sleeve.

Movement of the pins is controlled by cams 25 fixedly mounted on the shaft 14 and which are shaped, as best seen in FIGURES 6 and 7. Each cam 25 is circular about the axis of the shaft 14 throughout at least the upper 180° of its circumference and is formed in its bottom portion with a single depression merging gradually into the circular portion and having its part of minimum radius at the bottom. As the sleeve 12 rotates and carries the pins and their supporting sleeves 21 around with it, the pins will be caused to project beyond the surface of the sleeve 12 by the cams 25 throughout the upper position of the pins and will be fully retracted when the pins are in the bottom position, as shown.

The sleeve 12 is adapted to be driven in step-by-step fashion by an air cylinder 26, as best seen in FIGURE 3. The piston rod of the air cylinder carries a pawl 27 adapted to engage a ratchet 28 secured to the end of the sleeve so that on each stroke of the air cylinder 26 the sleeve 12 will be turned through a predetermined angle. In the apparatus shown, there are six groups or sets of pins and since it is desired to stop the sleeve 12 with one group of pins in a horizontal position for sealing, as described hereinafter, the ratchet mechanism is so designed and limited that each stroke of the air cylinder 26 will turn the sleeve 12 through one-twelfth of a revolution. For apparatus in which the number of groups of pins is equal to a multiple of four so that when one group of pins is at the top winding position, another group will be in a horizontal position, the ratchet mechanism could be so designed that each operation thereof will turn the mounting sleeve through the full angular position between adjacent groups or sets of mounting pins.

Supply of air to the upper end of the cylinder 26 is controlled by a solenoid operated valve 30 (FIGURE 1) which when open supplies air to the top of the cylinder and when closed vents the top of the cylinder to atmosphere. The valve 30 is normally open and is closed when energized to exhaust the air and allow the piston in the cylinder to move to its upper position under the influence of an internal spring, not shown.

The air cylinder in its operation operates limit switches LS4 and LS5, both of which are normally open and which are closed when engaged by an operating member carried by the piston rod of the air cylinder. As shown, the switch LS4 is closed when the piston rod is in its upper position and the switch LS5 is closed when the piston rod is in its lower position.

The Winding Head

Wire is adapted to be wound on the bobbins at the top position on the sleeve 12 by means of winding spindles corresponding in number and spacing to the mounting pins in each group on the mounting sleeve 12. As shown, the spindles are supported by a frame 29 (FIGURE 3) pivotally mounted on a horizontal mounting pin 31 carried by the upper end of a support 32. The rod 33 carrying a counterbalance weight 34 may be provided projecting from one side of the pivotal axis to counterbalance to the desired degree the weight of the frame and winding head. At the opposite side of the axis the frame carries at its outer end three vertical spindles or shafts 35 having drive pulleys 36 at their upper ends through which they are interconnected for simultaneous rotation by belts 37. As shown, only the center shaft is directly motor driven with the side shafts being connected to the center shaft through the sheave and belt arrangement illustrated to

drive them from the center shaft. Preferably the sheaves and belts are notched, as best seen in FIGURE 2, so that there will be no slipping of the belts and the shafts will all move simultaneously in the same angular relationship to each other.

The center shaft carries a driving sheave 38 through which it is connected by a driving belt 39 to a sheave 41 on a vertically extending worm shaft 40 going into a gear box 42. The gear shaft is drivably connected through a belt 43 to a driving motor 44 mounted with its shaft vertical on the pivoted frame 29. The belt 43 may be maintained under tension, as best shown in FIGURE 2, by mounting the motor 44 on a supporting plate 45 which is pivoted at one side on an axis 46 and which is urged outwardly at its other side by a spring 47 to tension the belt 43.

In addition to being driven, the center shaft 35 carries a magnetic brake 48 which acts when energized to brake rotation of the shafts, to slow the winding heads rapidly and to bring them eventually to a complete stop.

