Dec. 9, 1952 N. B. ORNITZ 2,620,769

MEANS FOR HANDLING AND VARNISHING ELECTRICAL WINDINGS

Filed Oct. 30, 1948 7 Sheets-Sheet 1

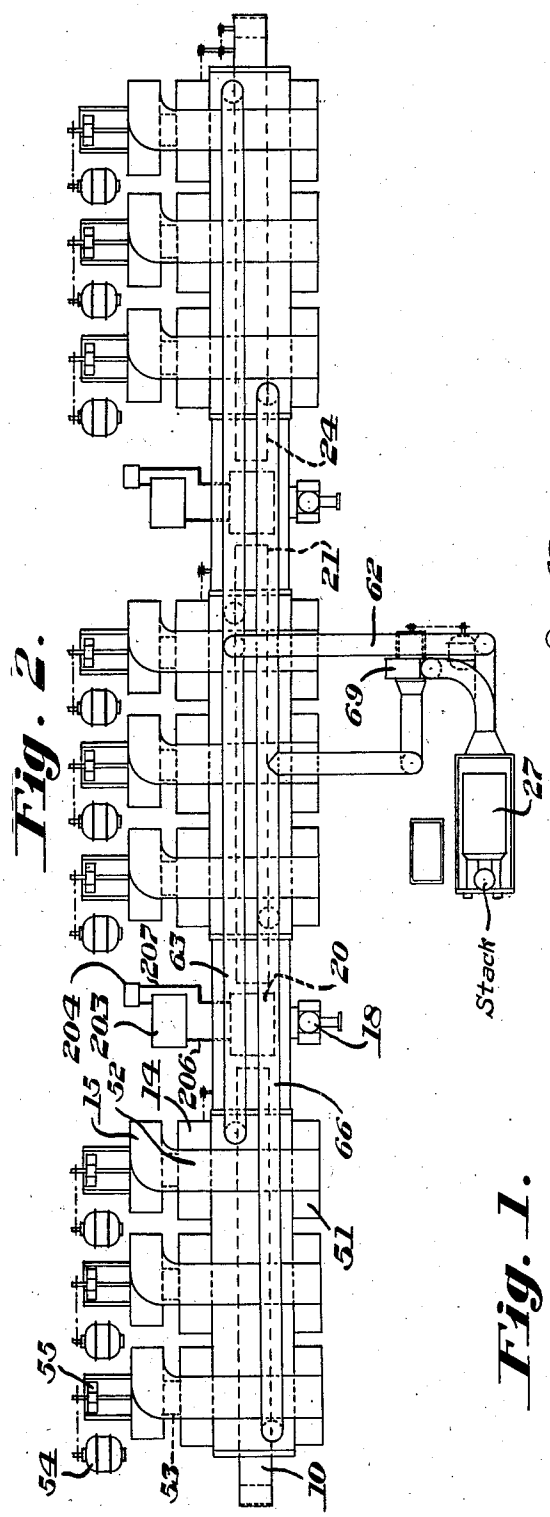


Fig. 2.

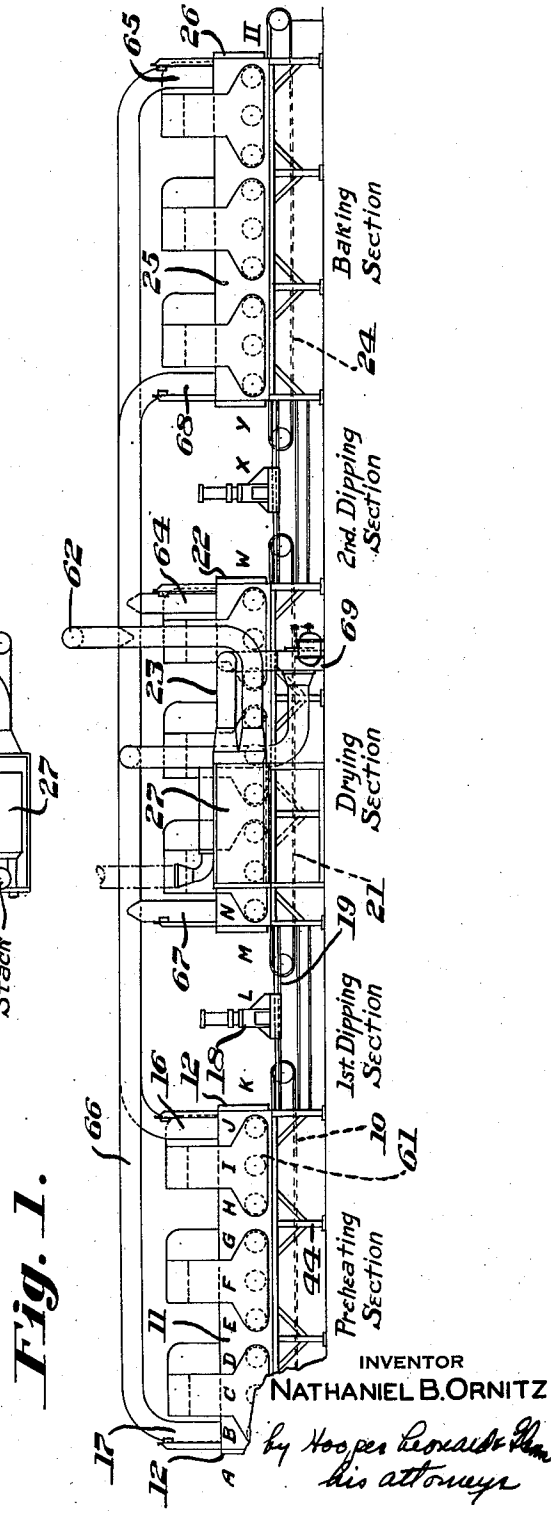


Fig. 1.

INVENTOR
NATHANIEL B. ORNITZ
by Hooper Lovejoy & Shaw
his attorneys

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MEANS FOR HANDLING AND VARNISHING ELECTRICAL WINDINGS

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Fig. 9.