Each shaft 35 at its lower end carries an arm or disc 49 having a wire guiding arm 51 extending downward from one side thereof and terminating in a guiding loop 52 at its lower end. At its opposite side each disc or arm 49 carries a counterbalance weight 53 to counterbalance the weight of the guiding arm 51.

When the frame 29 is in its lower position, as shown, which is the normal position for the start of a winding operation, each of the wire guide loops 52 will be approximately at the level of the bottom of the adjacent bobbin 11. Each of the shafts 35 is hollow and wire, as shown at 54, is fed vertically downward from suitable spools which are provided with the usual drag mechanism to maintain tension on the wire downward through each of the shafts 35 and then through the guiding loop 52, as shown in FIGURE 1.

To lay the wire evenly on the bobbins during a winding operation, the frame is tilted about its axis to move the winding heads toward and away from the cylinder so that the guiding loops will travel axially of the bobbins to lay the wire uniformly thereon. For this purpose, a cam 55, as shown best in FIGURE 3, is provided on the gear box 42 and is driven by the gearing therein in timed relation with rotation of the heads. The cam rides on a cam follower 56 carried by the upper end of an adjustable supporting post 57 so that as the cam turns the frame 29 will be tilted about its pivotal support to move the winding heads axially of the bobbins. It will, of course, be apparent that the cams 55 can be replaced and that the gearing ratio driving these cams can be changed so that each cam will always stop at the end of a winding operation in the position shown in FIGURE 3 with the winding heads adjacent to the mounting sleeve 12. It will also be apparent that the cam 55 may make any desired number of revolutions during a winding operation to produce the desired level wind effect.

The winding heads are driven by the motor 44 through the major part of a winding operation at high speed and are then stopped and restarted at low speed for the last revolution or few revolutions and are then stopped in a predetermined angular position such that the arms 51 will lie axially at the sides of the adjacent bobbins so as not to interfere with indexing of the mounting sleeve 12. For this purpose, control switches LS1 and LS2 are provided and are adapted to be operated by an arm 58 driven through gearing 59 by a drive pinion 61 on the gear box and driven by the gearing therein. It will be noted that the gears 59 and the pinion 61 may easily be changed to provide a different gearing ratio so that the change of speeds and stopping of the winding heads may occur after different numbers of revolutions of the winding heads. The end of the arm 58 will engage and operate the switch LS1 once during each complete revolution of the arm and an extension arm 62 on the arm 58 will engage and operate the switch LS2 a desired predetermined number of

revolutions later. During the major portion of a normal winding cycle, the motor **44** will operate at high speed to drive the winding heads at high speed, as described more fully hereinafter in connection with the control circuit. When the switch LS1 is operated by the arm **58** the motor will be de-energized and the magnetic brake **48** will be energized to stop the motor and the winding heads rapidly. Immediately thereafter the motor will be caused to continue operation at slow speed until the switch LS2 is energized at which time the motor will be caused to stop and will be latched in a predetermined angular position.

To effect the latching the vertical gear shaft which carries the sheave **41** also carries a ratchet disc **63** which is circular throughout the major portion of its periphery and which is formed with a single locking notch or recess **64**. The recess **64** is adapted to receive a latch pin **65** carried by a latching arm **66** pivoted intermediate its ends on a pivot **67**. A spring **68** acts on one end of the latch arm **66** urging it in a direction to move the latch pin **65** into the recess **64**. The other end of the arm **66** is connected to a solenoid **69** which when energized moves the arm **66** in a direction to hold the latch pin **65** away from the recess or notch **64**.

When the latch pin **65** moves into the recess or notch **64** to stop the latch plate **63**, the outer end of the arm **66** will engage and operate a switch LS3 which functions to move the apparatus automatically and to its next step of operation, as described hereinafter.