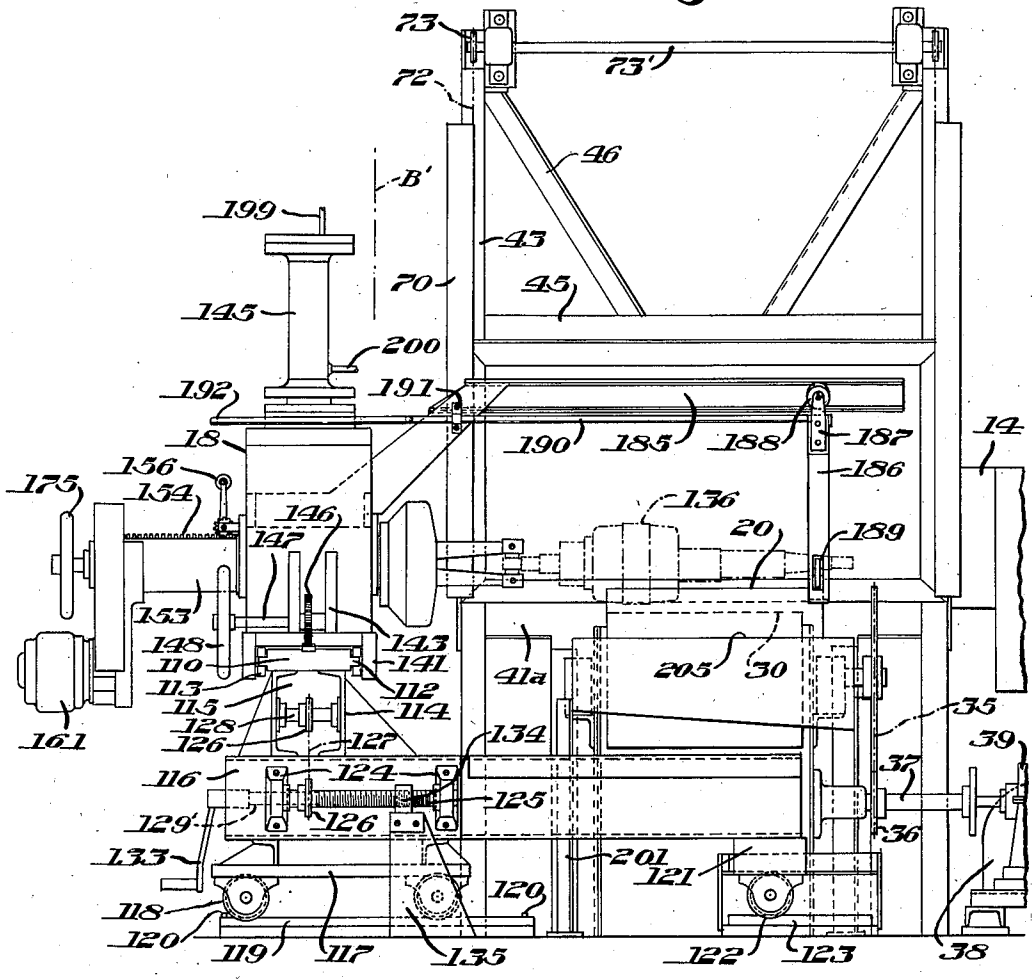
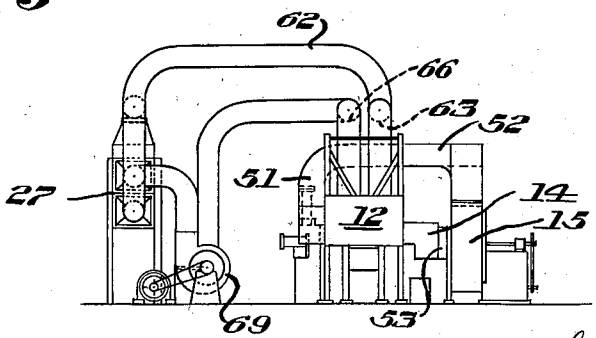


Fig. 3.



INVENTOR
NATHANIEL B. ORNITZ
by Hooper, Leonard & Glenn
his attorneys

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MEANS FOR HANDLING AND VARNISHING ELECTRICAL WINDINGS

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Fig. 15.

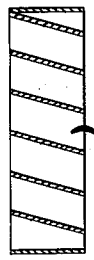


Fig. 4.

Fig. 14.

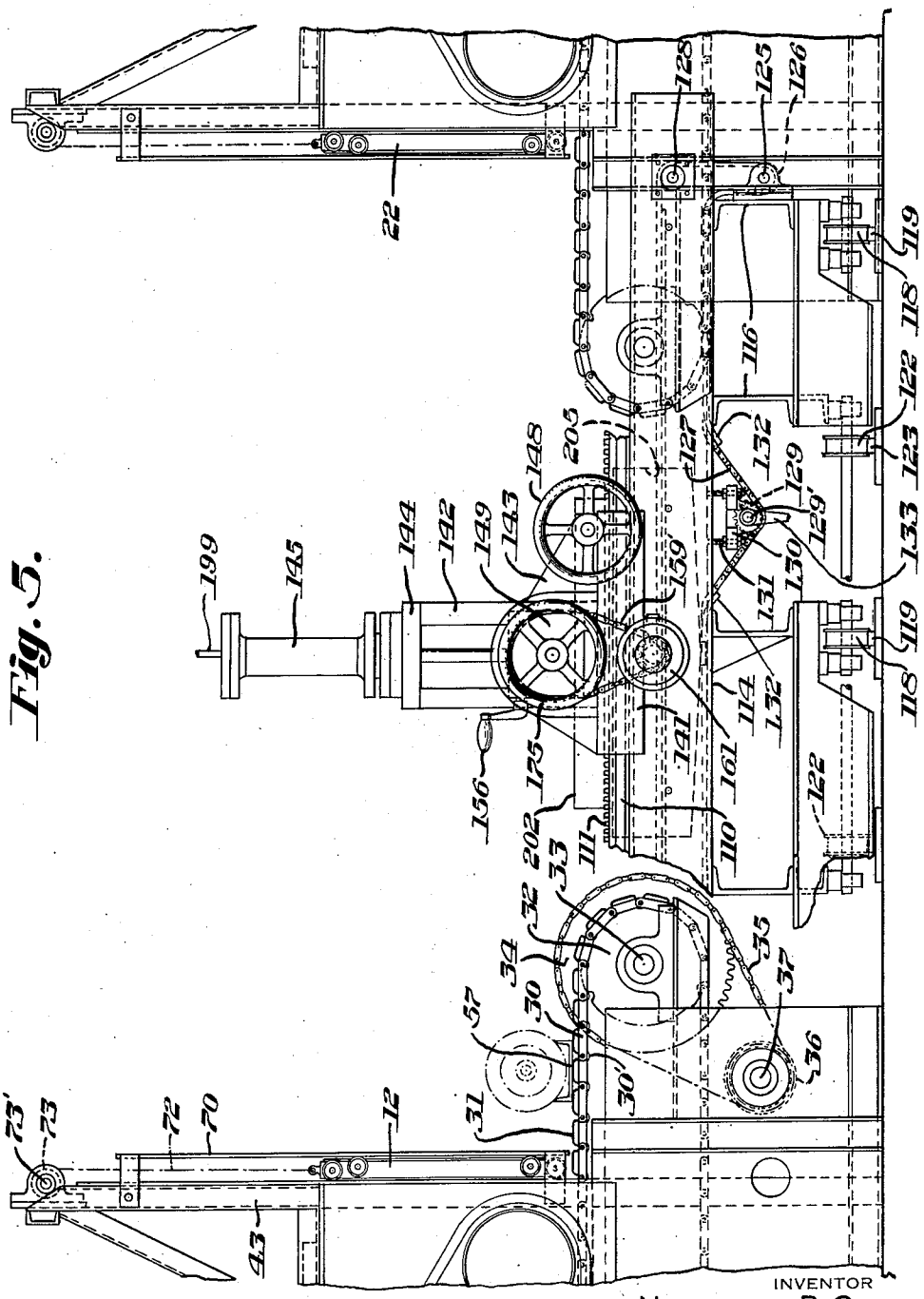
INVENTOR
NATHANIEL B. ORNITZ
by Hooper, Leonard & Glenn
his attorneys

Dec. 9, 1952 N. B. ORNITZ 2,620,769

MEANS FOR HANDLING AND VARNISHING ELECTRICAL WINDINGS

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Fig. 5.



INVENTOR
NATHANIEL B. ORNITZ
by Hooper, Leonard & Glenn
his attorneys

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MEANS FOR HANDLING AND VARNISHING ELECTRICAL WINDINGS

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Fig. 8.

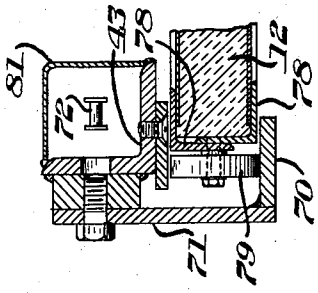


Fig. 16.



Fig. 7.

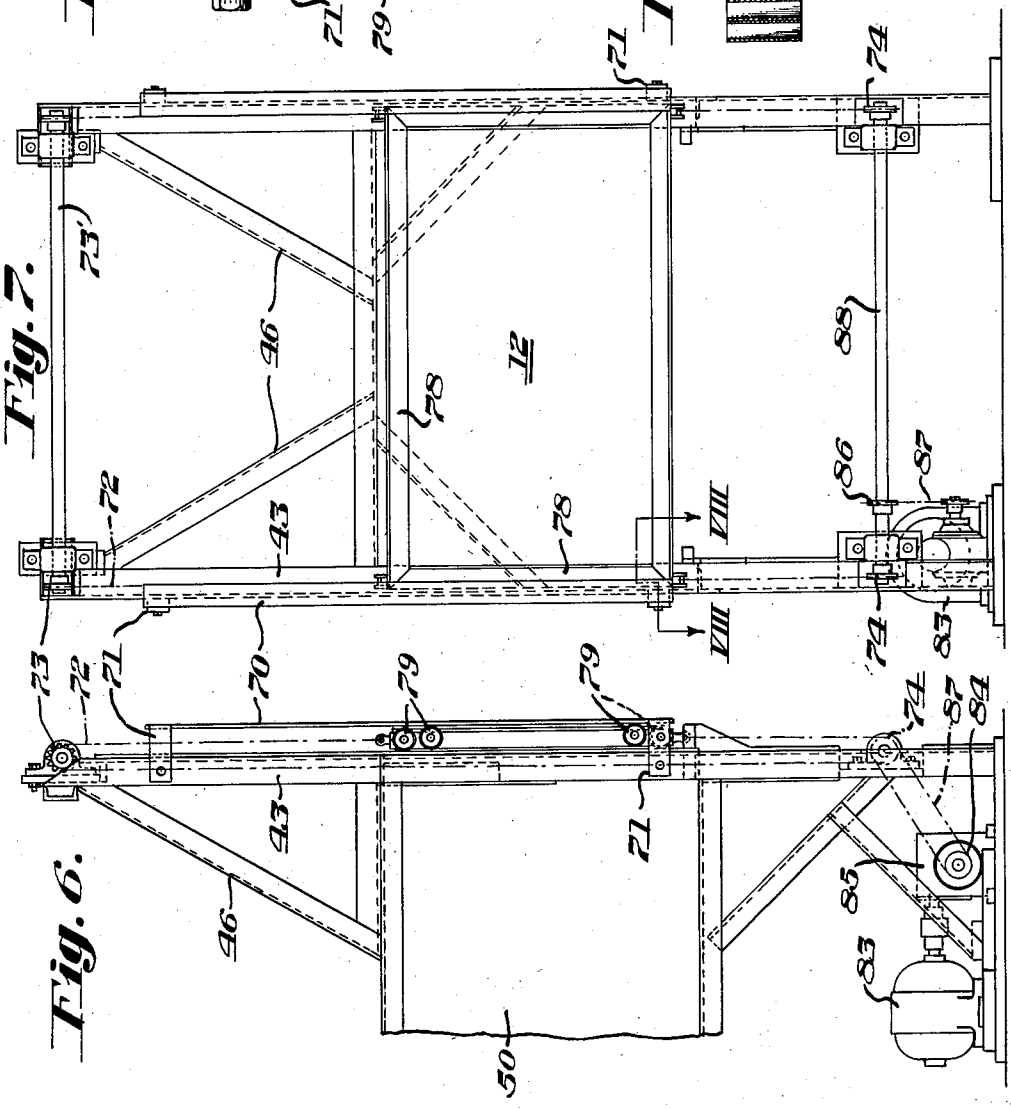


Fig. 6.

INVENTOR
NATHANIEL B. ORNITZ
by Hoopes, Leonard & Glenn
his attorneys

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MEANS FOR HANDLING AND VARNISHING ELECTRICAL WINDINGS

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Fig. 10.

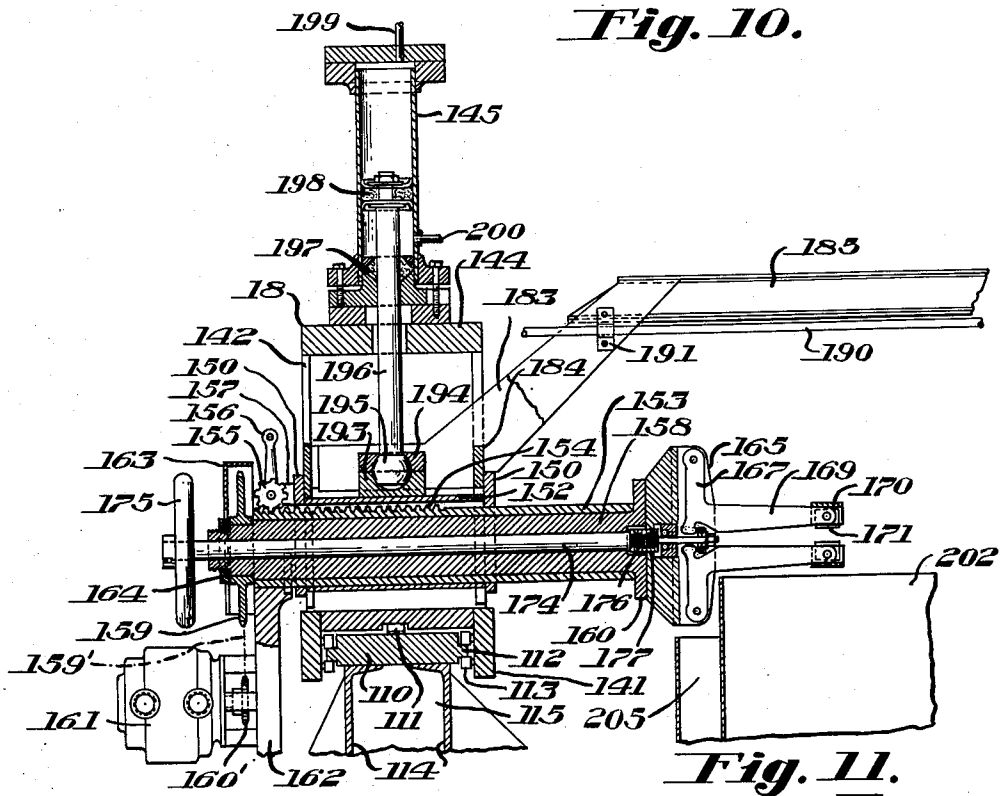


Fig. 11.

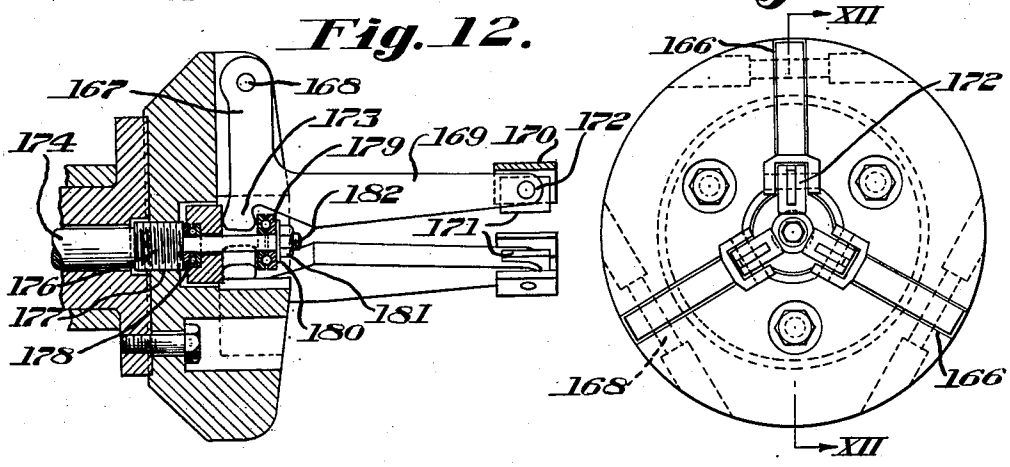


Fig. 12.