The Sealing Means

In order to seal the wire on the coils against accidental unwinding, a sealing wax or the like is dripped onto the coils after they are wound and solidifies on the coils thereby holding the outer turns of the wire in place. The sealing means, as shown, comprises a container or tank **71** for molten wax formed with an opening therein to receive an electric heating element **72**. The container may be open at its top and is formed in its bottom with three spaced discharge openings receiving relatively small discharge nipples **73**, as best seen in FIGURES 10 and 11. The bottom wall of the container is formed with a plurality of cylindrical bores **74** to receive rotatable valve plugs **75** which may be inserted through the ends of the bores which are thereafter sealed by inserting and soldering, or otherwise suitably securing in place sealing plugs **76**. The wall at the top of the bores **74** is cut away throughout the upper part of the bores, as indicated at **76** in FIGURE 12 to establish communication between the molten wax in the container and the valve plugs **75**.

As best seen in FIGURES 10 and 11, each of the valve plugs is formed with a passage therethrough terminating at one end in an open socket **77** and at its opposite end in a threaded opening to receive a tube **78**. The tubes **78** extend upwardly and terminate in open upper ends which are at all times above the level of molten wax in the container.

The valve plugs are adapted to be turned from a filling position, as shown in FIGURE 10, to a discharge position, as shown in FIGURE 11. For this purpose, each of the tubes **78** carries a short rod element **79** at its upper end and the several rod elements **79** are pivotally interconnected by a link **81**. The link **81** is connected through a connecting link **82** to the piston rod **83** of an air motor **84** (FIGURE 1). The air motor **84** normally occupies a position to turn the valves to the position shown in FIGURE 10, but when air is supplied thereto through a solenoid valve, as described hereinafter, the cylinder will move the parts to the position shown in FIGURE 11 for discharge of wax.

With the container filled with molten wax to approximately the level shown and with the valve plugs **75** turned to the position shown in FIGURE 10, molten wax may flow into the passages through the plugs and up into the tubes **78**. When the valve plugs are turned to the discharge position shown in FIGURE 11, the molten wax in the valve passage **77** and in the tube **78** will flow out through the discharge nozzle **73**. As seen in FIGURE 7, this operation is so timed that the wax flow will occur when a wound bobbin lies beneath each of the nozzles **73** with its axis approximately horizontal. Thus the measured quantity of wax discharged from each of the nozzles will drop onto the side of the wound bobbin and will flow generally throughout the length of the bobbin. As the wax cools and solidifies, which will occur quite rapidly, it will seal the outer turns of wire on the bobbin against accidental unwinding so that the bobbin can be handled freely as a unit without likelihood of accidental damage thereto.

The Wire Cutting Mechanism

In winding a series of coils on the apparatus, the wires will extend continuously between the coils from the winding heads and in order to separate the wound coils the wire must be cut between them. For this purpose, the mounting sleeve **12** is provided between the rows or groups of mounting pins with hardened strips **85** over which the wire extending circumferentially of the mounting sleeve from one coil to another is trained. At the intermediate position shown in FIGURE 7, one of the strips **85** will register with a series of cutting knives **86** which are movable radially toward and away from the cylinder to cut the wires. As best seen in FIGURE 3, each of the cutting knives is moved radially toward the cylinder to effect cutting of the wire by an air cylinder **87** and normally occupies a position spaced sufficiently far from the mounting sleeve **12** to clear the mounting pins **18** and the bobbins mounted thereon.

The Control Circuit

The apparatus is controlled automatically in a cycle by a control circuit illustrated diagrammatically in FIGURE 13. In the illustrated circuit a four-bank stepping switch is employed having in each bank ten contacts or multiples of ten. The four banks are designated on FIGURE 13 with the corresponding contacts being correspondingly numbered **1** through **10**. The control circuit is powered from a conventional power source having line wires L1 and L2 with a master switch **88** in the line wire L1 to de-energize the circuit. A signal lamp **89** is preferably provided connected across the line wires beyond the switch **88** to indicate when the power is on and the apparatus is ready to operate.