INVENTOR
NATHANIEL B. ORNITZ
by Hopper, Leonard & Eleun
his attorneys

Dec. 9, 1952 N. B. ORNITZ 2,620,769

MEANS FOR HANDLING AND VARNISHING ELECTRICAL WINDINGS

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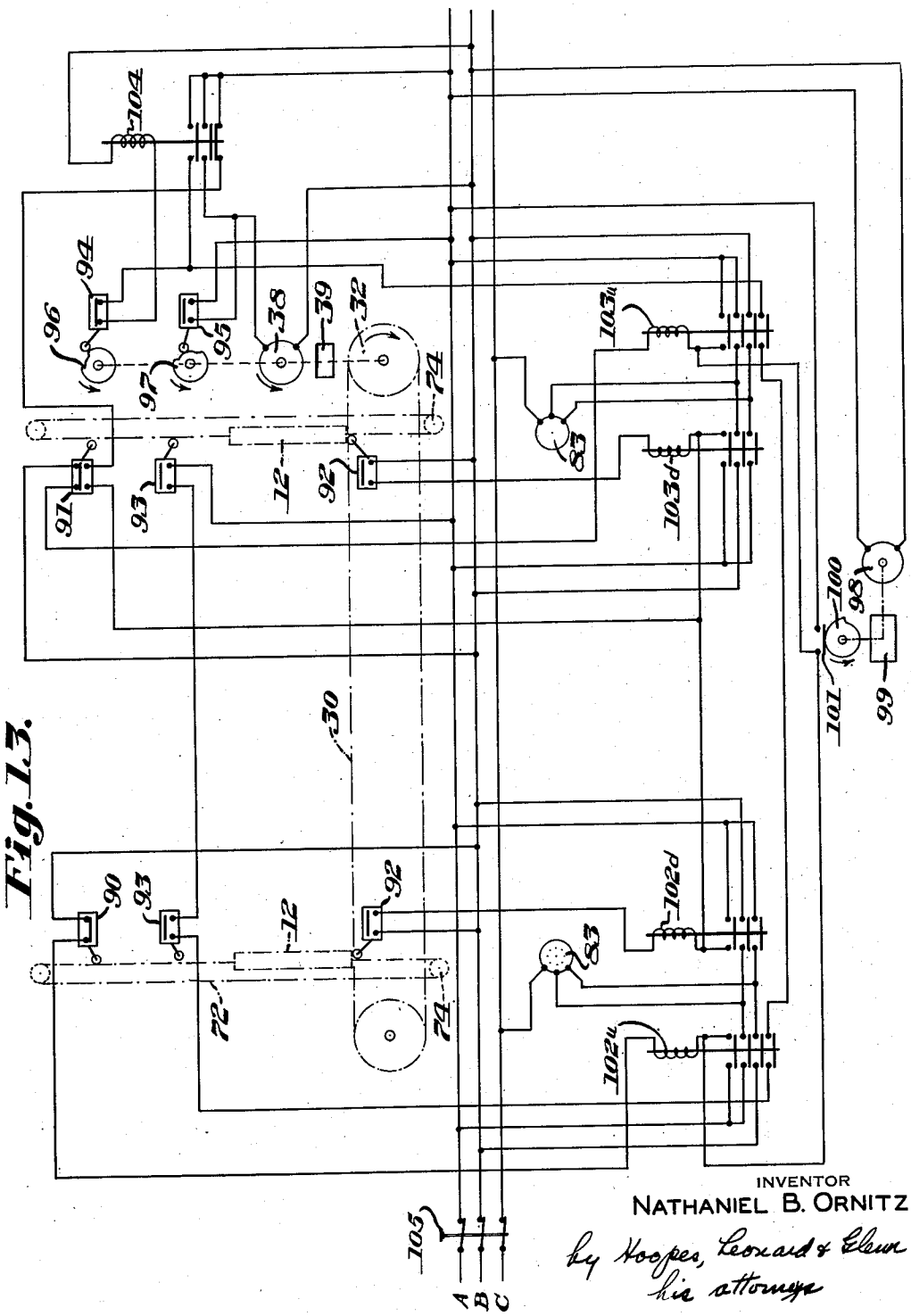


Fig. 13.

INVENTOR
NATHANIEL B. ORNITZ
by Hoopes, Leonard & Elwin
his attorneys

Patented Dec. 9, 1952 2,620,769

UNITED STATES PATENT OFFICE

2,620,769

MEANS FOR HANDLING AND VARNISHING ELECTRICAL WINDINGS

Nathaniel B. Ornitz, Pittsburgh, Pa., assignor to Blaw-Knox Company, Pittsburgh, Pa., a corporation of New Jersey

Application October 30, 1948, Serial No. 57,492

3 Claims. (Cl. 118—423)

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This invention relates to a system for quickly and efficiently carrying out the heating, impregnation and drying of electrical windings. More particularly, this invention pertains to a machine assembly and operational steps for varnishing rotors, stators and the like on a production line basis.

This invention is advantageously employed in carrying out a varnishing process such as that shown in United States Patent No. 2,411,180 or in the United States Patent No. 2,417,538. As used in this specification, the terms "impregnated" and "impregnation" refer to the effects of the immersion in the varnish to which the windings in question are subjected.

In a prior practice of varnishing electrical windings, it was customary first to heat a batch of such windings in an oven in which the atmosphere was heated and circulated in a general fashion. The windings were then removed and immersed in a dip tank containing varnish at a lower temperature with machined faces in some cases protected by plastic coatings to prevent varnish from adhering thereto. In dipping armatures particularly, the winding was usually immersed that radial distance inward from the outer periphery which upon rotation would impregnate the coil portions of the winding without touching parts such as an armature shaft at a greater distance from the periphery. The windings were removed from the dip tank and heated to drive off any remaining volatile material and to dry the varnish base material.

It was observed that such heating was inefficient in transferring heat to the windings, was not controllable with any satisfactory degree of precision, did not result in uniform heating of the entire batch or necessarily of each winding in the batch, and did not raise the windings to the desired temperature in the time which could be allotted in commercial practice to the heating operation. Moreover, if all of the batch were removed from the oven in order to begin heating a new batch, progressive atmospheric cooling occurred as the heated windings awaited their turn at the dipping tank. Even though the temperature and composition of the varnish solution in the dip tank were frequently checked, as cooler and cooler windings in the heated batch were immersed somewhat uneven impregnation would result. As a consequence, a relatively greater amount of varnish base material was required to insure meeting specifications, with greater likelihood of building up a gummy deposit. In addition, there were no fast, accurate handling means, particularly with the heavier pieces, for transferring the windings from the oven or controlling the depth of their immersion with precision.

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The foregoing difficulties and disadvantages inherent in such a prior practice are overcome by the employment of this invention.

Thus, in this invention, the heating and impregnation of electrical windings is carried out on a production line basis by progressively heating them in step-by-step fashion to a predetermined temperature at conveyor stations in an oven provided with cooperating directed blasts or streams of a heated atmosphere which play over the articles at those stations. When uniformly heated, such windings are successively presented to a manipulator station where each is speedily gripped and transported without substantial loss of heat to an adjacent dip tank having a constant level body or pool of varnish therein. This varnish solution is maintained under substantially constant temperature and composition conditions suited to the particular character of impregnation to be performed. There the winding is dipped until all of its desired portions are impregnated. Then it is quickly removed by the manipulator and deposited on a conveyor platform farther along the direction of progression of the articles. The windings are carried forward again on the second conveyor in step-by-step fashion through an oven and dried by similarly directed streams of a heated atmosphere. Means are provided for closing the ovens during the dwell of the conveyors when the windings are on station and for subjecting the windings to heating and dipping in a single synchronized machine assembly until the desired varnishing of the windings has been achieved.