The movable contact for bank **1** of the setting switch is normally disconnected from line wire L1, but may be connected thereto by a single pole double throw switch **91** which disconnects the line wire from the remainder of the circuit when bank **1** is energized. This bank is used solely for resetting the stepping switch to its starting position at contact **1** and in it contact **1** is blank, but the remaining contacts are all connected in parallel through a rectifier **92**, a normally closed safety switch **93**, an actuating coil **94** for the stepping switch and a fuse **95** to the line wire L2. A resistor **96** and capacitor **97** are preferably connected in series in shunt with the coil **94** to prevent an inductive kick from this coil feeding back to the circuit.

Below the switch **91** a start circuit and indexing circuit for the mounting sleeve **12** is provided. The starting circuit includes a push button switch **98** in series with a relay 4CR which comprises a master relay. When the relay 4CR is energized it closes holding contacts 4CR–1 which are in series with a stop switch **99** which can be manually operated to stop the machine. The stop switch is normally in the "up" position shown to complete a circuit through the relay 4CR, but when depressed will complete a circuit to the magnetic brake **48** through a line **101** and a full wave rectifier **102**. It will be seen that when the stop switch **99** is operated it will connect one side of the rectified directly through the line L1 with the

other side of the rectifier being connected to the line L2 through a fuse 103.

The indexing circuit includes a push button switch 104 which is normally open and which can be closed any desired number of times to energize solenoid AVT which controls the solenoid operated valve 27 to cause the air motor 26 to operate to index the mounting sleeve 12 through one step. Normally, the indexing operation is performed only at the beginning of a winding operation to move mounting pins having bobbins mounted thereon into registry with the winding heads.

The movable wiper of bank 2 is connected to the line L1 beyond a double toggle switch 105 having one switch section in each of the lines L1 and L2. In bank 2 of the stepping switch contacts 2, 3 and 8 are connected to a line 106 which is in turn connected through the rectifier 92 to the stepping switch operating solenoid 94 so that each time a pulse is transmitted to the line 106 the solenoid 94 will be energized to move the stepping switch through one step.

In bank 3, contact 1 is connected through the limit switch LS1 to the line 106 and contact 4 is similarly connected through the limit switch LS2 to the line 106. Contact 5 is connected through normally open contacts LS3–2 to the line 106, it being noted that the limit switch LS3 also includes a set of normally closed contacts LS3–1. Contacts 6 and 9 of bank 3 and contact 6 of bank 4 are interconnected and are connected to the solenoid AVT to operate the air motor 26 when any of them is energized. These same contacts are also connected through the limit switch LS4 to the line 106. Contact 8 of bank 3 is connected to the solenoid AVC which operates the air valve for the cutter air motor 87 so that when the solenoid AVC is energized the cutter blades will be moved radially in to cut the wire. The remaining contacts of bank 3 are blank.

In bank 4, contact 1 is connected to a relay 1CR. Contacts 2 and 3 are interconnected and are connected through contacts 4CR–3 to the upper side of the rectifier 102. Contact 4 is connected to relay 2CR which may also be energized through normally open contacts 3CR–1. Contact 5 of bank 4 is connected to relay 3CR. Contacts 7, 8 and 9 of bank 4 are interconnected and are connected through the solenoid AVW which operates the air valve for the fluid motor 84 controlling the wax valves. Contact 10 of bank 4 is interconnected with contact 7 of bank 3 and is connected through the limit switch LS5 to the conductor 106.

Operation

To operate the unit, the operator will first place empty bobbins on a row of projecting mounting pins 18 adjacent to the top of the cylinder and approximately at the 10 o'clock position, as seen in FIGURE 6, assuming that all of the mounting pins were initially empty. With wire threaded through the winding head spindles 35 and guides 52 the ends of the wire may be wrapped around the mounting pins at the top or 12 o'clock position simply to anchor the wire for the start of a winding operation. At this time, the master switch 88 may be closed and the reset switch 91 may be moved to the right to energize the wiper of bank 1 of the stepping switch. If the stepping switch is in any position other than the number 1 position, the solenoid 94 therefor will be energized each time the wiper engages one of the contacts on bank 1 until the stepping switch has turned around to the number one position, at which time it will stop. The operator may now operate the indexing switch 104 to bring the mounting pins on which the bobbins are mounted to the top of 12 o'clock position. The apparatus is now ready to start a winding operation.

For this purpose, the start switch 98 is temporarily closed to energize the relay 4CR so that the relay contacts 4CR–1, 4CR–2 and 4CR–3 will all close and will be held closed by the relay until the stop switch 99 is operated. The operator now closes the toggle start switch 105 to energize the several stepping switches of the remaining parts of the control circuit.

In position 1 of the stepping switch the relay 1CR will be energized and will start the motor 44 at high speed through the contact 1CR–1 and closed contacts 4CR–2. The motor will continue to turn at high speed winding wire on the bobbins until the arm 58 engages and closes the limit switch LS1. At this time, the stepping solenoid 94 will be energized through the limit switch LS1 and contact 1 of bank 3 to index the stepping switch to position 2. As soon as the stepping switch leaves position 1, the relay 1CR will be de-energized to open the contacts 1CR–1 and interrupt the motor circuit. At the same time, the brake 48 will be energized through the rectifier 102 and the closed contacts 4CR–3 and either contact 2 or 3 of bank 4. Because contacts 2 and 3 of bank 2 are connected to the stepping relay 94, the stepping switch will continue to step through contacts 2 and 3 to contact 4, the time required for this stepping providing time for the brake to function to bring the motor to a stop.

When the stepping switches reach contact 4, the relay 2CR will be energized through contact 4 on bank 4 and contact 4 on bank 3 will be connected to normally open switch LS2 to the line 106. When relay 2CR is energized, it will close contacts 2CR–1 and will energize the motor 44 through a rheostat 107 so that the motor will operate at a low speed variable by adjusting the rheostat 107. The motor will continue to turn at this low speed through a small number of turns until the arm 62 engages and closes the limit switch LS2 at which time a pulse will be supplied through contact 4 of bank 3 to the stepping solenoid 94 to step the stepping switch to position 5.

In position 5, the relay 3CR is energized through contact 5 on bank 4 to open normally closed contacts 3CR–2 and to close normally open contacts 3CR–1. Closing of the contacts 3CR–1 will maintain the relay 2CR energized so that the motor will continue to be energized through the rheostat 107. Opening of the normally closed contacts 3CR–2 will de-energize the solenoid 69 releasing the latch arm 66 and allowing the spring 68 to move the stop pin 65 toward the ratchet disc 63. The motor will continue to turn at low speed counterclockwise, as seen in FIGURE 2, until the stop pin 65 drops into the notch 64 to stall the motor and to stop the winding heads in the desired angular position. At the same time, limit switch LS3 will be operated to open the normally closed contacts LS3–1 thereby to prevent re-energizing of the solenoid 69 and to close the normally open contacts LS3–2 to supply a pulse from contact 5 of bank 3 to the stepping solenoid 94 to move the stepping switches to position 6. In position 6, a circuit will be set up through normally open limit switch LS4 and through line 106 to the stepping solenoid 94. Since the piston of air motor 26 is normally in its lower position because air valve 27 is normally open, switch LS4 will remain open until the piston of air motor 26 has moved to its extreme upper position. In position 6, however, solenoid AVT will agan be de-energized and the piston for the air motor 26 will move downward to turn the mounting sleeve 12 through one step equal to one-half the circumferential space between adjacent groups or rows of mounting pins. At this time, the parts will be in the position illustrated in FIGURE 7. In position 7, the solenoid AVW will be energized through contact 7 on bank 4 and will remain energized through positions 8 and 9 so that ample time will be provided for the heated wax to drip from the control valves onto the wound coils in the operation illustrated in FIGURE 7 and as described above. Also, in position 7, contact 7 of bank 3 will be connected to limit switch LS5 which will be closed when the piston of air motor 26 reaches the bottom of its stroke to supply a pulse to the stepping relay 94 to move the stepping switch to position 8.