Other objects and advantages of this invention will be apparent from a consideration of the following description and of the drawings, which are illustrative only, in which,

Figure 1 is a view in side elevation of a machine assembly made in accordance with this invention;

Figure 2 is a plan view of the apparatus shown in Figure 1;

Figure 3 is an end view of the apparatus shown in Figure 1;

Figure 4 is a vertical section taken from the exhaust side of one end of an oven and its adjacent manipulator;

Figure 5 is a view in side elevation taken from the pressure side of the adjacent ends with the vestibule casings removed, of two adjacent ovens and the manipulator interposed therebetween;

Figure 6 is a side view of one end of an oven showing the door actuating mechanism;

Figure 7 is an end view of the structure shown in Figure 6;

Figure 8 is a cross-sectional view taken on line VIII—VIII of Figure 7;

Figure 9 is a side view of a manipulator looking toward the end of an adjacent oven;

Figure 10 is a vertical section through the manipulative portion of the manipulator shown in Figure 9;

Figure 11 is an end view of the gripping member assembly of the manipulator;

Figure 12 is a vertical section taken on line XII—XII of Figure 11;

Figure 13 is a schematic wiring diagram for use with the machine assembly shown in Figure 1;

Figure 14 is a view in elevation of a form of nozzle used in ovens made in accordance with this invention;

Figure 15 is a cross-sectional view taken on line XV—XV of Figure 14; and

Figure 16 is a cross-sectional view of another form of nozzle used in this invention as shown in Figure 4.

General construction and operation

In a preferred embodiment of the invention, windings are successively placed on a conveyor 10 at station A. These windings are moved in step-by-step fashion through a tunnel-like passage of an oven 11, stopping in the course of their progression therethrough respectively at stations B to J, inclusive. Doors 12 automatically open before movement of conveyor 10 commences and automatically close when such movement is about arrested so that the windings are in a closed oven while at rest at each station of their progress therein. A heated atmosphere, usually air, is directed laterally across oven 11 in continuous blasts through pressure orifices fitted with suitable nozzles to convey heat primarily to the windings in respective axial alignment with the streams. Exhaust vestibules 14 on the opposite side of oven 11 act to recirculate the heated atmosphere through turboblowers 15 to the oven. In addition, a countercurrent flow of the heated atmosphere passes longitudinally through the oven from the vicinity of station J to the vicinity of station B. The windings are thereby heated to a temperature somewhat higher than the desired predetermined final temperature and initially reach such temperature at an intermediate station such as station H. The continued heating and soaking at stations I and J results in each winding reaching station K in a substantially uniformly heated condition throughout its mass by an efficient use of the heating atmosphere. Furthermore, each winding successively presented at station K is at substantially the same temperature as the preceding winding, regardless of whether it is of a different character or size.

Each winding on station K is picked up by a manipulator 18 which travels on a way 19 and is so arranged that station K projects and overlaps the adjacent end of the path of travel of manipulator 18. The character of manipulator 18 makes it capable of handling stators, armatures and other forms of windings, which after being gripped are transferred to station L and dipped in the constant level constant temperature pool of varnish solution in dip tank 20. The winding is usually lowered with accuracy and sureness to a predetermined radial distance inward from the outer periphery thereof. Then it is rotated and automatically at a preselected rate to evenly immerse all portions of the winding requiring it. Because of the freedom and facility with which the manipulators such as manipulator 18 move and operate, each winding reaching station K or a similar station can be transferred and treated at the next station before there has been any material loss of the heat which it received in the preceding oven. Since the temperature and composition of the contents of the dip tanks are maintained substantially constant, uniform impregnation of the windings results. When this invention is used to apply different varnish, the winding and dip tank temperatures and related factors must be correspondingly altered and correlated.

Upon impregnation of each winding at station L, it is removed and deposited by manipulator 18 at station M on a conveyor 21, freeing manipulator 18 for return to station K to pick up the next succeeding winding as it is presented. Station M on conveyor 21 is also adjacent tank 20 but on the advance side thereof and overlaps the path of travel of manipulator 18. The dwell or rest interval between movements of the conveyors 10 and 21 is preferably of sufficient duration to enable a winding to be taken from station K, treated at station L and deposited at station M and to enable manipulator 18 to be returned to station K just about the time such succeeding winding is there presented. The same relation would also obtain between stations W, X and Y. The movements of all the conveyors and oven doors are coordinated and preferably occur at the same time, although for special purposes it may be desirable to run one conveyor and its related oven doors in predetermined but differing relation to another.

Soon after the winding has been deposited at station M and while manipulator 18 is returning to station K, doors 12 on oven 11 and the doors on the other ovens begin to go up and near the top of their travel the next incremental step of the respective conveyors begins. It ends at the next station or index position of the respective conveyors just about the time the doors are beginning to close. In this way, the windings are progressively and successively moved in a production line from heating zone to heating zone with impregnation between such zones so that the entire benefit of the temperature differentials between windings and varnish bath is preserved.

The drying baking sections comprising conveyors 21 and 24 and ovens 23 and 25, are similar in structure and operation to conveyor 10 and oven 11. Likewise, the manipulator and way serving station X are similar in structure and operation to manipulator 18 and way 19. Each winding progresses therethrough station by station until it arrives at station II, thoroughly and uniformly impregnated, dried and baked, and ready to be removed.

The heated atmosphere is supplied in the preferred embodiment by a central, recirculating heater 27 fired by oil or other fuel, connected to ovens 11, 23 and 25. The ovens thus receive air or other atmosphere suitable to special purposes heated to the same predetermined degree, although it is entirely possible to have a heated atmosphere either of the same or different character and temperature independently supplied to each of the ovens. Moreover, although the ducts from heater 27 provide a longitudinal flow of atmosphere through the ovens counter to the direction of movement of the conveyors, in addition to the cross blasts, separate heaters for each

oven or even for each blower 15 can be arranged to provide the continuous cross blasts only.

Oven and conveying mechanism.

Referring to conveyor 10, it comprises an endless belt 30 of links supported on rollers 30'' and connected to articulated flat arch steel slats 31. A pair of spaced sprockets 32 are rotatably supported by shafts 33 journaled in pillow blocks at each end of a conveyor table 40. These sprockets of which there are two in spaced relation on each shaft 33, engage the journals of rollers 30' at the respective ends thereof. A sprocket wheel 34 is keyed at one end of one of the shafts 33 and is driven by chain 35 and gear 36. Gear 36 is keyed to shaft 37 and receives its motive power from an electric motor 38 through a gear reducer 39. Motor 38 is subject to the control of the limit switches and cams shown in Figure 13 so that each movement of belt 30 is for the preselected linear distance between stations.