In position 8, the wax valve will remain open through contact 8 on bank 4 and the cutter will be energized by energizing solenoid AVC which controls a valve supply-

ing air to the cutter air motor 87. At this time, the cutting knives 86 will move in rapidly to cut the wire between adjacent completed coils beyond the sealing point. The stepping switches will also be stepped to position 9 through contact 8 on bank 2.

In position 9, the solenoid AVT will be energized through contact 9 on bank 3 to close the air valve 27 and allow the piston in air motor 26 to move upward under the influence of its spring. When the piston in air motor 26 reaches its top position it will close the limit switch LS4 which is also connected to contact 9 of bank 3 thereby to supply a pulse to the stepping solenoid 94 to move the stepping switch into position 10. This will cause the mounting sleeve 12 to turn through an additional step to bring the next row or group of mounting pins into alignment with the winding heads. During the previous winding operation the operator will have loaded empty bobbins onto this row of pins so that they are ready to be wound. At the same time, the mounting sleeve will have indexed to the position shown in FIGURE 6 in which the lowermost row of mounting pins are retracted into the mounting sleeve so that the wound bobbins supported thereby will drop freely by gravity into a suitable receptacle. In position 10, contact 10 of bank 4 is connected to limit switch LS5 which will close as soon as the piston in air motor 26 has moved to its lowermost position thereby supplying a pulse to the stepping solenoid 94 to move the stepping switch back to position 1 for a subsequent winding operation.

It will be seen that winding will continue automatically in this manner as long as a supply of wire is available and as long as the operator mounts empty bobbins on the row or group of mounting pins in approximately the 10 o'clock position of FIGURE 6 which will next move into registration with the winding heads. Since the air motor 26 is normally energized and is at its bottom stroke position the pawl carried thereby will remain in engagement with the ratchet 28 which turns the mounting sleeve 12 to hold the mounting sleeve in its desired indexed position without possibility of its accidentally turning to move the bobbins being wound out of registration with the winding heads.

While one embodiment of the invention has been shown and described herein, it will be understood that it is illustrative only and not to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. Coil winding apparatus comprising a support, a plurality of groups of bobbin mounting elements on the support to hold bobbins to be wound thereon, each group of mounting elements comprising a plurality of elements arranged side by said in a row, a plurality of winder heads arranged side by side in a row and registering respectively with the elements of one of said groups, each of the winder heads being rotatable about an axis aligned with the axis of the bobbin with which it registers and wire guiding means to lay wire on the bobbin as the head rotates, and means to move the support and the winder heads bodily relative to each other in a direction transverse to said rows to bring the winder heads into registration with a different group of elements.

2. Coil winding apparatus comprising a support, a plurality of groups of bobbin mounting elements on the support to hold bobbins to be wound thereon, each group of mounting elements comprising a plurality of elements arranged side by said in a row, a plurality of winder heads arranged side by side in a row and registering respectively with the elements of one of said groups, each of the winder heads being rotatable about an axis aligned with the axis of the bobbin with which it registers and wire guiding means to lay wire on the bobbin as the head rotates, a frame on which the winder heads are mounted, means to move the frame toward and away from the support to lay the wire evenly on the bobbins throughout their length, and means to move the support relative to the frame in a direction transverse to said rows to bring a different group of elements into registration with the winder heads.

3. The apparatus of claim 1 in which the bobbin mounting elements comprise pins movable from positions projecting beyond the support to positions retracted within the support, and cam means to move the pins to projecting position when they are in registration with the winding heads and to retracted position for stripping the bobbins therefrom after they have moved out of registration with the winding heads.

4. Coil winding apparatus comprising a movably mounted support, a plurality of groups of bobbin mounting elements carried by the support to hold bobbins to be wound, the elements of each group being spaced across the support transverse to its direction of movement, a plurality of winding heads adjacent to the support and spaced across its width to register respectively with the elements of different groups when the support is moved to different positions, each of the winding heads including a wire guide rotatable about a bobbin on one of the elements to lay wire thereon, and means to stop the winding heads with the wire guides laterally beside the respective mounting elements so as not to interfere with movement of the support.

5. Coil winding apparatus comprising a movably mounted support, a plurality of groups of bobbin mounting elements carried by the support to hold bobbins to be wound, the elements of each group being spaced across the support transverse to its direction of movement, a plurality of winding heads adjacent to the support and spaced across its width to register respectively with the elements of different groups when the support is moved to different positions, each of the winding heads including a wire guide rotatable about a bobbin on one of the elements to lay wire thereon, means to stop the winding heads with the wire guides laterally beside the respective mounting elements so as not to interfere with movement of the support, means to supply sealing material to each of the wound bobbins after it is moved out of registration with a winding head to prevent unwinding of the wire thereon, and means to cut the wire between bobbins of different groups while the bobbins are on the support and after application of sealing material thereto.

6. Coil winding apparatus comprising a movably mounted support, a plurality of groups of bobbin mounting elements carried by the support to hold bobbins to be wound, the elements of each group being spaced across the support transverse to its direction of movement, a plurality of winding heads adjacent to the support and spaced across its width to register respectively with the elements of different groups when the support is moved to different positions, each of the winding heads including a wire guide rotatable about a bobbin on one of the elements to lay wire thereon, means to drive the winding heads at high speed for a predetermined number of turns and thereafter to drive them at a slower speed for a smaller predetermined number of turns, and means to stop the winding heads with the wire guides laterally beside the respective mounting elements so as not to interfere with movement of the support.

7. Coil winding apparatus comprising a cylinder mounted for rotation about its axis, a plurality of angularly spaced groups of mounting pins carried by the cylinder to hold bobbins thereon, a plurality of winding heads mounted in a fixed position adjacent to the periphery of the cylinder to register respectively with the pins of different groups as the cylinder is turned, each of the winding heads including a wire guide rotatable about the bobbin registering therewith to lay wire thereon, and means to turn the cylinder to bring the mounting pins of different groups into registeration with the winding heads.

8. Coil winding apparatus comprising a cylinder mounted for rotation about its axis, a plurality of angularly

spaced groups of mounting pins carried by the cylinder to hold bobbins thereon, a plurality of winding heads mounted adjacent to the cylinder to register respectively with the pins of different groups as the cylinder is turned, each of the winding heads including a wire guide rotatable about the bobbin registering therewith to lay wire thereon, a frame on which the winding heads are mounted, means to move the frame radially toward and away from the cylinder to lay the wire evenly on the bobbins, and means to turn the cylinder to bring different groups of mounting pins into registration with the winding heads.

9. The apparatus of claim 8 in which the frame carries the winding heads at one end and is pivoted at its other end on an axis parallel to and spaced from the cylinder axis and in which the moving means comprises a cam rotatable in synchronism with the winding heads.

10. Coil winding apparatus comprising a cylinder mounted for rotation about its axis, a plurality of angularly spaced groups of mounting pins carried by the cylinder to hold bobbins thereon, a plurality of winding heads mounted adjacent to the cylinder to register respectively with the pins of different groups as the cylinder is turned, each of the winding heads including a wire guide rotatable about the bobbin registering therewith to lay wire thereon, means to turn the cylinder to bring the mounting pins of different groups into registration with the winding heads, the mounting pins being radially retractable within the cylinder to release the bobbins, and cam means effective on rotation of the cylinder to cause the pins to project beyond the cylinder when they are adjacent to the winding heads and to retract within the cylinder when they are remote from the winding heads.