Conveyor 10 is supported on table 40 over the top surface 41 of which the belt 30 travels between track angles returning beneath said surface where the returning reach is supported on idler rollers 41'. The sides of table 40 are lagged to the floor by panels 42 to prevent loss of heat. A hand hole 42' therein provides access to each roller 41'. Oven 11 is positioned over table 41, its side extensions 41*a* and belt 30 and covers the greater portion thereof intermediate their extreme ends. This oven comprises a series of heating chambers, each opening into one another in endwise fashion to form a continuous tunnel-like passage, the intermittently moving floor of which is the upper reach of belt 30. These chambers are three in number and respectively include stations B, C and D; stations E, F and G; and stations H, I and J. The structural frame of oven 11 comprises a series of vertical end members 43 and intermediate vertical frame members 44. Horizontal structural members 45 are welded or riveted to members 43 and 44 at suitable intervals along the length of the oven to complete the rectangular structure. Suitably insulated panels 47 close the tops of all of the chambers in oven 11. Insulated panels 50 close the sides of the chambers by being bolted to the vertical frame members. The space between the lower ends of panels 50 and the sides of the upper reach of belt 30 is closed by side extensions 41*a*. Panels 50 also support the casings for pressure vestibules 51 and suction or exhaust vestibules 14 affixed thereto, there being a pair of such vestibules for each chamber in each oven, as shown in Figure 2. The upper end of each vestibule 51 narrows into a duct which is joined with a corresponding opening in a pressure duct 52 leading from the pressure side of a blower 15. Exhaust vestibules 14 are connected to the intake of blowers 15 by ducts 53. These blowers 15 are of standard design and are operated by electric motor 54 acting through gear reducers 55. Through each panel 50 on the pressure or blast side of oven 11 there are a series of three orifices 56. The distance between the centers of the orifices in a single chamber and between the adjacent orifices of adjacent chambers is the same and corresponds to the preselected linear distance which conveyor 10 travels between each rest interval. Hence, by placing an electrical winding with its center above the index position on conveyor 10 at station A in a cradle 57, at each station within oven 11 each winding so placed will be substantially centered relative an orifice 56. Cradles 57 are usually short lengths of channel iron, the flanges of which are sufficiently deep to hold the winding up from the web of the channel so that the heated atmosphere in the ovens will reach substantially the entire winding. They are positioned on the flat bed of conveyor 10 by reference to an index mark made on slats 31 or by experience in accordance with the spacing between the orifices 56.

A laterally directed continuous blast of heated atmosphere is obtained by the use of orifices 56 squarely against and along the axis of the windings during the time particularly that such windings are at the stations within the oven 11. For additional directional restriction of the blast, short "honeycomb" nozzles 58 and lattice nozzles 59 may be used as shown in Figure 4. Nozzles 58 comprise a bundle of axially disposed short lengths of pipe filling some of the orifices 56. In nozzles 59, the vertical louvers in the lattice are deflected slightly toward the center of the oven.

The laterally directed streams of heated atmosphere exhaust through the vestibules 14, whence the mass of atmosphere returns to the blowers 15 for recirculation. There is intermingling of the various streams and any longitudinal current of atmosphere some of which also passes out of oven 11 through exhaust line 17. The panels 50 comprising the inner side of the vestibules 14 have orifices 61 therein, generally corresponding in size and arranged opposite to the orifices 56. If larger exhaust passages are desired, the entire inner side of each vestibule 14 may be opened through its panel 50 into direct communication with the interior of oven 11. The heated atmosphere is preferably heated air which may be humidified, filtered or otherwise treated and which may also be used to carry some protective or beneficial ingredient if desired. Normally, the only air which needs to be added to the recirculating mass will be the make-up due to any air lost each time the doors of the oven are opened and to air bled off to the outside for reasons of safety. Less air will pass out when the oven doors are open if no longitudinal current of air is provided and in some cases partial baffles may be used to minimize any loss. The heater 27 supplies air heated to a predetermined temperature through line 62 and pressure header 63 by principally recirculating air drawn into exhaust header 66 and by circulating any new or make-up air which also generally enters through the oven doors when they are open. Pressure header 63 communicates with the delivery end of the respective ovens through lines 16, 64 and 65, respectively while exhaust header or manifold 66 communicates respectively with the ovens through lines 17, 67 and 68. This effects a countercurrent axial flow of air through the ovens although the headers may be arranged for some purposes to give concurrent axial flow. Any such flow is in addition to the directed cross blasts through the pressure orifices. The axial flow while not necessary in all cases for efficient use of this invention, does provide, particularly with larger electrical windings, a means of overcoming any tendency of the windings to reach a higher temperature on the end or side nearer the pressure vestibules during travel on the conveyors. An exhaust fan 69 connected to header 66 maintains suction for the axial recirculation and for fresh intake.

Spaced outwardly from each of the end vertical structural members 43 and substantially parallel thereto is a strip 70 connected to members 43 by brackets 71. Strips 70 with the respective members 43 form a pair of parallel vertical guide grooves at each end of oven 11 for rollers 79 of doors 12. Each insulated door 12 is hung on two endless chains 72, one at each side of each door, respectively connected to the top and bottom thereof as shown in Figure 6. Each pair of chains 72 is suspended from sprockets 73 supported on shafts 73' journaled in pillow block bearings attached to frame members 43. The lower end of chains 72 passes around sprockets 74 respectively. Hence, rotation of sprockets 73 and 74 in one direction or the other correspondingly raises and lowers the doors 12 to the limits of their movement. The construction and operation of the doors on ovens 23 and 25 are the same.

The four edges of each door 12 are formed from angle bars 78 supporting rollers 79 at the top and bottom of each door on each side for engagement with the aforesaid guide grooves. A metal guard 81 is provided for the rear of members 43 to cover some of the exposed portion of the chains 72. As the doors respectively open and close, rollers 79 also engage the limit switches illustrated in Figure 13.

A brake-type reversing motor 83 when actuated operates a driving gear 84 through a gear reducer 85. Driving gear 84 in turn rotates a driven gear 86 through chain 87 thereby turning shaft 88 and sprockets 74 to raise or lower the doors 12 automatically and in synchronism with conveyor 10, and with the operations and movements of the remaining sections of the assembly.

Electrical circuit diagram

A suitable electrical circuit for the operation of a machine made in accordance with this invention is illustrated in Figure 13. Modifications of this circuit are matters within the skill of the electrical art and may include control buttons to prepare the circuit and to stop all movement of the doors or conveyor in any or all of the ovens at the behest of any attendant at any position along the machine. In addition, in normal operation all of the ovens and conveyors in a single assembly will be interlocked and function at the same time and in the same manner, or in such relative and sequential operation as may be preselected.

In Figure 13 doors such as doors 12 of the preheating oven 11 shown in Figure 1 with its conveyor 30, are shown in outline. Essentially, substantially constant speed motor 98 actuates a constant speed timing cam 100 through a suitable transmission 99 to periodically and momentarily close a starting switch 101. Thereupon relay contactors 102*u* and 103*u* are energized closing the four sets of terminals shown for each. These contactors are sealed in respectively through normally closed limit switches 90 and 91. Limit switch 91 has a lower set of terminals which are normally open. The two intermediate sets of terminals of each contactor close the circuit to the brake-type reversing motors 83 operating on the 3-phase current from lines A, B and C. These motors operate the respective pairs of sprockets 74 in the direction which will raise doors 12. As soon as doors 12 begin to go up limit switches 92 return to their normally closed position.

Just before doors 12 reach the upper limit of their travel, they respectively strike limit switches 93 which are normally open and in series. Immediately a circuit is set up through the lowermost pair of terminals of relay contactors 102*u* and 103*u*, normally closed limit switch 94 and relay contactor 104. The energization of relay contactor 104 starts the single phase motor 38 which drives conveyor belt 30 through gear reducer 39 and sprockets 32. Motor 38 is then sealed in through limit switch 95 which was open when conveyor 30 was at index or rest position but which limit switch presently closes when it engages the cam rise of cam 97. A second cam 96 operates on the same shaft as cam 97 and has a dropped or dwell cam portion slightly in advance of the dropped or dwell cam portion of cam 97. These cams are rotated at a preselected and integrated rate of rotation by motor 38 through a suitable transmission. The same results may be obtained by using laterally extending overlapping shoes on the conveyor instead of cams to actuate limit switches 94 and 95.

The continued raising of doors 12 causes them to strike limit switches 90 and 91 soon after the engagement with limit switches 93, breaking the normally closed circuits through limit switches 90 and 91 and deenergizing relay contactors 102*u* and 103*u*, stopping both motors 83. Motor 38 continues to operate meanwhile until the predetermined length of travel of conveyor 30 to its next station or indexed portion is completed.

Just before the completion of travel of conveyor 30 in each of its incremental movements, limit switch 94 is opened by cam 96 and thus deenergizes the coil in relay contactor 104 causing it to drop breaking the upper two sets of contacts and remaking the lowermost. The making of the lowermost contact of relay contactor 104 energizes a circuit from line A through the lower set of poles of limit switch 91 made when the adjacent door 12 reached its upper limit, to the coils of relay contactors 102*d* and 103*d* severally connected through limit switches 92 which are normally closed, to line B. The energizing of contactors 102*d* and 103*d*, which are sealed in through the uppermost pair of contacts, restarts motors 83 in the opposite direction to lower doors 12. About that time, limit switch 95 is opened by cam 97 stopping motor 38 and conveyor 30.

As doors 12 reach their bottom limit of movement they strike and open limit switches 92, thereby deenergizing relay contactors 102*d* and 103*d* and stopping motors 83. This cycle is periodically repeated due to the continuing rotation of timing cam 100. The use of additional such timing cams on the same shaft with cam 100 or on separate shafts synchronized with cam 100 will provide for identical movement or such other synchronized relation among all the ovens and conveyors in the machine of this invention as may be desired. Other circuit arrangements adapted for elective interlocking or individual control of the respective ovens and conveyors may readily be included. An emergency switch 105, of which there may be one or more at each end of each oven as well as on a central or remote panel is provided to stop all movements at any stage in case of need.

Transfer and dipping mechanism

The transfer and dipping mechanism comprises the manipulators and ways such as manipulator 18 operable on its way or track 19 in combination with the ovens 11 and 23 to successively pick up and dip electrical windings from oven 11 before

there has been any time for them to lose any substantial portion of their heat, and then to deposit them on conveyor 21 successively without any further substantial loss of heat due to atmospheric cooling after removal from the varnish solution in dip tank 20. Because of the doors 12 and 22 adjacent track 19, the material from tank 20 which volatilizes escapes overhead and does not result in any material mixing with the heated atmospheres in the associated ovens. A hood can be placed over the manipulators and their tracks between the associated ovens to collect and exhaust such volatile vapors.

Way 19 comprises a horizontal slab 110 to one side and parallel to the axis of movement of conveyors 10 and 21, having a rack 111 supported along the upper longitudinal median line thereof. Laterally extending flanges 112 are integral with slab 110 and engage the rollers 113 to support manipulator 18 as it moves back and forth on track 19. Slab 110 in turn is supported on and affixed to channel beams 114 forming a hollow beam having a central longitudinal passage 115. Beams 114 are welded or bolted to laterally extending girders 116. These girders in turn are fastened to base plates 117 mounted on grooved rollers 118 which roll on track sections 119. Stops 120 limit the lateral movement of rollers 118 and consequently of manipulator 18 and its track 19.

Lateral girders 116 are spaced to span dip tank 20 and its attendant equipment. Support is afforded the girders 116 at the rear ends thereof by plates 121 mounted on grooved rollers 122 which roll on track sections 123.

The two outermost girders 116 have bearings 124 thereon rotatably supporting a threaded shaft 125. One end of each shaft 125 carries a sprocket 126 keyed thereto. An endless sprocket chain 127 engages other sprockets 126 journaled on stub shafts 128 in passage 115 in such fashion that almost all of chain 127 is within the passage. Intermediate the innermost girders 116 the lower flanges of channels 114 are separated sufficiently to permit chain 127 to engage a sprocket gear 129 keyed to shaft 129' which is journaled in bearing 130. Bearing 130 is adjustably affixed to the underside of channels 114 by threaded studs 131. By adjustment of bearing 130, chain 127 can be kept taut. Slide plates 132 with suitably depressed ends supportably guide the lower half of chain 127 during movement thereof. The forward end of shaft 129' is machine finished in a conventional polygonal form for engagement with a corresponding opening in the end of turning handle 133.

A threaded follower 134 engages the threads of each shaft 125. Since follower 134 is bolted to an upstanding bracket 135 fastened to the floor, movement of handle 133 results in the transverse movement of girders 116, manipulator 18 and track 19 in a direction depending upon the direction of rotation of handle 133. In this way, the machine of this invention is able to handle a greater diversity of sizes and types of electrical windings including stators with hollow centers and armatures having both symmetrical and asymmetrical shafts. Thus in Figure 9, manipulator 18 is gripping a large armature 136 shown in chainline outline. In the usual handling of various stators, the manipulator would have sufficient scope if its vertical center line coincided with position B'.

Manipulator 18 has a base plate or carriage 140 with depending flanges 141 which overlie flanges 112 of slab 110. Rollers 113 are rotatably supported on stud shafts affixed to the inside of flanges 141 in and closely engage the upper and lower horizontal surfaces of flanges 112 to provide substantially free rolling relation between manipulator 18 and its track 19. The construction and operation of the manipulator and way at station X are identical to manipulator 18 and way 19.

Two spaced vertical ways 142 are affixed to carriage 140 and receive added rigidity from bracket members 143. Ways 142 are capped by a plate 144 which in turn supports a double-acting hydraulic cylinder 145.

A pinion gear 146 is keyed to a shaft 147 journaled in brackets 143 and rotated by a hand wheel 148. Pinion gear 146 engages rack 111 so that the turning of hand wheel 148 moves carriage 140 along track 19 in the one direction or the other.

A crosshead 149 engages and is adapted to move vertically in the vertical ways 142. This crosshead comprises outer flanges 150 having stepped back sides to slidably engage the inner edges of the ways 142 and a barrel 152. A mandrel shaft 153 is in turn slidably but not rotatably supported in barrel 152 for movement transverse to the direction of movement of the conveyors. Along the top of shaft 153 at the front thereof a rack 154 is mounted and projects into a corresponding recess in the uppermost portion of barrel 152. Rack 154 is engaged by a pinion gear 155 turned by a handle 156 supported on a bracket 157 affixed to crosshead 149. When handle 156 is turned, shaft 153 moves through crosshead 149 transversely of track 19.

Shaft 153 has a hollow bore and rotatably supports therein a cylindrical spindle 158. The material and machining of the bore through shaft 153 and of the exterior of spindle 158 is such as to provide easy operation. A sprocket gear 159 is keyed to the front end of spindle 158, the hub of which gear with flange 160 at the rear of spindle 158 causes the spindle to follow any transverse movement of shaft 153. Sprocket 159 is actuated by chain 159' through a driving gear sprocket 160' affixed to the shaft of an hydraulic motor 161. This motor is mounted on a depending apron 162 carried by the front of shaft 153. A metal protecting guard 163 encloses the upper portion of sprocket 159. Sprocket 159 is held against spindle 158 by a nut 164.

A chuck 165 is bolted to flange 160 at the rear end of spindle 158 and is rotatable therewith. The rearward face of chuck 165 has slotted recesses 166 in which gripping members 167 in the form of bent levers are pivoted on bearings 168. Levers 167 have outwardly extending arms 169, the tips of which carry friction plates 170 for gripping action upon outward movement of the arms and friction plates 171 upon inward movement of the arms toward the axis of chuck 165. These friction plates are made of brass or of strong non-metallic, non-marking material. They are pivoted to the forked ends 172 of arms 169 as shown in Figures 11 and 12. Intermediate the ends of levers 167 are projections 173 by means of which arms 169 are jointly given their synchronized inward or outward gripping movement.

A shaft 174 extends through a bore along the axis of spindle 158 and terminates at the front end thereof in a hand wheel 175. The rear end 176 of shaft 174 is slightly enlarged and is threaded for engagement with a tapped opening 177 in chuck 165. Thrust bearings 178 and 179 bear against the respective sides of projections

173. The other side of bearings 178 is abutted by an enlarged end 176 of shaft 174. Bearing 179 is held by a washer 180 and nut 181 on the threaded end of a stud 182 screwed into end 176 of shaft 174. Hence, when hand wheel 175 is turned, shaft 174 and stud 182 moving together either close arms 169 by moving forwardly or spread arms 169 by moving rearwardly. The threaded portion 176 on shaft 174 is of sufficient length to allow for adequate movement of arms 169 for the variety of work to be done.