11. Coil winding apparatus comprising a cylinder mounted for rotation about its axis, a plurality of angularly spaced groups of mounting pins carried by the cylinder to hold bobbins thereon, a plurality of winding heads mounted adjacent to the cylinder to register respectively with the pins of different groups as the cylinder is turned, each of the winding heads including a wire guide rotatable about the bobbin registering therewith to lay wire thereon, means to drive the winding heads through a predetermined number of turns, means to stop the winding heads with the wire guides lying axially of the cylinder from the respective pins so as not to interfere with turning of the cylinder, and means operative after stopping of the winding heads to turn the cylinder to bring a different group of pins into registration with the winding heads.

12. Coil winding apparatus comprising a cylinder mounted for rotation about its axis, a plurality of angularly spaced groups of mounting pins carried by the cylinder to hold bobbins thereon, a plurality of winding heads mounted adjacent to the cylinder to register respectively with the pins of different groups as the cylinder is turned, each of the winding heads including a wire guide rotatable about the bobbin registering therewith to lay wire thereon, means to drive the winding heads at high speed through a predetermined number of turns and thereafter at lower speed through a smaller predetermined number of turns, latch means to stop the winding heads with the wire guides axially at the sides of the respective pins so as not to interfere with turning of the cylinder, and means operative after engagement of the latch means to turn the cylinder to bring a different group of pins into registration with the winding heads.

13. Coil winding apparatus comprising a cylinder mounted for rotation about its axis, a plurality of angularly spaced groups of mounting pins carried by the cylinder to hold bobbins thereon, a plurality of winding heads mounted adjacent to the cylinder to register respectively with the pins of different groups as the cylinder is turned, each of the winding heads including a wire guide rotatable about the bobbin registering therewith to lay wire thereon, means to turn the cylinder step by step to move different groups of mounting pins into registration with the winding heads, means operable when the cylinder is stationary to apply sealing material to a wound bobbin which has been moved out of registration with the winding heads to prevent unwinding of the wire therefrom, and means operative when the cylinder is stationary to cut the wire between bobbins on the cylinder after sealing material has been applied thereto.

14. The apparatus of claim 13 in which the means to apply sealing material comprises a container of molten wax mounted adjacent to the upper part of the cylinder, and valve means operated in timed relation with turning of the cylinder to release a quantity of molten wax to drop on the side of a wound bobbin held on the cylinder with its axis generally horizontal.

15. The apparatus of claim 13 in which the wire cutting means comprises knives movable radially toward the cylinder, and power means operable in timed relation to turning of the cylinder to move the knives radially inward to cut the wire against the cylinder.

16. In a coil winding machine, a relatively thin walled cylindrical sleeve forming a support for bobbins to be wound, a plurality of mounting pins slidable radially through openings in the sleeve and adapted to have their outer ends project beyond the sleeve to receive and hold bobbins to be wound, springs urging the pins radially in one direction, cams fixedly mounted in the sleeve and engaging the inner ends of the pins to cause them to move radially from projecting positions to retracted bobbin releasing positions, and means to turn the sleeve.

17. In a coil winding apparatus, a rotatable winding head, an electric motor connected to the head to drive it, a first switch effective when closed to energize the motor for high speed operation, a second switch effective when closed to energize the motor for low speed operation, operating means for the switches operable in timed relation with the winding head to open the first switch and close the second switch after a predetermined number of revolutions of the winding head and to open the second switch after a further predetermined number of revolutions of the winding head, a latching disc connected to the winding head and having a single latching part thereon, a detent mounted adjacent the disc to engage the latching part and hold the winding head in a predetermined angular position, means to hold the detent out of engagement with the latching part, and means operative simultaneously with opening of the second switch to make the last named means ineffective.

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