Between the vertical ways 142 there is a bifurcated cantilever support 183 which has integral bent portions 184 thereon bolted to flanges 150 of crosshead 149. The outermost end of the support 183 meets and is joined to an I-beam type of trolley rail 185, extending horizontally and rearwardly of the machine transverse to the track 19. A closed loop sling 186 in turn is supported by rigid straps 187 depending from the shafts of rollers 188 respectively engaging the lower flanges of beam 185. The lower end of the trolley sling 186 is recessed to accommodate two oppositely disposed and closely positioned supporting rollers 189 which rotatably support any member, such as an armature shaft as shown in Figure 9. A rod 190 is hooked at its rearward end to sling 186 and is slidably guided by strap 191 so that upon pulling forward end 192 thereof, trolley sling 186 is positioned to accommodate varying types and sizes of windings. When processing conventional stators, sling 186 is pushed to its rearmost position and is not used.

A lower ball socket block 193 is fastened to the top surface of barrel 152. An upper block 194 is bolted to block 193 after being assembled with the ball bearing 195 integral with the lower end of a piston rod 196. Piston rod 196 passes through an opening plate 144 and through a suitable packing gland 197 at the lower end of cylinder 145, terminating in piston 198. Ports 199 and 200 are provided in cylinder 145 on opposite sides of piston 198 to lower crosshead 149 and attendant parts when hydraulic fluid enters through port 199 and to raise them when hydraulic fluid enters ports 200. A conventional manually operated hydraulic valve connected by flexible hosing controls admission to and exhaust from each of the ports and secures a steady and accurate elevation or lowering of arms 169 to that vertical position in which crosshead 149 is to be held by setting the said hydraulic valve. A conventional hydraulic valve is also used for starting, operating and shutting off hydraulic motor 161 to which it is connected by flexible hose.

Dip tank 20 is supported on the floor on legs 201. Varnish fills tank 20 and preferably is held at constant level and substantially at constant temperature and of constant composition. By controlling the rate of recirculation of varnish solution from a storage tank 203 by means of a pump 204, some varnish in tank 20 will overflow into basin 205 whence it returns through line 206 to storage tank 203. Such overflow maintains a constant level. The solution in tank 203 is cooled by cold water cooling coils to the predetermined temperature it should have before being returned to tank 20 through line 207. The tank assembly at station X is the same as that at station L which has just been described.

Because of the three dimensional translatory movement available to arms 169 because of their mounting in manipulator 18, a wide range of different sizes and types of electrical windings can readily be handled and accurately dipped to any chosen radial distances extending inwardly toward their centers and for preselected periods at chosen rates of rotation. Upon completion of the rotation necessary to impregnate all parts of the winding held by arms 169 at the time being, crosshead 149 is raised, hand wheel 148 is actuated to advance the winding to the next station, station M, handle 156 is turned to effect transverse movement of the winding until properly positioned over a cradle, crosshead 149 is lowered to deposit the winding on the cradle, and hand wheel 175 is turned to disengage levers 169. Rotation of handle 156 then withdraws the mandrel and gripping members from the vicinity of the winding so that the manipulator can be returned immediately to station K to be ready when the next winding comes out of oven 11. In one operation of a machine made in accordance with this invention armatures and stators for unit horsepower motors are heated and varnished.

Operation of an illustrative embodiment

In one embodiment, which is mentioned soley for purposes of illustration and without the scope of the invention being limited thereto, the machine is built for a linear travel of the conveyors in each incremental step of about 20'', at a rate of speed of about 30' per minute. The dwell or rest interval between each such movement is three minutes so that a winding is in each oven about 27 minutes. All ovens and conveyors in the machine operate in unison.

Heated air is passed through the pressure orifices at a linear velocity of approximately 3600 feet per minute and no forced axial flow of air is used. This air is heated to about 1000 degrees F. independently in this case by electrical means connected to each of the chambers. All ovens, conveyors and air circulation equipment are lagged to prevent loss of heat.

By the seventh station, coresponding to station H in oven 11, the windings initially reach a temperature of about 340 degrees F. and at station K they optimally have a temperature throughout of about 320 degrees F. A loss of about 30 degrees F occurs as a consequence of the immersion in the dip tank 20 from whence the winding is quickly transferred to and put on the next conveyor for progression through the drying and subsequent sections.

In the dip tank the varnish is held substantially to a constant composition and at a constant temperature of about 100 degrees F. in this illustration. Other types of varnish and compositions would require corresponding adjustments in the temperature and composition relations between the varnish and the temperature of the windings presented thereto. The windings as a consequence are efficiently and uniformly preheated, impregnated and dried resulting in a completely standardized specification product.

Although a preferred embodiment and practice of the invention have been described, it will be recognized that modifications thereof may be made within the scope of the appended claims.

I claim:

1. Apparatus for preparing electrical windings for varnishing, comprising in combination, an endless belt flat bed conveyor, a drive for moving said conveyor in one direction in step by step fashion, an oven having a passage therethrough, said conveyor substantially constituting a moving floor for said oven, doors at the ends of said oven, synchronizing means for opening and closing said

doors and moving said conveyor while said doors are substantially open, laterally directed interior orifices along at least one side of said oven, said orifices being spaced apart substantially the same distance that said conveyor advances at each step, blower means for supplying heated air to said orifices, and means for heating said air to a predetermined temperature, whereby heated windings ready for further handling are successively presented at a substantially uniform temperature and condition by said conveyor.

2. Apparatus for preparing electrical windings for varnishing, comprising in combination, a flat bed conveyor, a drive for moving said conveyor in one direction in step by step fashion, said steps being of equal length with equal time intervals between successive steps, an oven having a passage therethrough, said conveyor substantially constituting a moving floor for said oven and extending beyond the ends thereof, doors at the ends of said oven, synchronizing means for opening and closing said doors and substantially completing the movement of said conveyor while said doors are open, laterally directed interior orifices along at least one side of said oven, said orifices being spaced apart in a direction parallel to said conveyor substantially the same distance that said conveyor advances at each step, nozzles associated with said orifices for increasing the lateral direction thereof, means for supplying air to said orifices at a predetermined temperature and velocity, inlet and outlet ducts adjacent opposite ends of said oven, and means for circulating heated air through said ducts, whereby windings are successively and uniformly heated to a predetermined temperature by lateral and axial convection and then successively presented by said conveyor for further handling.

3. Apparatus for transporting and impregnating heated electrical windings with varnish, comprising in combination, a manipulator for handling said windings, a track on which said manipulator travels in rolling engagement, rack and pinion means for moving said manipulator along said track, a crosshead on said manipulator, an hydraulic cylinder to raise and lower said crosshead, a mandrel shaft carried in a bore in said crosshead in slidable engagement therewith and substantially transverse to said track, a spindle journaled in said shaft in rotatable engagement therewith, a chuck rigidly connected to the rearward end of said spindle, gripping members pivotally connected to said chuck and adapted to be jointly operated for gripping action by movement respectively toward and away from the axis of said spindle, means for rotating said spindle, and a dip tank adjacent said track within reach of said gripping members, whereby heated windings of different sizes and configurations positioned laterally of said track at one end may be picked up by said manipulator and transported to a dip tank for immersion to a predetermined radial distance from their outer periphery, rotated while so immersed and removed without substantial loss of heat due to atmospheric cooling.

NATHANIEL B. ORNITZ.

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